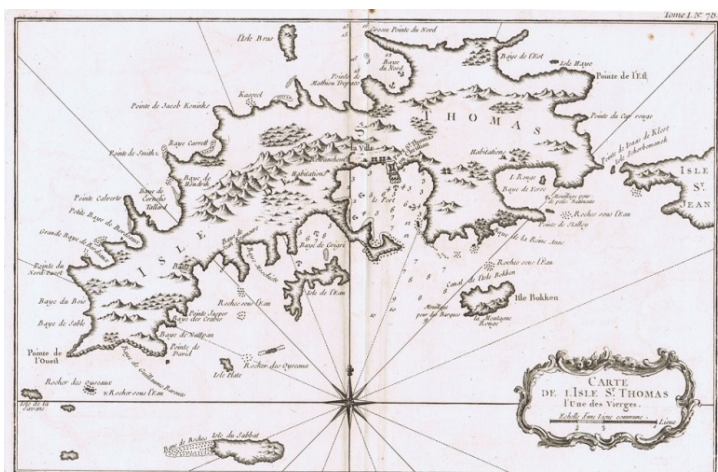




# Phase I Archaeological Investigation for Tutu Wells Project

St. Thomas, U.S Virgin Islands

January 2017



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# Phase I Archaeological Investigation for Tutu Wells Project

St. Thomas, U.S. Virgin Islands

January 2017

**PREPARED BY**

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**LEAD AGENCY**

Environmental Protection  
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## Management Summary

### Involved State and Federal Agencies

Environmental Protection Agency (EPA)

**Survey Phase:** Phase I Cultural Resources Survey

### Location Information

Location: Anna's Retreat, St. Thomas, USVI

Minor Civil Division: Anna's Retreat

Administrative Subdistrict: Tutu

### Survey Area

Number of Acres Surveyed: 4.3

7.5 Minute Quadrangle Map: Eastern St. Thomas (1983)

### Results of Research

Sites within 1 mile: 1

Surveys in vicinity: 10

NR/NRE sites in or adjacent: 0

USVISHPO inventoried structure in or adjacent: 0

Precontact Sensitivity: Low; Historic Sensitivity: Low

### Results of Archaeological Survey

Both the investigation and assessments from the United States Virgin Islands (USVI) State Historic Preservation Office (SHPO) revealed no concerns regarding subsurface archaeological deposits within the proposed Area of Potential Effects (APE). The investigation, consisting of literature review and physical inspection of the proposed well locations by the archaeologist, indicates that the APE, which is situated on rocky slopes with exposed bedrock at or near surface, has been subject to extensive modification caused by modern anthropogenic fill deposition, grading, and asphalt paving.

### Results of Architectural Survey

The investigation revealed no concerns regarding impacts on buildings or structures from the Tutu Wells monitoring project (Project) area. Well placement activities, consisting of drilling within the area, poses no impact, physical or visual, on any listed or eligible structure within a 0.5-mile (0.8-km) radius of the Project area.

### Recommendations

No archaeological remains were identified within the Project's direct APE (ground disturbance footprint). The APE lacks the potential for intact archaeological deposits owing to shallow sediments overlying bedrock and the extensive modification of the area caused by modern activity such as fill deposition, road grading, and paving. The APE of exposed bedrock, characteristic of the Project area landform noted in soil characterizations and corroborated by boring-hole profiles and field observation. Document review and geomorphologic assessment demonstrates that there has been extensive fill and paving throughout the APE that would have heavily impacted and likely eradicated any shallow cultural deposits. Furthermore, USVISHPO has determined that activities within the APE will not adversely affect historical or archeological resources listed in or eligible for inclusion in the National Register of Historic Places (NRHP) nor will they adversely affect any potential subsurface archeological deposits, historic buildings, or historic structures.



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## Acronyms and Abbreviations

|          |                                                        |
|----------|--------------------------------------------------------|
| APE      | Area of Potential Effects                              |
| BTEX     | Benzene, toluene, ethylbenzene, and xylene             |
| CFR      | Code of Federal Regulations                            |
| cm       | Centimeter(s)                                          |
| CVOC     | Chlorinated volatile organic compound                  |
| EPA      | United States Environmental Protection Agency          |
| FS       | Feasibility Study                                      |
| FSRI     | Focused Source Remedial Investigation                  |
| km       | kilometer(s)                                           |
| NPL      | National Priorities List                               |
| NRCS     | Natural Resources Conservation Service                 |
| NRHP     | National Register of Historic Places                   |
| Project  | Tutu Wells monitoring project                          |
| RAC      | Remedial Action Contract                               |
| RI       | Remedial Investigation                                 |
| ROD      | Record of Decision                                     |
| USACE    | U.S. Army Corps of Engineers                           |
| USDA     | U.S. Department of Agriculture                         |
| USVI     | United States Virgin Islands                           |
| USVISHPO | U.S. Virgin Islands State Historic Preservation Office |

# 1 Introduction

On behalf of the United States Environmental Protection Agency (EPA), HDR conducted a Phase Ia archaeological site review and sensitivity assessment based on site literature review, site visitation, and boring-hole log review for the Tutu Wells Superfund Site (Project) in St. Thomas, United States Virgin Islands (USVI). The Phase Ia investigation was part of the work plan prepared by HDR for the Focused Source Remedial Investigation/Feasibility Study (FSRI/FS) for the Tutu Wells Superfund site in St. Thomas, USVI (Appendix A: Map 1). The FSRI/FS is being carried out under Work Assignment Number 031-RICO-021D under the EPA Remedial Action Contract (RAC) 2 Contract Number EP-W-09-009, focusing on the Curriculum Center property in the northern portion of the Tutu Wells Superfund site (Appendix A, Map 2).

Earlier remedial investigations (RIs) for the area completed in 1987 identified four sources of groundwater contamination, qualifying the Tutu Wells Superfund site for inclusion on the National Priorities List (NPL) in September 1995. Subsequently, additional investigation and Remedial Action was implemented to address the source area and site-wide contamination. The aims of this FSRI/FS are to further investigate the nature and extent of the contamination at the Curriculum Center area and evaluate risks to human health and the environment as well as identify and evaluate remedial alternatives in support of a Record of Decision (ROD). FSRI/FS tasks include background research, site inspection, and geophysical survey, as well as groundwater sampling and groundwater elevation measurement. The Phase Ia investigation was carried out in response to the potential impact of the required installation of monitoring wells for FSRI/FS activities (Appendix A, Map 2).

The purpose of the site review and sensitivity assessment was to identify all archaeological and historical resources within one mile of the proposed area of potential effects (APE) and determine, through site literature consultation and visitation of the proposed Project APE, any potential subsurface archaeological and historical resources that may be affected by project activities. The review was prepared in compliance with Section 106 of the National Historic Preservation Act of 1966, as amended, and adhered to Department of the Interior and USVI State Historic Preservation Office (USVISHPO) Standards for Cultural Resource Investigations.

HDR archaeologist Roberto Herrera, PhD, RPA, began by conducting background research at the USVISHPO at the St. Thomas regional library on all archaeological sites and listed, eligible, or inventoried architectural structures within one mile of the proposed Project location in December of 2016. Dr. Herrera then visited the Project site and consulted with on-site technicians. Dr. Herrera served as the Project's Principal Investigator. He performed the review and site visits, authored the report, and prepared all relevant graphics.

## 2 Project Information

The Project area is on the eastern end of St. Thomas, USVI, in the Anna's Retreat section of the Tutu subdistrict. It is situated within the upper Turpentine Run drainage basin, which covers approximately 2.3 square miles (6 km<sup>2</sup>) and runs roughly north-south. The Project area is situated in mountainous terrain and bounded by relatively steep hills ranging from 12-percent grades within the APE to over 25-percent grades in the surrounding area.

Early RI sampling from 1992 to 1995 identified four main sources of contamination at the Tutu Wells Superfund site: two chlorinated volatile organic compound (CVOC) plumes at the northern and southern extremes of the site and two benzene, toluene, ethylbenzene, and xylene (BTEX) plumes at the former Texaco and Esso (now Puma) filling stations within the site area (see Map 1 in Appendix A). However, the focus of the current work plan is centered on the Curriculum Center source area, and related cultural resources assessment confined to the northern Curriculum Center/Housing Authority sector (see Map 2 in Appendix A). Further details on the Tutu Wells site history and remediation progress are available in the Final Pre-Design Report (CDM 2001) as well as the 2016 Annual Remedial Action Progress Report (Arrowhead Contracting, Inc. 2016).

### 3 Area of Potential Effects

The APE represents the geographic area or areas within which an undertaking may directly or indirectly cause alteration in the character or use of historic properties, if any such properties exist (36 Code of Federal Regulations [CFR] 800.16 [d]). For the Project, the direct APE represents the area within the general Project area that will be impacted by proposed drilling activities. As mentioned above, Appendix A: Maps 1 and 2 show the current conditions of the Project area and direct APE. The Project has minimal aboveground components, and therefore the indirect APE is considered to be the area within 0.25 mile of the direct APE.

Properties within the APE are owned and managed by USVI Department of Education and the St. Thomas Housing Authority; the latter is also used by the St. Thomas Police Department. As demonstrated in Maps 1 and 2, the APE covers a total area just under five acres. This area has had increased urban development and traffic since the construction of the nearby Tutu Park Mall just 0.2 miles (0.32 km) southwest of the Project area.

The direct APE is bounded on the west-northwest by Douglas Street and on the east-southeast by Flamboyant Avenue. To the south the direct APE is bounded by Route 38/Smith Bay Road, which leads into the eastern sector of the Tutu Park Mall complex. The area north of the APE comprises an asphalt parking area with a patch of wooded promontory leading to the properties of Joseph Gomez Elementary School and the community of Los Cerritos.

## 4 Environmental Information

### 4.1 Topography and Bedrock Geology

The Tutu Wells Project area is in a rocky ridgeline, mountainous hill slope environment in the eastern interior sector of St. Thomas with bedrock observable at surface to near surface (Appendix B, Photos 9-12). The bedrock is composed of weathered and unweathered strata overlain by shallow soil; the bedrock consists of igneous andesitic tuff and breccias overlain by sedimentary deposits from volcanic and calcareous parent material. While the bedrock is observable within the immediate area around the APE, drill profiles also demonstrate extensive anthropogenic fill in the area representing an attempt to level the uneven terrain (Appendix D).

### 4.2 Soils and Drainage

According to the United States Department of Agriculture (USDA)/Natural Resources Conservation Service (NRCS) custom soil resource report for USVI, the area within the proposed direct APE is predominantly composed (approximately 99.9 percent) of Fredriksdal-Sussannaberg complex at 12 to 20 percent slopes and extremely stony. This is followed by 0.1 percent of the same extremely stony complex at its southwest end at 20 to 40 percent slopes (USDA 2016).

The Fredriksdal series consists of shallow, well drained, slowly permeable soils on summits and side slopes of volcanic hills and mountains. They formed in material weathered from igneous bedrock. Slopes range from 12 to 90 percent. The Sussannaberg series consists of shallow, well drained, slowly permeable soils on summits and side slopes of volcanic hills and mountains. They formed in material weathered from volcanic residuum. Slopes range from 12 to 90 percent. Table 1 in Appendix C details the depth, consistency, inclusions, and drainage quality of the sediments found within the APE. As evident from the table provided, over 99 percent of the APE is composed of extremely stony and relatively steep depositional environment with very shallow soils not conducive to preserving cultural deposits.

## 5 Historical Background of Tutu Wells Site

Archaeological literature and primary and secondary historic period sources were examined to obtain a better idea of the developmental history of the Project area and its surrounding environment. Background discussion is limited to activities relevant to the immediate area surrounding the Project area with extensive literature review of the prehistory covered elsewhere (Bullen 1962; Righter 2002; Rouse 1952, 1964, 1982; Wheaton 1999).

### 5.1 Precontact Period

Precontact is used in this report to designate the period prior to the encroachment of European colonization and the use of written records. Based on a combination of ethnographic accounts, Precontact indigenous artifact collections, and archaeological data, the Precontact era can be divided into three main periods. These periods are well-documented in the literature and owing to comprehensive coverage elsewhere will be presented in limited detail to provide context for identifying potential subsurface deposits within the Tutu Wells direct APE.

The three main periods for the Antilles consist of the Paleoindian Period (ca. 9500 B.C.–5000 B.C.), Mesoindian (5000 B.C.–A.D. 1) and Neoindian (A.D. 1–1500). Archaeological evidence in the Tutu subdistrict generally pertains to the Mesoindian and Neoindian periods which are further subdivided into the Saladoid (500 B.C.–A.D. 545) and Ostionoid (A.D. 600–1500) phases with the latter phase subdivided further to incorporate a putative Elenoid phase (Rodriguez 1985; Vescelius 1979).

While archaeological data for the area are sparse, evidence found throughout the Antilles suggests that Paleoindian and Mesoindian subsistence strategies were similar in nature, consisting of a mobile and largely coastal subsistence strategy of hunting, gathering, and exploitation of marine resources. From Paleoindian and Mesoindian periods to Neoindian periods, indigenous lifeways (material culture, settlement and subsistence patterns) shifted from this archaic, aceramic, and mobile subsistence regime to one consisting of broad-spectrum and horticulturally based sedentism with more nucleated village settlements migrating inland as time progressed from Saladoid to Ostionoid phases (Wheaton 1999; Vescelius 1979). These changes in subsistence were accompanied by new waves of migration and occupation during the Saladoid and Ostionoid. The Saladoid demonstrates a significant shift, with earlier preceramic assemblages and mobile subsistence strategies giving way to more sedentary strategies associated with newly introduced cassava, yucca, and maize cultigens as well as ceramic technology. The next major migration occurs during the Ostionoid when settlements throughout the Antilles increase, with evidence from Puerto Rico indicating an association of some settlements with ball courts and ceremonial centers.

While ceremonial centers or ball courts have yet to be found on St. Thomas, the Tutu village archaeological site represented one of the largest of Ostionoid period village sites (Righter 2002). However, while the nearby area has yielded examples of Saladoid and Ostionoid material culture, the immediate area surrounding the direct APE yielded no evidence of such activities.

### 5.2 Historic Period Summary

Historically, the APE is part of contact and colonial periods characterized by large scale plantation based economy. After Columbus' encounter in 1493, the history of the Virgin Islands and the Antilles was dominated by Spanish, Dutch, and Danish attempts to control the area. The first permanent European colony was established in Charlotte Amalie by the Danish West India Company with its main sector located in the southern bay built around Fort Christian. Colonial population varied



through this time due in part to the inability to retain indentured labor on the island. This labor shortage, along with the introduction of sugar plantations prompted the adoption of slave labor. Increased revenue from sugar exports led to a commensurate increase in the African slave population with numbers in St. Thomas reaching a total of 155 Europeans colonists and 3,042 African slaves by 1715 (Williams 1984). In all, the peak number of plantations on St. Thomas reached 177 by 1725, decreasing in number as cane production shifted to neighboring St. Croix. With slavery abolished in 1848 the economy of St. Thomas and the Virgin Islands overall shifted to animal husbandry and entered a period of decline. By the eighteenth century St. Thomas' importance had decreased significantly as modernized maritime industry bypassed its port for better alternatives. The island's shift from Danish colonial resource to burden led to its sale to the United States in 1917 for its strategic military value. Economic conditions did not begin to improve until after World War II when an increase in tourism laid the foundations for St. Thomas' current economic conditions.

The Project APE was likely part of the general plantation system consisting of Great Houses, Factories, Worker Villages and Field infrastructure (Tyson and Baumgardt 1987). Great House Complexes consisted of the plantation owner's residence, outbuildings, wells, cisterns, gardens, and graveyards frequently situated on slopes or hilltops adjacent to cultivated fields, and near the center of the property. Factory Complexes included grinding mills, boiling and still houses, curing sheds, storehouses, stables, pens and cisterns also often situated on hilltops with good exposure owing to the wind powered nature of some of St. Thomas' energy. Worker Villages consisted of wattle and daub or stone houses, gardens, yards, and burial grounds located at the base of the hill slopes, adjacent to the fields and often below and within site of the Great House. Field infrastructure consisted of walls, fences, terraces, water troughs, ponds, roads, and fire breaks distributed across the plantation. Wheaton (1999) notes that Route 38, which corresponds to Smith Bay Road on the southern boundary of the APE, follows the historic road linking the town of Charlotte Amalie with eastern St. Thomas. A portion of this road, extending from town up Raphune Hill, existed as early as 1686 with the earliest cartographic depiction of the entire length of the road dating to 1830s. The map shows that the road ran alongside sites associated with six plantations: St. Thomas, Raphune, New Herrnhut, Donoe, and—most relevant to this investigation—Charlotte Amalie and Anna's Retreat (Tutu). Both Charlotte Amalie and Anna's Retreat (Tutu) areas fall within the 1-mile radius of the APE. Notwithstanding, USVISHPO determined that no historic sites would be adversely affected (see Appendix D).

### **5.3 Previous Investigations, Known Archaeological Sites and Historical Properties**

Background site research and site visitation was conducted in December 2016. Information was gathered in consultation with representatives of USVISHPO with the purpose of identifying the presence of previously recorded surveys, and listed, eligible or otherwise inventoried archaeological and architectural sites within a 1-mile radius of the APE.

Consultation with the database yielded nine surveys within one mile of the Project area (Appendix C: Table 2) with one highway survey extending into the proposed APE. No eligible archaeological sites were recorded within one mile (1.6 km) of the Project area, nor were any archaeological resources noted within the APE. With the exception of the Tutu Village archaeological investigation published by Righter in 2002, which yielded significant data, the above studies all presented the same assessment, identifying a heavily impacted rocky/stony context composed of modern fill with little historical archaeological potential and no evidence of Precontact habitation or resource exploitation

in the form of village campsites or middens. The 2002 report, while substantial, recorded a large village site that has since been eradicated or buried under the Tutu Park Mall. Recent soil borings conducted by Geraghty and Miller (Appendix D) support this overall assessment, showing evidence of fill and bedrock strata with no cultural material beneath the fill.

USVISHPO records note multiple properties within a 1-mile radius of the Project area; however, USVISHPO representatives have previously assessed that there was no potential for direct impact of the APE to any of the eligible or potentially eligible structures. This is supported by the state of the APE as shown by site photographs taken of the Project area (Appendix B: Photographs 1–20). As such there is no possibility of direct or indirect visual impact from the APE on eligible properties.

## 6 Conclusions and Recommendations

Under contract to the EPA, HDR has conducted Phase Ia site review and sensitivity assessment for the proposed installation of monitoring wells for the Tutu Wells Project area. The investigation was completed to assist EPA in meeting its regulatory obligation pursuant to Section 106 of the National Historic Preservation Act. The purpose of the investigation was to identify the likelihood of encountering archaeological or historical resources listed in or eligible for listing in the NRHP within the proposed APE. Results from this investigation would then be used to recommend follow-up measures if necessary.

The Phase Ia background investigation of the Project area located no extant archaeological sites within a 1-mile radius of the direct APE. No known archaeological sites were recorded within the APE. Therefore no site will be impacted by the proposed activities of the Tutu Wells Project. Background research of the previously inventoried structures on file with USVISHPO did indicate the presence of structures eligible for NRHP within the 1-mile (1.6-km) radius of the APE. However, USVISHPO determines these structures to be well outside of the radius for indirect impacts. This assessment, along with their condition as determined by consultants at the USVISHPO, also eliminates the visual impact that any alteration within the APE may impose on them (Appendix D).

Subsurface sensitivity assessment of the APE consisted of reviewing background literature and boring-hole logs of samples distributed across the APE. No significant historic or Precontact material was recovered from these samples nor were any conditions present that were amenable to the preservation of archaeological sites or associated cultural material. The area of ground disturbance encompassed in the APE for the Tutu Wells South Project area covers locations that have been shown to be predominantly bedrock and previously impacted by imported fill material. This severely compromises the potential for intact archaeological sites and associated cultural deposits. Therefore, due to the disturbed nature of the Project area with no significant archaeological resources and high level of modern impact, the proposed Project will have no effect on archaeological resources.

HDR's cultural resource experts have assessed the location's geomorphology, environmental setting, history and potential for subsurface and visual impacts as outlined above. As a result of this investigation, it is HDR's recommendation that no further cultural resource investigations are required as the proposed Project will have no effect on historic properties within the Project's APE. In concurrence with the USVISHPO (Appendix D) relative to the scale and nature of the proposed APE, the potential for intact archeological sites and associated cultural deposits is low. However, as per the recommendation of USVISHPO, subsequent drilling should nonetheless monitor any samples for potential deposits and report any finding to the USVISHPO.

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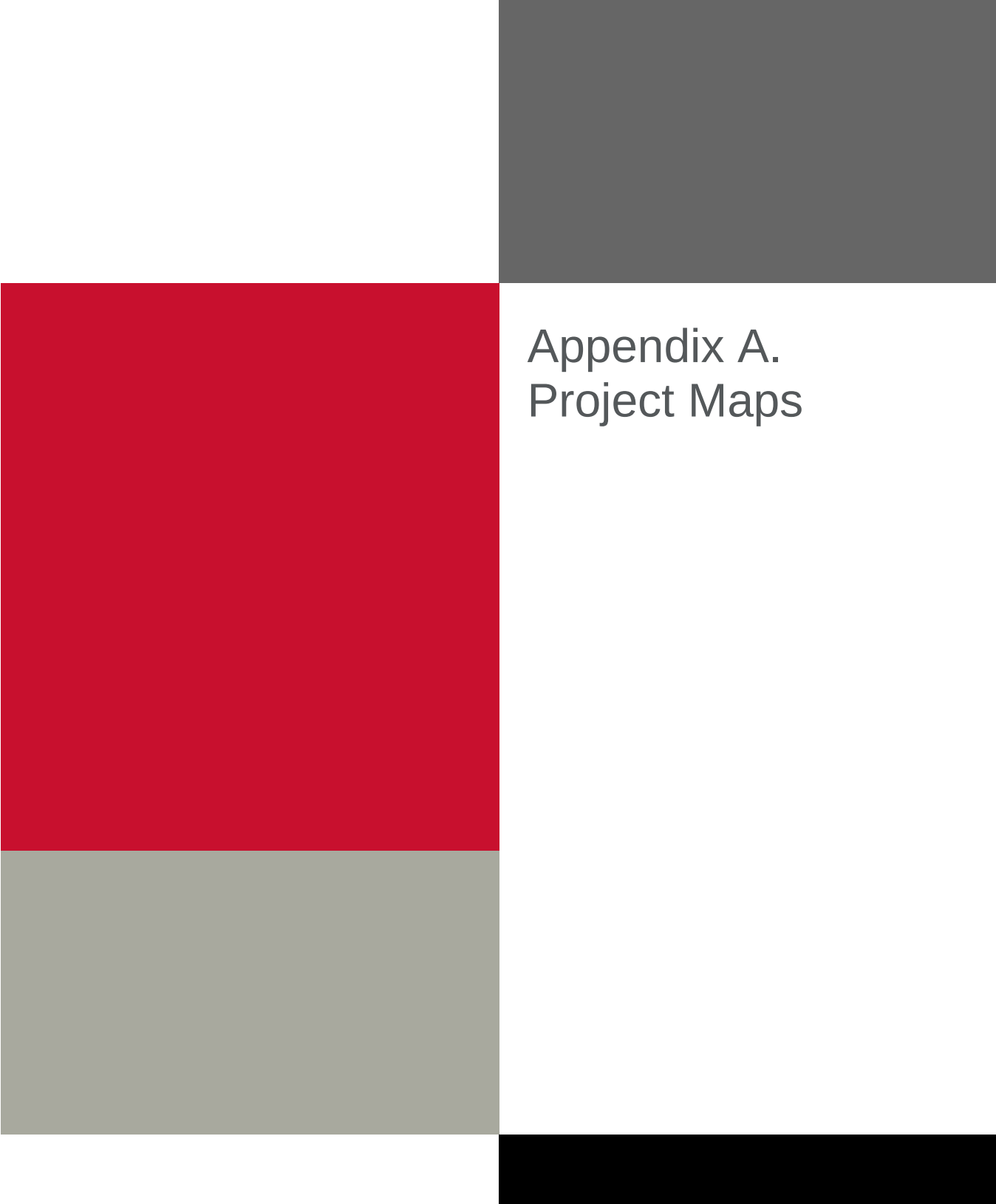
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1984     *From Columbus to Castro, the History of the Caribbean, 1492-1969.* Vintage Books, New York.

Wheaton

1999     *Phase Ia Cultural Resources Survey of Ground Water Treatment Facility Sites in the Tutu Drainage, St. Thomas.*

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# Appendix A. Project Maps

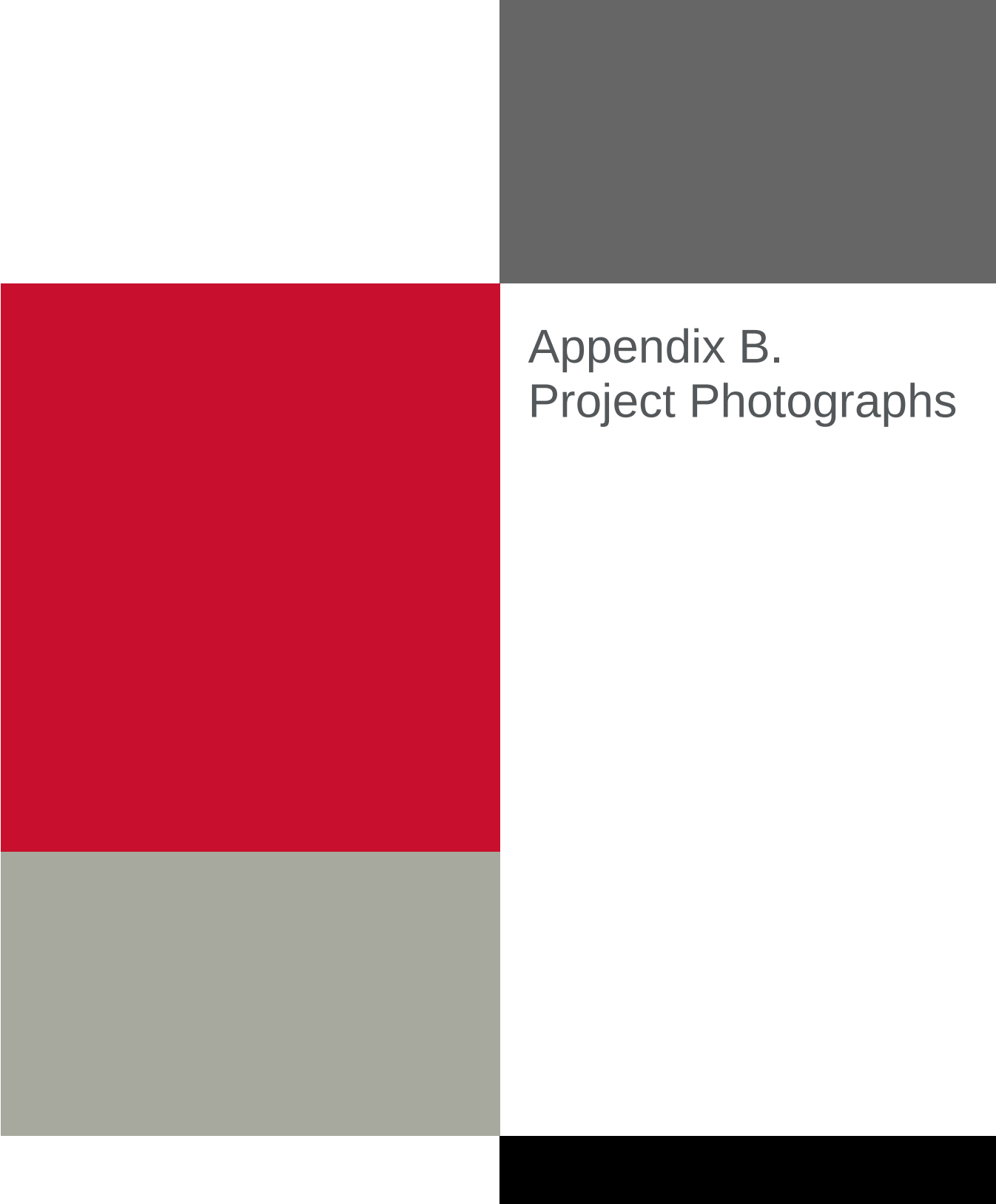
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## Appendix B. Project Photographs

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**Photograph 1: View east of Tutu Wells South Project area showing geotechnical drilling equipment.**



**Photograph 2: View southwest of Curriculum Center parking area.**





Photograph 3: View southwest of Curriculum Center parking area.



**Photograph 4: View east of Curriculum Center parking area.**





**Photograph 5: View southwest of Curriculum Center northern area showing pre-existing well location.**





**Photograph 6: View west of northern end of Curriculum Center showing proposed drill area amid disturbed rocky sediment.**



**Photograph 7: View northeast of proposed drill area, Curriculum Center.**





**Photograph 8: View southwest of proposed drill area adjacent Housing Authority.**



**Photograph 9: View west showing graded and rocky nature of Housing Authority sediment context.**





**Photograph 10: View east of rear area of Curriculum Center property.**





**Photograph 11: Closeup of preexisting well location and graded rocky surface.**





**Photograph 12: View east of rear sector of Curriculum Center showing exposed, weathered bedrock.**





**Photograph 13: View northwest of Tutu Wells North Project area showing asphalt area west of Housing Authority building.**



**Photograph 14: View west of parking area west of Curriculum Center.**





**Photograph 15: Close-up of datum point for well location**





**Photograph 16: View east of Tillet Gardens proposed well location.**



**Photograph 17: View of Tillet Gardens proposed well location.**





**Photograph 18: View north of rear sector of Housing Authority.**



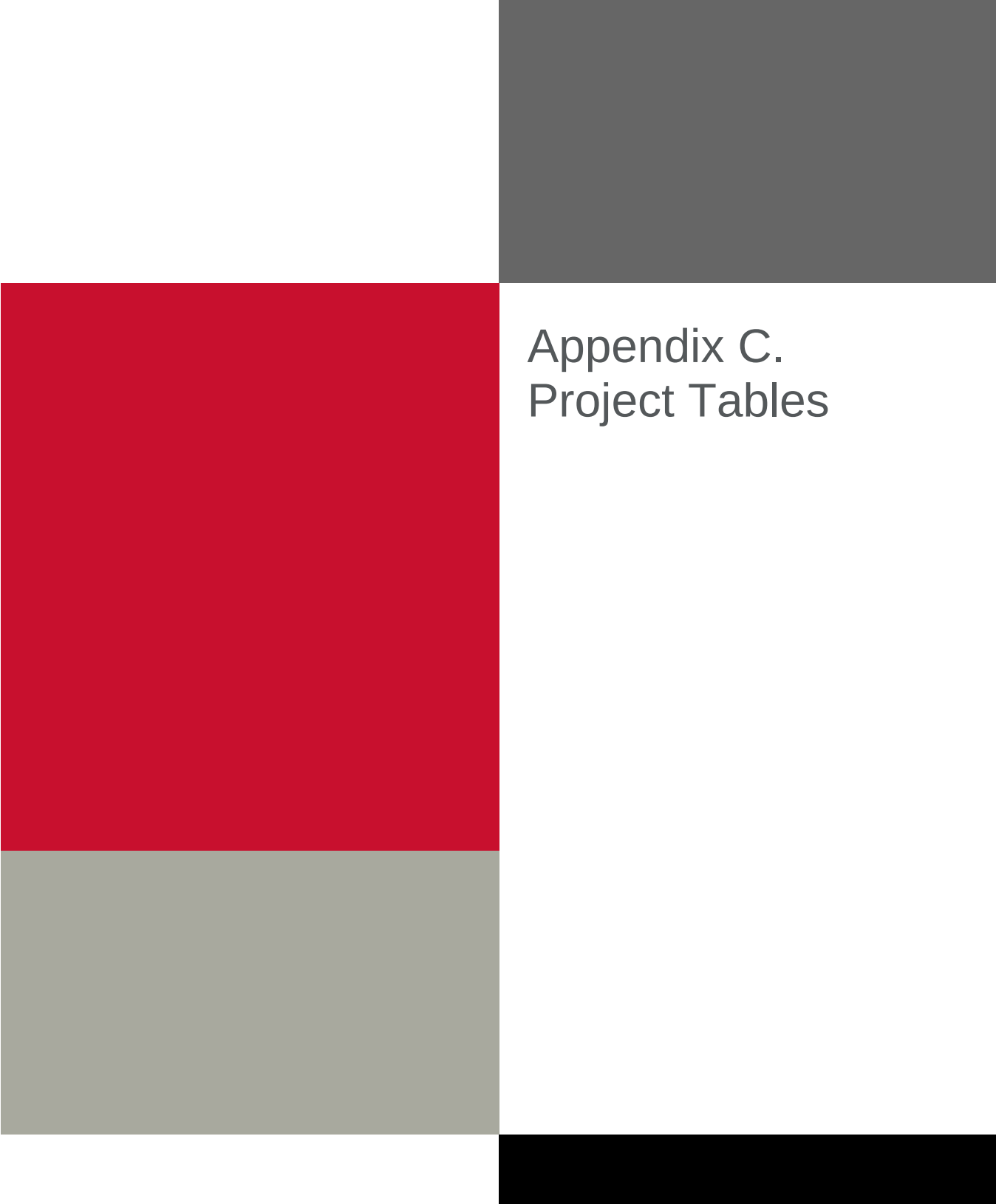


**Photograph 19: View northwest of rear of Housing Authority showing graded and disturbed surface.**



**Photograph 20: View west of Housing Authority parking lot.**



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# Appendix C. Project Tables

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**Table 1: Soil Types and Descriptions at Tutu Wells APE**

| Name        | Depth<br>cm (in)           | Color  | Texture,<br>Inclusions | Slope                      | Drainage                                                  | Landform                                                      |
|-------------|----------------------------|--------|------------------------|----------------------------|-----------------------------------------------------------|---------------------------------------------------------------|
| Fredriksal  | A 0-17.8 cm (0-7 in)       | DkRBrn | Cl Lo Grl<br>Rts       | 12-20<br>percent<br>slopes | Shallow, well<br>drained,<br>slowly<br>permeable<br>soils | Summits, side<br>slopes of volcanic<br>hills and<br>mountains |
|             | Bw 17.8-30.5 cm (7-2 in)   | RBrn   | Cl Lo Gr<br>Rts        |                            |                                                           |                                                               |
|             | Cr 30.5-40.6 cm (12-16 in) | YRd    | WBr                    |                            |                                                           |                                                               |
|             | R 40.6-152.4 cm (16-60 in) |        | UBr                    |                            |                                                           |                                                               |
| Susannaberg | A 0-5.08cm (0-2 in)        | VDkBrn | Cl Lo Rts              | 12-90<br>percent<br>slopes | Shallow, well<br>drained,<br>slowly<br>permeable<br>soils | Summits, side<br>slopes of volcanic<br>hills and<br>mountains |
|             | Bw 5.08-22.9cm (2-9 in)    | VDkBrn | Cl Rts                 |                            |                                                           |                                                               |
|             | Cr 22.9-53.3cm (15-21 in)  | YBrn   | WBr                    |                            |                                                           |                                                               |
|             | R 53.3-152.4cm (21-60 in)  | YBrn   | UBr                    |                            |                                                           |                                                               |

Sources: USDA NRCS 2007, USDA NRCS 2014

Soil Description Key:

Shade: Dk–Dark

Color: Brn–Brown, RBrn–Red Brown, YRd–Yellow Red

Soils: Cl–Clay, Lo–Loam,

Other: Grl–Gravel, Rts–Roots, Weathered-W, U–Unweathered, Bedrock-Br



**Table 2: Previous Surveys within 1 Mile of Project**

| Survey # | Agency  | Project                                                                                                                                                                        | Contractor                 | Author                              | Year |
|----------|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|-------------------------------------|------|
| N/A      | N/A     | A Phase 1 Survey of the Proposed Mangrove Lagoon/Turpentine Run Flood Control Project, St. Thomas, USVI                                                                        | MAAR Inc.                  | Thomas, Ronald and Lauren Archibald | 1983 |
| N/A      | N/A     | Marine Archaeological Survey of the Proposed Mangrove Lagoon/Turpentine Run Wastewater Treatment Project, St. Thomas, USVI                                                     | MAAR Inc.                  | Tyson, George                       | 1985 |
| N/A      | N/A     | Report on a Stage 1A and 1B Archaeological Survey of a Modified Effluent Outfall ROW, for the Mangrove Lagoon/Turpentine Run Wastewater Treatment Facilities, St. Thomas, USVI | MAAR Inc.                  | Thomas, Ronald and Harding Polk     | 1987 |
| N/A      | USACE   | Final Report, A Cultural Resource Survey of the Proposed Turpentine Run, Flood Control Project, St. Thomas, USVI.                                                              | Garrow and Associates      | Garrow and Associates               | 1989 |
| N/A      | USACE   | Cultural Resources Survey of Segment B, Turpentine Run, St. Thomas, USVI.                                                                                                      | Brockington and Associates | Espenshade, Christopher T.          | 1994 |
| #318     | USVIDPW | A Phase IA-B Cultural Resources Survey of Route 38, St. Thomas, USVI.                                                                                                          | New South Associates       | Wheaton and Tyson                   | 1994 |
| #318     | USVIDPW | Phase II Cultural Resources Testing of Route 38, St. Thomas USVI, Including Additional Phase 1 Survey of the Harthman Property.                                                | New South Associates       | Wheaton and Tyson                   | 1995 |
| #665     | EPA     | Phase Ia Cultural Resources Survey of Groundwater Treatment Facility Sites in the Tutu Drainage. St. Thomas USVI                                                               | New South Associates       | Wheaton, Thomas                     | 1999 |
| #881     | G.E.R.S | Phase I Archaeological Survey. Estates Hoffman and Nullyberg, Parcel A. St. Thomas, U.S. Virgin Islands                                                                        | Soltec International       | Soltec                              | 2009 |
| #969     | N/A     | Phase I Archaeological Survey of Parcel #28-5-1 Estate Charlotte Amalie, No.3, New Quarter, St. Thomas VI                                                                      | David Hayes, RPA           | Hayes, David                        | 2014 |

## Appendix D. Additional Documentation

D.1 USVISHPO correspondence

D.2 Soil borings/Drill profiles

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## D.1 USVISHPO Correspondence



### GOVERNMENT OF THE UNITED STATES VIRGIN ISLANDS

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#### DEPARTMENT OF PLANNING AND NATURAL RESOURCES Virgin Islands State Historic Preservation Office

1640 Dronningens Gade 71 & 72A, Kongens Quarter  
Charlotte Amalie  
St. Thomas, Virgin Islands 00802

Telephone: (340) 776-8605

Facsimile: (340) 776-7236

Roberto A. Herrera, PhD, RPA  
Archaeology Project Director  
HDR  
500 Seventh Avenue  
New York, NY 10018

October 19, 2016

Re: VISHP Literature Background Research for proposed deep and shallow monitoring wells in the area of Tutu, Estate Charlotte Amalie, St. Thomas, U.S. Virgin Islands by HDR, Inc.

Dear Mr. Herrera:

Although your e-mail did not describe the project at hand in any detail, we are able to surmise that HDR is planning to add extra monitoring wells to the already active monitoring wells existing in the area. In that regard, although the proposed locations are in the general area of the known Prehistoric Village Site of Tutu (12VAm3-054), as well as in the area of the historic location of Ft. Mylner, we feel it best to address the concerns that the project addresses in total, rather than piecemeal. Thus, for the purposes of Section 106 consultation, the background literature search is unnecessary. Our findings are as follows:

The proposed wells are in the immediate vicinity of existing wells and/or on previously disturbed soils. The impact of any monitoring well hole-drilling therefore, is minimal to any potential cultural resources. Even the proposed Staging and IDW Storage areas (as shown on the Proposed Monitoring Well and Borehole Drilling, Curriculum Center, Dept. of Education .pdf image) are located on carved-out-to-bedrock areas created for the construction of the Curriculum Center itself.

**Therefore, the VISHPO has no objection to the proposed monitoring well-drilling project by HDR, Inc. for the EPA, provided that if any significant artifacts are encountered, especially any possible human remains, the drilling will cease immediately and the VISHPO will be contacted.**

Thank you for the opportunity to address this matter.

Sincerely,

Sean L Krigger  
Acting Director, VISHPO

## D.2 Soil borings/Drill profiles

**Geologic Log of MW-1  
Tutu Service Station Investigation  
St. Thomas, U.S. Virgin Islands**

| <u>Description</u>                                                                                                         | <u>Sampled Interval<br/>(feet below<br/>land surface)</u> |
|----------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|
| ASPHALT                                                                                                                    | 0 - 0.1                                                   |
| CLAY; some Silt; little Sand, fine to coarse, trace weathered<br>rock fragments; angular, hard, dry, brown, greenish-gray. | 0.1 - 1.8                                                 |
| Top of bedrock inferred at 1.8 feet below land surface.                                                                    |                                                           |

(See also Geologic Log of MW-1D)

PR01301/052193.log/1cb

GERAGHTY & MILLER, INC.

TUT 005 1050



**Geologic Log of MW-1D  
Tutu Service Station Investigation  
St. Thomas, U.S. Virgin Islands**

| <u>Description</u>                                                                                                                                                                                                                                                                                           | <u>Sampled Interval<br/>(feet below<br/>land surface)</u> |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|
| ASPHALT                                                                                                                                                                                                                                                                                                      | 0 - 0.3                                                   |
| Fill consisting of GRAVEL medium to fine; some Clay; trace silt;<br>trace Sand, medium to coarse; dry to moist; brown.                                                                                                                                                                                       | 0.3 - 2.5                                                 |
| CLAY; some SILT; little to trace Sand, medium to coarse; little rock<br>fragments, medium to large, angular; little to trace gravel,<br>fine to medium; trace pieces of wood; very hard, dry to moist,<br>light brown to brown.                                                                              | 2.5 - 2.8                                                 |
| VOLCANIC BRECCIA (coarse grained); greenish-gray; strong to moderately<br>strong; fine, medium, large grained, rectangular and irregular<br>shape, moderately sorted; plagioclase feldspar, pyroxenes, and<br>chlorite minerals, dull to vitreous; calcite veins, iron stains;<br>fresh to slightly altered. | 2.8 - 15.0                                                |
| VOLCANIC BRECCIA (finer grained); mottled gray and white; some pebble<br>sized, angular clasts; contact metamorphism; plagioclase feldspar,<br>hornblende, pyroxene, magnetite.                                                                                                                              | 15.0 - 21.2                                               |
| VOLCANIC BRECCIA - Debris Flow; dark, grayish-green; competent,<br>jointed interval; porphyritic, fine to coarse; large (8 cm) slump<br>clasts; large plagioclase and pyroxene crystals.                                                                                                                     | 21.2-89.0                                                 |
| Fracture zones observed from 2.34 to 15.09 feet bls, 19.34 to 21.2 feet bls, 34.5 to<br>35.5 feet bls, and 54.0 to 55.0 feet bls.                                                                                                                                                                            |                                                           |

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bls below land surface

PR01301/052193.log/wh

TUT 005 1051

GERACHTY & MILLER, INC



**Geologic Log of MW-2  
Tutu Service Station Investigation  
St. Thomas, U.S. Virgin Islands**

| <u>Description</u>                                                                                              | <u>Sampled Interval<br/>(feet below<br/>land surface)</u> |
|-----------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|
| ASPHALT                                                                                                         | 0 - 0.4                                                   |
| SILT; some Clay, little rock fragments, small; trace Sand, fine to medium; trace roots; hard, dry; brown to tan | 0.4 - 1.2                                                 |
| CLAY; some Silt; little rock fragments, small; trace Gravel, fine to medium; hard to very hard; dry, gray.      | 1.2 - 3.1                                                 |
| Top of bedrock inferred at 3.4 feet below land surface.                                                         |                                                           |

PR01301/052193.log/tcb

TUT 005 1052

GERBACHTY & MILLER, INC.



**Geologic Log of MW-3  
Tutu Service Station Investigation  
St. Thomas, U.S. Virgin Islands**

| <u>Description</u>                                                                                                            | <u>Sampled Interval<br/>(feet below<br/>land surface)</u> |
|-------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|
| CONCRETE                                                                                                                      | 0 - 0.4                                                   |
| Fill, CLAY; some Silt; trace Sand, fine to medium; trace rock<br>fragments, small to medium; hard, dry; brown, reddish brown. | 0.4 - 2.0                                                 |
| No recovery.                                                                                                                  | 2.0 - 2.4                                                 |
| Top of bedrock inferred at 2.4 feet below land surface.                                                                       |                                                           |

PR01301/052193.log/1cb

GERAGHTY & MILLER, INC.

TUT 005 1053

**Geologic Log of MW-4  
Tutu Service Station Investigation  
St. Thomas, U.S. Virgin Islands**

| <u>Description</u>                                                                                                                                                                                                    | <u>Sampled Interval<br/>(feet below<br/>land surface)</u> |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|
| CONCRETE                                                                                                                                                                                                              | 0 - 0.7                                                   |
| CLAY; some Silt; some organic content (4.7 - 6.7 feet); trace Sand,<br>fine to coarse; trace Gravel; subangular, very stiff to hard;<br>reddish brown, dark greenish-gray, brown, dark brown, gray, and<br>dark gray. | 0.7 - 7.1                                                 |
| No recovery.                                                                                                                                                                                                          | 8.7 - 9.8                                                 |
| Top of bedrock inferred at 8.7 feet below land surface.                                                                                                                                                               |                                                           |
| (See also Geologic Log for MW-4D)                                                                                                                                                                                     |                                                           |

PR01301/052193.log/feb

TUT 005 1054

GERAGHTY & MILLER, INC



**Geologic Log of MW-4D  
Tutu Service Station Investigation  
St. Thomas, U.S. Virgin Islands**

| <u>Description</u>                                                                                                                                                                                                                                                                                                | <u>Sampled Interval<br/>(feet below<br/>land surface)</u> |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|
| CONCRETE PAVEMENT                                                                                                                                                                                                                                                                                                 | 0 - 0.7                                                   |
| CLAY; some Silt, little Sand, fine to coarse; little Gravel; stiff to hard; moist; reddish brown to brown, bluish-gray, dark gray; medium plasticity.                                                                                                                                                             | 0.7 - 9.5                                                 |
| Weathered rock fragments and CLAY; some Silt; some to little Sand.                                                                                                                                                                                                                                                | 9.5 - 10.7                                                |
| Top of weathered bedrock inferred at 10.7 feet.                                                                                                                                                                                                                                                                   |                                                           |
| Weathered rock fragments and CLAY - some Silt; angular, small to large; hard; moist to wet at 14.7 and 18.7 feet, gray, blue, green, brown, white, red, black stains; crumbled.                                                                                                                                   | 10.7 - 22.8                                               |
| Top of competent bedrock inferred at 22.8 feet below land surface.                                                                                                                                                                                                                                                |                                                           |
| VOLCANIC ANDESITE TUFF; dark green; highly fractured to 26.5 feet bls; gray; moderately strong to strong; very fine grained; pyroxene, plagioclase feldspars, some quartz, chlorite, and orthoclase minerals; calcite veins; iron stains; contact metamorphism and hydrothermal alteration 26.5 to 28.2 feet bls. | 22.8 - 28.2                                               |
| VOLCANIC BRECCIA; gray; fine to medium grained; plagioclase, pyroxene, magnetite; pyroxene crystals (2 cm); fining upward sequences.                                                                                                                                                                              | 28.2 - 33.0                                               |
| Weathered VOLCANIC BRECCIA; SILT and CLAY; light brown, very fine grained to pebble sized fragments; semi-angular.                                                                                                                                                                                                | 33.0 - 35.0                                               |
| No recovery                                                                                                                                                                                                                                                                                                       | 35.0 - 37.1                                               |

PR01301/052193.log/leh

TUT 005 1055

GERAGHTY & MILLER INC



**Geologic Log of MW-4D  
Tutu Service Station Investigation  
St. Thomas, U.S. Virgin Islands**

| <u>Description</u>                                                                                                                                                                                                                                                                                    | <u>Sampled Interval<br/>(feet below<br/>land surface)</u> |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|
| VOLCANIC ANDESITE TUFF; dark green, gray; strong; aphanitic, very fine grained; pyroxene, plagioclase feldspars, epidote, some quartz, magnetite, chlorite, and orthoclase minerals; calcite veins; black minerals 60% rock matrix; white plagioclase amygdules 35% of rock matrix, slightly altered. | 37.1 - 58.3                                               |
| DIORITE; dark gray; very dense; strong; very fine to coarse grained; pyroxene, plagioclase feldspar, quartz, chlorite, and orthoclase minerals; pyroxene minerals ranged from 35 to 60% of rock matrix; plagioclase minerals ranged from 35 to 40% of rock matrix, slightly altered.                  | 58.3 - 64.0                                               |
| Weathered VOLCANIC ANDESITE TUFF; altered to SILT and CLAY; very fine to medium grained; friable, vertical foliations; calcite, kaolinite, chlorite; white-rust color.                                                                                                                                | 64.0 - 66.5                                               |
| VOLCANIC ANDESITE TUFF; dark green; fine grained; aphanitic; pyroxene, plagioclase, epidote; calcite filled vertical fractures.                                                                                                                                                                       | 66.5 - 68.0                                               |
| Fracture zones observed from 9.0 to 25.5 feet bls, 30.0 to 38.2 feet bls, and 65.0 to 66.5 feet bls.                                                                                                                                                                                                  |                                                           |
| Highly weathered fracture plane at 40.9, 55.0, and 64.0 feet bls.                                                                                                                                                                                                                                     |                                                           |

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bls    below land surface

PR01301/052193.log/leb

TUT 005 1056

GERAGHTY & MILLER INC

**Geologic Log of MW-5  
Tutu Service Station Investigation  
St. Thomas, U.S. Virgin Islands**

| <u>Description</u>                                                                                                                                             | <u>Sampled Interval<br/>(feet below<br/>land surface)</u> |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|
| Fill, SILT; little Sand, fine to medium; little Gravel, fine to medium;<br>trace rock fragments, small; trace clay; trace pieces of wood;<br>hard; dry; brown. | 0 - 4.0                                                   |
| Highly weathered bedrock; very weak; grayish-green.                                                                                                            | 4.0 - 4.8                                                 |
| Top of bedrock inferred at 4.8 feet below land surface.                                                                                                        |                                                           |

PRO1301/052193.log/1cb

GERACHTY & MILLER, INC.

TUT 005 1057

**Geologic Log of MW-6D  
Tutu Service Station Investigation  
St. Thomas, U.S. Virgin Islands**

| <u>Description</u>                                                                                                                                                                                                                                                                                                                                                                                                                           | <u>Sampled Interval<br/>(feet below<br/>land surface)</u> |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|
| ASPHALT                                                                                                                                                                                                                                                                                                                                                                                                                                      | 0 - 0.3                                                   |
| CLAY; some SILT; trace Sand, fine to very coarse; little rock fragments, small to medium; hard; dry; brown to gray.                                                                                                                                                                                                                                                                                                                          | 0.3 - 2.0                                                 |
| No recovery.                                                                                                                                                                                                                                                                                                                                                                                                                                 | 2.0 - 4.0                                                 |
| VOLCANIC BRECCIA; grayish-green to dark green; moderately strong; porphyritic, medium to coarse grained; rectangular to massive phenocrysts (2 mm to 6 cm), moderately sorted; plagioclase feldspar, pyroxene minerals, dull, glassy, vitreous; white minerals ranged from 10 - 15% of rock matrix; slightly to highly altered and stained; Clay - little Silt; trace Sand, fine to coarse; light gray; soft; wet; magnesium and iron oxide. | 4.0 - 32.0                                                |
| VOLCANIC ANDESITE TUFF; grayish-green; moderately strong to weak; fine to medium grained, rectangular and irregular shape, moderately sorted; plagioclase feldspar, pyroxenes, epidote and chlorite minerals; dull, glassy; calcite veins; iron staining; moderately to highly altered.                                                                                                                                                      | 32.0 - 45.0                                               |
| VOLCANIC BRECCIA - Debris Flow, with slump casts; competent, jointed interval; medium to coarse grained, plagioclase, epidote, chlorite, pyroxene; rounded slump blocks (6 cm) of dark gray, coarse grained Tuff in a mottled dark gray-green matrix.                                                                                                                                                                                        | 45.0 - 53.0                                               |
| VOLCANIC BRECCIA; grayish-green; competent, jointed interval; strong to moderately strong; coarse grained, rectangular, cubic and irregular shape; plagioclase, chlorite, and epidote minerals, dull, glassy; calcite veins; fresh to slightly altered.                                                                                                                                                                                      | 53.0 - 60.0                                               |

PR01301/052193.log/lcb

GFRAGHTY & MILLER, INC

TUT 005 1058

**Geologic Log of MW-6D  
Tutu Service Station Investigation  
St. Thomas, U.S. Virgin Islands**

| <u>Description</u>                                                                                                                                                                                                                                                             | <u>Sampled Interval<br/>(feet below<br/>land surface)</u> |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|
| VOLCANIC BRECCIA - Debris Flow, with slump casts; greenish-gray; moderately strong; fine grained, rectangular to irregular shaped slump casts (8 cm), dark gray, pyroxene rich, coarse Tuff; matrix is fine grained; well sorted; plagioclase, dull, glassy, slightly altered. | 60.0 - 65.0                                               |
| Fracture zones observed from 9.6 to 32.0 feet bls, 35.0 to 35.5 feet bls, 37.0 to 40.0 feet bls, and 43 to 60 feet bls.                                                                                                                                                        |                                                           |

Note: This log is a combination of the geology observed at MW-6 (abandoned) and MW-6D.

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bls    below land surface

PR01301/052193.log/lcb

GERAGHTY & MILLER INC

TUT 005 1059



**Geologic Log of MW-7  
Tutu Service Station Investigation  
St. Thomas, U.S. Virgin Islands**

| <u>Description</u>                                                                                                                          | <u>Sampled Interval<br/>(feet below<br/>land surface)</u> |
|---------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|
| Fill, CLAY; some Silt; little rock fragments, small to medium; trace Sand, medium to very coarse; trace roots; hard; dry; brown.            | 0 - 4.0                                                   |
| Highly weathered Rock; SAND, fine to medium; some Silt; trace Sand, coarse to very coarse; trace Gravel, fine; trace Clay; hard, dry, gray. | 4.0 - 6.0                                                 |
| Highly weathered bedrock; weak, grayish-green.                                                                                              | 6.0 - 15.0                                                |

PR01301/052193.log/feb

TUT 005 1060



**Geologic Log of MW-8  
Tutu Service Station Investigation  
St. Thomas, U.S. Virgin Islands**

| <u>Description</u>                                                                                                                                      | <u>Sampled Interval<br/>(feet below<br/>land surface)</u> |
|---------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|
| Fill, CLAY; some Silt; trace Sand, very fine to very coarse; trace rock fragments, small to medium; very stiff; dry; brown.                             | 0 - 0.35                                                  |
| Moderately weathered rock; SILT; little to trace Sand, very fine to fine; little trace rock fragments; very stiff to hard; dry; brown to reddish-brown. | 3.3 - 8.3                                                 |
| Top of bedrock inferred at 8.3 feet below land surface.                                                                                                 |                                                           |

PR01301/052193.log/1ch

GERAGHTY & MILLER INC

TUT 005 1061

**Geologic Log of MW-9  
Tutu Service Station Investigation  
St. Thomas, U.S. Virgin Islands**

| <u>Description</u>                                                                                                                                                                                                                                                                                                                                                                                        | <u>Sampled Interval<br/>(feet below<br/>land surface)</u> |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|
| Fill, consisting of CLAY; some Silt; little rock fragments, small to large;<br>trace Sand, fine to very coarse; hard; dry; brown to reddish-brown.                                                                                                                                                                                                                                                        | 0 - 5.0                                                   |
| Top of bedrock inferred at 5.0 feet below land surface.                                                                                                                                                                                                                                                                                                                                                   |                                                           |
| VOLCANIC BRECCIA; light greenish-gray; moderately strong; porphyritic,<br>fine to large grained, rectangular to irregular shape, moderately<br>sorted; plagioclase, epidote, and chlorite minerals, some chert;<br>dull, vitreous; calcite veins; plagioclase minerals range from<br>10 to 25% of rock matrix; slightly altered; Clay; observed at<br>10 feet, little Silt, trace Sand, medium to coarse. | 5.0 - 15.0                                                |
| VOLCANIC ANDESITE TUFF, and Silt and Clay; homogenous, aphanitic,<br>very fine grained; plagioclase, pyroxene, chlorite, some quartz;<br>calcite veins; slightly to highly altered; bluish-green to grayish-green.                                                                                                                                                                                        | 15.0 - 28.0                                               |
| VOLCANIC BRECCIA; grayish-green; moderately strong; porphyritic, fine<br>to coarse grained; moderately to poorly sorted; plagioclase, calcite,<br>hornblende, magnetite, chlorite, and pyroxene minerals; calcite veins;<br>slightly altered.                                                                                                                                                             | 28.0 - 35.0                                               |

PR01301/052193.log/lcb

TUT 005 1062

GEOTECHNICAL ENGINEERING INC.

**Geologic Log of MW-10  
Tutu Service Station Investigation  
St. Thomas, U.S. Virgin Islands**

| <u>Description</u>                                                                                                                          | <u>Sampled Interval<br/>(feet below<br/>land surface)</u> |
|---------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|
| Fill, CLAY; some Silt; little Sand; medium, little rock fragments, small to medium; trace Gravel, fine to medium; hard; dry; gray to brown. | 0 - 2.9                                                   |
| Top of bedrock inferred at 2.9 feet.                                                                                                        |                                                           |
| See also Geologic Log of MW-10D.                                                                                                            |                                                           |

PR01301/052193.log/eb

GERAGHTY & MILLER INC

TUT 005 1063



**Geologic Log of MW-10D  
Tutu Service Station Investigation  
St. Thomas, U.S. Virgin Islands**

| <u>Description</u>                                                                                                                                                                                                                                     | <u>Sampled Interval<br/>(feet below<br/>land surface)</u> |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|
| ASPHALT                                                                                                                                                                                                                                                | 0 - 0.5                                                   |
| CLAY; some Silt; trace Sand, fine; trace Gravel, fine to medium;<br>little rock fragments, small to medium; hard; dry; gray to brown.                                                                                                                  | 0.5 - 1.7                                                 |
| VOLCANIC BRECCIA, greenish-gray; moderately strong; medium to<br>large grained, rectangular to irregular shape, moderately sorted;<br>plagioclase minerals, dull; manganese oxidation, iron stains;<br>calcite stains; moderately to slightly altered. | 2.3 - 5.0                                                 |
| VOLCANIC ANDESITE TUFF; greenish-gray; moderately strong,<br>fine grained, plagioclase, hornblende, less pyroxene.                                                                                                                                     | 5.0 - 6.0                                                 |
| VOLCANIC BRECCIA; greenish-gray, moderately strong, medium to<br>coarse grained, plagioclase, pyroxene, heterogeneous, zoned<br>rectangular clasts, alteration to iron oxides.                                                                         | 6.0 - 8.2                                                 |
| VOLCANIC ANDESITE TUFF; grayish-blue, moderately strong and<br>competent, fine grained, plagioclase, pyroxene, calcite.                                                                                                                                | 8.2 - 12.0                                                |
| VOLCANIC ANDESITE TUFF; grayish-blue, highly fractured and<br>crushed, fine grained, pyroxene, plagioclase, calcite.                                                                                                                                   | 12.0 - 19.0                                               |
| VOLCANIC BRECCIA; mottled olive-green, moderately strong and<br>competent, fine grained; plagioclase, calcite, pyroxene, epidote,<br>hornblende, alteration to magnesium and iron oxides.                                                              | 19.0 - 21.0                                               |
| VOLCANIC ANDESITE TUFF; light gray, highly fractured and crushed;<br>very fine grained, homogeneous, plagioclase, calcite, pyroxene,<br>epidote, hornblende.                                                                                           | 21.0 - 22.0                                               |

PR01301/052193.log/kcb

GERAGHTY & MILLER INC

TUT 005 1064

**Geologic Log of MW-10D  
Tutu Service Station Investigation  
St. Thomas, U.S. Virgin Islands**

| <u>Description</u>                                                                                                                                                                                                                                                                                                | <u>Sampled Interval<br/>(feet below<br/>land surface)</u> |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|
| VOLCANIC BRECCIA; greenish-gray; weak, highly fractured to crushed at 22.0 to 27.5; medium to coarse grained, rectangular to irregular shape, moderately sorted; plagioclase, pyroxenes, and some quartz minerals, dull, glassy; manganese oxidation, iron stains, calcite veins; moderately to slightly altered. | 22.0 - 32.0                                               |
| VOLCANIC BRECCIA - Debris Flow; mottled greenish-gray; strong, moderate jointing; medium to large grained; rectangular, irregular shape, large clasts; poorly sorted; plagioclase, quartz, pyroxenes, epidote and chlorite minerals; calcite veins; fresh to slightly altered                                     | 32.0 - 75.0                                               |
| Fracture zone observed from 6.0 to 8.2 feet bls, 12.0 to 19.0 feet bls, 21.0 to 27.5 feet bls, and 53.4 to 55.0 feet bls.                                                                                                                                                                                         |                                                           |

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bls    below land surface

PR01301/052193.log/tcb

TUT 005 1065

GERAULTY SAILER INC

**Geologic Log of MW-11D  
Tutu Service Station Investigation  
St. Thomas, U.S. Virgin Islands**

| <u>Description</u>                                                                                                                                                                                                                                                                                                                                                                         | <u>Sampled Interval<br/>(feet below<br/>land surface)</u> |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|
| Fill consisting of CLAY; some to little Silt, trace Sand, fine to coarse; trace Organic material; very stiff; dry to moist; light brown, brown to reddish-brown.                                                                                                                                                                                                                           | 0 - 4.0                                                   |
| SILT; little SAND, fine; trace clay; trace Sand, coarse to very coarse; hard; dry; brown.                                                                                                                                                                                                                                                                                                  | 4.0 - 10.2                                                |
| VOLCANIC ANDESITE TUFF; bluish-green; strong to moderately strong; fine grained, rectangular, cubic and irregular shape, well sorted; plagioclase feldspar, epidote, quartz, and pyroxene minerals, dull, glassy, bright to silky; calcite veins, iron stains; white minerals ranged from 10 to 25% of rock matrix; fresh, slightly to highly altered.                                     | 10.2 - 52.0                                               |
| VOLCANIC ANDESITE TUFF; contact metamorphism, zoned (heated) clasts (1 cm); bluish-green, strong to moderately strong; fine grained; well sorted; plagioclase feldspar, epidote, quartz, and pyroxene minerals, glassy, silky dull; calcite veins, iron stains; fresh to slightly altered; white minerals ranged from 10 to 25% of rock matrix (plagioclase content increases with depth). | 52.0 - 75.0                                               |
| Fracture zone observed from 12.0 to 25.0 feet bls, 30.0 to 32.0 feet bls, 36.0 to 37.0 feet bls, at 38.0 feet bls, 42.0 to 45.0 feet bls, and 50 to 52.0 feet bls.                                                                                                                                                                                                                         |                                                           |

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bls    below land surface

PR01301/052193.log/lcb

GERAGHTY & MILLER, INC.

TUT 005 1066



Page 1 of 2

**Geologic Log of MW-12D  
Tutu Service Station Investigation  
St. Thomas, U.S. Virgin Islands**

| <u>Description</u>                                                                                                                                                                                                                                                                                                                                                   | <u>Sampled Interval<br/>(feet below<br/>land surface)</u> |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|
| Fill consisting of SILT; some Clay; trace Sand, very fine to very coarse;<br>trace Gravel, medium, trace rock fragments; trace Organic material;<br>hard; dry; brown.                                                                                                                                                                                                | 0 - 2.0                                                   |
| CLAY, some SILT; trace Sand, very fine to very coarse; trace rock<br>fragments, medium to large, trace organics; very stiff.                                                                                                                                                                                                                                         | 2.0 - 4.0                                                 |
| No recovery.                                                                                                                                                                                                                                                                                                                                                         | 5.9 - 10.0                                                |
| Highly weathered and altered VOLCANIC BRECCIA, SILT and CLAY;<br>crushed; little to trace rock fragments, small to medium; trace<br>Sand, very fine to coarse (5 cm clasts); stiff to very stiff; dry;<br>brown to yellow, light brown.                                                                                                                              | 10.0 - 15.0                                               |
| Top of weathered bedrock inferred at 15.0 feet below land surface.                                                                                                                                                                                                                                                                                                   |                                                           |
| VOLCANIC BRECCIA; orange to light brown, light gray to reddish-gray;<br>coarse grained, competent; pyroxene and plagioclase phenocrysts,<br>calcite veins, iron stains; moderately to highly altered.                                                                                                                                                                | 15.0 - 29.0                                               |
| VOLCANIC BRECCIA - Debris Flow; dark greenish-black; coarse<br>grained matrix with fine grained angular slump clasts, plagioclase,<br>pyroxene, epidote.                                                                                                                                                                                                             | 29.0 - 31.0                                               |
| VOLCANIC ANDESITE TUFF; bluish-green and gray; strong to weak to<br>moderately strong; fine to very fine grained, aphanitic, angular<br>fragments; plagioclase feldspar, pyroxenes, quartz and pyrite minerals,<br>dull, vitreous, metallic; calcite veins, iron stains; plagioclase minerals<br>range from 5 to 10% of rock matrix; slightly to moderately altered. | 31.0 - 50.2                                               |

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TUT 005 1067



**Geologic Log of MW-12D  
Tutu Service Station Investigation  
St. Thomas, U.S. Virgin Islands**

| <u>Description</u>                                                                                                                                                                                                       | <u>Sampled Interval<br/>(feet below<br/>land surface)</u> |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|
| VOLCANIC BRECCIA - Debris Flow; dark grayish-black, moderately fractured, coarse grained matrix and clasts, pyroxene and hornblende clasts and plagioclase, pyroxene, and hornblende matrix.                             | 50.2 - 65.0                                               |
| No recovery.                                                                                                                                                                                                             | 65.0 - 75.0                                               |
| Fracture zones observed from 10.0 to 15.0 feet bls, 18.5 to 19.0 feet bls, 20.0 to 21.0 feet bls, 37.0 to 40.0 feet bls, 45.0 to 46.0 feet bls, 48.5 to 49.5 feet bls, 51.0 to 53.0 feet bls, and 59.7 to 63.0 feet bls. |                                                           |

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bls    below land surface

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TUT 005 1068

**Geologic Log of MW-13D  
Tutu Service Station Investigation  
St. Thomas, U.S. Virgin Islands**

| <u>Description</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <u>Sampled Interval<br/>(feet below<br/>land surface)</u> |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|
| CLAY; some Silt; little Sand, very fine; trace Gravel, small to medium; trace Organic material; very hard; dry; light brown.                                                                                                                                                                                                                                                                                                                                                              | 0 - 2.0                                                   |
| CLAY, some Silt; little Sand, very fine to medium; little Gravel, fine; trace Sand, very coarse to coarse; trace rock fragments, large to medium; hard; dry; light brown.                                                                                                                                                                                                                                                                                                                 | 2.0 - 5.0                                                 |
| VOLCANIC ANDESITE TUFF; dark green with white mottling in some areas; moderately strong to very weak at 20.0 feet bls; highly fractured and crushed, fine, medium grained, irregular shape, moderately sorted; plagioclase feldspar, quartz and epidote minerals, dull; calcite veins; slightly to moderately altered at 5.3 feet bls, highly altered with iron stains at 20.0 feet bls; plagioclase minerals range from 10 to 35% of rock matrix.                                        | 5.0 - 20.0                                                |
| VOLCANIC BRECCIA; fine to coarse grained, highly altered and fractured (20.0 to 30 feet bls), vertical foliations, friable, alteration to Clay minerals (calcite, chlorite, kaolinite), mottled grayish-green.                                                                                                                                                                                                                                                                            | 20.0 - 45.0                                               |
| VOLCANIC BRECCIA - Debris Flow; coarse grained with 6 cm slump clasts, clasts are very fine grained Tuff, epidote, chlorite, pyroxene, plagioclase, and calcite, FeO <sub>2</sub> staining, dark green and mottled.                                                                                                                                                                                                                                                                       | 45.0 - 55.0                                               |
| VOLCANIC BRECCIA; dusky yellow green to grayish-green; moderately strong to weak; epiclastic, fine, medium, large grained, occasional clast of 1 to 3 cm (40 to 55 feet bls), rectangular, cubic, and irregular shape, moderately to well sorted; plagioclase feldspar, epidote, chlorite, and pyroxene minerals, glassy, dull; calcite veins, iron stains; slightly to highly altered (55 to 85 feet bls); plagioclase minerals range from 10 to 35% of rock matrix (40 to 55 feet bls). | 55.0 - 88.0                                               |

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TUT 005 1069

**Geologic Log of MW-13D  
Tutu Service Station Investigation  
St. Thomas, U.S. Virgin Islands**

| <u>Description</u>                                                                                                                                                                            | <u>Sampled Interval<br/>(feet below<br/>land surface)</u> |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|
| VOLCANIC BRECCIA; finer grained, competent, primary minerals are pyroxene and hornblende, secondary minerals are epidote, plagioclase, and chlorite, vertical foliations, grayish-blue green. | 88.0 - 92.0                                               |
| VOLCANIC BRECCIA - DEBRIS FLOW; fine and coarse grained slump blocks (7 to 15 cm), rounded, plagioclase, pyroxene, some pyrite, calcite veins oriented 45°, grayish-green to blue green.      | 92.0 - 110.0                                              |
| VOLCANIC ANDESITE TUFF; fine to very fine grained; competent and relatively unweathered, plagioclase, epidote, and pyroxene, calcite inclusions, dark greenish-blue.                          | 110.0 - 120.0                                             |
| Fracture zones observed from 5.0 to 36.0 feet bls, 56.0 to 60.0 feet bls, 63.0 to 65.0 feet bls, and 70.0 to 75.0 feet bls.                                                                   |                                                           |

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bls    below land surface

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TUT 005 1070



**Geologic Log of MW-14  
Tutu Service Station Investigation  
St. Thomas, U.S. Virgin Islands**

| <u>Description</u>                                                                                                           | <u>Sampled Interval<br/>(feet below<br/>land surface)</u> |
|------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|
| ASPHALT                                                                                                                      | 0 - 0.1                                                   |
| CLAY; some Silt; some Sand; trace Gravel to some weathered rock<br>fragments, angular; very hard; greenish-gray, brown gray. | 0.1 - 3.0                                                 |
| Top of bedrock inferred at 3.0 feet below land surface.                                                                      |                                                           |

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TUT 005 1071