

Final Report

Wellhead Protection Project

Submitted by the

Virgin Islands
Department of Planning and
Natural Resources and
the University of the Virgin
Islands Conservation Data
Center

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WELLHEAD PROTECTION PROJECT

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DISCLAIMER

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ABSTRACT

- Title: Wellhead Protection Project
- Investigators: Marjorie Emanuel, Stevie Henry, Syed Syedali and Dayle Barry
- Project Period: March 1, 2000 through February 28, 2001
- Project Description: The Wellhead Protection Project undertaken by the Department of Planning and Natural Resources and the University of the Virgin Islands is a pilot project which:
- Selected sample wells to be surveyed;
 - Calculated and delineated Wellhead Protection Areas (WHPAs);
 - Inventoried Wellhead Protection Areas for potential sources of contamination;
 - Analyzed the findings of the inventory; and
 - Proposed management recommendations for Wellhead Protection Areas

The Department of Planning and Natural Resources will utilize the methodologies and recommendations in this report to establish a Wellhead Protection Program (WHPP) as mandated by the June 1986 amendments to the Federal Safe Drinking Water Act (SDWA). The public participation processes and guidelines outlined in this report will be invaluable to the successful establishment of the WHPP.

TABLE OF CONTENTS

Background	1
Project Planning	2
Project Administration.....	2
Sample Selection.....	3
Data Collection and Organization.....	3
General.....	3
DPNR and USGS Groundwater Site Inventory Database	4
Calculated Fixed Radii and the Simplified Variable Shapes Delineation methods	4
WHPA GIS Mapping	5
Trimble GeoExplorer II® Global Positioning System Receiver and Pathfinder® Software	6
Field Findings and Data Analysis	6
General.....	6
Adventure Wellfield Survey	6
Barren Spot Wellfield Survey.....	8
Bethlehem Wellfield Survey.....	9
Concordia Wellfield Survey.....	10
Golden Grove Wellfield Survey	11
La Grange Wellfield Survey.....	12
Negro Bay Wellfield Survey.....	13
Management Recommendations for Wellhead Protection Areas	14
General.....	14
Permitting Structure	15
Locational Requirements	16
Operational Requirements.....	17
Closure Requirements.....	17
General Management	18
The Next Steps.....	18
Public Awareness/Participation Mechanisms	19
Local Media	20
Water Resources Research Institute Seminar	20
Nonpoint Source Pollution Conference	20
Nonpoint Source Pollution Committee Newsletter.....	20
30 th Annual St. Croix Agriculture and Food Fair	20
Professional Publications	21
World Wide Web Posting	21
Wellhead Protection Program Development.....	21
Bibliography.....	22

LIST OF FIGURES

Figure 1. Adventure Wellfield – Distribution of Potential Sources of Contamination	7
Figure 2. Barren Spot Wellfield – Distribution of Potential Sources of Contamination...	8
Figure 3. Bethlehem Wellfield – Distribution of Potential Sources of Contamination.....	9
Figure 4. Concordia Wellfield – Distribution of Potential Sources of Contamination....	10
Figure 5. Golden Grove Wellfield – Distribution of Potential Sources of Contamination	11
Figure 6. LaGrange Wellfield – Distribution of Potential Sources of Contamination	12
Figure 7. Negro Bay Wellfield – Distribution of Potential Sources of Contamination...	13

WELLHEAD PROTECTION PROJECT

FINAL PROJECT REPORT

Submitted by

*Department of Planning and Natural Resources
and
University of the Virgin Islands Conservation Data Center
February 28, 2001*

BACKGROUND

The United States Congress approved amendments to the Federal Safe Drinking Water Act (SDWA) in June 1986, thus providing a mechanism for states to protect groundwater sources of public water supply systems (PWSS) from contamination, which may have an adverse effect on human health through the establishment of a state wellhead protection program (WHPP). The Virgin Islands Department of Planning and Natural Resources (DPNR), Division of Environmental Protection (DEP), is charged with the implementation and administration of the WHPP. At present, the US Environmental Protection Agency (EPA) has not approved the draft Virgin Islands (VI) WHPP. It is anticipated that once an EPA-approved VI WHPP is in place, DPNR will become eligible for federal grants to implement the program.

The VI WHPP must include the following elements:

- 1) address the roles of various territorial, federal and other agencies within the context of the WHPP;
- 2) develop and evaluate the methodology for the delineation of wellhead protection areas (WHPAs);
- 3) establish a process for developing an inventory of potential contamination sources;
- 4) identify management mechanisms adequate to protect groundwater supplies;
- 5) incorporate contingency plans for public water systems;
- 6) establish requirements for new well development; and

- 7) establish and expand the venue for public participation in the development and management of a WHPP.

In order to effectively accomplish the above elements of the WHPP, strong inter-agency cooperation, documented in a task-specific Memorandum of Understanding (MOU) must be developed between DPNR and various stakeholders. Specifically, the Eastern Caribbean Center (ECC) has entered into an MOU with DPNR to evaluate the methodology for the delineation of WHPAs on the island of St. Croix (element 2), inventory potential contamination sources within the delineated WHPAs (element 3), and to prepare standards for the protection of wells that are utilized for public drinking water supply (element 4). The referenced MOU resulted in a joint project for the practical application of standardized methods of defining WHPAs. The project also incorporates the planning process to ensure proper management of those areas in order to protect the groundwater resources that are utilized by the public. The project is intended to be developed and used as a model that can be applied for water quality protection of wells providing public drinking water within the U.S. Virgin Islands and in other small tropical islands with similar hydrogeological and topographical conditions. As noted previously, existing and planned Memoranda of Understanding with other agencies and stakeholders will cover other aspects of VI WHPP development.

The project is funded by a grant from the U.S. Geological Survey (USGS), through the Water Resources Research Grant Program administered by the University of the Virgin Islands Water Resources Research Institute (WRRI). The WRRI has contracted the Conservation Data Center, a unit within the ECC to be the lead agency of this project.

The project has been organized into four phases: project planning; data collection and organization; data analysis and preparation of standards; and final submission.

PROJECT PLANNING

Project planning commenced immediately after the grant was awarded, with certain budget change requests reflecting modifications that were necessary to effectively implement the project.

PROJECT ADMINISTRATION

The project was administered jointly by the primary research team composed of staff from the Department of Planning and Natural Resources and the University of the Virgin Islands. As stated above, a Memorandum of Understanding between DPNR and UVI formalized this collaboration. The Conservation Data Center, a unit within the ECC that collects, analyzes and disseminates information on the natural resources of the Territory, served as the point of contact for the Water Resources Research Institute, the grant administrator.

The Conservation Data Center's role included:

- Hiring temporary staff for data collection;
- Providing Geographic Information Systems (GIS) support for the project;
- Cooperating in the researching and development of standards that would appropriately protect Wellhead Protection Areas;
- Management of receipt and disbursement of funds from the WRII;
- Providing data archiving and backup services for the project data and mapping; and
- Assisting in the preparation of the final report.

The Department of Planning and Natural Resources participated by:

- Supervising temporary staff hired for the project;
- Developing and implementing the methodology for delineation of the Wellhead Protection Areas;
- Developing the system for inventorying potential sources of contamination;
- Cooperating in the researching and development of standards that would appropriately protect Wellhead Protection Areas; and
- Assisting in the preparation of the final report.

SAMPLE SELECTION

The project is limited to the delineation of WHPAs for each of the seven wellfields owned/operated by the VI Water and Power Authority (WAPA) on St. Croix. WAPA operates the major public water system in the VI, and supplies potable water (from wells and desalination plant) to approximately 30,000 customers on St. Croix through a piped distribution system. Sample wells from within each of the seven wellfields were selected during this phase, and well data were obtained. Field data collection personnel were also hired during this first phase of the project.

A closer evaluation of these WAPA wellfields indicate that they are all tapping the most productive aquifer on St. Croix, namely the Kingshill carbonate rock system aquifer. Consequently, a deviation from the initial plan to sample wells representative of the three types of aquifers present in the Virgin Islands - fractured volcanic bedrock aquifers, carbonate rock system aquifer, and alluvial deposit aquifers - had to be made. Due to the limited aerial extent and lower yields of the fractured volcanic bedrock aquifers and alluvial deposit aquifers, they are not fully developed on St. Croix.

DATA COLLECTION AND ORGANIZATION

GENERAL

The data collection and organization phase was operational from June 26th through August 25, 2000. During this period of time, the field researchers were taught to utilize the following: 1) DPNR and USGS Groundwater Site Inventory (GWSI) database, 2) the

Calculated Fixed Radii and the Simplified Variable shapes methods of Wellhead Protection Area calculations 3) ArcView® Geographic Information System (GIS) to delineate the WHPAs and 4) Trimble GeoExplorer II® Global Positioning System (GPS) receiver and Pathfinder® software for field data collection. Each task is described in detail in the following sections but is summarized below.

An extensive literature survey was conducted to gather pertinent information regarding the well (depth, pumping rates, etc.) and hydrogeology of the WAPA well fields selected for study. The information was used to define the size of the wellhead protection areas surrounding each selected well field, using either the Calculated Fixed Radii method or the Simplified Variable shapes method. The extent of the WHPAs for each selected well field was then developed into the ArcView® GIS and superimposed onto a digital orthophoto of St. Croix. Once the WHPAs had been established and delineated onto the aerial photograph, the WHPAs were then inventoried for various contamination sources using the Trimble GeoExplorer II® Global Positioning System receiver and Pathfinder® software.

DPNR AND USGS GROUNDWATER SITE INVENTORY DATABASE

The USGS completed a comprehensive well location survey for its GWSI database in the U.S. Virgin Islands in 1990. The database is continually updated and maintained by DPNR. Well-specific and hydro geologic information was obtained from the GWSI and supplemented by WAPA. The information was used as the input parameters for the Calculated Fixed Radii or the Simplified Variable shapes methods. The specific types of data that were gathered (well pumping rate, porosity of the aquifer and open screen interval, hydraulic gradient, hydraulic conductivity, saturated thickness and hydrologic divides) are provided in Attachment 1.

Where well specific data were not available, default values were used based on previous scientific studies conducted by the USGS on the carbonate rock aquifers. It was reported that the depth to the top of the water table could range from 5 feet (Concordia Wellfield) to 60 feet (Golden Grove Wellfield) below ground surface. Similarly, well yields ranged from less than 5 gallons per minute (Adventure Wellfield) to 80 gallons per minute (Golden Grove Wellfield). Aquifer specific capacity ranged from 1 to 14 gallons per minute per foot draw down (Adventure Wellfield) with a corresponding aquifer transmissivity ranging from 180 to 3,300 feet squared per day.

CALCULATED FIXED RADII AND THE SIMPLIFIED VARIABLE SHAPES DELINEATION METHODS

The two criteria for WHPA delineations used for this project are: 1) 10-20 year average time required for the groundwater to flow to the well (Time of travel = TOT); and 2) the effects of hydrologic boundaries (e.g., faults, guts and ridge lines). These criteria allow a technical definition of the WHPA such that the WHPA will represent the actual contributing area (zone of contribution = ZOC) for that well (or well field).

The WHPA identified zones based on the following:

1. Ownership of the area surrounding the wellhead.
2. A 10-20 year TOT within the ZOC to assure an effective pollution mitigation response to a known pollution source.

The delineation of the WHPA was achieved using one of two methods, based on the amount and quality of information available: 1) Calculated Fixed Radii Method, and 2) Simplified Variable Shapes Method. The Calculated Fixed Radius (CFR) method of WHPA delineation uses a simple volumetric flow equation to calculate a radius around the wellhead for a given TOT. The data required to determine a CFR include the time of travel, well pumping rate, porosity of the aquifer and open screen interval.

The Simplified Variable Shapes (SVS) method requires, in addition to the data specified above, data for hydraulic gradient, hydraulic conductivity, saturated thickness, and hydrologic divides. SVS provides a more realistic down-gradient and lateral limits to the water source for the well.

Choice of the delineation method was dependent upon several factors including: 1) population served by the well or well field, 2) threat of contamination to the well or well field, 3) amount and quality of data available. The WHPA results of the CFR and SVS methods are provided in Attachment 2.

WHPA GIS MAPPING

Once the radii of the WHPAs were calculated using the CFR and SVS methods, GIS layers of the buffer zones for each well field were delineated using the AV GIS buffer tool. The buffer tool requires a spatially referenced feature in order to create a zone of a specified distance. Using a data layer comprised of wells operated by the Water and Power Authority, two or more wells were selected from each well field to produce a buffer zone that covered all the wells in each well field (see Table 1).

Table 1 Wells Selected for Buffers

WELL FIELD	No. of WAPA WELLS	No. of WAPA WELLS SELECTED FOR BUFFER
Negro Bay	6	2
La Grange	6	5
Golden Grove	9	6
Concordia	5	3
Bethlehem	2	2
Barren Spot	9	4
Adventure	9	6
TOTAL	46	28

These WHPA delineations are depicted in Attachment 5.

TRIMBLE GEOEXPLORER II® GLOBAL POSITIONING SYSTEM RECEIVER AND PATHFINDER®
SOFTWARE

An inventory of potential sources of groundwater contamination, within each WHPA, was performed according to the categories listed in Table 2. Each potential source of contamination was georeferenced, using a Global Positioning System (GPS) and was then photo documented. The georeferenced positions were converted into an ArcView® shapefile and superimposed onto their respective WHPAs. A listing of potential sources of contaminants is provided in Attachment 4.

FIELD FINDINGS AND DATA ANALYSIS

GENERAL

Potential sources of contamination were grouped into five categories as established by a draft DPNR report, *Wellhead Protection Program for the United States Virgin Islands* (July, 1999). While the draft report actually notes six categories of potential contamination, field observations were not able to detect Category VI contaminants – Naturally occurring sources whose discharge is created and/or exacerbated by human activity. Figures 1-7 quantify, in a graphic manner, the distribution of the sources of contamination found in each sample wellfield.

Table 2 Categories of Sources of Contamination

CONTAMINANT CATEGORY	DESCRIPTION
Category I	Sources designed to discharge substances
Category II	Sources designed to store, treat, and/or dispose of substances; discharge through unplanned release
Category III	Sources designed to retain substances during transport or transmission
Category IV	Sources discharging substances as a consequence of other planned activities
Category V	Sources providing conduit of inducing discharge through altered flow patterns

ADVENTURE WELLFIELD SURVEY

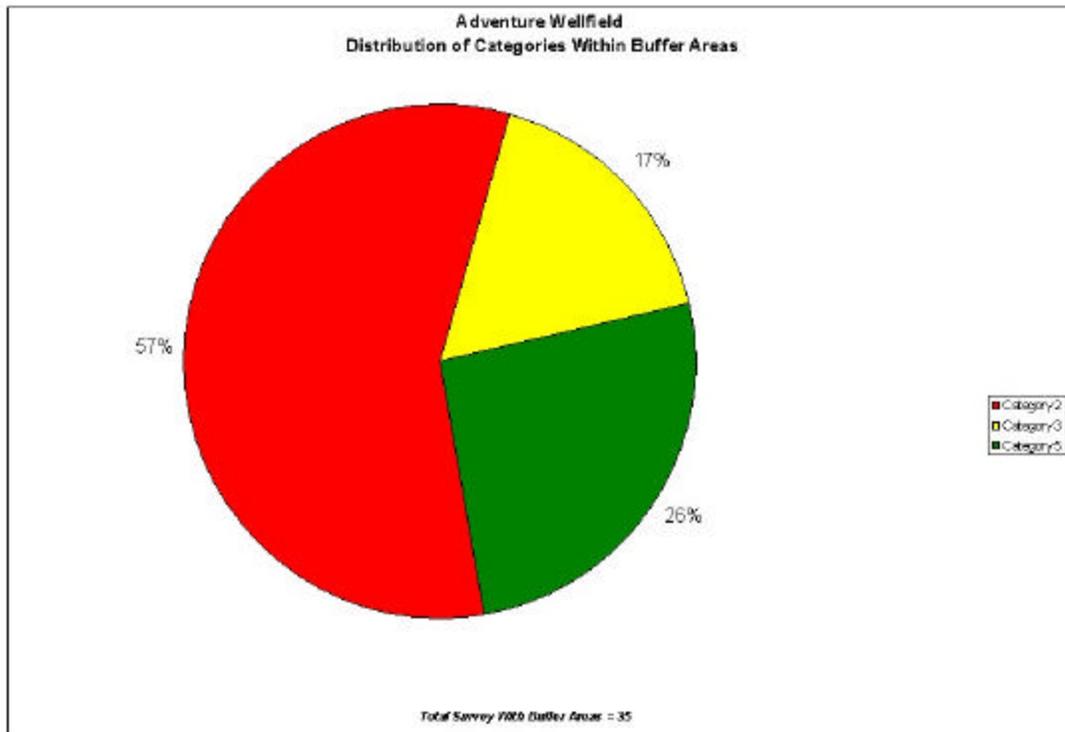
This site encompassed a total of fourteen (14) wells – 9 operated by the Water and Power Authority (WAPA), 2 production wells and 3 other production wells. The 10-year Wellhead Protection Area (WHPA) encompasses a total of 111.59 acres, while the 20-year WHPA comprises a total of 177 acres. A total of 35 potential sources of

contamination were identified in the Adventure WHPA. As was evident in all the sample wellfields, the largest single category of potential sources of contamination in the WHPA was Category II sources (57%). (See Figure 1.) These included illegally dumped materials, municipal trash containers, above ground storage of materials, and underground storage. The next largest class of contaminants in this wellfield was Category V (17%) – sources providing conduit. In addition to the production wells, this category included other production wells and construction excavation. Category III sources -- sources designed to retain substances, encompass 17% of the contaminants found in the Adventure wellfield. Pipelines were the only Category III sources in this wellfield.



Aside from the wells, the 10-year WHPA is relatively free of contaminants, with three open dumps and some pipelines. The majority of the sources of contamination (26) occur in the 20-year WHPA. Of the sources of contamination found in this wellfield, the open dumps are potential sources of metals and hydrocarbons – potential health risks for cancer, liver, kidney and circulatory disorders. Illegal dumping is also a source of microbiological contamination, which can lead to gastrointestinal illnesses and meningitis. Lead from pipes and solder are also a health risk for nerve problems and birth defects.

Figure 1. Adventure Wellfield – Distribution of Potential Sources of Contamination



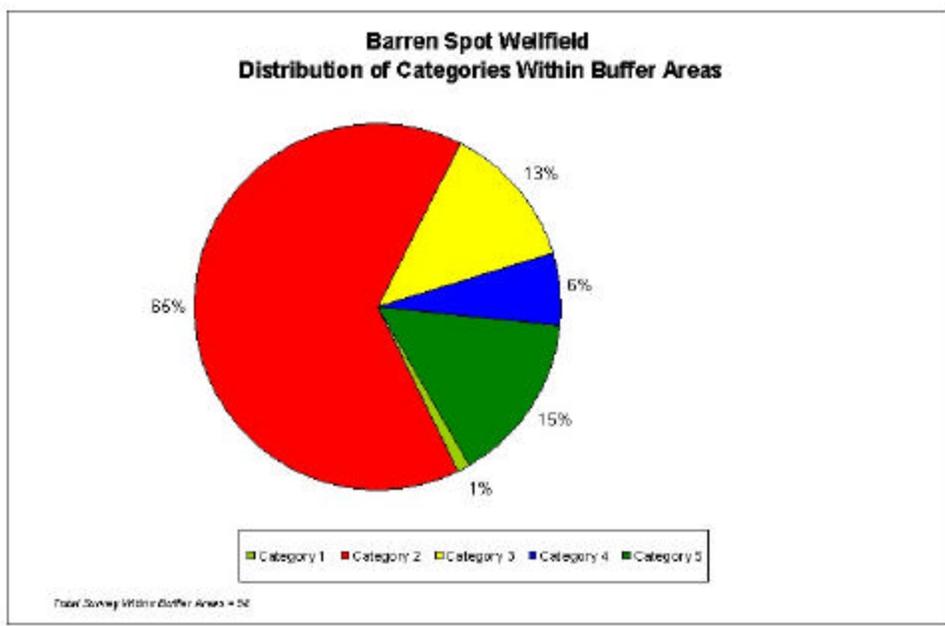
BARREN SPOT WELLFIELD SURVEY

The Barren Spot wellfield is in the midst of a suburban section of the island of St. Croix; and its WHPA comprises approximately 212 acres.¹ The mixed-use development in the area surrounding the wellfield precipitated the identification of a total of 94 potential sources of contamination. The four types found in this wellhead protection area were Categories II, III, IV and V. (See Figure 2.) Of the potential sources of contamination found within the Barren Spot WHPA, 65% were Category II, 15% were Category V, 13% were Category III, 6% were Category IV and 1% was Category 1.



Some of the distinct potential sources of contamination in this WHPA include: land application of pesticides and/or fertilizers, materials and stockpiles, open burning sites, residences, surface impoundments, material transport and transfer operations, animals, and fertilizer storage/application. These land uses can potentially introduce hydrocarbons, microbiological contaminants, and chemical contaminants. These types of contaminants have been linked to cancer, liver and kidney defects, methemoglobinemia (blue baby syndrome) and gastrointestinal illnesses.

Figure 2. Barren Spot Wellfield – Distribution of Potential Sources of Contamination



¹ The 10-year WHPA was not delineated for the Barren Spot Wellfield because of its close proximity to the 20-year buffer boundary.

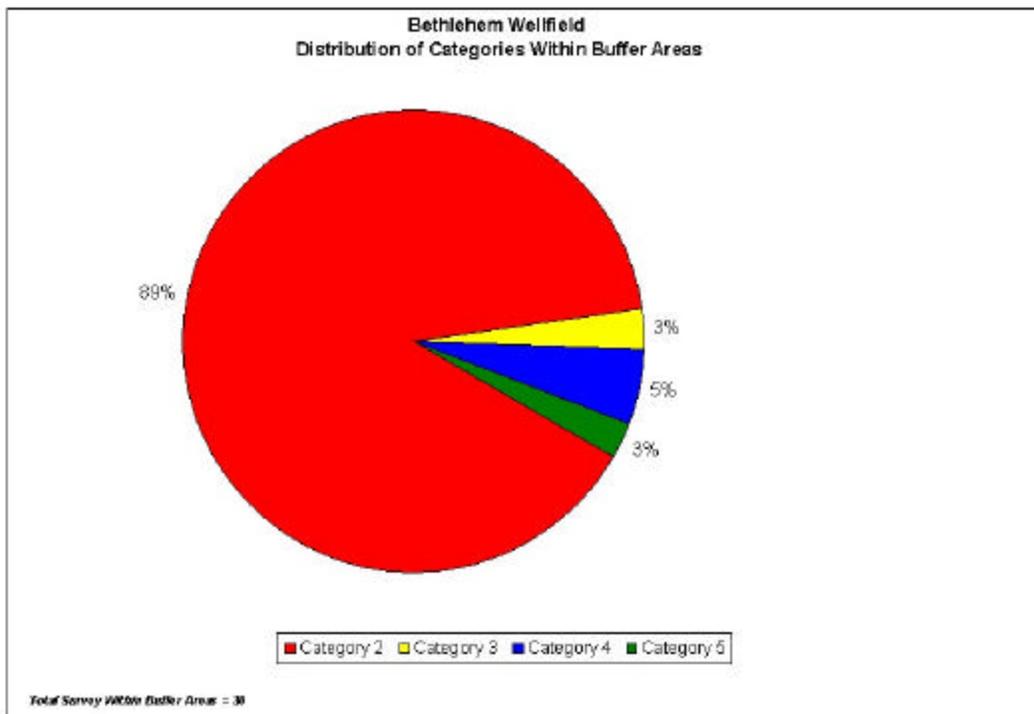
BETHLEHEM WELLFIELD SURVEY

The Bethlehem wellfield, consisting of only two WAPA wells, has a 10-year wellhead protection area of approximately 106 acres, and a 20-year WHPA that is 191½ acres. The field inventory revealed a total of 38 potential sources of contamination within the 20-year WHPA, with the overwhelming majority of these sources being Category II sources (89%). These included above ground storage of unknown substances, materials stockpiles, illegal open dumps, and inactive underground storage tanks at a closed gas station within the WHPA. Other potential sources of contamination were found in Categories III, IV and V, and included material transportation and transfer operations, municipal sewer pipelines, and animal feedlots. (See Figure 3.)



The contaminants found in this WHPA are potential sources of metal and lead leachate, microbiological contamination, and hydrocarbons from waste oil, which can result in cancer, acute gastrointestinal illnesses and meningitis.

Figure 3. Bethlehem Wellfield – Distribution of Potential Sources of Contamination



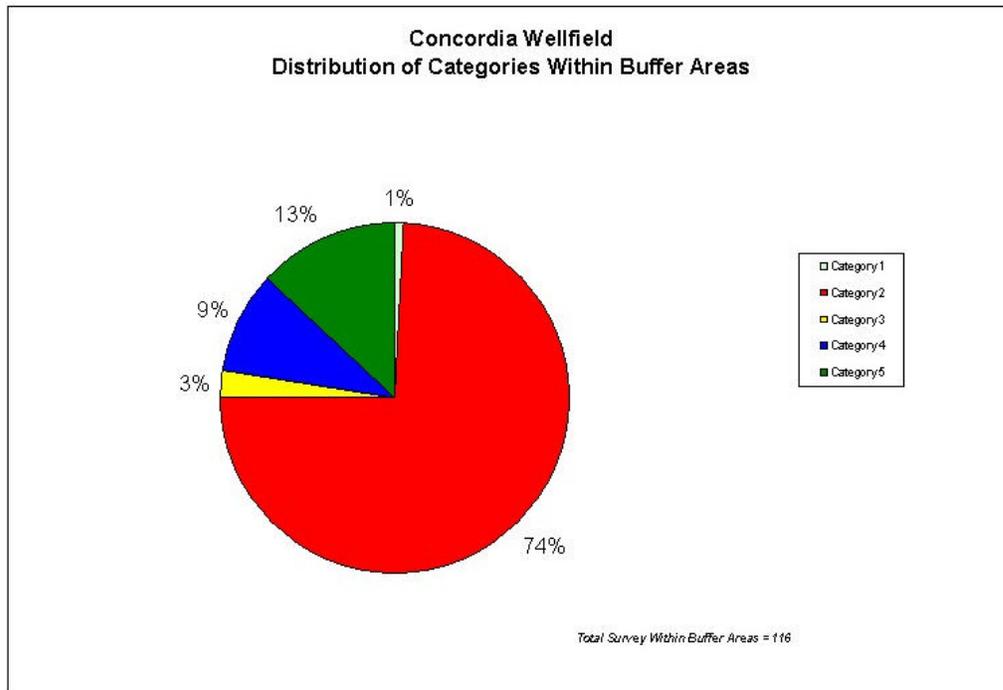
CONCORDIA WELLFIELD SURVEY

The Concordia wellfield, located in the north central part of St. Croix, is comprised of a total of 5 WAPA wells. The 20-year WHPA incorporates a total of 173.43 acres, with a wide mix of land uses.² Almost ¾ of the potential sources of contamination found in the WHPA are Category II sources. The next highest category, comprising 13% of the inventoried potential sources of contamination, was Category V, which includes construction excavation, improperly abandoned wells, production wells, and other production wells. The remaining 13% is split between Category IV, with 9%, Category III (3%), and Category I (1%). The types of land uses found in these categories consisted of pipelines, animal feedlots and land application of pesticides and/or fertilizer.



The contaminants found in this WHPA are potential sources of leaching metals from improperly disposed materials, chemicals from pesticide application, microbiological contamination from animal feedlots and wastes, and hydrocarbons from waste oil, which can result in cancer, liver and kidney defects, acute gastrointestinal illnesses and meningitis.

Figure 4. Concordia Wellfield – Distribution of Potential Sources of Contamination



² The 10-year WHPA was not delineated for the Concordia Wellfield because of its proximity to the 20-year buffer boundary.

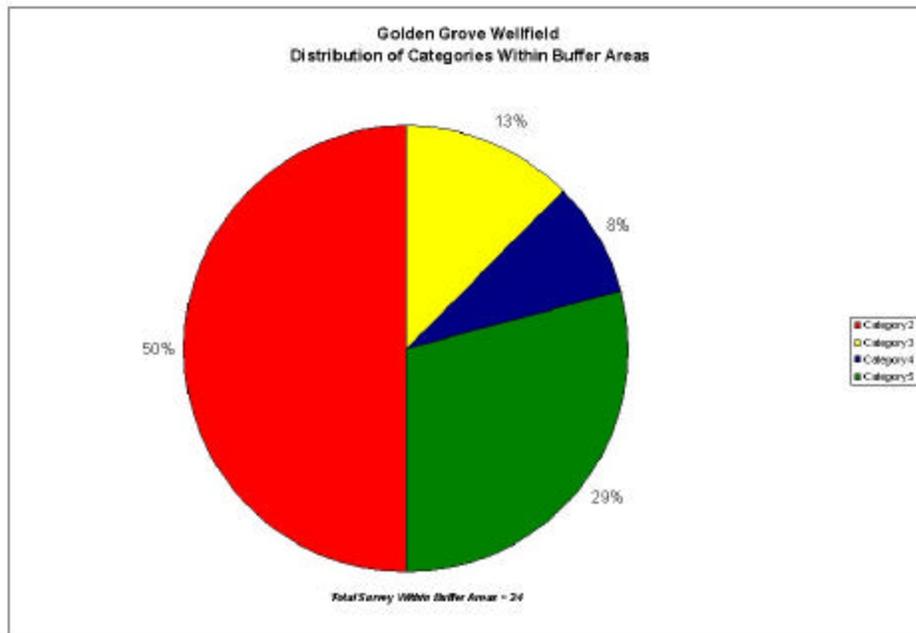
GOLDEN GROVE WELLFIELD SURVEY

The Golden Grove WHPA consists of approximately 121 acres, with a total of 15 wells of various types.³ Included in the WHPA are the Patrick Sweeny Police Station and the St. Croix Motor Vehicle Bureau (MVB). Half of the potential sources of contamination were Category II sources (above ground storage, containers and illegal open dumps), including waste oil stored at the MVB. (See Figure 5.) The remaining 50% of the potential sources of contamination were split between Category III (13%), Category IV (8%) and Category V (29%). Land uses identified within those categories included sewer lines, animals, irrigation, construction excavation, improperly abandoned wells, production wells and other production wells.



Potential health risks from these contamination sources include cancer from hydrocarbons associated with the storage of waste oil, methemoglobinemia associated with leachate from feedlots for animals and treated sewage, acute gastrointestinal illnesses from overflowing or leaking sewer pipes, and liver and kidney problems from metals leaching into the water table from illegally dumped materials.

Figure 5. Golden Grove Wellfield – Distribution of Potential Sources of Contamination



³ The 10-year WHPA was not delineated for the Golden Grove Wellfield because of its close proximity to the 20-year buffer boundary.

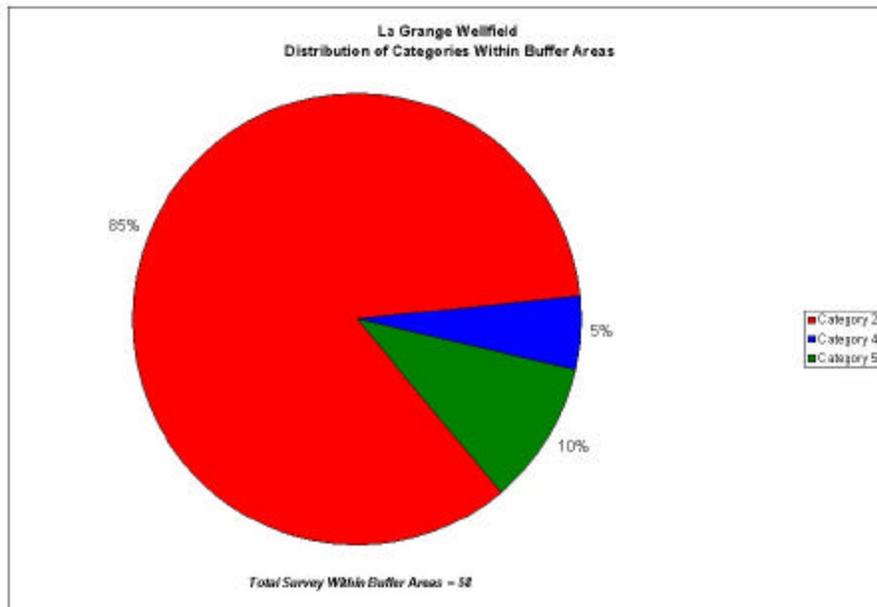
LA GRANGE WELLFIELD SURVEY

Two 20-year wellhead protection areas were established to the north and east of Frederiksted for the La Grange wellfield.⁴ Located in a suburban to rural section of the island of St. Croix, the two WHPAs comprise a total of 173 acres. During the inventory, a total of 58 potential sources of contamination in three categories were identified and mapped. In Category II, the field researchers found above ground storage, containers, open burning sites, open dumps, residences, and underground storage tanks. These potential sources accounted for 85% of those found within the La Grange WHPAs. Animal grazing sites were the only Category IV source found in this WHPA and encompassed 5% of the inventoried sources; while Category V uses (10% of the potential sources of contamination in this WHPA) included construction excavation, production wells and other production wells. (See Figure 6.)



As discussed above, microbiological contaminants from animals and human wastes can cause gastrointestinal illnesses and meningitis. Metals leaching into groundwater from illegal dumpsites can pose risks for liver and kidney problems. There is also a risk of methemoglobinemia associated with leachate from feedlots for animals.

Figure 6. LaGrange Wellfield – Distribution of Potential Sources of Contamination



⁴ The 10-year WHPA was not delineated for the La Grange Wellfield because of its proximity to the 20-year buffer boundary.

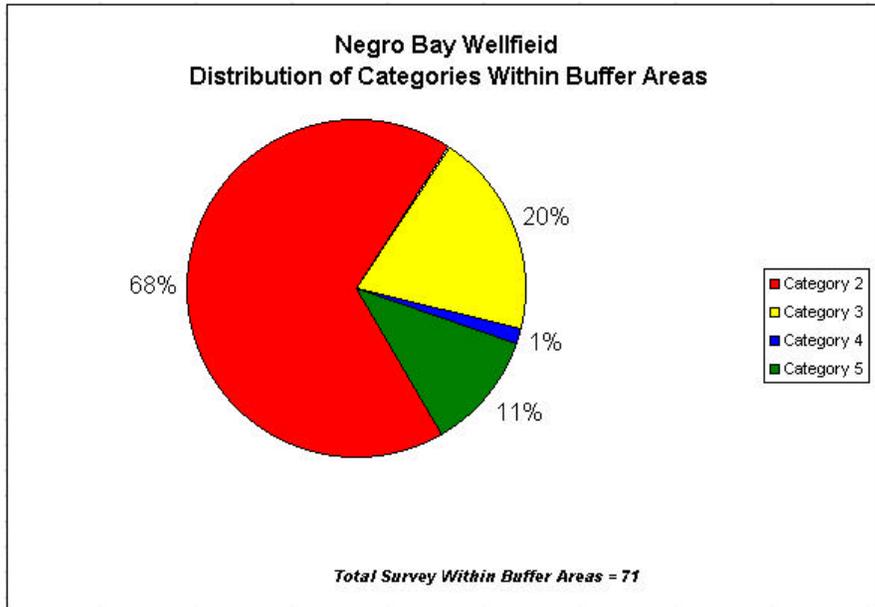
NEGRO BAY WELLFIELD SURVEY

Located in an industrial area between the Henry E. Rohlsen Airport and the Melvin Evans Highway, and encompassing portions of both, the Negro Bay 10-year wellhead protection area consists of a total of 131½ acres, while the 20 WHPA is comprised of 201½ acres. A total of 71 potential sources of contamination were inventoried in the 20-year WHPA, with the majority found in the northern half of the WHPA. As in all other WHPAs, Category II sources of contamination were found to occur most frequently (68%), while Category IV sources occurred the least (1%). Pipelines, a Category III use, accounted for 20% of the sources of contamination found in the WHPA; and Category V uses accounted for the remaining 11%. The sources of contamination found in this WHPA include: above ground storage, containers, materials stockpiles, illegal open dumps, underground storage tanks, pipelines, irrigation, construction excavation, improperly abandoned wells, production wells and other production wells.



The types of materials and substances found within the WHPA pose risks for nerve problems and birth defects from lead leaching from piping and solder; liver and kidney problems from metals leaching into the groundwater from illegally dumped materials; acute gastrointestinal illnesses from overflowing or leaking sewer pipes; and cancer from hydrocarbons.

Figure 7. Negro Bay Wellfield – Distribution of Potential Sources of Contamination



MANAGEMENT RECOMMENDATIONS FOR WELLHEAD PROTECTION AREAS

GENERAL

The seven Wellhead Protection Areas (WHPAs) that were selected for study are representative of other WHPAs on St. Croix. Based on the wellhead protection areas project team's findings and data analysis (both of which have been discussed in previous sections of this report) several standards are hereby recommended that the US Virgin Islands government can utilize to address current potential contamination sources in WHPAs, and prevent or mitigate future potential sources of contamination from occurring in areas of public drinking water supplies in the US Virgin Islands.

The purpose of the US Virgin Islands Wellhead Protection Areas (WHPAs) Management Standards is to:

1. protect the public drinking water supply of the US Virgin Islands from those land use activities that could contaminate groundwater, and
2. protect aquifer recharge areas from land use activities that could inhibit their recharge capabilities.

Subsequent to the adoption of US Virgin Islands wellhead protection areas management standards, the Department of Planning and Natural Resources (DPNR) will play a pivotal role in the implementation and administration of the standards. Of the host of standards or mechanisms that are available to governments for the protection of groundwater resources from pollutants, several are recommended for adoption in the US Virgin Islands. The standards are not costly to implement, and would be politically feasible.

The management standards include: a site plan review for applications for new wells and other land use activities that could adversely impact groundwater; minimum location distances for the siting of new wells from potential sources of contamination, minimum location distances between wellhead protection areas and land use activities that could be potential sources of contamination; monitoring of wellhead protection areas to determine the quality of groundwater; inventorying of wellhead protection areas for new potential sources of contamination; notification requirement for hazardous spills within wellhead protection areas; closure requirement for wells that are to be abandoned; identification and mapping by DPNR of aquifer recharge areas; rezoning of property to allow compatibility between land use and aquifer recharge areas; public notification requirement by DPNR of substances hazardous to groundwater resources; amortization or grand fathering of existing land uses that potential sources of contamination to WHPAs; and public awareness/participation to garner public awareness and support for groundwater protection activities.

PERMITTING STRUCTURE

Site Plan Review Team

The Department of Planning and Natural Resources shall appoint a Site Plan Review Team, which will be responsible for reviewing all applications for new wells, non-residential development, subdivisions of three or more lots on individual septic systems, and single lot residential developments in excess of two dwellings in the second tier of the Coastal Zone.

The Site Plan Review Team shall be comprised of staff of the divisions of Building Permits, Environmental Protection, Comprehensive and Coastal Zone Planning, and Archaeology and Historic Preservation. The Site Plan Review Team shall review, and approve or disapprove all applications for the developments that have been identified in the afore-section of this report. Each permit application for appropriation, use or development shall be reviewed by the Wellhead Protection Area Task Force for compliance with Wellhead Protection Area Management Standards. The Department shall not issue a permit for any proposed development that the Team has found to be non-compliant.

Site Plan Review

The site plan review shall require the submission of a separate form (Form "B"), which will become part of the site plan review submissions that are set forth in the Virgin Islands Zoning, Building and Housing Laws and Regulations. The following information is required for all applications for new wells, non-residential developments, subdivisions of three or more lots on individual septic systems, and single lot residential developments in excess of two dwelling units in Tier 2 of the coastal zone:

A comprehensive description of the proposed development, including, but not limited to the following:

1. Location of all existing public drinking water supply wells within a 1000-foot radius of the proposed development.
2. A mapping of sensitive hydrogeological or natural resources or delineated WHPAs within a 1,000-foot radius of the development.
3. The development's potential impact to groundwater quality. For new and existing public water supply systems utilizing groundwater, a WHPA shall be delineated and inventoried for potential contaminant sources by the applicant.
4. A listing of the types and amounts of all hazardous materials to be generated, stored, manufactured, treated, discharged, used, or transported to or from the development (other than those associated with normal household use), and the provisions for disposal of the materials.
5. A listing of potential sources of contamination that exist on the property to be developed.

6. A description of the types and amount of waste that will be generated, as well as the method(s) to be employed for waste disposal.
7. Other additional information as may be required by the site plan review team.

LOCATIONAL REQUIREMENTS

Requirements for Siting of New Wells

New wells intended to be used for public drinking water supply shall not be constructed in areas that are subject to flooding, or in areas of potential sources of contamination. The applicant is responsible for delineating the WHPA based upon projected well construction details and anticipated well pumping rates. The applicant is also responsible for inventorying the delineated WHPA; and the following potential sources of contamination must be excluded from the WHPA:

1. Above and underground storage tanks
2. Auto service, repair or painting facilities
3. Feedlots
4. Cemeteries (human and animal)
5. Industrial, commercial or institutional facilities, which use, store or dispose hazardous materials
6. Major subdivision with private septic tanks
7. Manufacture, use or storage of hazardous
8. Open burning of materials containing hazardous substances
9. Quarries and mining operations
10. Rifle and pistol ranges
11. Sanitary landfills and junkyards
12. Sewage treatment facilities

Requirements for Location of Potential Sources of Contamination

Subsequent to the adoption of the wellhead protection area standards, the following land uses activities shall be prohibited within designated wellhead protection areas:

1. Above and underground storage tanks
2. Auto service, repair or painting facilities
3. Feedlots
4. Cemeteries (human and animal)
5. Industrial, commercial or institutional facilities which use, store or dispose hazardous substances
6. Major subdivision with private septic tanks
7. Manufacture, use or storage of hazardous substances
8. Open burning of materials containing hazardous substance
9. Quarries and mining operations
10. Rifle and pistol ranges

11. Sanitary landfills and junkyards
12. Sewage treatment facilities

OPERATIONAL REQUIREMENTS

Accessibility

All wells that are part of the public drinking water supply shall be accessible for inspection and testing by the Department.

Inspections

The Department shall annually inspect all wellhead protection areas for new potential sources of contamination, and shall map all new potential sources of contamination that are detected. When new potential sources of contamination are found, the Department shall notify the owners of such property, or the operator of the potential sources of contamination, for immediate remediation action.

Water Quality Testing

The Department shall annually inspect the well mechanics of all wells used for public drinking water supply, and test the water supply for bacteria, nitrate, fertilizers, pesticides or petroleum products.

Notification Regarding Spills

Any property owner shall be responsible to notify the Department of the spill of petroleum products, caustic substances or other hazardous materials within a wellhead protection area or within 100 feet of a wellhead protection area. Notification shall be given within twenty-four (24) hours.

It shall be illegal to discard any potential source of contamination within a WHPA. Any property owner shall be liable for the costs of investigation, enforcement and remediation of any potential sources of contamination discarded within a wellhead protection area.

CLOSURE REQUIREMENTS

For the purpose of preventing the contamination of aquifer recharge areas, the owner of a well upon abandoning the well shall notify the Department, and shall effectively seal the well with the supervision of a licensed well driller or pump installer to the satisfaction of the Department.

GENERAL MANAGEMENT

Identification and Mapping by DPNR of Aquifer Recharge Areas.

The Department of Planning and Natural Resources shall identify and map those areas, which are essential to the recharge of wells used for public drinking water supply. The maps shall be kept current of all changes, and be made available to all permitting and licensing agencies within the US Virgin Islands.

Rezoning for Compatibility between Land Use Activity and Aquifer Recharge Areas.

Aquifer recharge areas that are zoned for densities and impervious surface coverage that are incompatible with the recharge of the aquifer shall be identified for rezoning to a density that would permit adequate recharge.

Public Notices by DPNR of Substances Hazardous to Areas of Public Drinking Water Supply

The Department of Planning and Natural Resources shall semi-annually publish notices in a newspaper of general circulation and on the radio, of those substances that the federal and local Environmental Protection Agencies have deemed to be potentially hazardous if discarded into the soil, with instructions for the proper use and storage of the substances.

Amortization/Grand Fathering of Land Use Activities that are Potential Sources of Contamination.

Within six (6) months of the adoption of the wellhead protection areas management standards, the Department shall identify properties with existing land use activities that are potential sources of contamination to WHPAs to be phased out over a period of time sufficient to amortize the investment or grand fathered (permitted as a preexisting nonconforming use).

THE NEXT STEPS

Under the auspices of the Safe Drinking Water Act, the Department of Planning and Natural Resources is mandated to establish a Wellhead Protection Program for those wells used for public water supply. As a result of the groundwork laid by this research project, DPNR now has the foundation, methodology and management recommendations for the development of a Virgin Islands Wellhead Protection Program. The following steps are recommended in Wellhead Protection: A Guide for Small Communities (an EPA publication).

1. *Develop a community planning team to initiate and implement the program* – The publication recommends a team comprised of community organizations, regulatory agencies, government agencies and the private sector. DPNR has had

- several successful examples of this type of effort, including the Mooring Committee (which developed amendments to mooring laws and regulations) and the Nonpoint Source Pollution Committee (which hosts the annual Nonpoint Source Pollution Conference). This pilot effort was a joint project between the University of the Virgin Islands and the Department, which engaged the assistance of the Virgin Islands Water and Power Authority. Future development of a Territorial program would have to involve private operators of public water supply wells, the Department of Health, environmental organizations such as the St. Croix Environmental Organization and the Environmental Association of St. Thomas – St. John, and property owners within delineated WHPAs.
2. *Delineate the Wellhead Protection Area* – The methodologies for delineating WHPAs has been tested and proven feasible through this pilot project. The technology for mapping those areas using Geographic Information Systems has been demonstrated to be effective.
 3. *Identify and locate potential sources of contamination* – Because of its relatively small size, field inventory appears to be an effective and accurate process for identifying and locating potential sources of contamination. The use of Global Positioning Systems to pinpoint exact locations of sources proved invaluable during the course of this pilot project; and this process is recommended for use in the development of a Territorial Wellhead Protection Program.
 4. *Manage the wellhead protection area* – Several management recommendations have been provided in the Management Recommendations section of this report. The individuals comprising the community planning team will undoubtedly have many more sound recommendations for implementation of an effective Wellhead Protection Program. Management will have to incorporate both regulatory and non-regulatory mechanisms in order to be effective and sustained. Some of the regulatory standards recommended above include: revised permitting requirements; setbacks for certain types of development; water quality testing; and closure requirements. Some non-regulatory mechanisms that should be explored include ongoing public education on issues related to WHPAs and land donations within WHPAs.
 5. *Plan for the future* – This step involves regular review, evaluation and update of the Wellhead Protection Program. Problems in plan implementation would be identified and solutions to those problems would be developed.

Using the methodologies described in this report and applying the steps outlined above, the Department of Planning and Natural Resources has the basis for the creation of an effective Wellhead Protection Program for the U.S. Virgin Islands.

PUBLIC AWARENESS/PARTICIPATION MECHANISMS

During the coming year, the project team will engage a number of processes in order to ensure that the public has the opportunity to consider the information gathered during the course of this research project, as well as the potential adverse impacts that may be realized if a viable wellhead protection program is not established in the U.S. Virgin

Islands. It is hoped that increased awareness and the ensuing change in behaviors and practices by both the construction industry and homeowners will result in improved water quality throughout the Virgin Islands.

LOCAL MEDIA

The project principals, with the approval of the Water Resources Research Institute, will provide a copy of the project's final report findings, analysis and recommended actions, in summary form, to the local print and electronic media in order to facilitate presentation to the wider Virgin Islands public. Other opportunities for exposure will include at least one appearance on a local talk show and a guest editorial in the print media.

WATER RESOURCES RESEARCH INSTITUTE SEMINAR

The project principals will make a presentation at a Water Resources Research Institute Seminar, detailing the methodology, findings and conclusions of the project. These seminars are usually held in one of the University's televideo conference rooms, permitting audience participation on two islands. Local media are usually invited to these seminars, and coverage of the topic would be facilitated.

NONPOINT SOURCE POLLUTION CONFERENCE

One of the principals on the project team made a presentation during the 6th Annual Nonpoint Source Pollution Conference, which included some of the findings of the wellfield inventories. During the next NPS Conference, the project team will present final findings, analysis and recommendations to the over-100 participants that attend this annual event. Additionally, press coverage will provide information from this forum to a wider audience.

NONPOINT SOURCE POLLUTION COMMITTEE NEWSLETTER

Information regarding this project will be published in the *NPS Update*, a quarterly newsletter published by the Virgin Islands Nonpoint Source Pollution Committee and produced by UVI's Cooperative Extension Service. The newsletter is intended to inform the public about ongoing NPS pollution control and prevention projects in the Territory.

30TH ANNUAL ST. CROIX AGRICULTURE AND FOOD FAIR

During the 30th Annual St. Croix Agriculture and Food Fair, attended by approximately 60,000 individuals during the 3-day event, the project team displayed, in poster form, an overview of the wellhead protection project. Many fair participants such as farmers and homeowners rely heavily of groundwater, and utilize substances that could be potential sources of contamination, such as pesticides and fertilizers.

PROFESSIONAL PUBLICATIONS

The project team will submit a revised version of its final report to the Journal of the American Planning Association (JAPA) for review and publication. JAPA is a juried quarterly that is published by the American Planning Association.

WORLD WIDE WEB POSTING

The Conservation Data Center will post a copy of the project's final report on the World Wide Web at the site, <http://cdc.uvi.edu>.

WELLHEAD PROTECTION PROGRAM DEVELOPMENT

The Department of Planning and Natural Resources intends to use this pilot project as an impetus to develop a Territory-wide Wellhead Protection Program, as provided for in the 1986 Safe Drinking Water Act. As a part of that project's development, the Department will institute a significant public participation program. This will permit the public a wide variety of forums for input as DPNR develops a WHPP for the U.S. Virgin Islands.

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