

Public Health Assessment for

SDMS Document



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ISLAND CHEMICAL CORPORATION/
VIRGIN ISLAND CHEMICAL CORPORATION
CHRISTIANSTED, ST. CROIX, U.S. VIRGIN ISLANDS
CERCLIS NO. VID980651095
MAY 19, 1998

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
Agency for Toxic Substances and Disease Registry



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PUBLIC HEALTH ASSESSMENT

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Prepared by:

Superfund Site Assessment Branch
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

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THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment was prepared by ATSDR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) section 104 (i)(6) (42 U.S.C. 9604 (i)(6)), and in accordance with our implementing regulations (42 C.F.R. Part 90). In preparing this document, ATSDR has collected relevant health data, environmental data, and community health concerns from the Environmental Protection Agency (EPA), state and local health and environmental agencies, the community, and potentially responsible parties, where appropriate.

In addition, this document has previously been provided to EPA and the affected states in an initial release, as required by CERCLA section 104 (i)(6)(H) for their information and review. The revised document was released for a 30-day public comment period. Subsequent to the public comment period, ATSDR addressed all public comments and revised or appended the document as appropriate. The public health assessment has now been reissued. This concludes the public health assessment process for this site, unless additional information is obtained by ATSDR which, in the agency's opinion, indicates a need to revise or append the conclusions previously issued.

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FOREWORD

The Agency for Toxic Substances and Disease Registry, ATSDR, was established by Congress in 1980 under the Comprehensive Environmental Response, Compensation, and Liability Act, also known as the *Superfund law*. This law set up a fund to identify and clean our country's hazardous waste sites. The Environmental Protection Agency, EPA, and the individual states regulate the investigation and clean up of the sites.

Since 1986, ATSDR has been required by law to conduct a public health assessment at each of the sites on the EPA National Priorities List. The aim of these evaluations is to find out if people are being exposed to hazardous substances and, if so, whether that exposure is harmful and should be stopped or reduced. If appropriate, ATSDR also conducts public health assessments when petitioned by concerned individuals. Public health assessments are carried out by environmental and health scientists from ATSDR and from the states with which ATSDR has cooperative agreements.

Exposure: As the first step in the evaluation, ATSDR scientists review environmental data to see how much contamination is at a site, where it is, and how people might come into contact with it. Generally, ATSDR does not collect its own environmental sampling data but reviews information provided by EPA, other government agencies, businesses, and the public. When there is not enough environmental information available, the report will indicate what further sampling data is needed.

The DHAC Child Health Section Workgroup recommends that the Health Effects and Conclusions sections of the standard PHA Foreword be modified to the following:

Health Effects: If the review of the environmental data shows that people have or could come into contact with hazardous substances, ATSDR scientists evaluate whether or not these contacts may result in harmful effects. ATSDR recognizes that children, because of their play activities and their growing bodies, may be more vulnerable to these effects. As a policy, unless data are available to suggest otherwise, ATSDR considers children to be more sensitive and vulnerable to hazardous substances. Thus, the health impact to the children is considered first when evaluating the health threat to a community. The health impacts to other high risk groups within the community (such as the elderly, chronically ill, and people engaging in high risk practices) also receive special attention during the evaluation.

ATSDR uses existing scientific information, which can include the results of medical, toxicologic and epidemiologic studies and the data collected in disease registries, to determine the health effects that may result from exposures. The science of environmental health is still developing, and sometimes scientific information on the health effects of certain substances is not available. When this is so, the report will suggest what further public health actions are needed.

Conclusions: The report presents conclusions about the public health threat, if any, posed by a site. When health threats have been determined for high risk groups (such as children, elderly, chronically ill, and people engaging in high risk practices), they will be summarized in the conclusion section of the report. Ways to stop or reduce exposure will then be recommended in the public health action plan

ATSDR is primarily an advisory agency, so usually these reports identify what actions are appropriate to be undertaken by EPA, other responsible parties, or the research or education divisions of ATSDR. However, if there is an urgent health threat, ATSDR can issue a public health advisory warning people of the danger. ATSDR can also authorize health education or pilot studies of health effects, full-scale epidemiology studies, disease registries, surveillance studies or research on specific hazardous substances.

Interactive Process: The health assessment is an interactive process. ATSDR solicits and evaluates information from numerous city, state and federal agencies, the companies responsible for cleaning up the site, and the community. It then shares its conclusions with them. Agencies are asked to respond to an early version of the report to make sure that the data they have provided is accurate and current. When informed of ATSDR's conclusions and recommendations, sometimes the agencies will begin to act on them before the final release of the report.

Community: ATSDR also needs to learn what people in the area know about the site and what concerns they may have about its impact on their health. Consequently, throughout the evaluation process, ATSDR actively gathers information and comments from the people who live or work near a site, including residents of the area, civic leaders, health professionals and community groups. To ensure that the report responds to the community's health concerns, an early version is also distributed to the public for their comments. All the comments received from the public are responded to in the final version of the report.

Comments: If, after reading this report, you have questions or comments, we encourage you to send them to us.

Letters should be addressed as follows:

Attention: Chief, Program Evaluation, Records, and Information Services Branch, Agency for Toxic Substances and Disease Registry, 1600 Clifton Road (E-56), Atlanta, GA 30333.

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SUMMARY

The Island Chemical/Virgin Island Chemical site is an inactive facility in the south central portion of St. Croix, U.S. Virgin Islands. The site, which covers about 3 acres, is located about 1,500 feet north of the Alexander Hamilton Airport. The site was used from the early 1970s to the mid 1980s by several chemical companies for the manufacture of pharmaceuticals, primarily phenacetin, ethoxyquin, and quinidine, and other chemicals, such as benzyl acetate and benzyl salicylate. In the late 1980s, a portion of the site was used for an alcohol (ethanol) dehydration project. Currently, the site is unoccupied and in a state of disrepair.

The site is bordered on the north and east by an intermittent stream known as River Gut; on the west by an undeveloped lot; and on the south and southwest by Route 66. A concrete batch plant, an asphalt paving company, and two automobile repair shops are located east of the site, across River Gut.

Historical operations at the site resulted in contamination by various organic compounds, including chloroform, pyridine, quinidine gluconate, quinine sulfate, and toluene in the following areas of the site: 1) soil between above-ground storage tanks (ASTs) #8 and #9; 2) water and sludge in the process pit and associated sludge in the drainage line from the process pit; 3) soil under the concrete loading dock and in a trench next to the loading dock which had been contaminated by leakage/drainage from the former lab pit; and 4) soil under concrete slab #3 near the ASTs. Most of the contaminated materials in these areas have since been either removed or remediated. However, organic contaminants, primarily chloroform, from past site operations are present in groundwater at the site and in nearby public supply wells, including the Virgin Islands Water and Power Authority (VIWAPA) Fairplains wells and the Virgin Islands Port Authority (VIPA) airport wells. In addition, volatile organic compounds (VOCs), including ethylbenzene and xylenes, are present at significant levels in subsurface soil and groundwater in the AST area.

ATSDR has classified the Island Chemical/Virgin Island Chemical site a **no apparent public health hazard** because available environmental sampling data do not indicate that people have been exposed to site contamination at levels that would be expected to cause adverse health effects. Nevertheless, ATSDR believes the site's numerous physical hazards, including miscellaneous debris (e.g., old pipes, pieces of metal, old plant equipment, junk cars, old tires, nails, old lockers, old lab equipment); dilapidated and deteriorating buildings and storage tanks; and unsecured outside stairways could pose a minor safety threat to site trespassers.

ATSDR has identified two completed human exposure pathways associated with contamination from the site: 1) users of the municipal water supply who were likely exposed to low levels of contaminants, such as chloroform, lead, and mercury, in their residential drinking water, and 2) workers and visitors at the Alexander Hamilton Airport who were likely exposed to low levels of contaminants, including bromoform, bromodichloromethane, chloroform, chlorodibromomethane, aluminum, iron, lead, mercury, and vanadium, in the airport's drinking water. These past exposures are no longer occurring because the municipal and

airport wells that were impacted by contamination are no longer in use. In addition, some of the contaminants detected in the municipal and airport water supplies may not be directly related to contamination at the site. ATSDR's toxicological evaluation indicates that no adverse health effects, either carcinogenic or noncarcinogenic, will result from past exposures to contaminants in the municipal and airport drinking water supplies.

ATSDR has also identified the following potential human exposure pathways: 1) residents in the site area who use private well water for their household water needs (e.g., drinking, bathing, showering); 2) former plant employees, site investigators, and trespassers who may have come into contact with chemicals in raw materials, finished products, and wastes associated with former site operations, or contaminated soils and sediments resulting from former site operations; and 3) persons who may have come into contact with surface water (while the plant was in operation) or sediments in the River Gut stream channel downstream of the site. ATSDR believes that the public health significance of these potential exposures is likely to be minimal; however, additional information regarding the use and quality of private well water in the site area is necessary to fully evaluate this potential exposure pathway.

No community health concerns about the Island Chemical/Virgin Island Chemical site have been expressed by the citizens of St. Croix.

Health outcome data for the population surrounding the site was not identified during the gathering of information and data for this public health.

Data inadequacies include 1) limited sampling data for the VIWAPA Fairplains wells and the VIPA airport supply wells; 2) no sampling data for other VIWAPA wells near the site, such as the Bethlehem, Negro Bay, Golden Grove wells; and 3) no sampling data or water use information for private wells in the site area.

ATSDR has determined that no follow-up health activities are indicated for the site at this time. However, ATSDR will reevaluate the site for appropriate follow-up health activities if future data or information indicates that human exposure to site contaminants is occurring at levels of public health concern.

BACKGROUND

The Agency for Toxic Substances and Disease Registry (ATSDR), whose headquarters are in Atlanta, Georgia, is a federal agency within the U.S. Department of Health and Human Services and is authorized by the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) to conduct public health assessments of hazardous waste sites. As part of that mandate, ATSDR has evaluated the public health significance of the Island Chemical/Virgin Island Chemical site (e.g., Are health effects possible?) and has recommended actions to reduce or prevent possible health effects.

A. Site Description and History

The Island Chemical/Virgin Island Chemical site is an inactive facility on Route 66 (Melvin Evans Highway) in the south central portion of St. Croix, U.S. Virgin Islands (Figure 1). The site, which covers about 3 acres, is located about 1,500 feet north of the Alexander Hamilton Airport. The site was used from the early 1970s to the mid 1980s by several chemical companies for the manufacture of pharmaceuticals, primarily phenacetin, ethoxyquin, and quinidine, and other chemicals, such as benzyl acetate and benzyl salicylate. The site is bordered on the north and east by an intermittent stream known as River Gut, on the west by an undeveloped lot, and on the south and southwest by Route 66. A concrete batch plant, an asphalt paving company, and two automobile repair shops are located east of the site, across River Gut (1,2,3). The location of these and other facilities within a quarter mile of the site is shown in Figure 2 (3).

The site property is owned by the Charles H. Steffey Holding Corporation (CHS) (4). In May 1969, CHS leased the site to Houston Chemical Industries, Inc. (Houston) on a 30-year lease. In March 1972, Houston assigned the lease to Caribe Chemical Company, Inc, which was subsequently known as Pierrel America, Inc. Houston and Caribe reportedly used the facility to produce phenacetin and ethoxyquin. In June 1978, Pierrel America assigned the lease to Cooper Laboratories, Inc. (Cooper). In July 1978, Cooper incorporated Island Chemical Company as its subsidiary to assume production activities at the facility. Cooper used the facility to convert quinine to quinidine using toluene and pyridine. In November 1979, Cooper Laboratories sold all of its stock in Island Chemical Company to Berlex Laboratories, Inc. (Berlex). Berlex, operating under the name Island Chemical Company, produced quinidine gluconate from quinine sulfate, toluene, and methanol. In October 1982, Berlex shut down the Island Chemical operations, and between November 1982 and February 1983, removed several thousand gallons of toluene and xylenes from the facility's above ground storage tanks (ASTs) for off-site disposal. In September 1984, Berlex sold its Island Chemical Company assets to Virgin Island Chemical Company (VI Chemical). VI Chemical operated the plant until late 1985, initially producing benzyl acetate from benzyl chloride and acetic acid and later producing benzyl salicylate (1,2,3,5,6).

In 1984, U.S. Resources and Chemicals, Inc. began leasing a portion of the property from VI Chemical, and shortly thereafter began an alcohol dehydration operation at the site. U.S. Resource transferred the lease and ownership of the alcohol dehydration equipment to VIAG Fuels, Inc. By early 1991, the alcohol dehydration operation was no longer active although several of the facility's ASTs were still being used to store ethanol. VIAG later removed the ethanol and the alcohol dehydration equipment from the site. Currently, the site is unoccupied and in a state of disrepair (2,4,7).

In 1984, in conjunction with the sale of assets of Island Chemical Company to Virgin Island Chemical Company, Enviro-Sciences, Inc. (ESI) was hired to conduct an environmental investigation of the site. As a result of the ESI investigation, which was conducted from October 1984 to March 1986, four areas of contamination were identified and characterized through environmental sampling. The four areas (Figures 3 and 4) consisted of 1) soil between above-ground storage tanks (ASTs) #8 and #9 (Area B); 2) water and sludge in the process pit (Area C) and associated sludge in the drainage line from the process pit; 3) soil under the concrete loading dock (Area D) and in a trench next to the loading dock which had been contaminated by leakage/drainage from the former lab pit; and 4) soil under concrete slab #3 near the ASTs (Area E) (2,6).

Soil samples collected by ESI between October 1984 and March 1986 indicated the presence of various organic compounds, including toluene and pyridine, in the areas of concern described above. Toluene-contaminated soil in Areas B and E was excavated, heat treated in the plant's drying oven, and later shipped off the island for final disposal. Soil contaminated by pyridine in the loading dock area (Area D) was treated in-place (after removal of the overlying concrete surface) by aeration and biodegradation through periodic tilling of the soil. Sludge and wastewater in the process pit, an underground 8,000-gallon concrete tank, were removed and placed in drums for later disposal. At a later date, the process pit was sealed with concrete (2,4,6).

During the ESI investigation, the central storm drain, which conveyed stormwater and wastewater from the process pit to River Gut, was found to consist of 55-gallon drums, with their ends removed, welded end-to-end. The drain line drums were badly corroded and contained an oily sludge. ESI excavated the drain line and contaminated soil beneath the drain line and placed the drums, oily sludge, and contaminated soil in containers for later disposal. The excavated drain line was then replaced with a 10-inch polyvinyl chloride (PVC) pipe. Waste materials from the various ESI site activities, including treated soil from the drying oven, water and sludge from the process pit, and drums and sludge from the excavated central drainage line, were removed from the site and shipped off the island in late 1985 (2,4,6).

In September 1985 and March 1986, EPA conducted two enforcement inspections under authority of the Resource Conservation and Recovery Act (RCRA) to verify the effectiveness of ESI's soil remediation activities and to determine compliance with applicable RCRA

regulations. Samples collected during the RCRA inspections indicated the presence of toluene, phthalates, benzene, chloroform, polynuclear aromatic hydrocarbons (PAHs), chromium, and zinc in site soils and sediments, including sediments in the River Gut steam channel (2,4,5,6,8).

In January and February 1989, EPA's Response and Prevention Branch conducted a Preliminary Assessment and Removal Evaluation at the site. At that time, EPA found approximately 400 drums, in various conditions, inside the warehouse building (Area A, Figure 4). The drums contained a variety of substances including ethyl alcohol, methanol, benzyl acetate, benzyl chloride, toluene, methyl isobutyl carbinol, sodium hydroxide, paints, and unidentified substances. EPA also discovered leaking cylinders of chlorine and hydrogen chloride, and over 800 containers of laboratory reagents including sodium, potassium cyanide, phosphorus pentoxide, and ethyl ether in the lab building. Between February 1989 and October 1991, EPA removed more than 250 drums of the various chemicals, and more than 8,000 pounds of lab pack chemicals from the laboratory/warehouse building for off site disposal. In January 1990, during the site removal activities, EPA collected groundwater samples which showed chloroform to be present in an on-site production well and nearby municipal wells (2,4,7).

In February 1991, EPA's Field Investigation Team (FIT) conducted a sampling site inspection at the site during which groundwater, sediment, and soil samples were collected. Chloroform was found in on-site and off-site wells, and various organic and inorganic contaminants were present in the sediment samples from the facility's storm drains. Low level of several pesticides were also detected in the site soil and sediment samples (2,4).

In January 1994, the site was proposed to EPA's National Priorities List (NPL). The NPL is the national list of hazardous waste sites that qualify for cleanup under the federal Superfund program. The site was listed as final on the NPL in June 1996 (2).

In January and February 1995, EPA conducted an initial (Phase I) remedial investigation (RI) of the Island Chemical/Virgin Island Chemical site. The purpose of the RI was to characterize the nature and extent of contamination at the site and to evaluate whether such contamination posed a risk to human health and the environment. The initial RI field activities included site clearing, installation of four monitoring wells, completion of 11 soil borings, rehabilitation of two on-site production wells, and collection of numerous soil and groundwater samples. In May 1995, EPA revisited the site and collected an additional round of groundwater samples. The results of the initial RI activities indicated significant soil and groundwater contamination in the tank farm area due to leaks and/or spills from one or more of the ASTs. The RI data also showed some residual soil and groundwater contamination in other areas of the site from past site operations (3).

In May and June 1996, EPA conducted supplemental (Phase II) RI field activities to further characterize the extent of groundwater and soil contamination in the AST area and to evaluate groundwater quality near the former process pit (near the center of the site). The supplemental field activities included installation of two monitoring wells, completion of seven soil borings, and collection of groundwater and soil samples. The results of the supplemental investigation helped define the extent of VOC soil and groundwater contamination near AST tank #8 and indicated some residual groundwater contamination (primarily chloroform) near the former process pit (9).

Phase III of the RI is currently in the planning stages. The Phase III field activities will include additional soil and groundwater sampling to further characterize the extent of VOC contamination in the AST area, to evaluate the presence of VOC contamination in shallow and deep groundwater, and to determine the levels of contaminants in the River Gut stream channel. In addition, the field activities will include measurement of groundwater levels in order to evaluate the flow characteristics of the deep aquifer in the immediate site area (10).

B. Site Visit

In December 1994, Steve Richardson and De'borah Boling, ATSDR headquarters staff, and Steven Jones, ATSDR Region II representative, visited the Island Chemical/Virgin Island Chemical site. The following site conditions were observed during the site visit:

- Although the site was fenced, access to the site was not restricted due to a broken gate. Evidence of recent trespassing, such as discarded car batteries, beer and wine bottles, and old tires, was observed during the site visit.
- The site was littered with debris (e.g., old pipes, pieces of metal, wooden pallets, empty drums, old plant equipment, junk cars, semi-truck trailer, old tires, nails) which could pose a threat to site trespassers. Other potential physical hazards included the site's dilapidated and deteriorating buildings and unsecured catwalks and distillation tower stairway.
- The site was heavily overgrown by vegetation. No visual evidence of contamination was observed except for small piles of unknown, granular, black and orange substances and grey pellet-like materials on the floor of the warehouse/lab building.

In April 1997, Steve Richardson, De'borah Boling, and Brian von Gunten, ATSDR Region II representative, conducted a follow-up site visit. Most of the site conditions were similar to those observed during the December 1994 site visit. Access to the site was still unrestricted because sections of the perimeter fence were missing and the site entrance gate was broken. The site was still overgrown by vegetation although some areas had obviously been cleared during the previous RI field activities. The site was still littered with debris, and the site's

buildings and other structures (e.g., pipes, tanks, catwalks, stairways) had become more dilapidated and deteriorated since the previous site visit. The granular orange and black substances and grey pellet-like materials observed on the floor of the lab/warehouse building during the previous site visit were still present.

Other observations made during the April 1997 site visit included the following:

- An unknown man was wandering around the site when ATSDR staff initially entered the site.
- A mongoose, several goats, and numerous animal droppings were observed on the site. It appeared that the goats were domestic and were being allowed to graze freely on and around the site property. In addition, two horses were observed tied up in the dry River Gut stream channel downstream of the site near the Highway 66 bridge.
- A "for sale" sign was observed in front of the site property next to Highway 66. A local businessman, who was interested in purchasing the site property, confirmed that the property was up for sale.
- A small lot next to the southwest corner of the site along Highway 66 had been cleared and filled, and was apparently being developed for commercial use. At the time of the site visit, the lot was surrounded by a chain-link fence and contained some construction equipment and a small building foundation.
- Further evidence of the previous RI site activities were observed including the new on-site monitoring wells and sealed drums, apparently containing residuals from the drilling of soil borings and installation of monitoring wells, stored in the lab/warehouse building.
- In addition to the granular and pellet-like materials observed on the floor of the lab/warehouse building, the following visual evidence of contamination was noted at the site: (1) black stains on and around several metal poles supporting overhead pipes leading from the AST area to the old reactor area, and (2) residues inside the glass tubing in the glass reactor area.
- Just east of the site, an area of black-stained soil with a strong petroleum odor was observed in the River Gut stream channel and on the northern slope of the gut behind the concrete manufacturing plant. A small area of standing water with a noticeable oily sheen was also present in the gut at that location. The black petroleum material appeared to originate from a heavy equipment maintenance area at the concrete manufacturing plant. ATSDR reported the observed release to the Virgin Islands Department of Planning and Natural Resources (VIDPNR).

C. Demographics, Land Use, and Natural Resource Use

Demographics

The population of St. Croix is approximately 50,000, based on 1990 census data. The racial distribution of the U.S. Virgin Islands' population, which includes St. Croix, St. John, and St. Thomas, is about 80% black, 15% white, and 5% other. The Virgin Island population can be further classified according to the following ethnic groups: 74% West Indian (45% born in the Virgin Islands and 29% born elsewhere in the West Indies); 13% U.S. mainland; 5% Puerto Rican; and 8% other. In addition, 14% of the population is reported to be of Hispanic origin (0, 11). The specific demographic makeup of the population living near the Island Chemical/Virgin Island Chemical site cannot be determined based on currently available information.

Land Use

The area surrounding the Island Chemical/Virgin Island Chemical site is predominately agricultural and commercial. Several businesses are adjacent to the site (as shown in Figure 2) including (1) an unknown business inside a small, fenced area next to the southwest corner of the site (near the AST area); (2) a redi-mix concrete plant about 100 feet east of the site; (3) an asphalt paving company about 300 feet north of the site; (4) two auto repair shops about 400 feet north-northeast of the site; (5) an engineering company about 600 feet northwest of the site; and (6) an asphalt manufacturing plant about 700 feet northwest of the site. Other facilities in the site area include the Golden Grove Correctional Institute, located about 1,100 feet northwest of the site; a construction materials and equipment company, located approximately 1,300 feet southeast of the site; and an old quarry next to the construction company. In addition, the Alexander Hamilton Airport is less than half a mile south of the site (3).

A number of agricultural areas surround the site. These areas are used primarily to raise cattle and goats.

The nearest residences to the site are reportedly located about one-tenth of a mile south or east of the site. However, the existence of these residences cannot be confirmed. The nearest known residences are located about one-third of a mile north-northeast of the site in the Upper Bethlehem area. Other residences, including the mobile homes of the Golden Grove Trailer Park, are located about three-quarters of a mile northwest of the site in the Golden Grove area (2,4,7).

Natural Resource Use

Fresh water is a scarce commodity in the U.S. Virgin Islands. To meet the demand for fresh water on St. Croix, all available sources of fresh water are used, including desalinated seawater, groundwater, and rooftop rainfall catchment systems (cisterns).

Groundwater is used as a source of potable water supply for both private and public water systems on the island of St. Croix. The Virgin Islands Water and Power Authority (VIWAPA) has at least 60 public supply wells in about nine well fields across the island. However, less than half of these are believed to be currently active. Water from the active VIWAPA supply wells is used to supplement desalinated seawater from VIWAPA's four large desalination units near Christiansted. Water from the desalination units is mixed with water from the municipal supply wells and distributed in the same water lines. In the past, approximately 70% of the water distributed by VIWAPA was obtained from the desalination units while the remaining 30% was supplied by the municipal supply wells. Recently, the capacity of the desalination units was increased such that desalinated seawater now makes up nearly all of VIWAPA's water supply under normal conditions. During extremely heavy periods of demand, such as those that occur in the summer when rainfall is scarce, a greater portion of the municipal water is provided by the VIWAPA water supply wells (4,12).

The municipal well fields closest to the site are the VIWAPA Fairplains well field, located about 900 to 1,800 feet southeast of the site, and the Bethlehem well field, located about 1,000 to 1,200 feet northeast of the site. Other VIWAPA well fields near the site are the Golden Grove well field, which is about 3,000 to 4,500 feet west-northwest of the site, and the Negro Bay well field, located about 3,500 to 4,000 feet west and southwest of the site. The locations of the VIWAPA well fields in the site area are shown in Figure 5. Until recently, water from the individual wells in these well fields was pumped into a 100,000-gallon storage tank at the Fairplains well field where it mixed with desalinated seawater from the Christiansted treatment units. The combined water in the Fairplains storage tank was withdrawn, chlorinated, and distributed through the municipal distribution system to VIWAPA's water users. Over the past several years, some of the Fairplains wells were taken out of service, and, recently, the remaining Fairplains wells were shut down. According to VIWAPA authorities, there are no plans to use the Fairplains wells in the future. Currently, water from the other well fields—Bethlehem, Golden Grove, and Negro Bay—is pumped through a filtration system to remove particulates, and a reverse osmosis unit to reduce salinity, prior to entering the Fairplains storage tank. As before, the combined well water and desalinated seawater in the Fairplains tank is withdrawn, chlorinated, and distributed. As discussed above, the VIWAPA supply wells are used primarily when the availability of desalinated seawater from the Christiansted plant is insufficient to meet user demand (3,4).

The principle aquifer for the Fairplains and Golden Grove well fields is the alluvium which is composed mostly of low permeability clay. The thickness of this deposit in the site vicinity is

reported to range from about 55 to 100 feet. Imbedded in the clay are isolated, high permeability lenses of sand and gravel, ranging from 1 to 8 feet in thickness. Reported depth from ground surface to the water table in the site vicinity vary from 9 feet to 107 feet. For example, water levels in the Fairplains wells near the site reportedly range from 16 to 20 feet below ground surface. In the site area, the direction of shallow groundwater flow has not been adequately defined (2,3,4).

The soil structure beneath the Island Chemical/Virgin Island Chemical site is generally consistent with the alluvial deposits found in the site area. Boring logs indicate that the site is underlain by at least 25 feet of sandy clay and silty clay with discontinuous lenses of gravelly sand and silty sand. The lowermost lens, which is encountered at a depth of 24 to 33 feet below ground surface, is a silty sand that appears to be continuous across the site. At the site, depth from the ground surface to the water table varies from about 21 feet to 28 feet. In addition, two different shallow groundwater flow patterns have been reported at the site. Under typical (dry) conditions, a shallow groundwater divide exists, such that west of a line between MW-3 and MW-4, groundwater flows to the west and northwest, while east of a line between MW-3 and MW-4, groundwater flows to the east and northeast. In contrast, during and immediately after significant rainfalls, a reversal of flow direction occurs so that shallow groundwater flows to the west and northwest across the entire site. These periods of flow reversal are reported to last for a period of 1 to 2 weeks (2,3,4,9).

Underlying the alluvium in some areas of St. Croix, and exposed at the surface in other areas, is the Kingshill Limestone aquifer, which, in the site vicinity, is composed primarily of chalks and marls. The Kingshill aquifer has a maximum saturated thickness of approximately 200 feet, and is reported to be the most productive aquifer on the island. However, because of salt water intrusion, much of the groundwater in this aquifer has a high chloride content and, therefore, is not generally suitable for human consumption. The Kingshill aquifer is the principal aquifer for both the Bethlehem and Negro Bay well fields. The direction of groundwater flow in the deep Kingshill aquifer at the site has not been determined. In addition, the shallow alluvial and the deep Kingshill aquifers in the site area are believed to be interconnected, because of the presence of numerous old abandoned wells that are screened, perforated, or open across both aquifers (2,4).

The Kingshill aquifer is also tapped by two public wells near the site that are not part of the VIWAPA municipal water system. These two wells are located about 900 to 1,200 feet west of the site (Figure 2), and are about 110 feet deep. Until recently, the two wells, which are owned by the Virgin Islands Port Authority (VIPA), were used to supply water to the nearby Alexander Hamilton Airport. Water from the wells was pumped to a large storage tank on top of a hill near the airport. Water in the storage tank was distributed to the airport terminal and a number of businesses associated with the airport for various uses, including drinking water. VIPA officials indicate that powdered chlorine was periodically added to water in the storage tank for disinfection. Recently, the airport was connected to the VIWAPA's water distribution

system, thereby eliminating the need to use the two airport supply wells except in cases of emergency (2,3,4).

A large number of private water supply wells are located throughout the island of St. Croix, especially in areas that are not served by the VIWAPA municipal water system. Records containing specific information about private wells on the island are scarce and generally incomplete. Most private wells on the island are reported to be screened in the shallow alluvial aquifer or in the upper portion of the deeper Kingshill aquifer. These wells are believed to be used primarily for drinking water supply, irrigation, and commercial/industrial operations. The closest private wells to the site are two wells at the concrete plant about 150 feet east of the site, and two wells at the asphalt plant about 700 feet northwest of the site (Figure 2). These four wells are located across River Gut from the site, and are used for industrial/commercial purposes only—not for potable water supply. The closest private wells used for drinking water are not known for certain, but may be the wells at the Golden Grove Trailer Park located approximately three-quarters of a mile northwest of the site (2,3,4).

Most private dwellings on St. Croix have cisterns which are used to store rainwater from rooftop catchment systems. Cisterns provide almost 10% of the freshwater supplies on the island. Some residences depend on cisterns as their principle source of potable water, while others use cisterns to supplement their private well water. In addition, when rainfall is adequate, many residences use water from their cisterns instead of the municipal water supply to reduce their water costs (2,12).

The nearest surface water to the site is River Gut, an intermittent stream that borders the site on the north and east. The gut originates northwest of the site, flows past the site and then, about 800 feet to the southeast, flows under Highway 66 where it is joined by another intermittent stream, Bethlehem Gut. About 4,500 feet southeast of the site the combined streams discharge to the Caribbean Sea. River Gut is an intermittent stream that generally flows only during the island's rainy season (September to December). Although the gut is not likely to be heavily used for recreational activities such as boating or fishing, in the past children were reported to have used the gut for swimming downstream of the site (13). On the north and northeastern sides of the site, the gut is about 12 to 15 feet deep with steeply sloped, heavily vegetated sides. Rainfall runoff from the site reportedly drains to the gut either by sheet flow, generally from southwest to northeast, or by one of two storm drains which discharge to the gut on the southeast side of the site (2,3).

COMMUNITY HEALTH CONCERNS

During the December 1994 site visit, ATSDR staff contacted officials of the Virgin Islands Department of Health, the Virgin Islands Department of Planning and Natural Resources, the Virgin Islands Water and Power Authority, and the Virgin Islands Port Authority to gather information regarding health concerns about the site. These officials were not aware of any complaints from the public related to contamination at the Island Chemical/Virgin Island Chemical site. However, a representative of the Virgin Island Port Authority expressed concern about the possibility of site groundwater contamination affecting the two airport water supply wells located just west of the site.

ENVIRONMENTAL CONTAMINATION AND OTHER HAZARDS

This section of the public health assessment identifies contaminants of concern found in specific environmental media at the Island Chemical/Virgin Island Chemical site. The contaminants of concern will be evaluated later in the health assessment to determine if exposure to them will affect the public's health.

ATSDR selects and discusses contaminants of concern using the following information:

- concentrations of contaminants on and off site;
- the quality of field and laboratory data and sample design;
- comparison of on- and off-site contaminant concentrations with comparison values for cancer and noncancer endpoints; and
- community health concerns.

It is emphasized that the listing of a contaminant in the following tables does not mean it will cause adverse health effects if people are exposed at the reported concentrations. Rather, the listing of a contaminant indicates that the contaminant will be evaluated further in this public health assessment. When a contaminant is selected as a contaminant of concern in one medium, its presence or absence in all media sampled will be discussed.

The data tables presented in this section include the following abbreviations and/or acronyms:

Comparison Values (CVs)

■ CREG	=	Cancer Risk Evaluation Guide
■ EMEG	=	Environmental Media Evaluation Guide
■ RMEG	=	Reference Dose Media Evaluation Guide
■ LTHA	=	Lifetime Health Advisory
■ MCLG	=	Maximum Contaminant Level Goal
■ MCL	=	Maximum Contaminant Level
■ PMCLG	=	Proposed Maximum Contaminant Level Goal

Data Clarifiers

■ ppb	=	parts per billion
■ ppm	=	parts per million
■ ND	=	not detected
■ N/A	=	not analyzed or not available
■ N/R	=	not reported
■ J	=	associated numerical value is an estimated quantity

EMEGs are media-specific values developed by ATSDR for use in selecting environmental contaminants of potential health concern. EMEGs are calculated using noncancer health endpoints and do not consider potential carcinogenic effects. RMEGs are media-specific values developed by ATSDR from EPA Reference Doses (RfDs). RfDs are EPA's estimates of the daily exposure to a contaminant that is unlikely to cause adverse health effects. CREGs are estimated contaminant concentrations expected to cause no more than one excess cancer in a million persons exposed over a lifetime (70 years). Maximum Contaminant Level Goals (MCLGs) are EPA-developed drinking water health goals. EPA believes that MCLGs represent levels at which no known or anticipated adverse effect on the health of persons should occur (allowing for an adequate margin of safety.) Proposed Maximum Contaminant Level Goals (PMCLGs) are MCLGs that are being proposed. Maximum Contaminant Levels (MCLs) represent contaminant concentrations that EPA deems protective of public health (considering the availability and economics of water treatment technology) over a lifetime (70 years) at an exposure rate of 2 liters of water per day. EPA's Lifetime Health Advisories (LTHAs) represent the level of a contaminant in drinking water (with a margin of safety) at which adverse noncancer health effects would not be anticipated during a lifetime (70 years) exposure. While MCLs are regulatory concentrations, PMCLGs, MCLGs, and LTHAs are not.

A. On-Site Contamination

As previously discussed, sampling data have been collected since 1984 from various environmental media at the Island Chemical/Virgin Island Chemical site. Most data were collected during the ESI site investigations and the EPA Remedial Investigation. Relevant contaminant data from these and other sampling events, which were described previously in the Background section, are discussed and evaluated below.

For the purpose of this public health assessment, "on-site" refers to those areas within the general site boundary shown in Figure 6. All areas outside of the site boundary, including the River Gut stream channel, are considered to be "off-site".

Bulk Chemicals

Twenty, 8,500-gallon above-ground storage tanks (ASTs) were originally located in a tank farm (Area B, Figure 4) along the western site boundary. In the 1980s, six of the tanks were sold and removed from the site. The ASTs were used by the various site operators to store bulk chemicals for use in the plant's manufacturing operations.

In October and November 1982, four of the ASTs were sampled and found to contain toluene, xylene, para-phenetidine and 9-fluorenone. These chemicals were later removed from the site for off-site disposal. In March 1986, nine of the ASTs were sampled and the following liquids were found: 1) a solution of benzoquinone and fluorenone; 2) solutions of benzophenone and fluorenone with traces of VOCs; 3) p-phenetidine; 4) p-phenetidine with aromatics; 5) hydroxyfuranocoumarin; and 6) a mixture of hydroxyfuranocoumarin and p-phenetidine. In January 1989, four of the ASTs were found to be filled with ethanol, which was used by one of the site's operators in an alcohol dehydration project, while the other 10 were empty. In May 1989, ethanol was again found in the first four tanks while diesel fuel was discovered in the fifth tank. In April 1995, field investigators detected a black, petroleum-like liquid leaking from the drain valve on Tank #5 and a small area of stained soil beneath the leaking valve. In addition, at that time only 10 of the ASTs tanks were present; apparently, four of the tanks were removed from the site sometime between 1990 and 1994.

Sludge

In June 1985, ESI sampled sludge inside the process pit (Area C, Figure 4) for organics and inorganics. The sampling data showed high levels of several organic contaminants, such as benzyl acetate, benzene methanol, diphenyl methanone; low levels of other organics, such as chloroform; and elevated levels of several inorganic contaminants, including chromium, lead, and zinc. Sampling data for contaminants of concern, (i.e., contaminants whose concentration exceeded an applicable ATSDR comparison value and those for which there is no applicable comparison value) in the process pit sludge samples are shown in Table 1.

Wastewater

In July 1985, ESI sampled wastewater inside the process pit and found detectable levels of several organic and inorganic contaminants. However, most of the inorganic contaminant concentrations did not exceed applicable ATSDR comparison values. The contaminants detected in the July 1995 process pit wastewater samples were generally consistent with the contaminants found in the June 1995 process pit sludge samples. Sampling data for contaminants found at levels exceeding an applicable ATSDR comparison value and for contaminants which have no comparison value are presented in Table 2. After the July 1985 sampling event, the process pit tank was cleaned out and filled with concrete.

Table 1. Sampling Data for Contaminants of Concern in Sludge Samples from the Process Pit¹

CONTAMINANT	CONCENTRATION RANGE (ppm)	BACKGROUND CONCENTRATION (ppm)	COMPARISON VALUE	
			ppm	SOURCE
BENZENE METHANOL(t)	15,000J	N/A	NONE	
BENZYL ACETATE(t)	170,000	N/A	NONE	
CHLOROFORM(x)	220	N/A	500	cEMEG
CHLOROMETHYLBENZENE(t)	4,400J	N/A	NONE	
1-CHLORO-2-METHYLBENZENE(t)	40J	N/A	NONE	
DIPHENYL METHANONE(t)	30,000J	N/A	NONE	
9H-FLUORENE-9-ONE(t)	3,000J	N/A	NONE	
METHYLENE CHLORIDE	125	N/A	90	CREG
1,1'-(OXYBIS(METHYLENE))BIS-BENZENE(t)	4,000J	N/A	NONE	
TOLUENE	1,560	N/A	1,000	cEMEG
ARSENIC	40	<0.1 - 738 ²	0.5	CREG
CHROMIUM	592	10 - 300 ³	60	CREG (Cr+6)
COPPER	327	30 - 100 ³	NONE	
LEAD	688	10 - 300 ³	NONE	
ZINC(x)	3,594	ND - 200 ³	20,000	cEMEG

¹Source: Reference (2)²Source: Reference (14)³Source: Reference (15)

(t) tentatively identified compound

(x) contaminant of concern in other media at the site

Table 2. Sampling Data for Contaminants of Concern in Wastewater Samples from the Process Pit¹

CONTAMINANT	CONCENTRATION RANGE (ppb)	COMPARISON VALUE	
		ppb	SOURCE
BENZALDEHYDE(t)	3,000J	1,000	cRMEG
BENZENE	40	1	CREG
BENZENE METHANOL(t)	24,000J	NONE	
CHLOROMETHYL BENZENE(t)	300J	NONE	
DIPHENYL METHANE(t)	400J	NONE	
1,1'-(OXYBIS(METHYLENE))BIS-BENZENE(t)	400J	NONE	
PHENYL ACETATE(t)	26,000J	NONE	
TOLUENE	380	200	ciEMEG
ZINC	4,850	3,000	cEMEG

¹Source: Reference (2)

(t) tentatively identified compound

Soil/Sediment

Between September 1984 and February 1991, numerous soil and sediment samples were collected at the site from several areas of concern, including the AST area (Area B), the central and southern storm drain, the concrete slabs near the AST area (Area E), and the loading dock/lab pit area (Area D) (Figure 4). These data showed high levels of several organic compounds (such as benzophenone, phenol, pyridine, quinidine gluconate, quinine sulfate, and toluene), and slightly elevated levels of some inorganics (including antimony, iron, lead, and zinc) in site soils from the areas of concern. Sampling data for contaminants found at levels exceeding an applicable ATSDR comparison value, and for contaminants which have no comparison value are presented in Table 3. The highest contaminant concentrations were generally found in the AST area soils, which were reportedly contaminated due to a toluene spill from Tank #8, and in the loading dock/lab pit area soils, which were believed to have been contaminated due to leaks and/or drainage of liquids from the lab pit. The contaminants found in site soils were generally consistent with chemicals known to have been used as raw materials or manufactured as products during the plant's operating history. All contaminated soil in the AST area, the loading dock/pit area, and the area near the concrete slabs was reportedly remediated through excavation, heat treatment, and off-site disposal or through in-situ aeration and biodegradation.

Table 3. Historical (Pre-RI) Sampling Data for Contaminants of Concern in On-Site Soil/Sediment Samples (various depths)¹

CONTAMINANT	CONCENTRATION RANGE (ppm)	BACKGROUND CONCENTRATION (ppm)	COMPARISON VALUE (ppm)	
ALDRIN	0.012J - 30J	N/A	0.04	CREG
BENZOPHENONE	2,600 - 15,000	N/A	NONE	
d-BHC	0.0077J	N/A	NONE	
BIS(2-ETHYLHEXYL)- PHTHALATE	1.9J - 51	N/A	50	CREG
CARBON TETRACHLORIDE	10	N/A	5	CREG
a-CHLORDANE	0.0035J - 4J	N/A	0.5	CREG
g-CHLORDANE	0.0061 - 7.5J	N/A	0.5	CREG
CHLOROFORM(x)	0.0014J - 340	N/A	500	cEMEG
1,1-DCA	0.02	N/A	NONE	
4,4'-DDE (1,1-DICHLORO-2,2-BIS(p- CHLOROPHENYL)ETHYLENE)	0.024J - 5.8J	N/A	2	CREG
DI-N-OCTYLPHTHALATE	0.5J - 9	N/A	NONE	
HEPTACHLOR EPOXIDE	0.0048J - 10J	N/A	0.08	CREG
METHYLENE CHLORIDE	0.0015J - 1,240	N/A	90	CREG
2- METHYLNAPHTHALENE	0.63J	N/A	NONE	
PYRIDINE	0.02 - 3,014	N/A	50	cRMEG
QUINIDINE GLUCONATE	47 - 8,227	N/A	NONE	
QUININE SULFATE	82 - 2,594	N/A	NONE	
TOLUENE	0.007 - 13,880	N/A	1,000	ciEMEG
1,1,1-TRICHLOROETHANE	0.0008J - 0.011	N/A	NONE	
ALUMINUM	9,400 - 27,000	7,000 - 100,000 ²	NONE	
ANTIMONY	8.4 - 26.6	<1 - 8.8 ²	20	cRMEG
ARSENIC	1J - 9.1J	<0.1 - 738 ²	0.5	CREG
BERYLLIUM	7J	ND - 1.5 ³	0.2	CREG
CALCIUM	23,300 - 69,300	1,500 - 70,000 ³	NONE	
CHROMIUM	19.8J - 110J	10 - 300 ³	60	CREG (Cr+6)
COBALT	13.4 - 22.3	ND - 100 ³	NONE	

(Table 3. continued)

COPPER	45 - 367	30 - 100 ³	NONE	
IRON	21,500 - 183,000	30,000 - 50,000 ³	NONE	
LEAD	9 - 466	10 - 300 ³	NONE	
MAGNESIUM	3,630 - 7,800	7,000 - 15,000 ³	NONE	
MANGANESE	735 - 1,420	700 - 10,000 ³	NONE	
POTASSIUM	2,170 - 2,990	50 - 37,000 ²	NONE	
SODIUM	N/R	3,000 - 10,000 ³	NONE	
ZINC(x)	63 - 1,710 ¹	ND - 200 ³	20,000	cMEG

¹Source: Reference (2);²Source: Reference (14);³Source: Reference (15)

(x)contaminant of concern in other site media

During the RI field activities in January 1995, soil samples were collected from soil borings in the following areas of the site: the AST area (Area B), the process pit area (Area C), the loading dock/lab pit/lab drain area (Area D), the area in front of the concrete slabs (Area E), and the fenced storage area (Area F). Soil samples were also collected from borings used in the installation of the RI monitoring wells (Figure 7). Depth-discrete soil samples for the shallow monitoring well borings were collected from depths of 0-1 foot and 4-5 feet, while samples for the deep monitoring well borings were collected at various depth intervals ranging from 0-1.5 feet to 25.0-26.5 feet. All RI soil samples were analyzed for organic and inorganic contaminants.

Analysis of the RI soil samples indicated very low levels of VOCs, semi-volatile organics, and/or pesticides at all locations except the AST area, which contained significantly higher levels of three VOCs—acetone, ethylbenzene and xylene. The VOC soil contamination found in the AST area is believed to have been associated with leaks and/or spills of volatile chemicals and possibly diesel fuel from one or more of the ASTs. Soil levels of inorganic compounds across the site were similar to normal background levels except for zinc, which was significantly elevated. Sampling data for contaminants with concentrations that exceeded an applicable ATSDR comparison value are presented in Table 4 along with those contaminants which have no comparison value.

In May 1996, EPA collected additional soil samples in the AST area to better define the extent of the VOC contamination near Tanks #8 and #9. The soil sampling locations are shown in Figure 8. The sampling data showed higher levels of acetone, ethylbenzene and xylene than in the June 1985 samples. The soil samples also contained methylene chloride and toluene, which were not detected in the earlier samples. Contaminants of concern from the June 1985 soil samples are included in Table 4.

Table 4. RI Sampling Data for Contaminants of Concern in On-Site Soils¹

Contaminant	Concentration Range (ppm)	# Detects / # Samples	# Detects Above Comparison Values	Comparison Values (ppm)	Comparison Value Reference	Background Concentration Range (ppm)	Maximum Detection		
							Sample ID #²	Sample Date	Data Qualifier
Volatile Organic Compounds									
4-Methyl-2-pentanone	0.008	1/49	NA	NA	NA	NA	SBB11B/14-16	5/30/96	J
Semivolatile Organic Compounds									
Di-n-octylphthalate	0.120	1/27	NA	NA	NA	NA	SBD3/0-2/012095	1/20/95	J
Pesticides									
Endrin aldehyde	0.004	2/27	NA	NA	NA	NA	SBC2/0-1/013095	1/30/95	J
Metals									
Aluminum	9,350 - 28,200	31/31	NA	NA	NA	7,000 -100,000³	SBB1/ 0-1/013195D	1/31/95	*J
Arsenic	0.950 - 1.5	4/31	4	0.5 20 200	CREG EMEG (C) Child EMEG (C) Adult	ND - ND⁴	SBF1A/13-15/020395	2/3/95	BJ
Beryllium	0.15 - 0.58	27/31	26	0.2 300 4,000	CREG RMEG Child RMEG Adult	ND - 1.5⁴	SBB1/ 0-1/013195D	1/31/95	
Calcium	4,640 - 133,000	31/31	NA	NA	NA	1,00 - 70,000⁴	SBC1/20-22/012795	1/27/95	
Cobalt	8.1 - 31.7	31/31	NA	NA	NA	ND - 100⁴	SBB1/ 0-1/013195D	1/31/95	
Copper	27.9 - 141	31/31	NA	NA	NA	30 - 100⁴	SBF3/0-1/012495	1/24/95	N*J
Iron	18,100 - 63,400	31/31	NA	NA	NA	30,000 - 50,000⁴	SBF3/0-1/012495	1/24/95	*J
Lead	1.9 - 89.9	24/31	NA	NA	NA	10 -300⁴	SBE1/0-2/011895	1/18/95	
Magnesium	4,340 - 13,900	31/31	NA	NA	NA	7,000 - 15,000⁴	SBD4/0-1/012795	1/27/95	
Manganese	216 - 2,100	31/31	NA	NA	NA	700 - 10,000⁴	SBB1/ 0-1/013195D	1/31/95	
Potassium	597 - 4,330	31/31	NA	NA	NA	50 - 37,000³	SBB1/ 0-1/013195D	1/31/95	
Sodium	358 - 2,430	31/31	NA	NA	NA	3,000 - 10,000⁴	SBC1/0-1/012795	1/27/95	

¹Source: Reference (16)²Depth of sample is indicated after first slash (i.e., SBE1/0-2/011895 was collected at 0-2 ft below ground surface).³Source: Reference (14)⁴Source: Reference (15)

NA - Not available

B - For inorganics, the reported value is less than the Contract Required Limit but greater than the Instrument Detection Limit

N - Spike recovery not within control limits

* - Duplicate analysis not within control limits

Groundwater—Monitoring Wells

In January and February 1995 four shallow monitoring wells (MW-1, MW-3, MW-4, and MW-5) were installed at the site, during the RI field activities. The monitoring well locations are shown in Figure 9. The well depths ranged from 27 feet to 33 feet below ground surface. A fifth monitoring well (MW-2) was planned near the process pit, but was not installed because installation of a well in that area could have allowed soil contaminants, if present, to migrate into site groundwater.

In mid February 1995, the four monitoring wells were sampled for VOCs, semi-volatile organic compounds (SVOCs), pyridine, pesticides, polychlorinated biphenyls (PCBs), and inorganics. In May 1995, a second round of groundwater samples was collected from the wells. Analysis of the groundwater samples revealed the presence of several VOCs, SVOCs, pesticides, and inorganics in the groundwater samples. The highest contaminant concentrations, especially for VOCs and SVOCs, were generally found in samples from MW-1 in the AST area. Groundwater contamination in the AST area is believed to have resulted from leaks and/or spills of volatile chemicals and possibly diesel fuel from one or more of the ASTs.

Analytical data for contaminants found in the February 1995 or May 1995 samples at levels exceeding an applicable ATSDR comparison value, and for contaminants which have no comparison value are presented in Table 5.

In May 1996, two additional shallow monitoring wells were installed to further characterize groundwater quality at the site—MW-2 near the old process pit, and MW-6 between tanks #8 and #9 in the AST area (Figure 9). MW-2 and MW-6 were 29 feet and 27 feet in depth, respectively. In June 1996, groundwater samples were collected from the two new monitoring wells. Samples from MW-2 were analyzed for VOCs, SVOCs, pesticides, PCBs, cyanide, pyridine, and inorganics, while the MW-6 samples were analyzed for VOCs only. At MW-2, several organic compounds were detected, most notably: carbon disulfide, chloroform, and methylene chloride, and a number of inorganics (similar to those found in the 1995 samples from the other monitoring wells). At MW-6, high levels of ethylbenzene and xylenes were found, indicating significant VOC contamination beneath the AST area. Contaminants of concern from the May 1996 monitoring well samples are included in Table 5.

Table 5. Sampling Data for Contaminants of Concern in On-Site Groundwater Monitoring Wells¹

Contaminant	Concentration Range (ppb)	# Detects / # Samples	# Detects Above Comparison Values	Comparison Value (ppb)	Comparison Value Reference	Maximum Detection		
						Sample ID #	Sample Date	Data Qualifier
Volatile Organic Compounds								
Chloroform	590	1/10	1	6	CREG	MW-2/6/17/96D	6/17/96	
			1	100	EMEG (C) Child			
			1	400	EMEG (C) Adult			
Ethyl benzene	2 - 23,000	4/10	2	700	MCL	MW-6/06/17/96	6/17/96	
			1	1000	RMEG Child			
			1	4000	RMEG Adult			
Methylene chloride	0.4 - 6,400	4/10	2	5	CREG	MW-6/06/17/96	6/17/96	BJ
			1	600	EMEG (C) Child			
			1	2,000	EMEG (C) Adult			
Xylene (total)	0.9 - 27,000	5/10	2	2000	EMEG (I) Child	MW-6/06/17/96	6/17/96	
			1	7000	EMEG (I) Adult			
Semivolatile Organic Compounds								
4-Methylphenol	48	1/8	NA	NA	NA	MW-1/021695D	2/16/95	
Pesticides								
Aldrin	0.013	1/8	1	0.002	CREG	MW-3/021595RE	2/15/95	J
				0.3	EMEG (C) Child			
				1	EMEG (C) Adult			
alpha-BHC	0.039 - 0.083	2/8	2	0.006	CREG	MW-3/051195RE	5/11/95	
beta-BHC	0.017 - 0.18	2/8	1	0.02	CREG	MW-1/021695DRE	2/16/95	PJ
delta-BHC	0.057	1/8	1	0.02	CREG	MW-1/050995D	5/9/95	P
Endosulfan sulfate	0.035	1/8	NA	NA	NA	MW-1/021695DRE	2/16/95	PJ
Endrin aldehyde	0.025 - 0.041	3/8	NA	NA	NA	MW-1/021695DRE	2/16/95	PJ
Endrin ketone	0.025	1/8	NA	NA	NA	MW-1/021695DRE	2/16/95	J
Heptachlor	0.025	1/8	1	0.008	CREG	MW-1/050995D	5/9/95	P
				5	RMEG Child			
				20	RMEG Adult			
Heptachlor epoxide	0.014	1/8	1	0.004	CREG	MW-1/050995D	5/9/95	P
				0.1	RMEG Child			
				0.5	RMEG Adult			

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Table 5. Continued

Contaminant	Concentration Range (ppb)	# Detects / # Samples	# Detects Above Comparison Values	Comparison Value (ppb)	Comparison Value Reference	Maximum Detection		
						Sample ID #	Sample Date	Data Qualifier
Metals (total)								
Aluminum	306 - 18,500	9/9	NA	NA	NA	MW-5/021595	2/15/95	EN*J
Arsenic	1.8 - 5.4	6/9	6 4	0.02	CREG	MW-3/021595	2/15/95	B
				3	EMEG (C) Child			
				10	EMEG (C) Adult			
				50	MCL			
Beryllium	0.12 - 1.6	5/9	5	0.008	CREG	MW-1/050995D	5/9/95	N
				50	RMEG Child			
				2,000	RMEG Adult			
				4	MCL			
Calcium	44,900 - 211,000	9/9	NA	NA	NA	MW-3/051195	5/11/95	
Cobalt	6.7 - 82.5	3/9	NA	NA	NA	MW-5/021595	2/15/95	
Iron	339 - 28,400	9/9	NA	NA	NA	MW-5/021595	2/15/95	N*J
Lead	1.6 - 20.3	6/9	2	15	EPA Action Level	MW-5/051095	5/10/95	S
Magnesium	31,200 - 90,500	9/9	NA	NA	NA	MW-3/051195	5/11/95	
Manganese	108 - 14,100	9/9	NA	NA	NA	MW-5/021595	2/15/95	ENJ
Potassium	1,260 - 26,400	9/9	NA	NA	NA	MW-3/051195	5/11/95	
Selenium	2.2 - 24.2	3/9	2	20	EMEG (C) Child	MW-1/021695D	2/16/95	BJNW
Sodium	314,000 - 928,000	9/9	NA	NA	NA	MW-2/6/17/96D	6/17/96	E
Vanadium	15.3 - 456	9/9	8	30	RMEG Child	MW-5/021595	2/15/95	
			1	100	RMEG Adult			

¹Source: Reference (16)

B - For inorganics, the reported value is less than the Contract Required Limit but greater than the Instrument Detection Limit

E - Exceeded the calibration range of the instrument

W - Furnace AA post-digestion spike out of control limits

* - Duplicate analysis not within control limits

P - Greater than 25 percent difference between 26C columns

ppb - parts per billion

S - Determined by the Method of Standard Additions

NA - Not available

N - Spike recovery not within control limits

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Groundwater—Private Wells

Two water supply wells are located at the site. These wells were used while the plant was active to supply process water for the plant's operations and for fire protection. The north supply well (P-2) was sampled in March 1986 and the southwest supply well (P-1), in February 1991. The locations of the two process wells are shown in Figure 9. The 250,000-gallon on-site water tank, formerly used to store water from the two supply wells, was sampled in January 1990. Sampling data for contaminants found at levels exceeding an applicable ATSDR comparison value, and for contaminants having no comparison value, are presented in Table 6. These data showed that chloroform was present in samples from both wells and the water tank, while two other organics—bis(2-ethylhexyl)phthalate and di-n-octyl phthalate—were found only in supply well P-2. In addition, a number of inorganic compounds were detected in samples from both P-1 and P-2.

Table 6. Sampling Data for Contaminants of Concern in On-Site Production Wells¹

CONTAMINANT	CONCENTRATION RANGE (ppb)	SAMPLING DATE	COMPARISON VALUE	
			ppb	Source
BIS(2-ETHYLHEXYL)- PHTHALATE	280	3/86	3	CREG
CHLOROFORM	23.9 - 130	3/86, 1/90, 2/91	6	CREG
DI-N-OCTYLPHTHALATE	2.4J - 3.9	3/86	NONE	
ARSENIC	2J - 7	3/86, 2/91	0.02	CREG
BERYLLIUM	5J	3/86, 2/91	0.008	CREG
CALCIUM	68,800	3/86, 2/91	NONE	
IRON	121	3/86, 2/91	NONE	
LEAD	3.1 - 5	3/86, 2/91	NONE	
MAGNESIUM	43,500	3/86, 2/91	NONE	
SODIUM	548,000	3/86, 2/91	NONE	

¹Source: Reference (2)

Ambient Air

No sampling data for VOCs in ambient air at the site were available during the development of this public health assessment. In addition, data from air sampling conducted inside the lab and warehouse building during previous site investigations and removal activities could not be found.

B. Off-Site Contamination

Groundwater—Public Water Supply Wells

VIWAPA Municipal Wells

Samples from three Virgin Islands Water and Power Authority (VIWAPA) supply wells near the site were collected several times between March 1988 and February 1991. The three wells, Fairplains Wells #6, #8, #9, are located about 900 to 1300 feet southeast of the site. Until recently, water from the VIWAPA Fairplains wells was pumped into the Fairplains water tank where it mixed with desalinated seawater from VIWAPA's Christiansted treatment units, and water from other VIWAPA municipal well fields, prior to being chlorinated and pumped into the municipal water distribution system. The VIWAPA Fairplains wells are no longer active.

As shown in Table 7, chloroform had been found in the past in the Fairplains municipal wells at levels exceeding ATSDR's comparison value, but not EPA's MCL. Several inorganic compounds commonly found in groundwater aquifers (such as calcium, magnesium, and manganese) were also detected in the well samples, along with low levels of lead and mercury. In addition, the well samples contained high levels of sodium, indicating that groundwater near the site is very saline.

Table 7. Sampling Data for Contaminants of Concern in Municipal Supply Wells^{1,2}

CONTAMINANT	CONCENTRATION RANGE (ppb)	SAMPLING DATE	COMPARISON VALUE	
			ppb	SOURCE
CHLOROFORM	5 - 75	(3)	6 100	CREG MCL
CALCIUM	69,900 - 127,000	2/91	NONE	
LEAD	3.9 - 4.2	2/91	NONE	
MAGNESIUM	48,600 - 71,600	2/91	NONE	
MANGANESE	17.7 - 400	2/91	NONE	
MERCURY	3.3	2/91	2	MCL/ MCLG
SODIUM	363,000 - 590,000	2/91	NONE	

¹VIWAPA Fairplains wells #6, #8, & #9

²Source: Reference (2)

³Samples taken 3/88, 10-11/88, 1/90, 6/90, & 2/91

VIPA Airport Wells

Two airport supply wells, operated by the Virgin Islands Port Authority (VIPA), are located about 900 to 1200 feet west of the site (Figure 2). Until recently, these two wells were used as the Alexander Hamilton Airport's primary water supply source. Between March 1988 and October 1995, the airport wells and the airport water supply were sampled on numerous occasions by site investigators and the VIPA. The only organic compounds detected in the airport well water samples were trihalomethanes (bromoform, bromodichloromethane, chloroform, and chlorodibromomethane). Several commonly occurring inorganics were also detected in the airport water samples, along with high levels of sodium. Sampling data for contaminants found in the airport wells at levels exceeding an applicable ATSDR comparison value, and for contaminants having no comparison value, are presented in Table 8.

Table 8. Sampling Data for Contaminants of Concern in Airport Supply Wells^{1,2}

CONTAMINANT	CONCENTRATION RANGE (ppb)	SAMPLING DATE	COMPARISON VALUE	
			ppb	SOURCE
BROMOFORM	68 - 121	(3)	4	CREG
BROMODICHLOROMETHANE	2	(3)	0.6	CREG
CHLOROFORM	2J - 11.5	(4)	6	CREG
CHLORODIBROMOMETHANE	6 - 8	(3)	0.4	CREG
ALUMINUM	60 - 70	(5)	NONE	
CALCIUM	61,300 - 75,800	2/91	NONE	
IRON	36	(5)	NONE	
LEAD	2 - 18	(6)	NONE	
MAGNESIUM	40,100 - 58,000	(5)	NONE	
POTASSIUM	2,100 - 2,200	(5)	NONE	
SODIUM	237,000 - 572,000	(5)	NONE	
VANADIUM	50.3I	2/91	30	ciMEG

¹VIPA wells #1 & #2

²Source: References (2) and (17)

³Samples taken 5/92, 9/92, 12/92, & 10/95

⁴Samples taken 3/88, 10-11/88, 6/90, 2/91, 5/92, 9/92, 12/92, & 10/95

⁵Samples taken 2/91, 5/95, & 7/95

⁶Samples taken 10/88, 2/91, 5/95, & 7/95

Groundwater—Private Water Supply Wells

Sampling data for off-site private wells were not available to ATSDR during the development of this public health assessment. ATSDR considers this a significant data gap because area private wells near the site could be affected by site-related groundwater contaminants now, or sometime in the future.

Surface Water

The only surface-water body at the site is River Gut, an intermittent stream along the north and east boundary of the site. The gut is normally dry, except after heavy rains. When the Island Chemical/Virgin Island Chemical facility was active, the gut received wastewater from the plant's lab pit, process water from the plant's process pit, and stormwater runoff from the plant property. No sampling data for surface water in the gut were available to ATSDR during the development of this public health assessment.

Sediment

Sediments in the River Gut stream channel were sampled in February 1986, March 1986, and February 1991. Samples were collected at various locations, including the point where the lab pit discharges to the gut and the point where the central storm drain discharges to the gut.

The sampling data showed low to moderate concentrations of several VOCs and SVOCs in the gut sediments; however, none of the contaminant levels exceeded ATSDR's comparison values. The greatest number of contaminants and the highest contaminant concentrations were generally found at the point where drainage from the process pit entered the gut via the central storm drain. A number of inorganics were also detected in the sediment samples. Again, the highest levels of contaminants, including chromium, lead, and zinc, were found at the central storm drain discharge point. Most of the inorganic concentrations (as shown in Table 9) were similar to normal background soil levels, and only a few—arsenic, beryllium, and chromium—exceeded an applicable ATSDR comparison value. Zinc levels in the gut sample, although elevated, did not exceed ATSDR comparison values.

Table 9. Sampling Data for Contaminants of Concern in River Gut Sediments¹

CONTAMINANT	CONCENTRATION RANGE (ppm)	BACKGROUND CONCENTRATION (ppm)	COMPARISON VALUE	
			ppm	SOURCE
DI-N-OCTYLPHTHALATE	7.7 - 17	N/A	NONE	
ALUMINUM	15,700 - 32,400	7,000 - 100,000 ²	NONE	
ARSENIC	0.8J - 4.1J	<0.1 - 738 ²	0.5	CREG
BERYLLIUM	7 - 8	ND - 1.5 ³	0.2	CREG
CALCIUM	45,600 - 82,100	1,500 - 70,000 ³	NONE	
CHROMIUM	10 - 71.1	10 - 300 ³	60	CREG (Cr+6)
COBALT	14.7 - 25.4	ND - 100 ³	NONE	
COPPER	25.3 - 69.7	30 - 100 ³	NONE	
IRON	25,700 - 39,200	30,000 - 50,000 ³	NONE	
LEAD	7.5 - 46.4	10 - 300 ³	NONE	
MAGNESIUM	7,600 - 11,800	7,000 - 15,000 ³	NONE	
MANGANESE	954 - 1,430	700 - 10,000 ³	NONE	
POTASSIUM	1,490 - 1,600	50 - 37,000 ²	NONE	
SODIUM	1,640I - 1,750	3,000 - 10,000 ³	NONE	

¹Source: Reference (2)²Source: Reference (14)³Source: Reference (15)

C. Toxic Chemical Release Inventory (TRI) Review

ATSDR conducted a search of the EPA Toxic Chemical Release Inventory (TRI) database for facilities in St. Croix, U.S. Virgin Islands. The search showed that some facilities in the area have released various organic and inorganic compounds to the air, water, and land. However, it should be noted that information in the TRI database is reported only by large companies that handle certain quantities of hazardous chemicals. Therefore, it is not possible to determine from the TRI records whether any small businesses have released contaminants in the site area.

D. Quality Assurance and Quality Control

The reports and laboratory data sheets ATSDR reviewed indicate laboratory procedures used to analyze samples from the site included quality control measures. ATSDR presumes that

appropriate protocols were followed, and that analytical data are accurate. The validity of ATSDR's evaluations, conclusions, and recommendations is contingent upon the completeness and reliability of the available site data and information.

E. Physical and Other Hazards

The Island Chemical/Virgin Island Chemical site is littered with debris (e.g., old pipes, pieces of metal, wooden pallets, empty drums, old plant equipment, junk cars, semi-truck trailer, old tires, nails) which could pose a threat to site trespassers. Other potential physical hazards include the site's dilapidated and deteriorating buildings and tanks and the unsecured outside stairway from which persons could accidentally fall and be injured. Access to these hazards by trespassers, such as the one observed during the April 1997 site visit, is possible because the site entrance gate is broken and some sections of the site fence are missing.

PATHWAYS ANALYSES

To determine whether persons are exposed to contaminants from the Island Chemical/Virgin Island Chemical site, ATSDR has evaluated the environmental and human components, or pathways, that lead to human exposure. This pathway analysis considers five elements: 1) a source of contamination; 2) an environmental medium in which contaminants may be present or through which contaminants may be transported; 3) a point of exposure; 4) a route of human exposure; and 5) an exposed population.

ATSDR classifies pathways as completed or potential. For a completed pathway to exist, all five elements must exist, and there must be evidence that human exposure to a contaminant has occurred in the past, is currently occurring, or will occur in the future. A potential pathway exists when at least one of the five elements is missing, or is not clearly defined, but could exist (e.g., exposure to a contaminant could have occurred in the past, could currently be occurring, or could occur in the future). A pathway is eliminated when at least one of the five elements is missing and will never exist (e.g., there is no evidence that people have been, are, or will be exposed).

Completed and potential human exposure pathways for the Island Chemical/Virgin Island Chemical site are summarized in Tables 10 and 11, respectively. Estimates of the number of exposed persons for completed exposure pathways and the number of potentially exposed persons for potential exposure pathways are shown in Tables 12 and 13, respectively. The discussion that follows these tables includes those exposure pathways considered important or relevant to the site. However, exposure pathways that have been eliminated are also discussed.

Table 10. Completed Human Exposure Pathways for the Island Chemical/Virgin Island Chemical Site

PATHWAY NAME	EXPOSURE PATHWAY ELEMENTS					TIME
	Source	Medium	Point of Exposure	Route of Exposure	Exposed Population	
Municipal Water Supply	Chemical use, disposal, spillage, and/or leakage	Groundwater	Residences Businesses	Ingestion Inhalation Skin contact	Residents Business employees	Past Present ¹ Future ¹
Airport Water Supply	Chemical use, disposal, spillage, and/or leakage	Groundwater	Airport	Ingestion ² Inhalation ³ Skin contact ³	Airport employees and visitors	Past

¹These are potential rather than completed exposures because it is not known whether any active municipal supply wells are currently impacted by site contaminants or whether any such wells will be impacted in the future.

²For airport employees and visitors

³For airport employees only

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Table 11. Potential Human Exposure Pathways for the Island Chemical/Virgin Island Chemical Site

PATHWAY NAME	EXPOSURE PATHWAY ELEMENTS					TIME
	Source	Medium	Point of Exposure	Route of Exposure	Exposed Population	
Private Well Water	Chemical use, disposal, spillage and/or leakage	Groundwater	Residences Businesses Industry	Ingestion Inhalation Skin contact	Residents Workers Visitors	Past Present Future
Source Chemicals	Chemical use, disposal, spillage and/or leakage	Chemicals used/stored/ manufactured at the plant; Air inside the lab or warehouse building	Plant lab or warehouse	Skin contact; Inhalation; Incidental ingestion	Plant employees Site investigators Site trespassers	Past
Site Soil/ Sediment/ Sludge/	Chemical use, disposal, spillage and/or leakage	Soil Sediment Sludge	Site areas with contaminated soil, sediment, and/or sludge, e.g., process pit, lab pit, and AST area (soil only)*	Incidental ingestion; Inhalation	Plant employees; Site trespassers; Site workers involved in sampling and/or digging/drilling activities*	Past Present* Future*
River Gut Sediments	Chemical use, disposal, spillage and/or leakage	Sediment	River Gut	Ingestion Skin contact	Persons accessing River Gut	Past Present Future
River Gut Surface Water	Chemical use, disposal, spillage and/or leakage	Surface Water	River Gut	Skin contact	Persons accessing River Gut while the plant was operating	Past

*Potential present and/or future exposures for site workers and contaminated subsurface soil in the AST area.

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Table 12. Estimated Population for Completed Exposure Pathways Associated with the Island Chemical/Virgin Island Chemical Site

EXPOSED POPULATIONS		AFFECTED BY A COMPLETED EXPOSURE PATHWAY* FOR:		
Location	Estimated Number	Chloroform	Other THMs (Bromoform, Bromodichloromethane, and Chlorodibromomethane)	Inorganics (e.g., lead, mercury, sodium)
Persons using the municipal water system	15,000	Municipal water supply	Unknown or No Exposure	Municipal Water Supply
Airport employees and visitors	> 325	Airport water supply	Airport water supply	Airport Water Supply

* Refer to Table 10 for a summary of completed exposure pathways.

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Table 13. Estimated Population for Potential Exposure Pathways Associated with the Island Chemical/Virgin Island Chemical Site

POTENTIALLY EXPOSED POPULATIONS		AFFECTED BY A POTENTIAL EXPOSURE PATHWAY* FOR:			
Location	Estimated Number	VOCs (e.g. chloroform, Ethyl benzene, toluene)	SVOCs (e.g., pyridine, phthalates)	Pesticides (e.g. aldrin, chlordane, DDE)	Inorganics (e.g., chromium, copper, lead, sodium)
Private well users in the site area	Unknown	Private well water**	Private well water**	Private well water**	Private well water**
Former plant employees	Unknown	Source chemicals; Site soil/sediment/ sludge	Source chemicals; Site soil/sediment/ sludge	Source chemicals**; Site soil/sediment/ sludge	Source chemicals**; Site soil/sediment/ sludge
Site workers/ investigators	Unknown	Source chemicals; Site soil/sediment/ sludge	Source chemicals; Site soil/sediment/ sludge	Source chemicals**; Site soil/sediment/ sludge	Source chemicals**; Site soil/sediment/ sludge
Site trespassers	Unknown	Source chemicals; Site soil/sediment/ sludge	Source chemicals; Site soil/sediment/ sludge	Source chemicals**; Site soil/sediment/ sludge	Source chemicals**; Site soil/sediment/ sludge
Persons accessing River Gut	Unknown	River Gut sediments; River Gut surface water**	River Gut sediments; River Gut surface water**	River Gut sediments	River Gut sediments

* Refer to Table 11 for a summary of potential exposure pathways.

** Sampling data are unavailable or insufficient to confirm the presence of this contaminant at the potential point of exposure.

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A. Completed Human Exposure Pathways

Municipal Water Supply Pathway

Chloroform has been found in numerous environmental media at the site, including sludge, soils, sediments, groundwater, and in nearby VIWAPA municipal supply wells (Fairplains #6, #8, and #9). Chloroform was also known to have been used earlier at the site, as past investigations found the substance stored in drums and lab containers, as well as empty drums that had previously contained chloroform. It is therefore evident that past releases of chloroform resulted in contamination of site soils and groundwater. Moreover, the groundwater chloroform levels are highest near the center of the site (in MW-2 near the former process pit), lower near the perimeter of the site (in wells P-1 and P-2), and generally lowest away from the site (in nearby VIWAPA and VIPA wells). This suggests that chloroform has migrated from the site and impacted nearby water supply wells.

Persons using the municipal water system before the VIWAPA Fairplains wells were shut down were likely exposed to chloroform in their drinking water. Exposure could have occurred by drinking contaminants in the water (ingestion), by breathing contaminants evaporating from the water during showering or other indoor water uses (inhalation), and by absorbing contaminants through the skin during bathing, showering, etc. (dermal contact). It is estimated that up to 15,000 people—the approximate number of persons served by the municipal water system—could have been exposed to low concentrations of chloroform from using municipal water. Because no sampling data are available for chloroform at the users' taps, the actual number of persons exposed and the actual exposure levels are not known. On one hand, because water from the wells was mixed with water from the VIWAPA desalinization plants in Christiansted and from other non-contaminated VIWAPA municipal wells in the Fairplains water storage tank, chloroform levels at the tap could have been much lower than those measured in the Fairplains water supply wells. (Note: Less than 30% of the water entering the water distribution system reportedly came from the Fairplains wells). The chloroform levels at the tap could also have been lower than the levels found in the municipal supply wells because of volatilization in the water distribution system. On the other hand, because chloroform is a common by-product of water chlorination and water pumped from the Fairplains storage tank was chlorinated prior to entering the water distribution system, it is possible that chloroform levels at the tap could have been similar to the levels found in the water supply wells.

Other VOCs present in groundwater beneath the site, such as ethylbenzene, toluene, and xylenes, have not been detected, to date, in any water supply wells near the site. However, these contaminants have only recently appeared in site groundwater, and no sampling data for the municipal supply wells have been collected in the past several years. It is possible, therefore, that VOCs other than chloroform may eventually migrate from the site and into nearby public water supply wells.

Persons using the municipal water system could also have been exposed to inorganics (such as calcium, lead, magnesium, manganese, mercury, and sodium) detected in the VIWAPA Fairplains wells. Note: These contaminants could be naturally occurring and not be related to contamination at the Island Chemical/Virgin Island Chemical site. Human exposure to inorganics in the Fairplains wells was likely insignificant because of the levels of contaminants in the Fairplains wells, and the large amount of dilution provided by mixing water from the Fairplains wells with water from other VIWAPA well fields and the VIWAPA desalination plant.

Airport Water Supply Pathway

Chloroform has been detected in the two VIPA airport supply wells, which are located less than a quarter mile southwest of the Island Chemical/Virgin Island Chemical site. As previously discussed, chloroform released into groundwater at the site has likely migrated into off-site water supply wells including the two airport wells.

Until recently, water from the two airport wells was pumped into a storage tank near the airport and occasionally chlorinated. Water from the storage tank was distributed to the airport terminal and other operations at the airport for various uses, including drinking fountains and restrooms. Samples collected at various points in the airport's water distribution system between May 1992 and October 1995 indicated chloroform and three other trihalomethanes (THMs)—bromoform, bromodichloromethane, and chlorodibromomethane—in the airport's water supply. Bromoform, bromodichloromethane, and chlorodibromomethane in the water distribution system could have been by-products of chlorination, rather than actual site-related contaminants.

Airport visitors were likely exposed to THMs in the airport's water supply through ingestion (i.e., drinking), while airport employees were likely exposed through ingestion and possibly inhalation and skin contact (during showering in the employees' shower rooms.) About 325 airport employees are estimated to have been exposed to low levels of THMs in the airport water supply; however, the number of airport visitors exposed is unknown.

Airport visitors and employees could have also been exposed to inorganic contaminants (such as aluminum, iron, lead, sodium, and vanadium) in the airport's drinking water. These contaminants were detected in the airport's two water supply wells; however, they could have been naturally occurring and, therefore, unrelated to contamination at the site.

The Alexander Hamilton Airport was recently connected to the VIWAPA municipal water system to supply all its water needs. At that time, the two airport wells were shut down. VIPA officials have indicated that the two wells will not be used in the future, except in cases of emergency.

B. Potential Human Exposure Pathways

Private Well Water Pathway

Numerous private wells have been reported in the site area for uses such as drinking water, irrigation, and commercial/industrial operations; however, information regarding specific wells and their locations is limited. Two wells at the concrete plant about 150 feet east of the site and two wells at the asphalt plant about 700 feet northwest of the site are the private wells closest to the site. These four wells, which are located across River Gut from the site, are used for industrial/commercial purposes only—not for potable water supply. The closest private wells used for drinking water are not known for certain, but could be the wells at the Golden Grove Trailer Park located approximately three-quarters of a mile northwest of the site.

Although no private wells in the site area are likely to have been impacted by groundwater contamination from the site, no sampling data are available at the present time for confirmation. It is possible that private wells in the site area could be affected in the future, as chloroform and other VOCs (such as ethylbenzene and xylene) continue to migrate away from the site. People using such wells for drinking water and other household uses could be exposed to VOCs from the site through ingestion, inhalation, and dermal contact (as discussed previously under the Municipal Water Supply Pathway).

Source Chemicals Pathway

Three main groups of people were potentially exposed to chemicals used, manufactured, or stored at the Island Chemical/Virgin Island Chemical plant: 1) former plant employees, 2) site investigators, and 3) site trespassers. Former plant employees, such as lab or warehouse workers, who handled or worked around raw materials, intermediate products, or finished products could have been exposed to contaminants through inhalation or skin contact. Site investigators involved in environmental inspections, sampling activities, or removal actions at the site were potentially exposed to chemicals or wastes stored or disposed of on the site property. For instance, during site removal activities in January 1990, environmental technicians were likely exposed to benzyl chloride and triethylamine while sampling drums in the warehouse. According to site documents, the technicians experienced skin irritation when benzyl chloride broke through their protective clothing and were later evacuated from the warehouse when triethylamine vapors reached unsafe levels. Site trespassers could have been exposed to chemicals or wastes stored onsite after the plant shutdown. For example, in October or November 1990, trespassers entered the warehouse building and overturned a number of drums containing powders (such as salicylic acid), and corrosive liquids (such as acetic acid and sodium hydroxide). The trespassers were probably exposed to some of these chemicals through skin contact and inhalation when the contents of the drums were dumped on the warehouse floor.

Site Soil/Sediment/Sludge Pathway

In the past, a number of organic contaminants (including benzophenone, chloroform, pyridine, quinidine gluconate, quinidine sulfate, and toluene) were found in site soils, sediments, and/or sludges. Most of the contaminants were limited, however, to specific areas of the site, such as the process pit area, the lab pit/loading dock area, the AST area, and the central storm drain. Over the years, the contaminated materials in these areas were either removed or remediated. Although some persons, such as plant employees, site investigators, or site trespassers could have been exposed to contaminants in site soils, sediments, and/or sludges in the past, the potential for current exposure is minimal.

Current soil contamination at the site is generally limited to an area near Tanks #8 and #9 in the AST area. This contamination, which reportedly resulted from spillage and/or leakage of volatile chemicals and possibly diesel fuel from one or more of the ASTs, is found at a depth of more than 10 feet below ground. Human exposure to contaminated soil at such a depth is unlikely except for persons involved in drilling or excavation activities, such as site investigators or remedial workers. These persons might experience short-term exposure to soil contaminants through incidental ingestion of contaminated soil or through inhalation of contaminants volatilizing from the soil. Such exposures, however, would likely be minimal since site workers are likely to use appropriate protective measures when conducting extensive soil-disturbing activities in areas where contaminated soil is present.

River Gut Sediment Pathway

Low levels of organic contaminants, such as butyl benzyl phthalate and di-n-octylphthalate, and elevated levels of inorganics, such as beryllium and zinc, have been detected in the past in the sediments of the River Gut stream channel. These contaminants were found primarily where process water and contaminated stormwater from the central storm drain discharged to the gut. Persons who access the gut, such as those observed standing with their horses in the gut downstream of the site, could be exposed to contaminants in the sediments through incidental ingestion and skin contact. However, due to the low levels of contaminants detected in the gut sediments and the difficulty of traversing the heavily vegetated gut stream channel next to the site, significant exposure to site-related contaminants in gut sediments is unlikely.

River Gut Surface Water Pathway

In the late 1970s and early 1980s, while the plant was in operation, process wastewater was discharged to River Gut from the lab pit and from the process pit (via the central storm drain). Based on historical sampling data from the lab pit, process pit, and storm drain lines, these discharges contained numerous organic contaminants, such as chloroform, methylene chloride, phenol, toluene and xylenes, and reportedly had a very high pH (13). As such, children who swam or played in the gut downstream of the plant (13) may have been exposed to

contaminants in the gut's surface water through dermal absorption. In addition, due to the high pH of the plant's discharges, these children may also have experienced skin and/or eye irritation from swimming or wading in the gut. Human exposure to contaminated surface water in the gut likely ceased after the plant shut-down in late 1982 and stopped discharging process wastewater to the gut.

PUBLIC HEALTH IMPLICATIONS

A. Toxicological Evaluation

Introduction

The contaminants of concern (Table 14) released into the environment at the Island Chemical/Virgin Island Chemical site have the potential to cause adverse health effects. However, for adverse health effects to occur the pathway for exposure must be completed. A release does not always result in exposure. Rather, a person can only be exposed to a contaminant by coming in contact with the contaminant. Health effects resulting from the interaction of an individual with a hazardous substance in the environment depend on several factors. One is the route of exposure: that is, whether the chemical is breathed, consumed with food, soil, or water, or whether it contacts the skin. Another factor is the dose to which a person is exposed, and the amount of the exposure dose actually absorbed. Mechanisms by which chemicals are altered in the environment or inside the body, as well as the combination (types) of chemicals are also important. Once exposure occurs, characteristics such as age, sex, nutritional status, genetics, life style, and health status of the exposed individual influence how the contaminants are absorbed, distributed, metabolized, and excreted. Together, those factors and characteristics determine the health effects that can occur as a result of exposure to a contaminant. Much variation in those mechanisms exists among individuals. For example, all children mouth or ingest non-food items to some extent. The degree of pica behavior varies widely in the population, and is influenced by nutritional status and the quality of care and supervision (18). Groups that are at increased risk for pica behavior are children 1 to 3 years old, children from families of low socioeconomic status, and children with neurologic disorders (e.g., brain damage, epilepsy, and mental retardation).

Health Guidelines

Health guidelines provide a basis for comparing estimated exposures with concentrations of contaminants in different environmental media (soil, air, water, and food) to which people could be exposed.

Noncancer Health Effects

ATSDR has developed a Minimal Risk Level (MRL) for contaminants commonly found at hazardous waste sites. The MRL is an estimate of daily exposure to a contaminant below which noncancer, adverse health effects are unlikely to occur. MRLs are developed for different routes of exposure (e.g., inhalation and ingestion), and for length of exposure, such as acute (less than 14 days), intermediate (15-364 days), and chronic (365 days or greater). Oral MRLs are expressed in units of milligrams of contaminant, per kilogram of body weight, per day (mg/kg/day). Because ATSDR has no methodology to determine amounts of chemicals absorbed through the skin, the Agency has not developed MRLs for dermal exposure. The method for deriving MRLs does not include information about cancer, therefore, an MRL does not imply anything about the presence, absence, or level of cancer risk. If an ATSDR MRL is not available as a health value, then EPA's Reference Dose (RfD) is used. The RfD is an estimate of daily human exposure to a contaminant for a lifetime below which (non-cancer) health effects are unlikely to occur (18).

Cancer Health Effects

The Environmental Protection Agency (EPA) classifies chemicals as Class A, Class B, Class C, Class D, or Class E. This classification defines a specific chemical's ability to cause cancer in humans and animals. According to EPA, Class A chemicals are known human carcinogens, and Class B chemicals are probable human carcinogens. Class B is further subdivided into two groups: Group B1 consists of chemicals for which there is limited evidence of carcinogenicity from epidemiologic studies in humans; and Group B2 consists of chemicals for which there is sufficient evidence of carcinogenicity in animals, but inadequate evidence or no data available from epidemiologic studies in humans. Group C chemicals are possible human carcinogens. Group D chemicals are not classifiable as to human carcinogenicity, and Group E chemicals are those for which there is evidence that they are not carcinogenic to humans. For carcinogenic substances, EPA has established the Cancer Slope Factor (CSF) as a guideline. The CSF is used to determine the number of excess cancers resulting from exposure to a contaminant. In its Annual Report on Carcinogens, the National Toxicology Program (NTP) classifies a chemical as a "known human carcinogen" based on sufficient human data. Its classification of a chemical as being "reasonably anticipated to be a carcinogen" (RAC) is based on limited human or sufficient animal data. ATSDR considers the above physical and biological characteristics when developing health guidelines (18).

Exposure Dose Estimation

To link the site's human exposure potential with health effects that can occur under site-specific conditions, ATSDR estimates human exposure to the site contaminant from ingestion and/or inhalation of different environmental medium (18). The following relationship is used to determine the estimated exposure to the site contaminant:

$$ED = (C \times IR \times EF) / BW$$

where: ED = exposure dose (mg/kg/day) C = contaminant concentration
IR = intake rate EF = exposure factor
BW = body weight

Standard body weights for adults, young children, and toddlers are 70 kg, 16 kg and 10 kg, respectively. The maximum contaminant concentration detected at a site for a specific medium is used to determine the estimated exposure, and use of the maximum concentration will result in the most protective evaluation for human health. The ingestion rates used are 1 liter of water per day for children and 2 liters of water per day for adults. Some exposures are intermittent or irregularly timed, and for those exposures, an exposure factor (EF) is calculated which averages the dose over the exposed period. When unknown, the biological absorption from the water is assumed to be 100%.

Development of Risk Estimates

Noncancer Risks

For noncancer health risks, the contaminant intake was estimated using exposure assumptions for the site conditions. This dose was then compared to a risk reference dose (estimated daily intake of a chemical that is likely to be without an appreciable risk of health effects) developed by ATSDR or EPA.

Noncancer effects, unlike carcinogenic effects, are believed to have a threshold (i.e., a dose below which adverse effects will not occur). As a result, the current practice is to identify, usually from animal toxicology experiments, a *no-observed-adverse-effect-level* (NOAEL). This is the experimental exposure level in animals at which no adverse toxic effect is observed. The NOAEL is then divided by an uncertainty factor (UF) to yield a risk reference dose. The UF is a number that reflects the degree of uncertainty that exists when experimental animal data are extrapolated to the general human population. The magnitude of the UF takes into consideration various factors, such as sensitive sub-populations (for example, children, pregnant women, and the elderly), extrapolation from animals to humans, and the

incompleteness of available data. Risk reference doses are selected to be much lower than dosages that do not cause adverse health effects in laboratory animals. Thus, exposure doses at or below the risk reference dose are not expected to cause adverse health effects in humans.

The measure used to describe the potential for noncancer health effects to occur in an individual is expressed as a ratio of estimated contaminant intake to the risk reference dose. If exposure to the contaminant exceeds the risk reference dose, there is concern for potential noncancer health effects. As a rule, the greater the ratio of the estimated contaminant intake to the risk reference dose, the greater the level of concern. A ratio equal to or less than one is generally considered an insignificant (minimal) increase in risk.

Cancer Risks

Increased cancer risks were estimated by using site-specific information on exposure levels for the contaminant of concern and interpreting them using cancer potency estimates derived by EPA, for that contaminant. An increased, excess-lifetime, cancer risk is not a specific estimate of expected cancers. Rather, it is an estimate of the increase in the probability that a person could develop cancer sometime in his or her lifetime following exposure to that contaminant.

Knowledge of cancer mechanisms is currently insufficient to decide if a level of exposure to a cancer-causing agent exists below which there is no risk of getting cancer—i.e., a threshold level. Every exposure, no matter how low, to a cancer-causing compound is assumed to be associated with some increased risk. As the dose of a carcinogen decreases, the chance of developing cancer decreases, but each exposure is accompanied by some increased risk.

A general consensus has not been reached within the scientific or regulatory communities on an acceptable level of estimated excess cancer risk. Because of the uncertainties in our scientific knowledge about the mechanism of cancer, some have recommended the use of the relatively conservative, excess-lifetime, cancer risk level of one in one million. Others feel that lower or higher risks can be acceptable, depending on scientific, economic and social factors. An increased lifetime cancer risk of one in one million or less is generally considered an insignificant increase in cancer risk.

Sources of Health Guideline Information

ATSDR has prepared toxicological profiles for many substances found at hazardous waste sites. Those documents present data and interpret information on the substances. Health guidelines, such as ATSDR's MRL and EPA's RfD and CSF are included in the toxicological profiles. Those health guidelines are used by ATSDR health professionals in determining the potential for developing adverse noncarcinogenic health effects and/or cancer from exposure to

a hazardous substance. Preparers of this public health assessment have reviewed the profiles for the contaminants of concern at the Island Chemical/Virgin Island Chemical site.

Development of Estimated Risks at the Island Chemical/Virgin Island Chemical Site

ATSDR has identified two off-site, completed, human-exposure pathways associated with the Island Chemical/Virgin Island Chemical site. The first completed exposure pathway involves airport employees and visitors who were likely exposed in the past to low levels of contaminants (Table 14), including THMs and inorganics (i.e., aluminum, iron, lead, sodium, and vanadium) in the airport water supply wells via ingestion and/or dermal contact. Because the point of exposure was at taps or showers located in the airport, it is believed that these exposures would have been intermittent. Because the nature of the contaminants and the process of delivery of the drinking water, it is unlikely that exposed persons would have been subjected to any contaminant at the maximum concentration detected during sampling events. It is estimated that about 325 airport employees could have been exposed to the low level contaminants in the airport water supply; however, the number of airport visitors exposed is unknown. The second completed exposure pathway involves users of the municipal water supply who were likely exposed in the past to low levels of chloroform, lead, manganese, mercury, and sodium (Table 14) from the VIWAPA Fairplains wells. Exposure to these chemicals would have occurred at any location that utilizes the municipal water supply as a source of drinking water. It is estimated that up to 15,000 people—the approximate number of persons served by the municipal water system—could have been exposed to low level contaminants in the municipal water supply.

Discussion of Contaminants of Concern

Bromoform (19)

Bromoform is a clear, heavy liquid that does not burn and is relatively stable in water. In the past it has been used by industry to dissolve dirt and grease and to make other chemicals, such as fire extinguisher fluid. Earlier this century it was used as a medicine to help children with whooping cough fall asleep. Currently, it is produced in small amounts for use in laboratories and in electronic and geological testing.

Bromoform is inadvertently generated during water chlorination when chlorine reacts with endogenous organic materials such as humic acid. Usually the level of bromoform in chlorinated drinking water is between 1 and 10 micrograms per liter ($\mu\text{g/l}$). Bromoform has also been detected in chlorinated swimming pools. In these situations bromoform can enter the body via ingestion, inhalation, and possibly via dermal absorption (although this has not been studied). Most of the bromoform is eliminated from the body via respiration, with 50% to 90% being eliminated within eight hours.

Bromoform was detected at a maximum concentration of 121 $\mu\text{g/l}$ in water samples taken from the airport supply wells. The calculated exposure doses are more than 100,000 times lower than the short-term exposure *lowest-observed-adverse-effect-level* (LOAEL) for humans (sedation) and the long-term NOAEL for animals (ulcer). No studies were found regarding health effects in humans following inhalation or dermal exposure to bromoform. At the reported concentrations, ATSDR does not expect any adverse, noncancer, health effects to occur in people exposed to bromoform in the airport water supply.

The EPA classifies bromoform as a Class B2 probable human carcinogen, based upon animal studies. The estimated exposure dose is more than 100,000 times lower than the cancer effect level (CEL) for animals. No increased risk for developing carcinogenic effects is expected in people exposed to the water at the airport.

Studies in animals suggest that humans exposed to alcohols, ketones, or other drugs that influence halomethane metabolism might be more susceptible to the toxic effects of bromoform. Because these organs are adversely affected by exposure to bromoform, persons with existing renal or hepatic disease might also be more susceptible to the toxic effects.

Bromodichloromethane (20)

Bromodichloromethane (BDCM) is a colorless, nonflammable, heavy liquid that evaporates quickly. It is usually found in the environment, dissolved in water or evaporated in air. BDCM is formed as a by-product when chlorine is added to drinking water. Small amounts of BDCM are produced for use in laboratories or in making other chemicals.

BDCM was detected in the airport water supply wells at a maximum concentration of 2 $\mu\text{g/l}$. Surveys of BDCM levels in chlorinated public drinking water systems across the United States have revealed that BDCM is present in most systems at concentrations averaging around 1 to 20 $\mu\text{g/l}$. The health effects resulting from short-term or long-term exposure via ingestion of water or inhalation of air containing specific levels of BDCM are not known. However, noncancer health effects are not expected to occur in people exposed to BDCM at the reported level.

BDCM is classified as a Class B2 probable human carcinogen, based upon animal data. However, at the reported level, ATSDR expects no increased risk of developing cancer from exposure to BDCM.

No studies were found regarding human populations especially susceptible to BDCM. However, since BDCM is known to cause liver injury in animals, it is possible that people with preexisting liver disease may be more susceptible to the hepatotoxic effects of BDCM. Likewise, people with preexisting kidney disease may also be susceptible to BDCM. By

analogy with carbon tetrachloride, persons who are heavy drinkers and/or take certain drugs that affect the liver may also be particularly susceptible to the effects of BDCM.

Chloroform (21)

Chloroform (or trichloromethane) is a colorless liquid with a pleasant, nonirritating odor. It has a slight, sweet taste. Nearly all chloroform made in the United States is used to produce other chemicals. Small amounts of chloroform are formed as an unwanted byproduct when chlorine is added to water to destroy bacteria.

Chloroform can easily enter the body through the skin. If the water is hot enough for the chloroform to evaporate, the chemical can also be inhaled during showering or bathing. Inhaled and ingested, chloroform quickly enters the bloodstream from the lungs and intestines. Once in the bloodstream it can be transported to other body tissues. Chloroform has an affinity for body fat. Some of the chemical is excreted in expired air, unchanged, and some is broken-down into by-products that, once inside susceptible cells, can cause harmful effects. Some of these breakdown products are released from the body in expired air, and a small portion leave the body via urination and excretion.

Chloroform has been detected in water from outdoor pools, indoor pools and spas at concentrations ranging between 4 and 402, 3 and 580, and <0.1 and $530 \mu\text{g/l}$, respectively. In another study, water from whirlpool spas treated with chlorine disinfectant contained chloroform concentrations ranging from 15 to $674 \mu\text{g/l}$. Chloroform was found in airport water supply wells and municipal wells at a maximum concentration of 11.5 and $75 \mu\text{g/l}$, respectively. The chronic oral MRL for chloroform is 0.01 mg/kg/day. The estimated daily exposure for persons possibly consuming the water is below the chronic oral MRL; therefore, exposure to the contaminant, at the reported concentrations, is not expected to cause adverse non-cancer health effects.

No studies were found regarding the carcinogenic effects in humans and animals following inhalation or dermal exposure to chloroform. Epidemiologic studies support a weak but significant association between risks of colon, bladder and rectal cancer and water chlorination constituents. Although human data suggest a possible increased risk of cancer at these three sites from exposure to chloroform in chlorinated drinking water, because chloroform is the predominant trihalomethane in drinking water, the data are too weak to support a conclusion about the carcinogenic potential. However, EPA has classified the substance as a probable human carcinogen by inhalation and ingestion. Both the NTP and the International Agency for Research on Cancer (IARC) have determined that this substance is anticipated to be a carcinogen. Based on the above worse-case scenario, there would be no increased risk of cancer from chronic exposure to chloroform at the maximum detected level of $75 \mu\text{g/l}$ in the contaminated water.

Individuals with liver or kidney impairment are more susceptible to chloroform toxicity because chloroform is metabolized mainly by these organs. Drinking water containing higher than acceptable levels of chloroform for extended periods of time can increase the risk for toxic side-effects. Chloroform's toxic effects upon the liver can also be increased by exhaustion and starvation. Studies on mice indicate that males can be more susceptible to the toxic effects of chloroform than females. This was associated with the level of testosterone in the animals, but it is not presently known if the same applies to humans.

Chlorodibromomethane (19)

Chlorodibromomethane (CDBM) is heavy, colorless, nonflammable liquid trihalomethane with a sweetish odor. In the past it was used to make other chemicals, such as fire extinguisher fluids, spray can propellents, and pesticides. It is currently produced only in small amounts for use in laboratories. CDBM is rarely measurable in non-chlorinated waters; however, it is frequently found in chlorinated drinking water. The levels of CDBM in finished drinking water has been investigated in several studies and, except for a few cases, the concentrations were less than 100 $\mu\text{g/l}$, with the average concentrations generally less than 10 $\mu\text{g/l}$.

CDBM was found in water samples taken from the airport water supply wells at a maximum concentration of 8 $\mu\text{g/l}$. The estimated exposure doses were more than 1,000,000 lower than the short-term and long-term LOAEL for less serious effects (minimal histological changes and fatty changes, respectively) in animals. No studies were found regarding health effects in humans following exposure to CDBM via inhalation, ingestion, or dermal absorption. ATSDR does not expect any adverse noncancer health effects in people exposed to CDBM at the levels reported.

CDBM is classified by EPA as a Class B2 probable human carcinogen, based upon animal study data. However, ATSDR expects no increased risk of developing cancer from exposure to CDBM at the reported levels.

Studies in animals suggests that humans exposed to alcohols, ketones, or other drugs that influence halomethane metabolism, might be more susceptible to the toxic effects of chlorodibromomethane. Persons with existing kidney or liver disease might also be more susceptible, since these organs are adversely affected by exposure to chlorodibromomethane.

Lead (22)

Lead (Pb) is a naturally occurring bluish-grey metal. It has no special taste or smell and can be found in all parts of the environment. Most of the Pb comes from human activities, such as mining, manufacturing, and burning fossil fuels. Pb's most important use is in the production of batteries. It has many other uses, and can also be found in ammunition, metal products

(pipes and solder), roofing, and devices to shield x-rays. Because of health concerns, Pb from gasoline, pipe solder, caulking, paints, and ceramics has been drastically reduced in recent years.

Foods such as fruits, grains, meat, seafood, soft drinks, vegetables and wine may contain Pb. Cigarettes also contain small amounts of lead. In addition, more than 99% of all drinking water contains less than 0.005 milligrams per liter (mg/l) Pb. However, the amount of Pb taken into the body through drinking water can be higher in communities with acidic water supplies. Children residing in older dwellings may be exposed to Pb by eating lead-based paint chips from peeling surfaces. This is particularly a problem in lower income communities. For occupationally exposed individuals, the usual route of exposure is through inhalation of Pb particles.

Pb was detected in water samples from the airport supply wells (0.018 mg/l) and the municipal wells (0.0042 mg/l). ATSDR has no MRL and EPA has no RfD for Pb, however, the estimated exposure doses for each target population is below the LOAEL for neurological effects in monkeys (0.05 mg/kg/day). Ingestion of Pb at very high levels, over time, can result in neurological impairment such as learning disabilities, especially in children. ATSDR believes that most of the exposures would have occurred on an intermittent basis, to low levels of contaminants. Currently ATSDR does not have any biological data on people who could have ingested the contaminated water, and such information would be required to make an accurate determination of possible health effects.

Pb is classified by EPA as a Class B2 probable human carcinogen, based on animal studies. While there is inadequate evidence to determine Pb's carcinogenicity in humans, the estimated exposure dose is more than 100,000 times lower than the CEL in animals.

Pb exposure is particularly hazardous for unborn children and young children because they are more sensitive to it during their development. The American Academy of Pediatrics considers Pb a significant hazard to the health of children in the United States. The blood lead levels defining lead poisoning have been declining, and the current consensus level of concern for children is 10 to 14 micrograms per deciliter ($\mu\text{g/dL}$). Effects on stature have been reported to begin at levels as low as 4 $\mu\text{g/dL}$, which is the present limit for accurate blood lead measurement. Taken together, effects occur over a wide range of blood lead concentrations, with no indications of a threshold. No safe level has yet been found for children, and even in adults, effects are being discovered at lower and lower levels as more sensitive analyses and measurements are developed.

Manganese (23)

Manganese is a silver-colored metal in its pure form and is found as a natural constituent in many types of rock. The metal form does not occur naturally in the environment, but rather in combination with other chemicals such as chlorine, oxygen, and sulfur. The metal manganese is mixed with iron to make steel. Some manganese compounds are used in the production of batteries, as an ingredient in some ceramics, pesticides, and fertilizers, and in dietary supplements.

The level of manganese in drinking water is usually about 0.004 mg/l, whereas in soils the level usually ranges from 40 to 900 mg/kg. For nearly all people, food is the main source of manganese, and usual daily intakes range from about 2,000 to 9,000 micrograms per day. The exact amount consumed depends upon the diet.

Manganese was found in water samples taken from municipal wells at concentrations ranging from 17.7 to 400 micrograms per liter. The estimated exposure dose for children drinking the water on a daily basis is slightly lower than the LOAEL for less serious effects in humans (0.059 mg/kg/day). Dermal absorption of manganese does not appear to be toxicologically significant, and no studies were found regarding carcinogenic effects in humans following exposure to manganese via ingestion, inhalation, or dermal absorption. ATSDR does not expect any adverse non-carcinogenic or carcinogenic health effects in people exposed to manganese at the levels detected in the municipal well water.

Neonates tend to retain a higher amount of manganese in their bodies than adults, and very high levels of retained manganese can lead to neurotoxicity. Other susceptible populations include the elderly, people with liver disease, and people with respiratory disease. Smokers are more susceptible to development of respiratory symptoms (wheezing, bronchitis) from inhalation of manganese dusts than non-smokers.

Mercury (24)

Mercury is a naturally occurring metal that has several forms. The metallic mercury is a shiny, silver-white, odorless liquid. If heated, it is a colorless, odorless gas. Mercury combines with other elements to form salts, most of which are white powders or crystals. Mercury combined with carbon forms organic mercury. The most common organic mercury is methyl mercury.

Metallic mercury is used to produce chlorine gas and caustic soda (lye) and also in thermometers, dental fillings, and batteries. Mercury salts are used in skin-lightening creams and in antiseptic creams and ointments. Since mercury occurs naturally in the environment it may be present in surface waters even when man-made sources of mercury are not present.

The concentrations of mercury in rainwater and fresh snow are generally below $0.2 \mu\text{g/l}$, and drinking water is generally assumed to contain less than $0.025 \mu\text{g/l}$ of mercury.

Mercury was detected in municipal wells and airport supply wells at maximum concentrations of 3.3 and $1.2 \mu\text{g/l}$, respectively. The estimated exposure doses are more than 100,000 times lower than the LOAEL for less serious effects in humans (nausea, vomiting, etc.). Therefore, ATSDR does not expect any adverse noncancer effects to occur in people who drank the contaminated waters at the levels reported.

Because of lack of data from studies on people and laboratory animals, The Department of Health and Human Services, the Environmental Protection Agency, and the International Agency for Research on Cancer, have not classified mercury as to its human carcinogenicity. No studies were found regarding cancer in humans following oral or dermal exposure to inorganic mercury, and no studies were located regarding cancer in animals following inhalation exposure to metallic mercury.

Sodium (chloride) (25)

Sodium chloride is generally in the form of colorless, transparent crystals to a white, crystalline powder. It is often referred to as "salt". Sodium chloride, at various concentrations, has a wide variety of uses in day-to-day life. In industry it is often used to produce chlorine, caustic soda, and soda ash, mainly in the form of brine. Sodium chloride is rapidly attacked by bromine trifluoride.

Sodium chloride is required by the human body to maintain proper electrolyte balance. Sodium, presumably in the form of sodium chloride, was detected in samples taken from the airport supply wells and the municipal wells at maximum concentrations of 572 mg/l and 590 mg/l , respectively.

Young children are very susceptible to the toxic effects of sodium chloride. Accidental substitution of sodium chloride for lactose in infants formulas have led to accidental fatal poisonings. Sodium chloride is filtered by the kidneys, therefore, people with kidney disease are susceptible to the effects of sodium chloride.

Vanadium (26)

Vanadium is a naturally occurring white to grey metal that is often found in the crystalline form. It does not occur in the environment in its pure state, which is virtually odorless, but rather combined with other elements to form chloride, oxygen, sodium, or sulfur compounds. It is not well known which forms of vanadium are more likely to be found at waste sites.

Table 14. Results of Comparison of Estimated Exposure Dose to Health Guidelines for Persons Exposed to Off-Site Contaminants Related to the Island Chemical/Virgin Island Chemical Site

Contaminant	Pathway Medium	Health Guideline (mg/kg/day)			Cancer Class
		Value	Source	Exceeded by Estimated Exposure Dose	
Bromoform	Airport Supply Wells	0.2	MRL	NO	B2
Bromodichloromethane	Airport Supply Wells	0.02	MRL	NO	B2
Chloroform	Airport Supply Wells Municipal Wells	0.01	MRL	NO	B2
Chlorodibromomethane	Airport Supply Wells	0.03	MRL	NO	C
Lead	Airport Supply Wells Municipal Wells		None		B2
Manganese	Municipal Wells	0.005	RfD	YES	
Mercury	Airport Supply Wells Municipal Wells	0	RfD		
Sodium	Airport Supply Wells Municipal Wells		Unknown		
Vanadium	Airport Supply Wells	0	RfD		
Unknown = Health guideline not available MRL = ATSDR's Minimal Risk Level					
None = Health guideline not available RfD = EPA's Reference Dose					

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Most people are exposed to low concentrations of vanadium daily via food, drinking water, and air. A person may take in as much as 10-20 micrograms per day in food.

Vanadium has been found in groundwater and at hazardous waste sites throughout the United States. In the past, vanadium was found in the airport water supply wells at a concentration of 50.3 $\mu\text{g/l}$. Drinking water is not considered to be an important source for vanadium exposure as vanadium does not dissolve well in water, but it can be carried in the water much the same way that sand is carried. Vanadium that has been ingested is unlikely to enter the bloodstream; it will most likely be excreted in the feces. It is also unlikely to enter the body via dermal exposure. The estimated exposure doses are less than the intermediate MRL of 0.003 mg/kg/day; therefore no illnesses are expected for people ingesting the water on an intermittent basis at the levels reported.

Toxicological Evaluation Summary

The estimated exposure dose for children consuming municipal water containing manganese at the maximum concentration reported was greater than EPA's reference dose. It was slightly less than the LOAEL for less serious effects in humans; therefore, ATSDR does not expect any adverse noncancer health effects to occur in the exposed children. Because of the lack of biological data, ATSDR could not determine if adverse health effects were likely to occur or have occurred as a result of exposure to lead in the water supplies. Adverse noncancer health effects are not expected from exposure, via ingestion, to the other contaminants evaluated in the Public Health Implications section of this document. However, because of the lack of air data, inhalation exposures could not be thoroughly evaluated at this time.

Carcinogenic health effects are not expected to occur as a result of exposure to bromoform, bromodichloromethane, chloroform, chlorodibromomethane, manganese, and vanadium. It is not known if lead, sodium, or mercury causes cancer in humans.

B. Health Outcome Data Evaluation

ATSDR conducts a review of health outcome data when the toxicologic evaluation indicates the likelihood of adverse health outcomes or when the community near the site has health concerns. The evaluation of health outcome data can give a general picture of the health of a community, or confirm the presence of excess disease or illness in a community. However, elevated rates of a particular disease might not necessarily be caused by hazardous substances in the environment. Other factors, such as personal habits, socioeconomic status, and occupation, can also influence the development of disease. In contrast, even if elevated rates of disease are not found, a contaminant can still have caused illness or disease.

The population surrounding the site is relatively small and transient. Health outcome data were not evaluated at this site because no previous health studies on the population around the site were identified during the gathering of data and information for this public health assessment. In addition, the Virgin Islands do not have a centralized cancer registry that could be used to determine if the occurrence of cancer, if any, near the Island Chemical/Virgin Island Chemical site is more than would be expected.

C. Community Health Concerns Evaluation

ATSDR has conducted two visits to the Island Chemical/Virgin Island Chemical NPL site. No community health concerns were identified during the process of gathering data and information for this public health assessment.

CONCLUSIONS

1. ATSDR has classified the Island Chemical/Virgin Island Chemical site a **no apparent public health hazard** because available environmental sampling data do not indicate that people have been exposed to site contamination at levels that would be expected to cause adverse health effects. Nevertheless, ATSDR believes the site's numerous physical hazards, including miscellaneous debris (e.g., old pipes, pieces of metal, old plant equipment, junk cars, old tires, nails, old lockers, old lab equipment); dilapidated and deteriorating buildings and storage tanks; and unsecured outside stairways could pose a minor safety threat to site trespassers.
2. ATSDR has identified two completed human exposure pathways associated with contamination from the site: 1) users of the municipal water supply who were likely exposed to low levels of contaminants, such chloroform, lead, and mercury, in their residential drinking water, and 2) workers and visitors at the Alexander Hamilton Airport who were likely exposed to low level of contaminants, including bromoform, bromodichloromethane, chloroform, chlorodibromomethane, aluminum, iron, lead, mercury, and aluminum, in the airport's drinking water. These past exposures are no longer occurring because the municipal and airport wells that were impacted by contamination are no longer in use. In addition, some of the contaminants detected in the municipal and airport water supplies might not be directly related to contamination at the site.

ATSDR has conducted a toxicological evaluation of contaminants (which may be site-related) in the municipal and airport drinking water supplies. Based upon that evaluation, ATSDR believes that adverse noncancer health effects will not occur. In addition, ATSDR believes that there would be no increased risk of developing cancer from exposures to those contaminants with known carcinogenic endpoints.

3. ATSDR has also identified the following potential human exposure pathways associated with the site: 1) residents in the site area who use private well water for their household water needs (e.g., drinking, bathing, showering); 2) former plant employees, site investigators, and trespassers who could have come into contact with chemicals in raw materials, finished products, and wastes associated with former site operations, or contaminated soils and sediments resulting from former site operations; and 3) persons who may have come into contact with surface water (while the plant was in operation) or sediments in the River Gut stream channel downstream of the site.

ATSDR believes that the public health significance of these potential exposures is likely to be minimal. However, additional information regarding the use and quality of private well water in the site area is necessary to fully evaluate this potential exposure pathway.

4. Health outcome data for the population surrounding the site was not identified during the gathering of information and data for this public health assessment.

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5. Data inadequacies include the following: (1) limited sampling data for the VIWAPA Fairplains wells and the VIPA airport supply wells; (2) no sampling data for other VIWAPA wells near the site, such as the Bethlehem, Negro Bay, Golden Grove wells; and (3) no sampling data or water use information for private wells in the site area.
6. No community health concerns about the Island Chemical/Virgin Island Chemical site have been expressed by the citizens of St. Croix.

RECOMMENDATIONS

Site Characterization Recommendations

1. If the VTWAPA Fairplains wells are ever returned to service, sample the wells and the Fairplains storage tank to ensure that site-related contaminants are not present in the wells or in the municipal water distribution system at levels of health concern.
2. Sample the two VIPA airport supply wells for site-related contaminants if they are ever used in the future to supply drinking water to the airport.
3. Consider sampling active VTWAPA municipal supply wells near the site, including the Bethlehem, Golden Grove, and Negro Bay wells, to ensure that these wells are not being impacted by groundwater contamination from the site.
4. If possible, identify private drinking water wells in the site area that could potentially be impacted by contaminants from the site, and sample the identified wells to ensure that site-related contaminants are not present at levels of health concern.

Cease/Reduce Exposure Recommendations

1. Restrict access to the site to protect persons from the numerous physical hazards present and to prevent unauthorized persons from entering the site during environmental sampling or remediation activities.
2. Implement actions, where appropriate, to prevent groundwater contamination from spreading to down gradient areas and possibly impacting other public and/or private water supply wells.
3. Consider institutional controls to prevent future site occupants from using contaminated groundwater beneath the site for drinking water supply. Such controls should remain in place until remediation or natural processes have reduced the contaminant levels to below levels of health concern.
4. Provide any environmental sampling/investigative personnel or remedial site workers working in areas where significant site contamination is present, or potentially present (such as the process pit and AST areas), with adequate protective equipment and training in accordance with 29 CFR 1910.120. Also, ensure that appropriate National Institute for Occupational Safety and Health (NIOSH) and Occupational Safety and Health Administration (OSHA) guidelines are followed.

Health Activities Recommendations

In accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended, the data and information developed in the Island Chemical/Virgin Island Chemical Public Health Assessment have been reviewed by ATSDR's Division of Health Education and Promotion (DHEP) and Division of Health Studies (DHS) for appropriate follow-up health activities. Based on their review, DHEP and DHS have determined that no follow-up health activities are indicated for the site at this time. However, ATSDR will reevaluate the site for appropriate follow-up health activities if future data or information indicates that human exposure to site contaminants is occurring at levels of public health concern.

PUBLIC HEALTH RECOMMENDATIONS AND ACTIONS

The Public Health Recommendations and Actions Plan (PHRAP) for the Island Chemical/Virgin Island Chemical site contains a description of actions taken, to be taken, or under consideration by ATSDR and/or other government agencies at or near the site. The purpose of the PHRAP is to ensure that this public health assessment not only identifies public health hazards, but provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. ATSDR and appropriate government agencies will follow up on this plan to ensure that it is implemented.

A. Actions Completed

ATSDR has conducted two visits to the site in order to verify site conditions and to gather pertinent information and data for the site. Harding Lawson Associates (HLA), the contractor for the Island Chemical Company, has completed the EPA Phase I and II RI activities for the site.

B. Actions Planned

As part of the EPA Phase III RI activities, HLA is planning to conduct additional environmental sampling at the site to further characterize the nature and extent of site contamination.

C. Recommendations for Further Action

ATSDR will collaborate with the appropriate federal, state, and local agencies to pursue the implementation of the recommendations outlined in this public health assessment.

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Division of Health Assessment and Consultation

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Environmental Health Engineer
Division of Health Assessment and Consultation

ATSDR Regional Representative:

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ATSDR Region II

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Island Chemical/Virgin Island Chemical - Final Release

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APPENDIX A - FIGURES

FIGURE 1



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

FOR ILLUSTRATION PURPOSES ONLY



Harding Lawson Associates

Engineering and
Environmental Services
14 Washington Road
Princeton Jct., New Jersey 08550
609-936-0700

DRAWN JOB NUMBER
WGA 35241.2.12

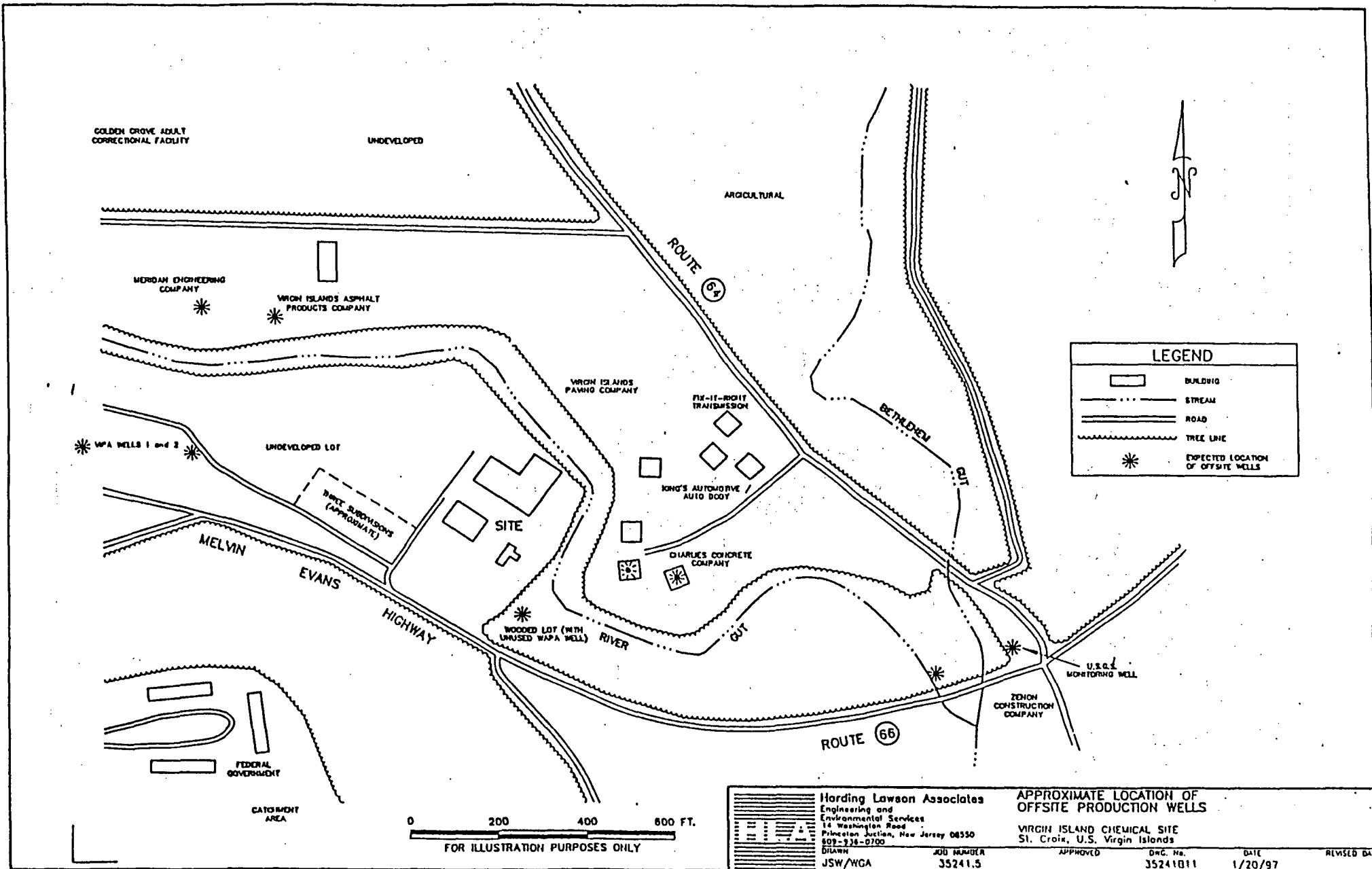
SITE LOCATION MAP

SOURCE: HLA, September 1996.

ISLAND CHEMICAL COMPANY
St. Croix, U.S. Virgin Islands

APPROVED DRAWING NUMBER DATE REVISED DATE
(Signature) 35241A00 8/23/96

FIGURE 2



Harding Lawson Associates Engineering and Environmental Services 14 Washington Road Princeton Junction, New Jersey 08550 609-938-0700		APPROXIMATE LOCATION OF OFFSITE PRODUCTION WELLS VIRGIN ISLAND CHEMICAL SITE St. Croix, U.S. Virgin Islands	
DRAWN JSW/WGA	JOB NUMBER 35241.5	APPROVED	DATE 1/20/97
		ENG. No. 35241011	REVISED DATE

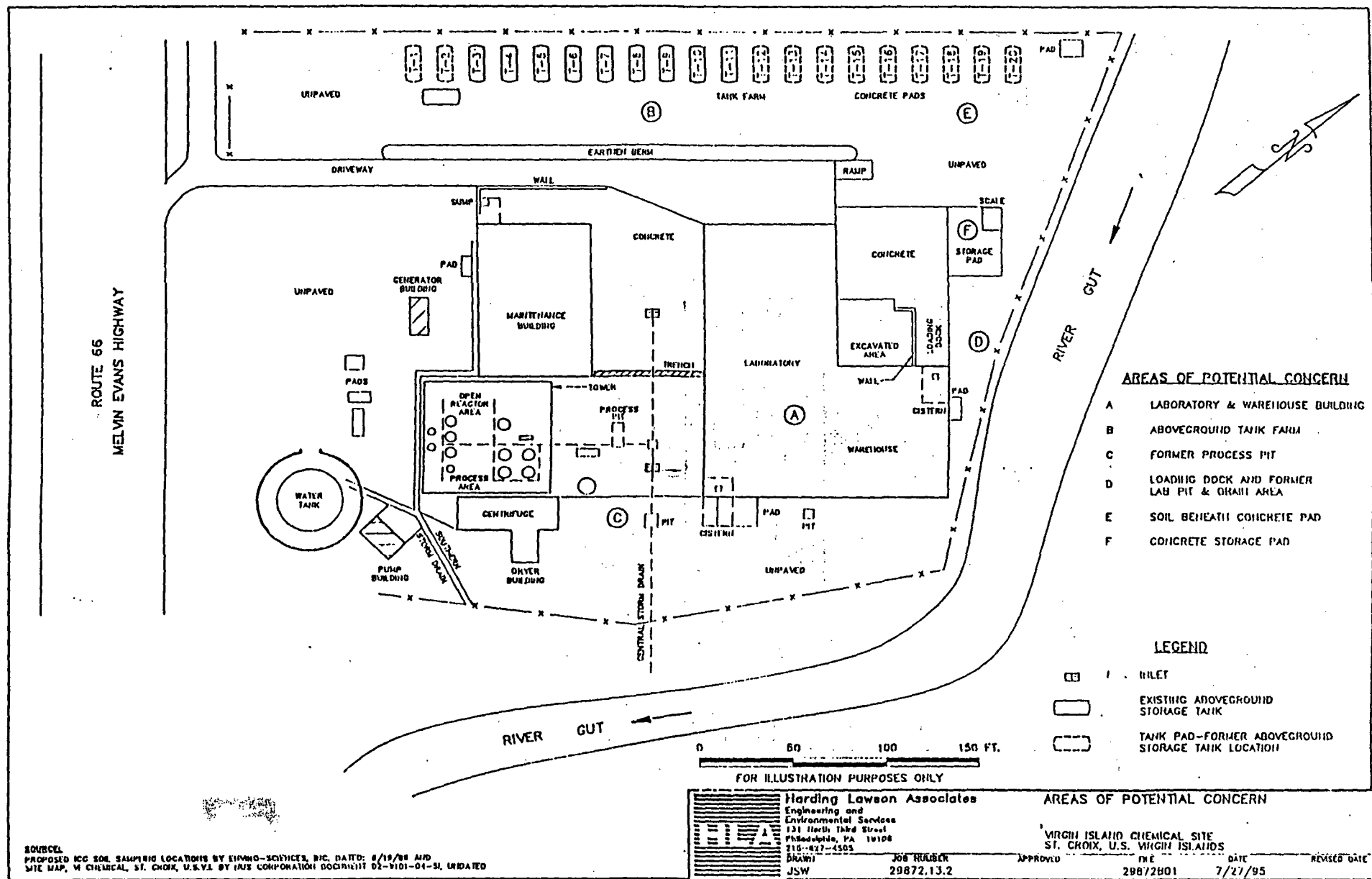
800068

Source: HLA, January 1997.



Areas of Contamination

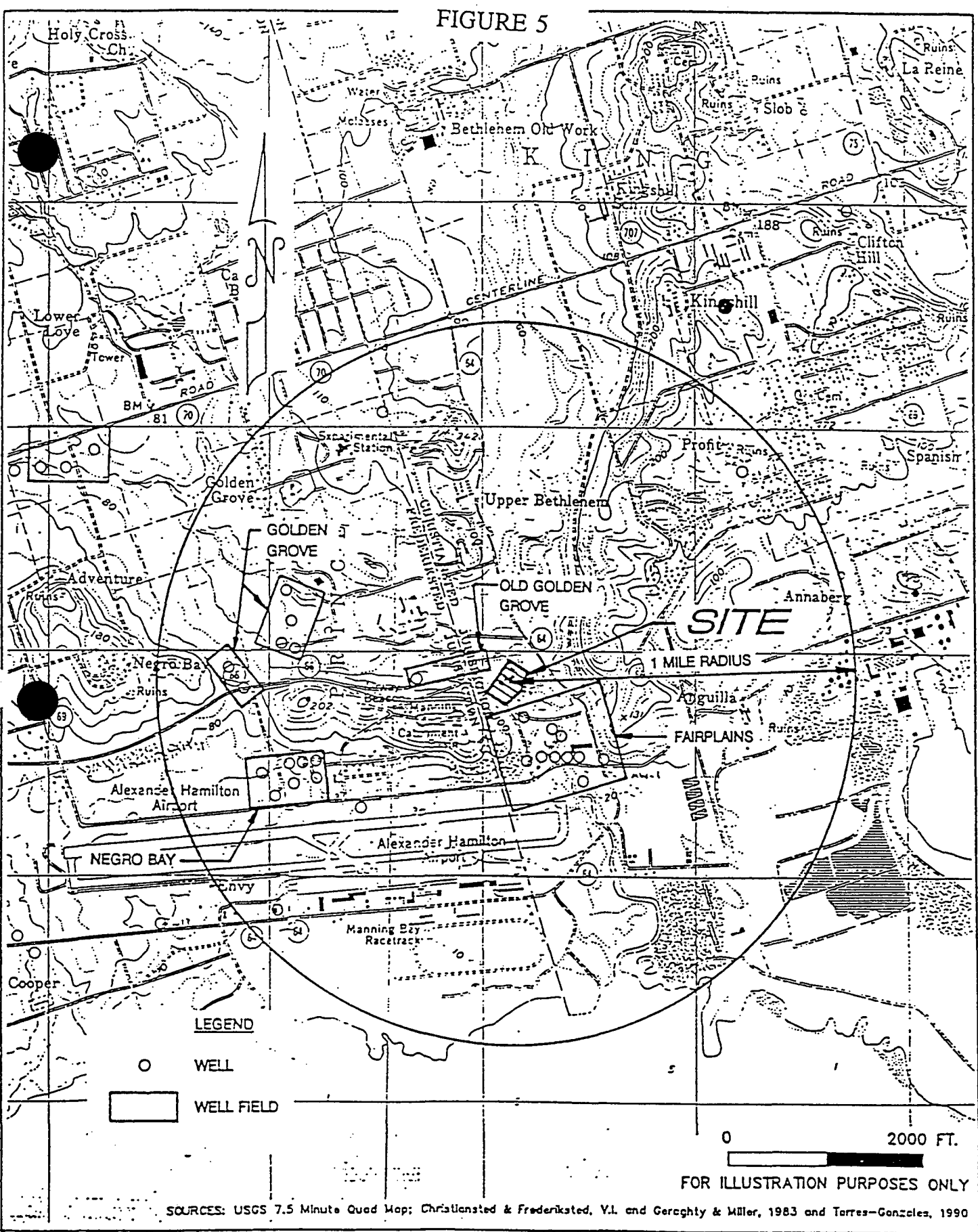
FIGURE 4



800070

SOURCE: HLA, August 1995

FIGURE 5



Harding Lawson Associates
Engineering and
Environmental Services
131 North Third Street
Philadelphia, PA 19106
215-627-4505

**APPROXIMATE LOCATIONS OF
NEARBY WELLS**

ISLAND CHEMICAL COMPANY
ST. CROIX, U.S. VIRGIN ISLAND

SOURCE: HLA, August 1994

DRAWN
JSW

JOB NUMBER
24231.2

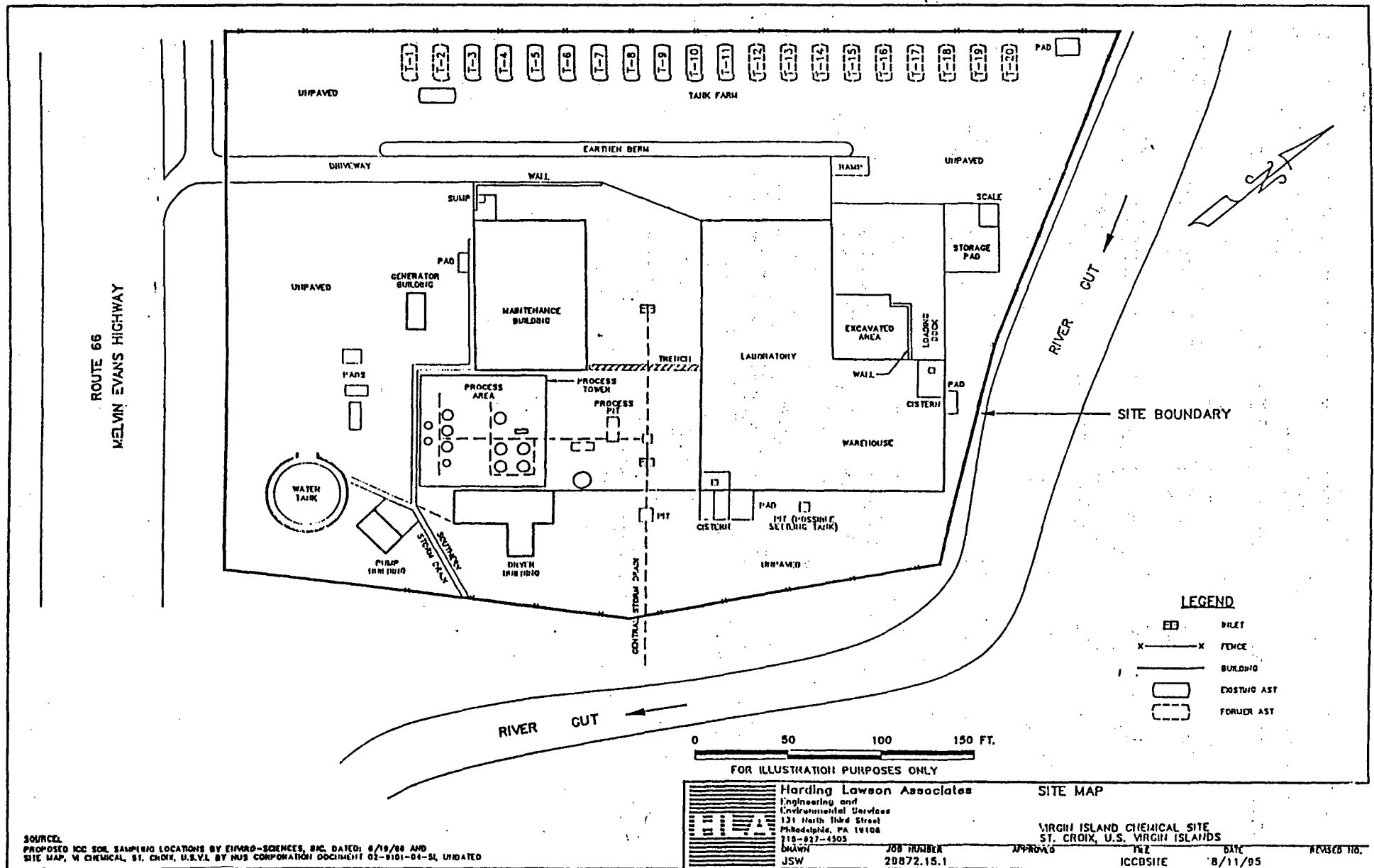
APPROVED

FILE
S-BASE

DATE
1/31/94

REVISED DATE

FIGURE 6



800072

SOURCE: HLA, August 1995

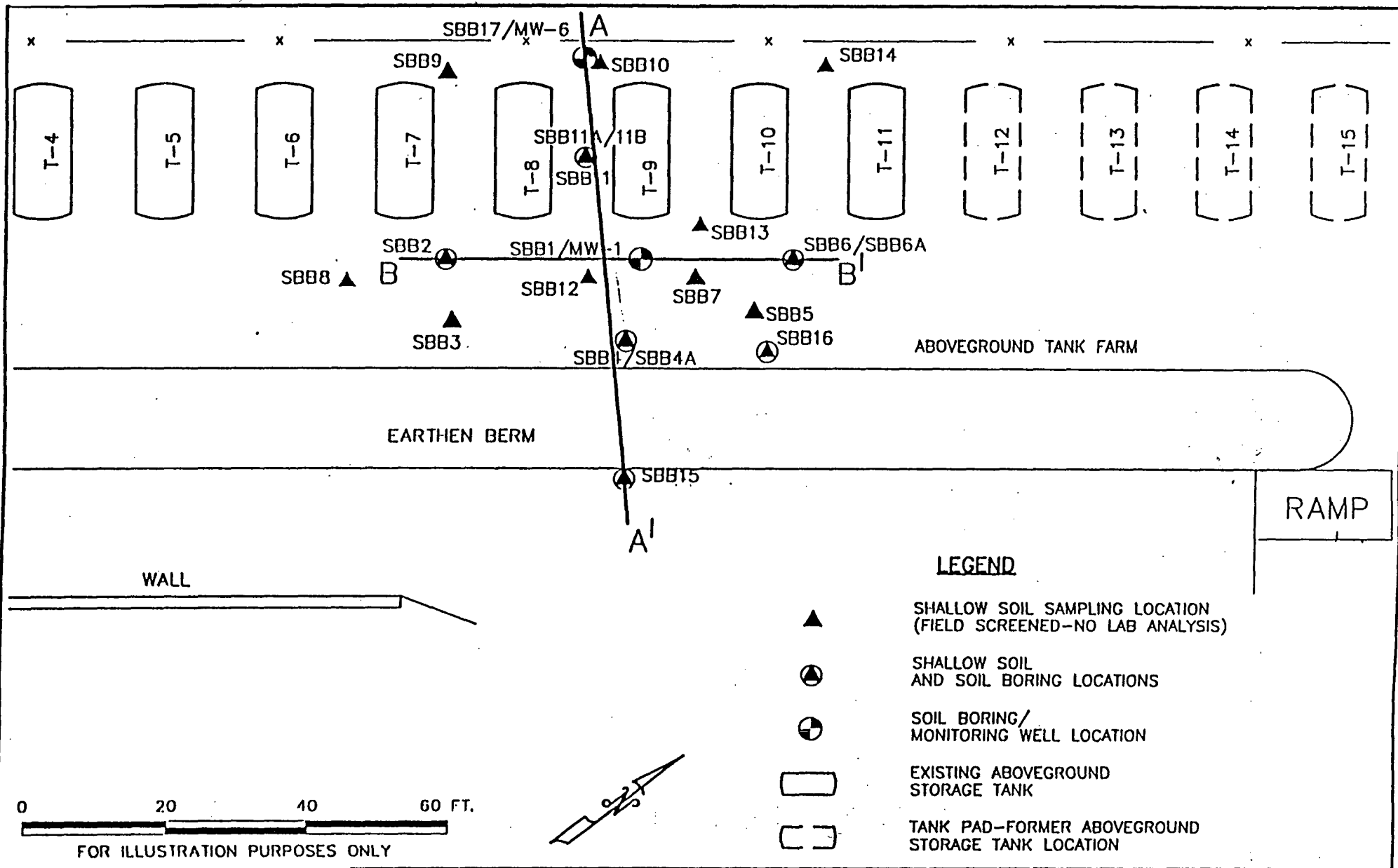
800073



SOURCE: HLA, August 1995

FIGURE 8

800074



Harding Lawson Associates
 Engineering and
 Environmental Services
 14 Washington Road
 Princeton Junction, New Jersey 08550
 609-936-0700
 DRAWN
 WGA

**LOCATIONS OF SURFACE SOIL SAMPLES,
 SOIL BORINGS & MONITORING WELLS,
 AND LINES OF CROSS-SECTION, AST AREA
 VIRGIN ISLAND CHEMICAL SITE
 St. Croix, U.S. Virgin Islands**

JOB NUMBER
 1.2.12

APPROVED

DRAWING NUMBER
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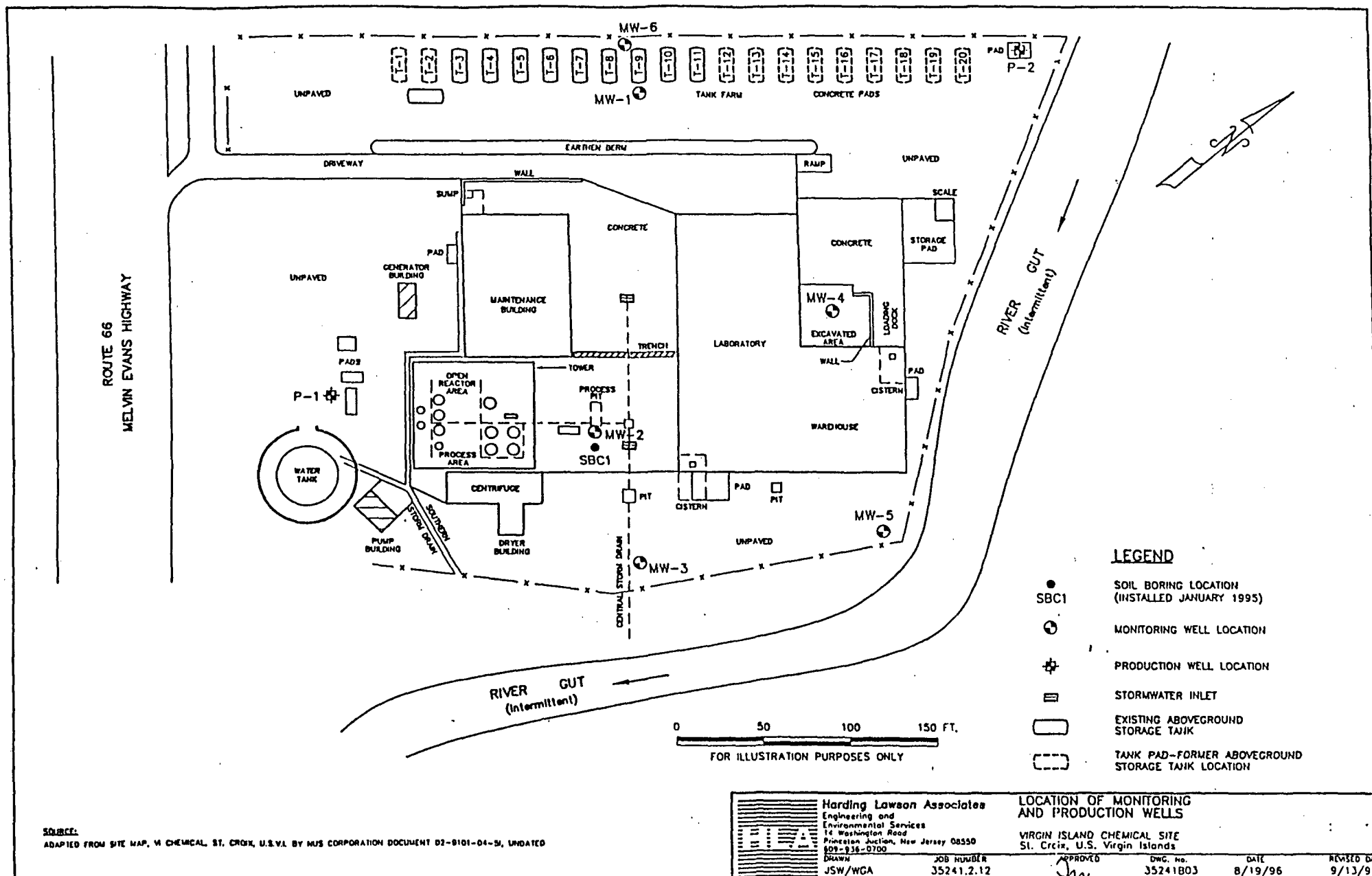
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REVISED DATE
 9/13/96

SOURCE: HLA, September 1996

FIGURE 9

COMMON XX 1 September 1996



800075

SOURCE: HLA, September 1996.

APPENDIX B - RESPONSE TO PUBLIC COMMENTS

ATSDR released a draft of this public health assessment for public comment on February 25, 1988. The public comment period ended on April 5, 1988. The only comments ATSDR received on the draft public health assessment were from a citizen of St. Croix in a letter dated March 19, 1998. This citizen, a former employee of the Island Chemical plant, indicated that during the early 1980s the plant routinely discharged high pH process wastewater, containing various chlorinated solvents, to River Gut without treatment. The citizen also stated that he had observed children swimming in the gut near the current Route 66 bridge downstream of the plant's discharge. He also indicated that plant management commonly disposed of solid "hazardous" waste materials by throwing them into the plant's dumpster for ultimate disposal in the St. Croix landfill.

Response: ATSDR appreciates the valuable information provided by the former Island Chemical employee and has used the information to supplement the exposure pathways evaluation in the final public health assessment.