NOAA ARRA USVI Watershed Stabilization Project

Coral Bay Watershed Management Project – Lower Bordeaux Drainage Improvements

National Oceanic and Atmospheric Administration
Virgin Islands Resource Conservation & Development Council
Coral Bay Community Council

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This report described the projects undertaken in one of six subwatersheds in Coral Bay, St. John, USVI with $1.5 million in National Oceanic and Atmospheric Administration (NOAA) Funding through the American Recovery and Reinvestment Act of 2009 (ARRA). These funds are part of the $2.7 million USVI Watershed Stabilization Project funds awarded to the Virgin Islands Resource Conservation & Development Council, Inc. (V.I. RC&D). The U.S. Environmental Protection Agency (EPA) provided $300,000 in funding to the Coral Bay Community Council (CBCC) under its Community Action for a Renewed Environment (CARE) program to provide the stormwater engineering expertise to provide the design portion of these projects and staff the CBCC Coral Bay Watershed Management Project. Local homeowners associations, the Virgin Islands government, and community volunteers have also provided more than $400,000 in resources and worked cooperatively to achieve the project objective of reducing the stormwater sediment plumes entering Coral Bay, thereby improving water quality, ecological health, and stormwater management while minimizing future negative impacts associated with roadways and new construction.

There are nine reports in this series, describing the complete NOAA ARRA USVI Watershed Stabilization Project:

- Coral Bay Watershed Management Project – Johnny Horn Trail Drainage Improvements
- Coral Bay Watershed Management Project – Hansen Bay Drainage Improvements
- Coral Bay Watershed Management Project – Lower Bordeaux Drainage Improvements
- Coral Bay Watershed Management Project – John's Folly Drainage Improvements
- Coral Bay Watershed Management Project – Calabash Boom Drainage Improvements
- Coral Bay Watershed Management Project – Carolina Valley Drainage Improvements
- Fish Bay, St. John Drainage Improvements
- East End Bay, St. Croix Erosion Repairs, Trail Construction, and Drainage Improvements
- NOAA ARRA USVI Watershed Stabilization Project Summary Report

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Overall project management was provided by the Virgin Islands Resource & Development Council and its Board of Directors listed below:

President - Diane Capehart
Vice President - Olasee Davis
Secretary - Marcia Taylor
Treasurer - Dee Osinski (first year)/Olasee Davis
At Large member - Paul Devine

Work would not have been possible without the contributed countless volunteer hours, including the project's Principal Investigator Marcia Taylor who put a substantial amount of volunteer time into this project.

Work in Coral Bay would not have been possible without the Coral Bay Community Council, Inc., a 501(c)(3) organization, its volunteer Board members and many community volunteers. President and Executive Director, Sharon Coldren, spent three years as a volunteer working almost fulltime to implement this project.

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Executive Summary

Photo 1: Plumes into Coral Harbor.

The Lower Bordeaux Watershed includes the southeast portion of Bordeaux Mountain that drains through several ghuts and empties into Coral Harbor. Development in this area has interrupted natural ghut flow paths, increased runoff, intensified vegetation debris getting washed onto culvert grates, added to small rock landslides down roads, and increased sediment in Coral Bay (Photo 1). **The goals of this project were improving the stormwater management functions (best management practices [BMPs]) on a recently paved public road, restoring natural ghut flows, and stabilizing private road ghut crossings; thereby, reducing sediment entering the bay.**

In order to accomplish this goal, the Coral Bay Community Council (CBCC) proposed the following actions in the 2009 National Oceanic and Atmospheric Administration (NOAA) American Recovery and Reinvestment Act (ARRA) Coral Bay Workplan (2009):

- Intersection of Route 107 & 108 – Replace clogged pipe culvert and stabilize outflow area in mangroves;
- Route 108 Repairs – Cleanout inlet and remove landslide debris, install box culvert to restore flow to bypassed ghut, and construct biofiltration area at upper switchback;
- Voyages Ghut (Spring Garden) – Install a forebay area with rock check dams and a box culvert at a ghut roadway crossing; and,
- Harold's Way – Remove accumulated sediment and install BMP device.

These proposed actions changed into the implemented stormwater BMPs after further investigation into watershed conditions and discussions with the Virgin Islands Department of Public Works (PW) which manages the main area road, Route 108. Ultimately CBCC:

- Cleared the existing pipe at the Route 107/108 intersection and stabilized the outflow area;
- Installed a trench drain on Route 108 to redirect flow to the bypassed main ghut; and,
- In the flatlands at Voyages Ghut and Spring Garden, constructed a concrete ghut crossing and berm and stabilized the ghut path and the adjoining unpaved road.

CBCC's partner, PW, undertook additional Route 108 paving high in the watershed from December 2010 to April 2011 and in cooperation with this plan improved the drainage flow at the "upper switchback", allowing CBCC to reprioritize the NOAA funds elsewhere. Figure 1 shows the location of these BMPs, which details pre-existing and new stormwater structures and other watershed features. Once installed, these BMPs improved the effectiveness of

stormwater devices and returned flows to appropriate natural ghuts to allow for increased infiltration and reduction of flow reaching the lowlands and the bay. These actions improved stormwater management in the Lower Bordeaux Watershed, visibly reducing Coral Harbor turbidity. The long-term impacts are:

1) Better functioning stormwater devices;
2) Restoration of flows to two natural ghuts; and reduced flow in an overwhelmed small ghut receiving paved road drainage; and,
3) Reduced erosion off unpaved roads and at ghut crossings.

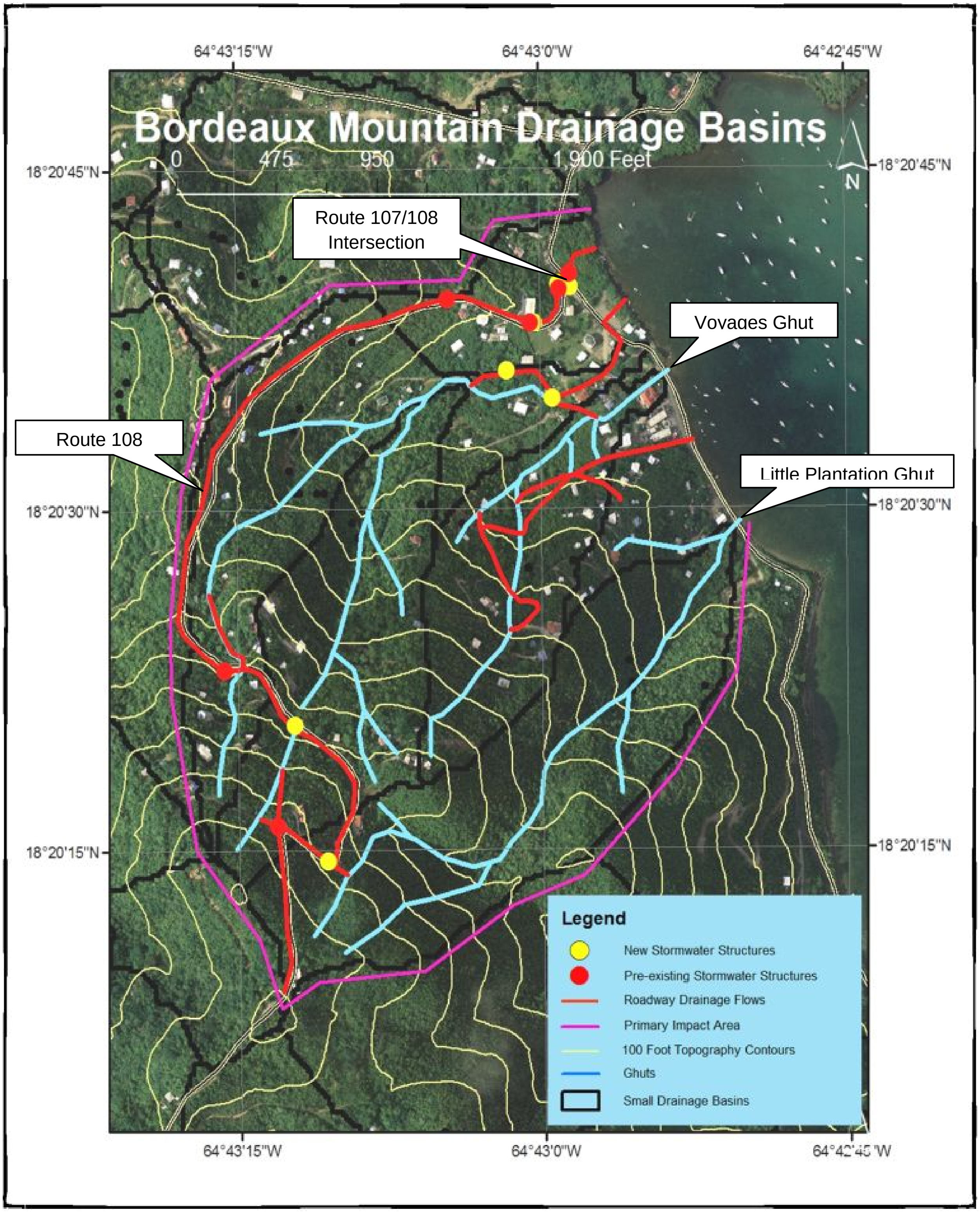


Figure 1: Lower Bordeaux Drainage Basin and Watershed Features.

1. Watershed Description

Photo 2: Lower Bordeaux Watershed.

Steep slopes with highly erodible soils characterize the Lower Bordeaux Watershed (Photo 2). This watershed includes the southeastern portion of Bordeaux Mountain bounded on the west by Picture Point and the north by Route 108 (Bordeaux Mountain Road), Coral Harbor to the east, and the ridgeline south of Little Plantation Ghut to the south. The lower portion of the watershed is characterized by a flat area called Spring Garden that includes numerous intermittent springs and the ghut outflow locally known as Voyages Ghut. Roughly 18 residences, 3 restaurants, and a shopping center occur in this flat area.

The upper portion of the watershed is reached by Route 108 which was paved by PW in sections starting with the lower portion of the road from 2002-2006 followed by the rest of the road, in 3 stages, by April 2011. This road accesses approximately 40 residences, mostly built since 2000.

The southern part of the watershed includes two residential areas:

- Harold's Way on the ridge south of Spring Garden hosting 30 houses; and,
- The Little Plantation Ghut area which includes one restaurant and about a dozen houses.

2. Problem Statement

The plume in the Lower Bordeaux project area (Photo 3) is generated predominantly by three pipe culverts crossing under Route 107, from the populated areas mentioned above.

2.1 Route 107/108 Intersection

The gutter along the uphill side of Route 108 conveys runoff from approximately 8 acres of land including the lower half-mile of Route 108 (Mina 2010). Three hundred yards above the bottom, the runoff was intended to enter several grated inlet box drains and enter a pipe that drained through a culvert at the Route 107/108 intersection into a baffle box before being discharged into the mangroves along the shore. Initially, only the lower part of this road was paved, with turbid and rock-laden stormwater from the unpaved section

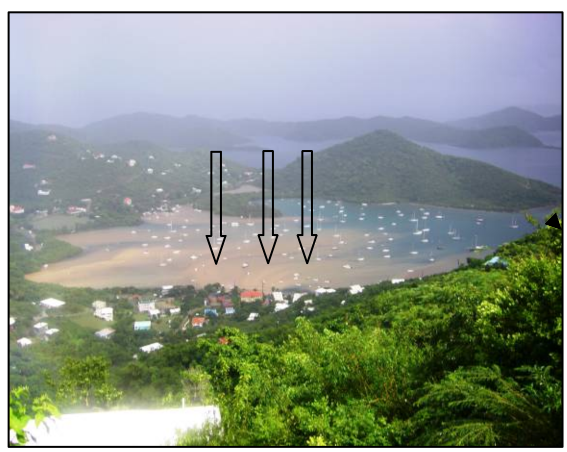


Photo 3: Sediment Plumes below the Lower Bordeaux Watershed.

being sent down the paved road clogging the new devices (Photos 4-5), and entering into the mangroves fringing Coral Bay (Photo 6). In this circumstance, because mangroves filter much of this sediment before it enters the bay, the quantity of sediment filtered out will eventually take a toll on the health of this habitat. Additionally, the volume of runoff laden with rock debris and sediment often caused the roadside and culvert grates to become blocked; thereby, leaving rocks and debris on the road surface, causing road damage and unsafe driving conditions (Photo 7). The area downstream discharges directly into the mangroves and was designed as an energy dissipater and sediment area; however, it has fallen into a state of disrepair. The originally installed culvert outlet baffle box was not designed properly for cleanout because it had a concrete bar blocking machine “bucket” access.

Route 107/108 Intersection

Photo 4: Culvert blockage.

Photo 5: Stormwater runoff.

Photo 6: Stormwater runoff.

Photo 7: Culvert blockage and stormwater runoff.

2.2 Route 108

Along the uphill length of Route 108, a series of problems, listed below, contribute to improperly managed stormwater flows causing high sediment loads to enter Coral Bay, due to the design and implementation of PW’s paving projects in this area. An insufficient number of cross-road culverts were installed, thereby causing too much flow to run down the roadside. Proper backfilling "to grade" was not done when concrete forms were removed after PW paving, thereby allowing water to flow under the concrete, erode the soil, and possibly undermine the roadway (Photo 8). After rains, landslides block roadside swales and sometimes even travel lanes causing altered flows, poor stormwater management, and dangerous driving conditions (Photo 9). These problems are exacerbated when PW does not have the resources to clear roadside swales quickly after storms. Road switchbacks have altered flow paths to convey runoff down roadways (Photos 10 & 11), increasing water volumes on roadsides in some ghuts and reducing the volume in others. Three ghuts serve this basin: the one draining to Little Plantation which serves the upper switchback area, and two other ghuts that merge downstream to become the "Voyages Ghut" and are bisected by Route 108. The 2006-2007 PW road paving project redirected water from the larger of these ghuts to flow down the roadway and into a single culvert at the head of the smaller ghut. This redirection of water by PW caused serious ghut bank erosion and damage to adjacent property and private roads. This was the most significant problem in the Lower Bordeaux Watershed.

Photo 8: Improper backfill.

Photo 9: Route 108 landslide.

Photos 10-11: Route 108 corner with unmanaged water flowing down the road into the wrong ghut.

2.3 Spring Garden and Voyages Ghut

Photo 12: Voyages Ghut and road crossings (red arrows) in Spring Garden.

Photo 13: Runoff from unpaved parking area into Voyages Ghut.

Residential dirt roads in the Spring Garden area cross one major ghut and several subghuts (Photo 12). Additionally, there are numerous springs that emerge after rainfall events throughout the area, including in the middle of roadways. Stormwater runoff and road layout ensure that water flowing through the area erodes the roads and is heavily sediment laden. The Voyages Ghut drains over half the Lower Bordeaux Watershed. All stormwater flowing out of this area discharges through a single culvert under Route 107 into Coral Bay (Photos 13 & 14). Pre-construction turbidity monitoring identified this ghut as the ghut in Lower Bordeaux that flows with the highest turbidity (223 nephelometric turbidity units [NTUs] sampled September 5, 2009 vs. 80.3 NTUs at the Route 107/108 intersection culvert outlet) (CBCC 2012).

Photo 14: Voyages Ghut runoff into Coral Harbor.

2.4 Harold's Way

There is a culvert under Route 107 that receives water from the Harold's Way drainage area (a system of paved and unpaved residential roads). Initially, the NOAA ARRA Coral Bay Workplan recommended that a BMP device was necessary to clean the runoff prior to discharge into the bay. However, when CBCC pointed out the problem, neighborhood residents took it upon themselves to clear the culvert and reduce overgrowth in the ditch leading up to the culvert, as well create an upstream water diversion. Based on storm observations, these actions reduced runoff overflow onto Route 107 (see Photo 15) and resolved the problem that was present during the grant planning stage. Since no NOAA ARRA project work was recommended, this area will no longer be discussed in this report except in Table 1 Proposed Actions. The U.S. Environmental Protection Agency (EPA) Community for a Renewed Environment (CARE) funded engineering expertise did look further at drainage problems higher up this roadway, but due

Photo 15: Harold's Way stormwater runoff.

to the location of subghuts bisecting residential properties and other issues, it was determined that short-term solutions were not feasible.

3. Background and Project Planning

Research has shown that as development increased in Coral Bay so has sedimentation of the bay, thereby threatening the health of the bay and its marine habitats (Devine et al. 2003). In order to reduce this threat, the partner agencies, CBCC, NOAA, the Virgin Islands Department of Planning and Natural Resources (DPNR), EPA, and the Virgin Islands Resource Conservation and Development Council (V.I. RC&D), have aggressively spent the last five years planning and implementing actions to reduce sediment loads in Coral Bay.

Starting in 2007, NOAA funded the Coral Bay Watershed Management Plan (WMP) as a DPNR pilot watershed plan to provide a demonstration site for the whole U.S. Virgin Islands. Upon publication of the WMP in 2008, CBCC applied for a $300,000 EPA CARE grant, and received it in early 2009 to begin implementation of the WMP as part of the overall Coral Bay Watershed Management Project. The primary goal of the EPA CARE grant was to implement *WMP Recommendation #1 – Provide direct, on-site technical assistance to watershed residents, businesses, developers, and others implementing watershed recommendations*. To help with this recommendation the WMP discussed five actions, two of which CBCC implemented as part of the EPA CARE grant:

- *Near-Term Action 1.1: Use EPA CARE grant as seed money to support a 1-2 year, full-time hydrologist/watershed manager for Coral Bay.*
- *Near-Term Action 1.4: DPNR and CBCC should consider providing resources needed to support new personnel (i.e. GIS, office basics, vehicle, etc.).*

In spring 2009, working through a local nonprofit partner, V.I. RC&D, CBCC secured $1.5 million of NOAA ARRA grant funds. CBCC and V.I. RC&D used these funds to implement actions proposed in the NOAA ARRA Coral Bay Workplan prepared for the grant application, based on the expertise provided by the newly hired CBCC Stormwater Engineer (see Section 4.1). These NOAA ARRA funds allowed for the restoration of natural drainage functions and paving of roads in six subwatersheds in Coral Bay in order to eliminate or reduce the sediment-laden stormwater runoff plumes entering the bay. These projects also implemented portions of *WMP Recommendation #3 - Evaluate and repair erosion and drainage problems that are threatening property, damaging infrastructure, or delivering excessive sediment loads to Coral Bay*. CBCC's website contains a Project Overview of the USVI Watershed Stabilization Project in Coral Bay and a description of the Coral Bay Watershed Management Project.

In the NOAA ARRA Coral Bay Workplan, CBCC developed a list of watershed stabilization techniques appropriate for the Coral Bay environment (see Appendix A) and directly aimed at reducing sediment plumes to the bay. These were used to formulate the following goals for the Lower Bordeaux Project:

1. Return ghut flow to the correct ghuts (Strategy 1);

2. Reduce sediment loading from ghut crossings and runoff from unpaved road and parking areas (Strategy 3);
3. Ensure stormwater management structures are in good working order and operating efficiently (Strategy 4);
4. Provide for stormwater management in areas where it is lacking (Strategy 4); and,
5. Reduce road damage and stabilize roadways from unmitigated flows (Strategy 4).

4. Project Implementation

4.1 Project Design

CBCC hired Joseph Mina, P.E. as its Stormwater Engineer in 2009 using the EPA CARE grant funds to provide design expertise and recommendations. Initially he wrote a series of engineering design memos based on field conditions to help identify the key BMPs for local implementation. He also contributed significantly to writing the NOAA ARRA Coral Bay Workplan and prioritizing the detailed projects in it. The EPA CARE grant funded the engineering design phase, with the NOAA ARRA funding taking over for the field engineering and inspection, permitting, construction bidding, and field construction phases. V.I. RC&D was directly responsible for the construction phases of the Coral Bay NOAA ARRA projects. For personal reasons, Mr. Mina had to leave CBCC's employment in June 2010 and CBCC hired Christopher Laude, P.E. to complete the design phase and implement the NOAA ARRA BMP projects over the following year.

4.2 BMP Selection Process

The 2009 NOAA ARRA Coral Bay Workplan identified the problem areas and proposed actions, as described in Table 1 below. Mr. Mina refined and amplified the NOAA ARRA Coral Bay Workplan Proposed Actions in a series of design memos written in May 2009 and January 2010. After further investigation into watershed conditions and discussions with PW, which manages the main area road, Route 108, the implemented stormwater BMPs were selected (Table 2). CBCC targeted primary BMPs with supporting BMPs to make the primary BMPs successful. Given the need to work with many different staff in PW (maintenance managers and engineers) and given their plan to accomplish more paving uphill on Route 108 during 2010, a number of different BMPs (culverts, trench drains, swales, etc.) were considered in order to be ready for whatever PW chose to construct that might affect CBCC work lower down in the watershed. Also, the NOAA ARRA projects needed to be coordinated in their timing with PW project implementation. Ultimately, the existing pipe was cleared at Route 107/108 and the outflow area stabilized; a trench drain was installed on Route 108 to redirect flow to the bypassed main ghut; and, in the flatlands at Voyages Ghut and Spring Garden, a concrete ghut crossing, a berm, and stabilization of the ghut path and the adjoining unpaved road section were accomplished with NOAA funds. CBCC's partner, PW, undertook additional Route 108 paving high in the watershed from December 2010 to April 2011 and in cooperation with this plan improved the drainage flow at the "upper switchback," allowing CBCC to reprioritize the NOAA funds elsewhere.

Table 1: Proposed Actions (Proposed June 2009)

Location	Proposed Action	Status	Comments
Route 107/108 Intersection	In cooperation with PW, replace clogged pipe culvert & stabilize outflow area in mangroves.	Refined and completed.	Refined design to clean out pipe, added sediment sacks to inlet grates above, and modified inlet and outlet structures to handle the water better and allow for cleanout.
Route 108	Cleanout inlet and remove landslide, install box culvert to restore flow to bypassed ghut; and construct a biofiltration area at upper switchback.	Trench drain was installed at bypassed ghut after homeowners association on subdivision below constructed paved road crossing for path of water.	PW has removed the landslides and continued routine maintenance; PW did the Upper Switchback.
Voyages Ghut	Install a forebay area with rock check dams in the ghut directly above the culvert under Route 107 to clean the water just prior to it entering the bay.	Work shifted 300 yards upstream to Spring Garden portion of ghut (see below).	Check dams were rejected by PW, due to their concerns about flooding and ability to machine clear. In fall 2009 to 2010, PW completely backhoed and cleared this 300-yard ghut channel to reduce flooding potential. By early 2012, it has re-established itself as a grassed and naturalized channel.
Spring Garden	Install a box culvert or small precast bridge (or similar device) over the private roadway crossing to restore flow to the ghut.	BMP chosen was concrete paved swale for crossing to accommodate driveways.	Also, cleaned and stabilized ghut & used Geoweb® on adjacent dirt road to improve road surface, correct drainage, & utilize removed "ghut sand".
Harold's Way	Remove accumulated sediment. Add a BMP device or series of devices in the roadside channel to culvert near ocean.	Cancelled.	Local residents implemented recommendations in fall 2009; problem solved.

Table 2: Implemented Actions (Designed 2010 - 2011)

Location	Implemented Action	Status	Comments
Route 107/108 Intersection	Clean out pipe and culvert, modify grate and culvert, and redesign energy dissipater.	Constructed (March and April 2011)	Refined as noted in Table 1.
Route 108	Install trench drain.	Constructed (September 2011)	Biofiltration area was not constructed.
Spring Garden	Clear ghut, pave ghut crossing, stabilize road, and place riprap in a roadside drainage channel.	Constructed (September to December 2011)	A paved ghut crossing instead of a box culvert or bridge was constructed. Also, ghut clearing, road stabilization, and riprap drainage channel added.

4.3 Problems Encountered/Overcome

This project highlighted both the problems and benefits of working with a partner public agency. PW is responsible for this steep secondary road - Route 108. Pressures to use limited PW funds to pave as much road surface as possible, led to removing engineered planned stormwater features like culverts and swales from the PW paving contracts. Different internal PW approaches on how to handle maintenance and selection of BMPs also took time and effort by both CBCC and PW in order to reach the most cost-effective and appropriate solutions. PW was very willing to volunteer resources that they had available for the NOAA ARRA objectives.

The project had to be very sensitive to any problems that might happen to private land or structures if old ghut water routes were re-established in order to ensure that project activities would not cause harm to a property. The first step of project design was hiking down the steep ghut paths to see if someone had started building in the ghut and what road crossings had been established.

To get the known dirt road crossing paved, CBCC had to find out who all the owners were in a subdivision, identify boundaries, get permissions from owners adjacent to the ghut, and encourage the formation of the Bay Rum Estates Homeowners Association (HOA). The 15+ owners raised $10,000 between themselves to pave the ghut crossing before CBCC’s project could begin. The HOA also raised funds to pave the second ghut crossing (where all the public road run-off water previously went).

After the trench drain project was bid out for two trench drains, it was necessary to halt and adjust plans, because it was discovered that PW had altered the upper watershed drainage during their new paving project to focus more water directly into CBCC’s construction area. After discussions and contract changes in their contract, PW paid for and installed a culvert at the upper switchback to provide proper drainage, eliminating the need for construction of the second trench drain. This allowed CBCC to reallocate some NOAA ARRA grant funds to necessary downstream work in Spring Garden.

4.4 Project Costs & Construction

After taking into consideration site conditions, BMP costs, and available project funds, the final BMPs implemented included culvert cleaning and outlet modifications, a trench drain, Geoweb® road stabilization, a concrete ghut crossing, and a riprap roadside drainage channel for a total cost of $120,422. Table 3 details project costs for both the implemented BMPs and the additional follow-up work. The narrative below the table provides a more detailed description of construction. Appendix A has detailed design drawings.

Table 3: Lower Bordeaux Project Costs

Description	Total Cost
Bordeaux Mountain Road	
Install trench drain.	$44,600
Clean out Route 107/108 culvert, inlet box, and upper drains on Route 108. Install silt sacks. Modify and reconstruct inlet box. Remove existing wall in culvert outlet structure and install new riprap energy dissipater at outlet.	$21,800
Spring Garden	
Excavate ghut.	$4,350
Install Geoweb®* to stabilize unpaved road.	$7,760
Construct ghut crossing and paving.	$38,562
Install riprap roadside drainage channel.	$950
Clean up, seed, and stabilize.	$2,400
Total Project Cost	$120,422
**Geoweb® product cost $5,000.00 and was purchased by the EPA grant as a demonstration project.*	

Route 107/108 Intersection Culvert

Culverts, or other below-ground devices, are necessary to funnel runoff below roads to maintain traffic flow even during heavy rains. Proper culvert design will provide for sufficient runoff conveyance and “flushing” flows to allow any accumulated vegetation and fist-sized rocks to pass through a culvert without clogging the pipe. In addition, energy dissipaters are required at the outlet to reduce the velocity of the runoff before discharge, which prevents downstream damage. For this project, the contractor, by pressure washer and manual labor, removed all debris that had accumulated in the existing pipe alongside the lower part of Route 108, inlets along this stretch, and the culvert at the Route 107/108 intersection. He then modified the primary inlet box to remove a previous construction defect that snagged debris in the pipe (Photo 16). Additionally, silt sacks were installed on three inlets along Route 108 to remove silt and sediment and keep it from clogging the drainage system. For the baffle outlet structure, the contractor saw-cut and removed the original cross beam energy dissipater that was located so close to the culvert mouth that machine cleanout was not possible, and thus the water flow backed up and the pipe became clogged (Photos 17 & 18). The contractor then installed a riprap energy dissipater in its place (Photo 19).

Photo 16: Route 107/108 Intersection culvert inlet repair.


Photo 17: Route 107/108 Intersection culvert energy dissipater repair.

Photo 18: Route 107/108 Intersection culvert energy dissipater repair.

Photo 19: Route 107/108 Intersection repaired culvert outlet.

Route 108 Trench Drain

There are many different choices for cross-road conveyance of stormwater flows. Trench drains are used to capture and convey larger volumes of water (compared to a waterbar or swale) across a road and allow for continued flow of traffic even in heavy rains. This project consisted of installation of an inlet box and a trench drain and erosion protection devices at the outfall location (Photos 20 & 21). The contractor started by saw cutting and removing underlying concrete paving in Route 108 and installing a 20-foot long by 3-foot deep by 3-foot wide concrete trench drain (approximate dimensions) sloped at one inch in four feet (minimum) and a 3-foot wide Neenah R-4999-LX Type C bolted Grate. In order to allow for construction access and backfill compaction, the contractor cut at least five inches beyond trench walls in both directions. The contractor then installed a reinforced concrete transition from the trench drain frame to existing pavement at max 10 H: 1 V slope. The contractor conducted the work so that traffic flow was maintained in at least one lane at all times. Finally, the contractor installed A-

Photo 20: Trench drain excavation.

Photo 21: Trench drain installation.

Jack®, concrete armor units, and large riprap at the trench discharge.

Spring Garden Ghut Excavation, Concrete Ghut Crossing, and Road Backfill

If debris accumulates in a ghut, it can change the ghut path or cause overtopping (spilling out of the expected channel). In some instances, debris removal is necessary to restore the ghut channel to more natural dimensions and to ensure flows aren't negatively impacted by the installation of any downstream structures. The contractor excavated a 150 linear foot section of the ghut upstream of the proposed concrete ghut crossing (Photo 22), which had been altered and filled by Tropical Storm Otto in 2010. The contractor then used this material to create a soil ramp on the low side of the road crossing. He also placed and compacted material excavated from the ghut on the road and driveway to within eight inches of final grade to install a concrete ghut crossing. Once the substrate was prepared, the contractor installed rebar for reinforcement and poured the concrete. In order to allow for one lane of continuous traffic use, the contractors constructed the crossing in two panels.

Photo 22: Excavated Voyages Ghut.

Photo 23: Geoweb® material prior to installation in Spring Garden.

The contractor also installed about 200 linear feet of Geoweb® (Photo 23) by first providing sufficient rebar (approximately 300 pieces, each 2-feet long) to anchor and stabilize the Geoweb® in place. He then used an excavator and manual labor to backfill the Geoweb® with excavated ghut material.

Spring Garden Riprap Drainage Channel

Stormwater managers typically use drainage channels to convey runoff in a desired direction and keep it off a road. These channels can be vegetated or lined with riprap or concrete. For the Spring Garden area, the contractor excavated a roadside drainage channel along the unpaved road to funnel water towards an existing concrete swale. He also, stabilized the road alongside the channel with Geoweb® using techniques described in the section above. The contractor then lined the channel with riprap to allow for some infiltration as well as stabilization. This method was chosen to replace a designed waterbar in this location.

4.5 Achieved Results

Since the project's component BMPs began to perform during the construction phase, the area has received at least six moderate rainfall events, plus a tropical storm (Irene - August 2011). Coral Bay residents, including the boating community, have noticed a considerable improvement in harbor clarity levels (less turbid waters) after these rainfall events. After a rain during the night, rather than waking up to see brown water around their boats, Coral Bay boaters have reported being pleasantly surprised to see normal water clarity or less evidence of suspended sedimentation, than they would previously have expected after hearing the duration/strength of the overnight rain. (Note: Most heavy post-construction rain thus far has been at night.)

For a total project cost of $120,422, CBCC was able to return flow to the proper ghuts, reconfigure existing drainage structures for more efficient stormwater management, and stabilize several road areas to ensure less erosion and sediment runoff. A partner HOA spent about $20,000 paving two ghut crossings, and PW constructed a culvert. Photographs 24-28

Photo 24: Trench drain.

Photo 25: Route 107/108 Intersection culvert inlet grate.

Photo 26: Route 107/108 Intersection culvert riprap energy dissipater.

Photo 27: Spring Garden swale.

Photo 28: Spring Garden riprap drainage channel.

below depict the completed BMPs. Attachment A includes the interpretive poster to highlight these achievements.

5. Sediment Reduction Monitoring

The NOAA ARRA marine monitoring project team did not do any monitoring focused in this watershed. However, as part of CBCC's Watershed Management Project, using EPA CARE funding, Dr. Barry Devine led a monitoring team (partially NOAA ARRA funded) that tracked turbidity in the watershed over a two-year period sampling in Lower Bordeaux from September 2009 through September 2011. In this watershed, he used two primary sampling points for turbidity monitoring – Bordeaux Mountain Outlet and Voyages Ghut. Bordeaux Mountain Outlet sampling occurred at the Route 107/108 intersection culvert outlet into the mangroves. The second sampling point was at the Voyages Ghut outlet capturing sediment outputs from this culvert. After analyzing the data, the results showed turbidity was lower at the Bordeaux Mountain Outlet after CBCC completed its drainage improvements in the watershed (before construction average 54.52 NTUs versus after construction average 37.45 NTUs) (CBCC 2012). Results from the Voyages Ghut sampling showed the same thus far (before construction average 432.50 NTUs versus during construction average 250.35 NTUs). However, there is a limited post-construction dataset (for instance no sampling has occurred after all the Spring Garden construction has been completed); therefore, any real conclusions will have to wait until researchers conduct further monitoring.

6. Lessons Learned

PW faces a constant funding challenge to complete “visible” feet of new paving with limited funds, as opposed to investing in “hidden” stormwater management features. Historically, even if these features were included in engineering plans, the controls (frequent culverts, removal of water from the roadside, careful analysis of ghut paths, and water flows before and after) may be left out of the construction contracts due to cost and limited funding levels. The NOAA ARRA project timeframe in the Lower Bordeaux Watershed was interrupted in late 2011 by the need to request a PW retrofit of their December 2010 to April 2011 paving project on Route 108 just above CBCC’s projects.

Redirecting water into natural ghut paths high in the watershed very significantly reduces water flows lower in the watershed, and reduces erosion along the entire ghut path. This is because water flow volumes are greatly reduced due to infiltration into the hillsides. Residents immediately noticed the reduced and changed water flows, and the benefits to their property. **The key lesson here is that any project doing stormwater management must be constantly vigilant about other parties making alternations that change stormwater flow patterns in the same area.** The project’s work would probably have been viewed as causing more problems than it cured, had CBCC not delayed and worked with PW to change their upstream alteration. Also, these issues provide support for the need for diligent DPNR enforcement of Territorial Pollutant Discharge Elimination System (TPDES) regulations, within building permitting processes. The activity of discharging water (pollutants) from construction sites is a federally regulated activity, delegated to the Virgin Islands DPNR. To be effective, there may also be a need for a special stormwater management authority or similar governing body that authorizes all construction projects with the potential to change stormwater flows, and has funding available to make priority retrofit corrections.

Geoweb® is an effective stabilizer of dirt roads, especially in areas that retain water or have underground springs/streams. To determine its cost-effectiveness, CBCC will be monitoring its durability and how much time can pass before re-grading is needed.

7. Next Steps

Continuous ongoing maintenance to remove sediment and leaves blocking grates must be conducted by PW. CBCC will maintain frequent contact with the St. John PW maintenance manager to help ensure that this maintenance is completed.

CBCC needs to secure funds to utilize its GPS and GIS equipment and software to establish a GIS-coordinated PW stormwater device maintenance plan. Lower Bordeaux is the most logical pilot area in Coral Bay, since clogging of entry points to the BMPs in this area, due to lack of frequent maintenance, can lead to serious property damage, not just more erosion. This is also consistent with PW's long-term management objectives.

Property owners need to be encouraged to complete more retrofit work in this watershed to improve drainage patterns -- before more road-cutting and paving, or subdivision of land is allowed.

A better grate and roadside swale design needs to be retrofitted on Route 108 and elsewhere on public roads in order to reduce blockages that redirect stormwater flows to the wrong places, creating erosion. (On Route 104, Gifft Hill Road on St. John, an ARRA construction project for PW in 2011 uses (what appears to be) a significantly better design for reducing vegetative clogging of the inlet boxes to culvert.)

Assure that the Voyages Ghut -- and all ghuts in lower, flat areas stay vegetated.

Project partners need to continue to consider ways to capture more fine sediment along a ghut path before it reaches ocean, including use of landscaping stream-restoration techniques.

8. References

Coral Bay Community Council (CBCC). 2012. *EPA CARE Grant Final Report*. Turbidity Report.

Devine, B., Brooks, G., and R. Nemeth. 2003. *Coral Bay Sediment Deposition and Reef Assessment Study*. State of the Bay, Final Project Report, Executive Summary. Submitted to VI DPNR Division of Environmental Protection MOA #NPS-01801.

Mina, Joseph, P.E. 2010. *Engineering Design Recommendation Memo* (January 8, 2010). Prepared for Coral Bay Community Council.

Attachment A: Watershed Poster

CORAL BAY COMMUNITY COUNCIL

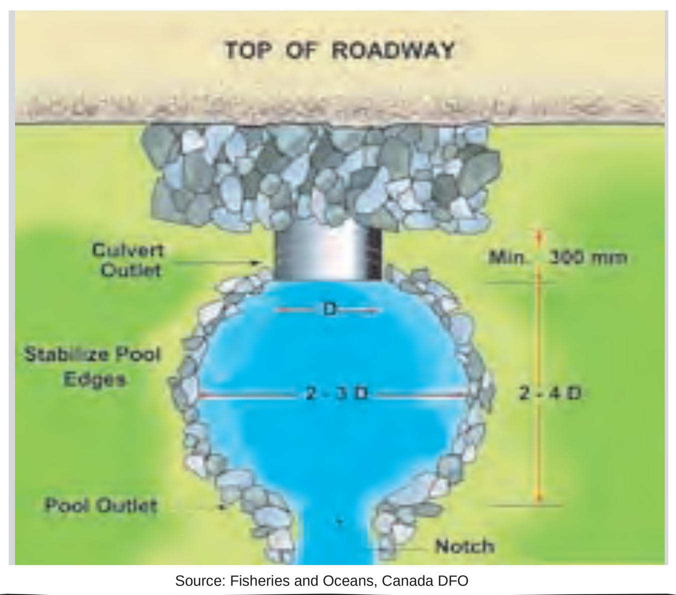
US VIRGIN ISLANDS RC&D COUNCIL, INC.

ROUTE 107 & 108 CULVERT

What Is Happening Here?

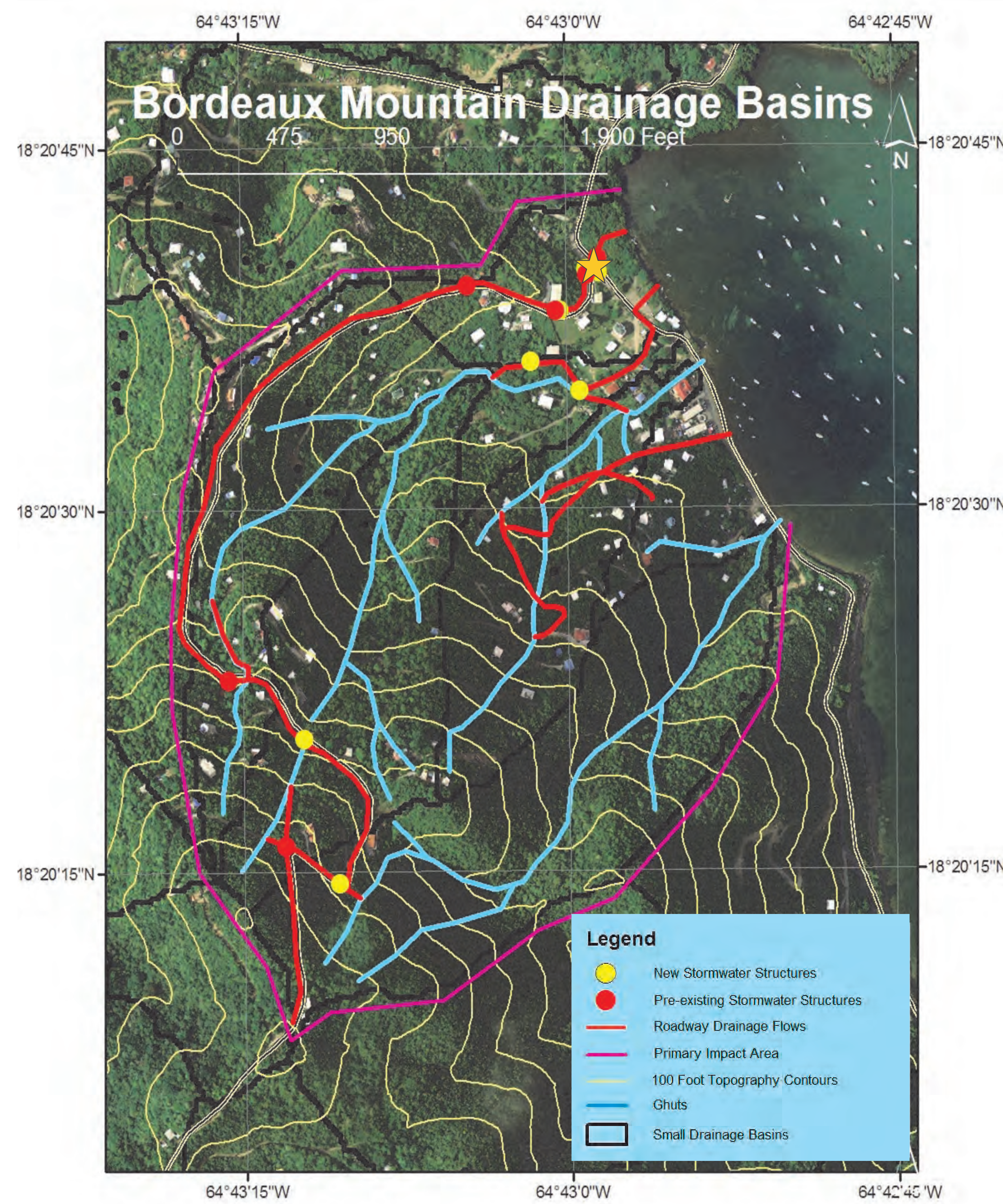
The intersection of Rt. 107 & Rt. 108 has numerous issues that contribute to the contamination of water entering the bay. On Rt. 108 uphill, there were a number of blocked inlets and swales from crumbling roadside cliffs and sediment from steep dirt roads at higher elevations. This led to debris-laden stormwater flowing down the newly paved roads, which clogged the pipe culvert under Rt. 107 with sediment and created roadway flooding. Cleaning the blocked culvert and inlet boxes, and redesigning the inlet & outlet boxes will allow cleaner water to filter through the mangroves. Regular clean out of the recessed outlet box from the culvert will remove accumulated sediment.

Typical Pipe Culvert



Before

In Construction



Lower Bordeaux Watershed

Drainage from the Lower Bordeaux watershed has a significant negative impact on the sedimentation of Coral Harbor and the mangroves. The natural drainage of the watershed has been altered by residential developments, landslides, and Public Works' paving of Rt. 108. This map shows the Lower Bordeaux area, sub-basins, natural drainage flow, pre-existing and new drainage structures.

After

Stabilization Objectives

1. Control stormwater runoff at switchbacks
2. Restore natural flow to ghuts
3. Reduce stormwater velocity
4. Clean and maintain inlets and swales
5. Pave dirt roads at higher elevations
6. Reduce sedimentation of mangroves and Coral Harbor

Site Locations

Watershed scale Geographic Information System (GIS) planning tools targeted water quality monitoring research that helped in selecting the priority sites for these sediment reduction projects. Follow-up terrestrial and marine sediment monitoring will quantify and demonstrate the success in reducing sediment pollution reaching the bay.

What YOU Can Do!

⇒ Vegetate bare slopes with native plants
⇒ Minimize use of pesticides & fertilizers
⇒ Clean up driveways, roadsides and gutters
⇒ Use cut brush to create berms on steep slopes
⇒ Eliminate muddy run-off water
⇒ Never dump anything down storm culverts or ghuts
⇒ Properly dispose of oils, paints and chemicals
⇒ Do not disturb ghuts for 30 feet from center of ghut
⇒ Preserve all trees
⇒ Pump and inspect your septic tank regularly
⇒ Notify DPNR if you notice a problem
⇒ DPNR permits are needed for using backhoes & trackhoes
⇒ Educate each other
⇒ Participate in community projects!

Protecting Coastal & Coral Reef Habitats by Reducing Erosion & Sedimentation

This project is one of 18 implemented in the Coral Bay watershed with $1.5 million in National Oceanic and Atmospheric Administration funding under the American Recovery and Reinvestment Act of 2009, as part of the $2.7 million USVI Coastal Habitat Restoration through Watershed Stabilization project to reduce sediment loading rates into the coastal waters of three USVI watersheds: Coral Bay and Fish Bay on St. John and East End Bay on St. Croix. The U.S. Environmental Protection Agency has provided funding to the Coral Bay Community Council under its Community Action for a Renewed Environment (CARE) program to support this work. Local homeowners associations, the Virgin Islands Government and community volunteers have also provided resources and worked cooperatively to achieve the project objective of reducing the stormwater sediment plumes entering beautiful blue Coral Bay. These projects are also part of implementing the Coral Bay Watershed Management Plan through public-private partnerships to improve water quality, ecological health, and stormwater management while minimizing future impacts associated with watershed development.

Thanks to our lead partners!

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Community volunteers and Homeowners Associations

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www.coralbaycommunitycouncil.org

ROUTE 108 TRENCH DRAIN

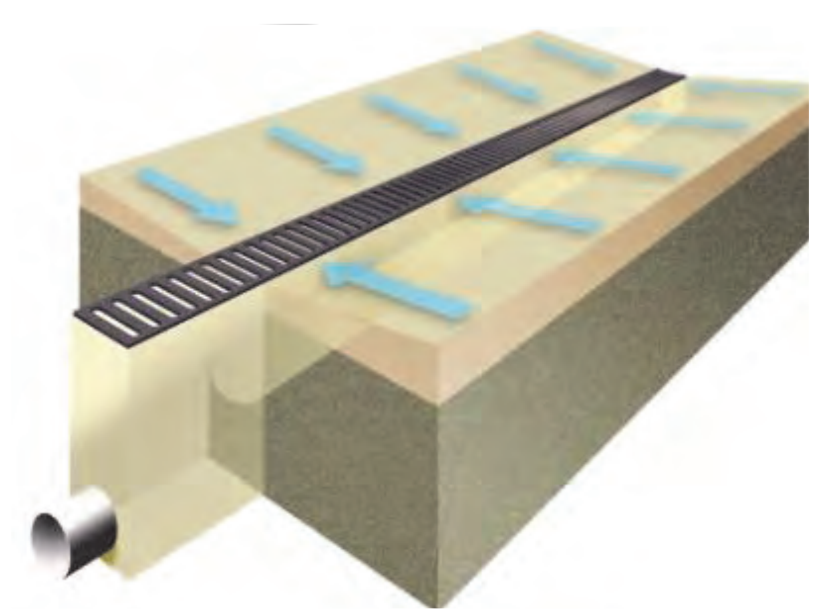
CORAL BAY
COMMUNITY
COUNCIL

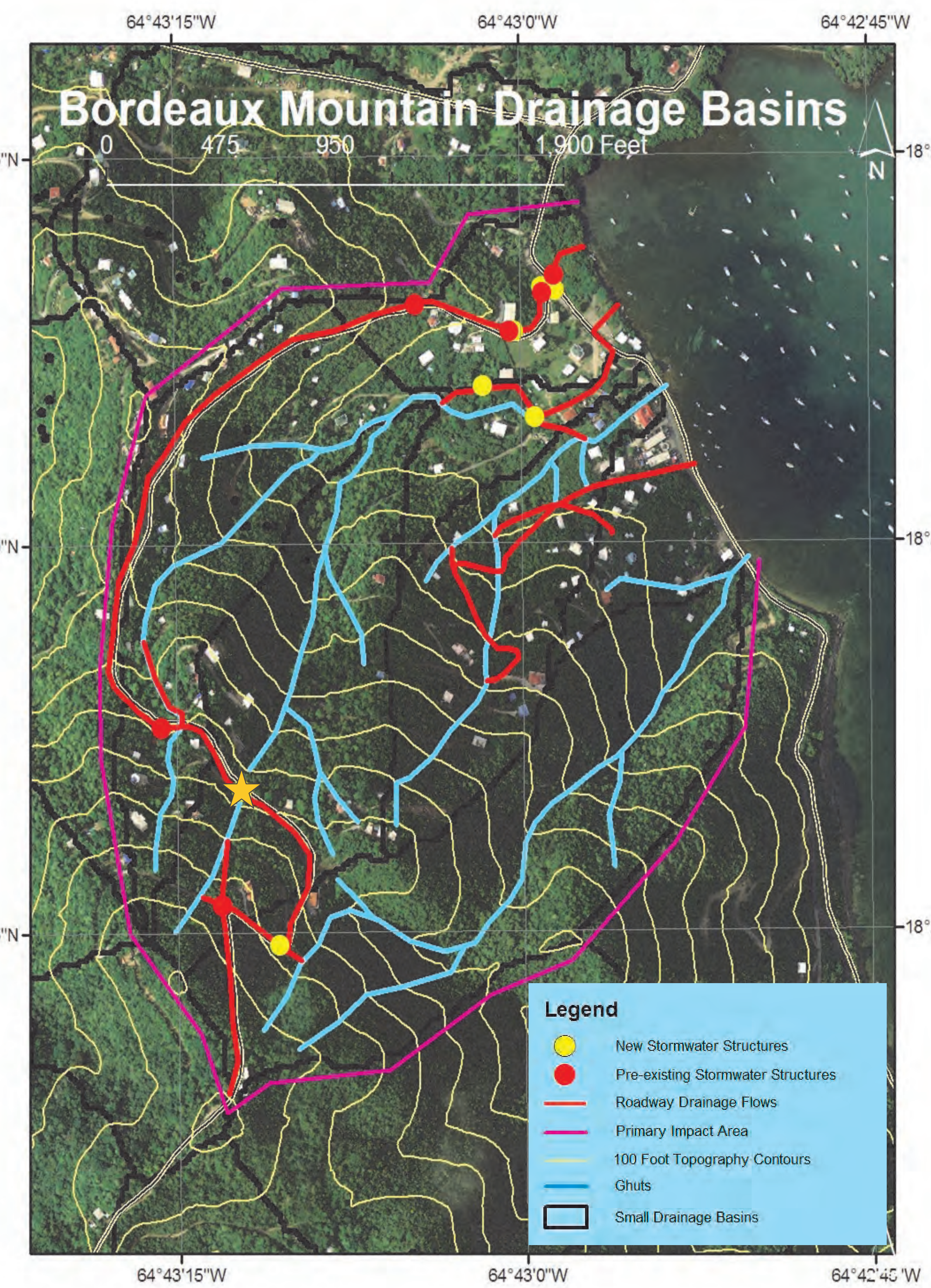
US VIRGIN ISLANDS
RC&D
COUNCIL, INC.

What Is Happening Here?

During development and Rt. 108 paving, runoff from two ghuts was redirected into a single ghut of the Lower Bordeaux watershed. This concentration of flow caused too much water flowing too quickly for that ghut. Significant erosion occurred, especially during large storms and sent large amounts of sediment into Coral Bay Harbor. Public works returned some excess water flow back into Little Plantation Ghut during their 2011 paving project on Rt. 108. We installed a trench drain across Rt. 108 to return the rest of the excess water into a different branch of the Lower Bordeaux watershed. Reducing the quantity of runoff that flows through the watershed reduced the velocity, which decreased the amount of erosion (see also Spring Garden Project). The result is less sediment and muddy water flowing into Coral Bay.

Typical Trench Drain





After

Stabilization Objectives

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2. Restore natural flow to ghuts
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4. Clean and maintain inlets and swales
5. Pave dirt roads at higher elevations
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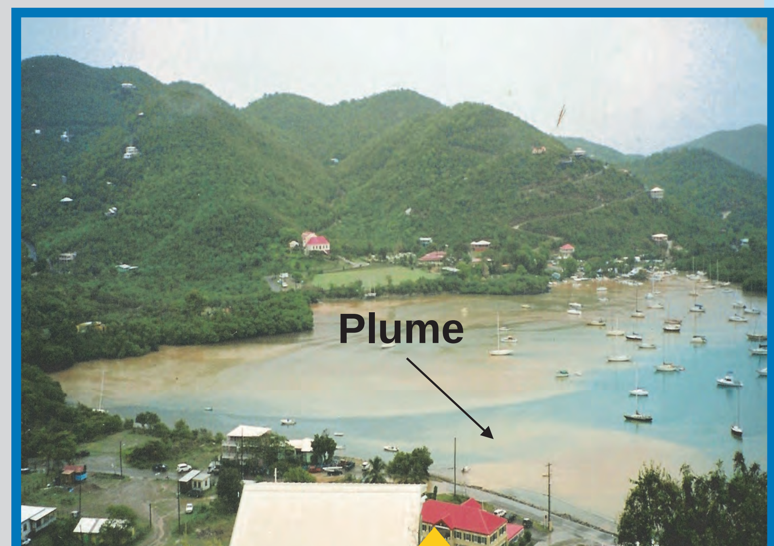

Before

During Construction

Lower Bordeaux Watershed

Drainage from the Lower Bordeaux watershed has a significant negative impact on the sedimentation of Coral Bay Harbor and the mangroves. The natural drainage of the watershed has been altered by residential developments, landslides, and Public Works' paving of Rt. 108. This map shows the Lower Bordeaux area, sub-basins, natural drainage flow, and pre-existing and new drainage structures.

What YOU Can Do!

- ⇒ Vegetate bare slopes with native plants
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- ⇒ Clean up driveways, roadsides and gutters
- ⇒ Use cut brush to create berms on steep slopes
- ⇒ Eliminate muddy run-off water
- ⇒ Never dump anything down storm culverts or ghuts
- ⇒ Properly dispose of oils, paints and chemicals
- ⇒ Do not disturb ghuts for 30 feet from center of ghut
- ⇒ Preserve all trees
- ⇒ Pump and inspect your septic tank regularly
- ⇒ Notify DPNR if you notice a problem
- ⇒ DPNR permits are needed for using backhoes & trackhoes
- ⇒ Educate each other
- ⇒ Participate in community projects!

Protecting Coastal & Coral Reef Habitats by Reducing Erosion & Sedimentation

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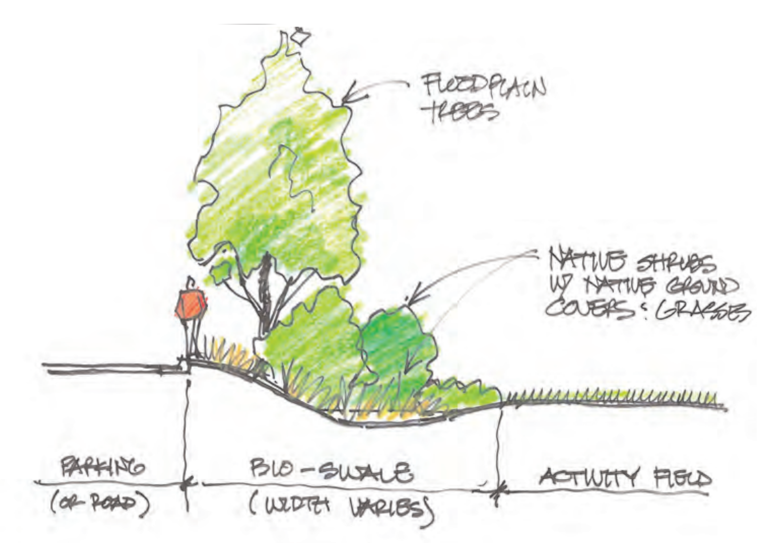
SPRING GARDEN

CORAL BAY COMMUNITY COUNCIL

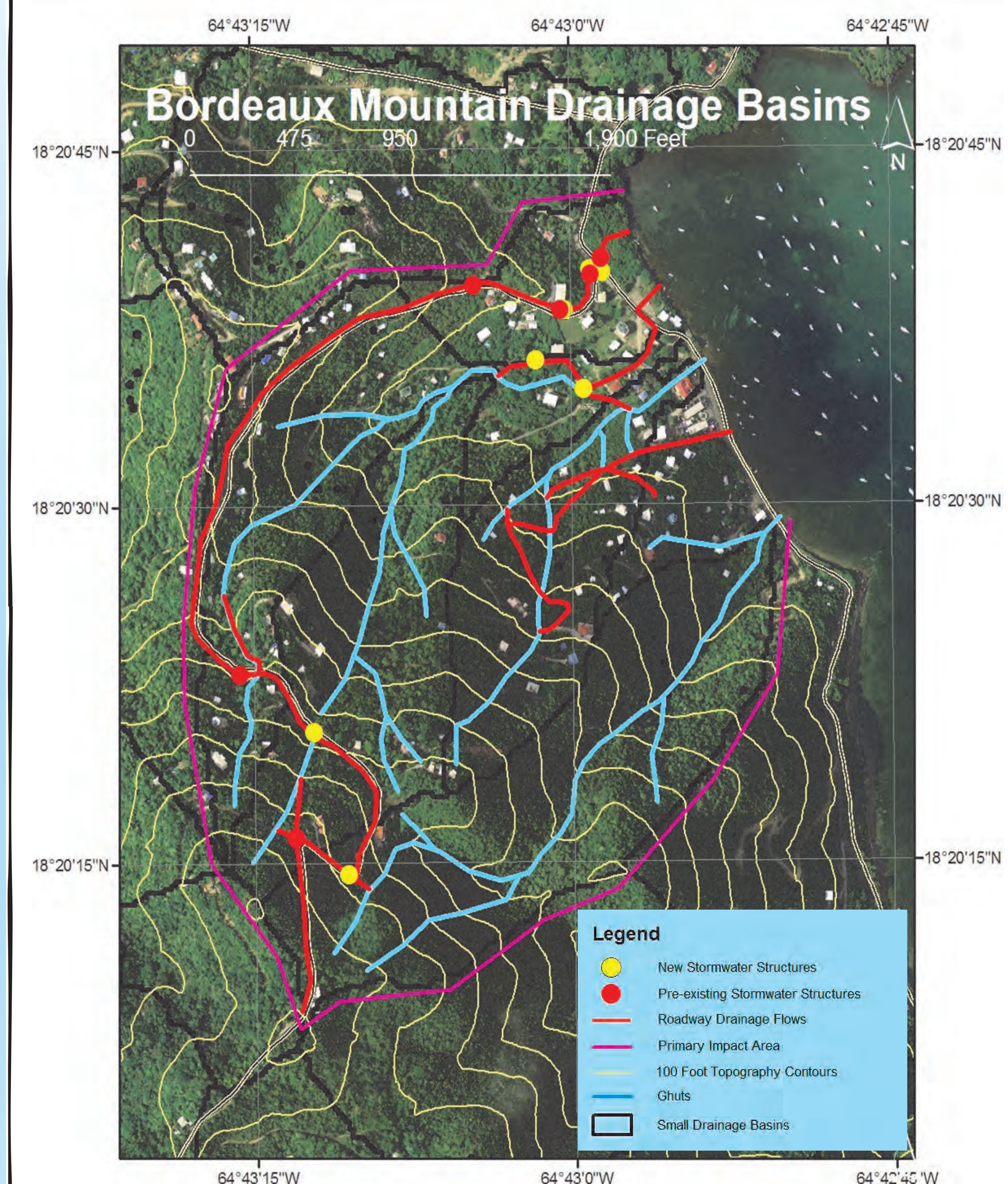
What Is Happening Here?

Several ghuts high on lower Bordeaux Mountain join into one flow before entering the ocean. The force of this flow generates significant erosion of ghut banks which results in sedimentation (see also Route 108 Trench Drain Project). When the ghut enters the flats in Spring Garden, sediment deposits have historically allowed the ghut to overflow its banks and run down a dirt road. The adjacent dirt road has also been a water channel. We cleaned the ghut and installed a berm, swale, waterbar, and used Geoweb™ road stabilization. Coupled with the reduced flows from the upper watershed, these features should reduce sedimentation potential of the waters flowing here.

Ghut Channels & Bioswales



Source: eWashtenaw.org, Washtenaw County,



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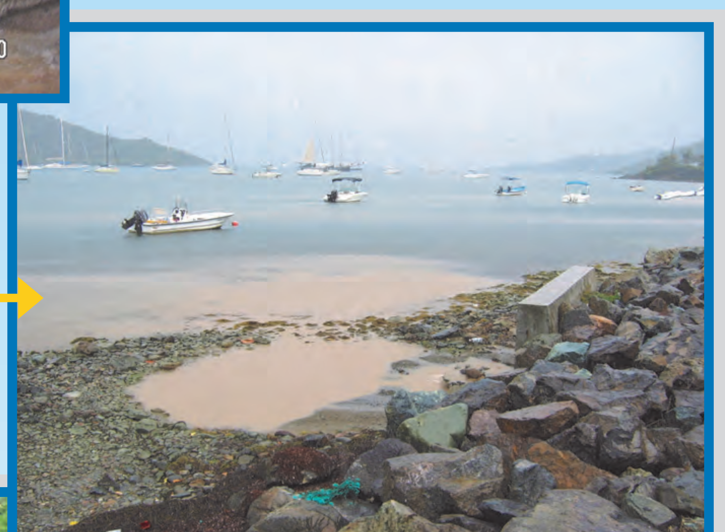
After



Before

During Construction

Stabilization Objectives

- Restore natural flow to ghuts
- Reduce stormwater velocity
- Stabilize ghut channel at crossings
- Decrease channel erosion
- Reduce sedimentation of Coral Bay

Site Locations

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Appendix A: Engineering Designs & Drawings

CORAL BAY COMMUNITY COUNCIL, INC.

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Coral Bay Projects Design Guidance

Strategies Appropriate for Coral Bay Environment

By: Joseph Mina, P.E.

1. Many natural drainage flows have been disturbed by construction and other man-made activities. A primary method of addressing water quality exiting the watershed into the bay will be to restore natural drainage flow patterns to the greatest extent possible both in intermittent drainage swales and ghuts and restoring sheet flow over steep slopes where possible. This will be accomplished primarily by:

a. Redirecting drainage from channels and redirecting the large areas of upslope water intercepted along many roads and construction sites and distribute that water using level spreaders, bioretention/infiltration devices and/or rock aprons or similar means to recreate the natural sheet flow, reduce velocity and improved percolation into soil.

i. Regrade roadbeds to direct flows to appropriate outflow devices where feasible, and add additional paving or permanent structures as appropriate to make preferred patterns of flow permanent.

ii. Add shallow vegetated swales, and detention areas with rocks and naturalized vegetation where possible to reduce velocity and promote infiltration.

iii. Install trench drains across driveways and roads into rain gardens, infiltration trenches, localized water collection systems for irrigation, or other appropriate devices.

b. Eliminate deep excavated unlined ditches which are common to many of the dirt roads in order to slow velocities and reduce amount of sediment produced by erosion. Check dams, bioretention swales, and underground stone trenches with perforated pipe will be installed where appropriate.

c. Reduce the length water travels in roadside swales by directing flow from roadways into devices often. Preferably at each switchback at a minimum by incorporating drywells, rain gardens and infiltration chambers using locally available materials and native species.

2. Retain and slow down water that reaches valley floor in larger scale regional detention/retention basins with Best Management Practices installed including forebays, infiltration cells and bioretention pond areas:

a. Devices will utilize native plantings and species where possible and available to mimic local Caribbean seasonal flow dry ghut conditions to promote both stormwater quality and to provide wildlife and riparian habitat restoration.

b. Sediment deposition retention area, cleaned regularly, with reuse of sediment material as gravel, topsoil, building sand, etc.

3. Provide “Last Chance” effort to reduce sediment entering sea at ends of ghuts and drainage ways immediately adjacent to where the flows enter the ocean.

a. Install devices just upstream of exit to the ocean from ghuts including:

i. Combination of weirs, pre-manufactured sediment retention chambers and/or small bioretention areas with local rock rip-rap aprons and multi-step natural rock retention step pools.

ii. Baffles and check dams where ghut is large enough.

iii. Construct and maintain natural “Caribbean Berm” (usually created by wave action and sand deposition) where water enters ocean in each area to provide natural sediment protection. Protection against mosquitoes and parasites in sitting water with guppies)

b. Slow, redirect and/or restore gut flow within 300 yards of ocean by installing the following where appropriate and feasible:

i. Re-vegetate gut outflow areas.

ii. Rock weirs, ghut slope and embankment protection including erosion control blankets, concrete cable mats or other manufactured devices to reduce erosion.

c. Install in-line biofiltration areas and flow spreading devices to slow velocities and provide opportunities for sediment to drop out and naturalized vegetation to reduce pollutant loading in the runoff.

4. Correction of failed devices, culverts, water routing by installing any appropriate Best Management Practices to attempt to solve some past poor choices of storm water management, or areas where no thought was given to management.

June 2009

CORAL BAY COMMUNITY COUNCIL, INC.
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Engineering Recommendation Memo
A Series of Observations & Preliminary Recommendations

CBCC Engineering Recommendation Memo #3

From: Joseph A. Mina, P.E. **Date:** May 14, 2009

Subject Property: Coral Bay

Specific Issue: Plumes of Sediment Laden Runoff in Multiple Locations – Coral Bay at Voyages

There are four primary areas where plumes of sediment laden water flow into the bay as a result of improper erosion and sediment pollution control in the various watersheds. These are Johnson Bay, Coral Bay at Voyages, Coral Bay at Kings Hill Road, and The Creek behind Skinny Legs. Due to the large amount of photos, these four areas will be the subject of four Engineering Recommendation Memos. This is the second of the four memos on this topic. The summary paragraphs below are repeated from ERM#2 for ease of reference.

Summary

On May 4, 2009 there was a substantial rainfall event that, according to various sources, dropped between 10 to 12 inches of rain on Cruz Bay. By my observations of the storm event's intensities in both Coral Bay and Cruz Bay, I estimate that between 8 and 10 inches fell in Coral Bay. During the event, I performed numerous site visits and took many photos.

It should be noted that in general, during an event of this magnitude, it is almost impossible to manage the runoff, and most BMP's seek to control the first 1" to 1.5" of runoff from a drainage area, or the 3" rain event. While I am still making a decision on which rain event to choose for our future BMP designs, I do know the devices will not manage this type of storm but only serve to pass larger events through safely after controlling the first 1" to 1.5" of runoff. It also needs to be noted that my estimates are prevalent throughout the memo. These are based on my personal observations of the intensities and reports from others describing the type of rain falling. At this time, there is no scientific measurement of these amounts, just a "best guess" based on professional experience.

During the early portion of my observations (prior to 8AM) few of the ghuts were actually flowing, and much of the runoff observed watershed-wide was clearly the result of impervious surfaces, construction activities, or runoff from existing roadways that acted as channels and decreased the initial runoff Times of Concentration. The Ghuts began to run between 8:30 and 10AM depending on the upstream watershed characteristics. This supports my "first flush" theory that the initial 1.5" of runoff is clearly the real culprit in the spiking amounts of sediment laden waters entering the bay.

Voyages Plume

This plume is generated by three pipe culverts crossing under Rt. 107. The first culvert is located under the open area that serves as a parking lot for an apartment building and Island Blues. The second is located where the ghut adjacent to the Voyages building is piped under Rt. 107. The last is on the southeast side of Cocolobo where an existing road directs flows from a roadside channel into a pipe culvert under Rt. 107.

Combined Plume from all three pipes

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Engineering Recommendation Memo
A Series of Observations & Preliminary Recommendations

Flow entering ghut at Voyages upstream of pipe

Road adjacent to Cocolobo

Runoff bypassing third pipe

Pipe at Voyages Outlet to Bay
(from previous storm)

Recommended Action

- Pipe under dirt parking area –
  Dirt surfaces serving as a parking area should be stabilized with grass pavers or gravel. These areas are basically flat enough that it is likely that gravel can be maintained there during all but the largest storms. It appears that during this storm, the majority of the sediment in this plume came from the parking areas and dirt areas just uphill of Rt. 107. Substantial improvement could be realized by simply stabilizing the open dirt areas adjacent to the road. Additionally, improvements further upstream could be installed to keep the flows in the ghut where a driveway and local road cross it by installing small plate bridge structure or a concrete or paver ford area or a combination of the two.
- Voyages Pipe and Cocolobo Pipe
  Little can be done on the ocean outlet side of the pipes, so improvements in the ghut and roadside swale should be investigated including rock check dams, step pools, and other devices. It may be possible to install a baffle box where the swale enters the pipe due to a drop to the pipe invert.
- Additional solutions are likely to be determined as this area is studied more closely. In general, the stabilization of dirt parking areas and dirt roads as well as installing devices to slow down the velocity of the water upstream to allow more sediment to drop out of suspension will help with any solutions installed at these three locations where there is not much room for any BMP's.

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Engineering Recommendation Memo
A Series of Observations & Preliminary Recommendations

CBCC Engineering Recommendation Memo #7

From: Joseph A. Mina, P.E. **Date:** May 20, 2009

Subject Property: Route 107 and Route 108 Intersection

Specific Issue: Blocked pipe culvert under road and managing large volumes of flow down Rt. 108

Blocked pipe
at Intersection causes
Flow over Rt. 107

Blocked inlets uphill cause large flows to bypass inlets and run over the road.

Recommended Action

- Immediately clean out blocked pipe and remove debris from inlets along road. Flush entire system to ensure removal of existing sediment and debris. Once this action is taken, the system should operate since much of the initial causes of this blockage are remedied with the recent paving of Rt. 108.
- Inspect inlets and pipes after every significant storm event, and clean as needed. At a minimum, perform routine cleaning and removal of debris twice a year before the spring and fall rains.
- Modify grates to raise them up from the road to allow smaller material (leaves, small stones, etc.) to flow into the system. This will help to prevent the clogging of the surface inlets. Simply welding small legs (approx. 1 inch) on to the existing grates would be sufficient. With the exception of the pipe crossing Route 107, the velocities in the system should cleanse the pipes on a regular basis.
- Ultimately, replace the pipe under Rt. 107 with a larger more accessible box culvert. Exact sizing should be done based on an analysis of the drainage area reaching the pipe, however, the culvert should be a minimum of 3 ft. high by 10 ft. wide and be fitted with a hatch opening to the road to allow for access and cleaning.
- Remove trees and debris immediately downstream of the culvert endwall. This area was cleared when the pipe was installed, however it has been allowed to grow again. Periodic maintenance should be performed in this area on a yearly basis at a minimum, and whenever vegetation growth appears within 10 ft. of the structure.
- Installation of a rip-rap energy dissipater immediately below the endwall would help to capture any remaining sediment and debris coming out of the system, and would slow down flows to reduce the chance of erosion in the area under the mangroves between this pipe and the bay. Sizing of this area should be done based on the velocity coming out of the pipe. Minimum of 8 inch rocks should be used.

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Engineering Recommendation Memo
A Series of Observations & Preliminary Recommendations

CBCC Engineering Recommendation Memo #10

From: Joseph A. Mina, P.E. **Date:** May 25, 2009

Subject Property: Bordeaux Mountain Road (Route 108)

Specific Issue: Ghut crossing areas on upper area of road

An additional ½ mile stretch of Bordeaux Mountain Rd. (Route 108) was paved in 2007. This has created much cleaner runoff from the road; however, the volume of water from the road and areas it intercepts has not been mitigated. A previous Engineering Recommendation Memo indicated issues on the lower portion and the intersection with Route 107 and the need to clean out the existing drainage system. This memo deals with an area near the top of the road where an existing ghut had flow restored to it. This ghut was properly directed across the road by a pipe. However, the residents downstream had a road installed, and houses built, and the redirection of this water caused significant damage to their property and the road. The private homeowners are currently seeking a solution to this and will likely need to install a culvert across their road to address the issue and keep the water directed into natural ghuts. There is another ghut above this pipe that was not directed across the street, and this volume of water now flows into the lower ghut. Additionally, just above these two ghuts, there is a bend in the road, and much of the water from the upper elevations is unmanaged in this area.

Another issue is that when the road was poured, and the concrete form removed, proper backfilling of the areas where the forms were was not performed. This is allowing water to flow under the concrete and will quickly undermine the roadway and cause the road surface to fail.

Finally, there are areas along the road where landslides have dropped debris into the roadside, and in some cases, even into the travel lanes.

Upper Bend – Water does not make
It around the curve

Area at edge of bend where water goes
Ideal area for installation of a BMP

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Engineering Recommendation Memo
A Series of Observations & Preliminary Recommendations

Roadside with undermining due to no backfilling after forms were removed

Landside debris in swale and roadway

Upper Ghut above existing pipe culvert

Recommended Action

- Immediately repair and properly backfill and compact areas adjacent to the road where the forms were removed. Make sure flow is directed into the existing concrete swales portion of the road.
- Remove debris from landslides, and wherever possibly, provide appropriate 2:1 slopes in cut areas. Where this is not possible, a minimum of 5-8 feet should be cut out next to the road to allow for a place for rocks and debris to fall without endangering passing motorists.
- Install a second culvert crossing the road at the upper ghut. There is an existing driveway at this location that also causes flow to cross the road, and the natural ghut is below the driveway. The ghut is just upstream from the driveway and the culvert should tie into some trench drain or other solution to prevent water from this private driveway from entering the roadway.
- At the upper bend of the road, there is an area of flat fill that could be used as a small detention basin. This area, if excavated and fitted with an outflow structure, would collect water from the uphill area, and release it through a level spreader to the downstream slope in a more controlled fashion. It would also provide cleansing of water from any silt or sediment and would require periodic cleaning and maintenance.
- An open bottom box culvert should be installed on the private roadway below the existing culvert across Rt. 108. This would be the responsibility of those homeowners that use the road for access. Currently, there is movement by the property owners in the area to solve this problem.

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Engineering Design Recommendation Memo

From: Joseph A. Mina, P.E. **Date:** Sept. 18, 2009

Subject Property: Bordeaux Mountain Road (Route 108) & Route 107 Intersection

Specific Issue: Detailed Recommendations for Ghut crossing roads and Blocked pipe culvert under Rt. 107

Project No: B-1&2-09

Attachments: Site Location & Drainage Area Map
Neenah Foundry R-4999 Heavy Duty Trench Specs
Details & Specifications for Trenches

This memo is an expansion on issues brought up in Engineering Recommendation Memos #7 and #10. Upon further study, some estimates for flow are included herein and a product is presented in this memo to address the issue of getting large volumes of water across the road while still maintaining the ability to easily clean out the debris and sediment that causes the culverts to clog.

Design Considerations & Methods of Analysis

- Three areas were analyzed. A Site Location Map is included with this memo.
  - Site #1 is the intersection of Rt. 107 and Rt. 108 at the blocked pipe.
  - Site #2 is the location of an existing pipe culvert under Rt. 108. This pipe was put in as part of the recent (2007) paving, and has caused some water flow damage and issues downstream on an estate road. .
  - Site#3 is where a ghut is intercepted by the road just above Site#2 and the roadside swale water should be redirected across the road to this existing ghut on or adjacent to 10-25-A Carolina to alleviate the large volumes going to Site#2.
- Flow estimates were completed using the Rational Method, and using IDF curves for Florida Zone 1 since none are readily available for the Islands. The 50 year storm intensity of 10.33 in/hr from these IDF curves was used as the base for the model, and an analysis was run for a range of flows to determine how the culvert would perform and when the flow would overtop the road/device.
- Times of Concentration were generally assumed to be 5 minutes to maintain a conservative estimate of flows, and due to the extreme steep slopes and quickly travelling water along the roadway in this watershed.
- The cover condition 'C' value was assumed to be .7. Actual values would likely come out lower if calculated on existing cover, but this assumption was made to adequately size the system to consider future development of ½ acre sites in this area.
- Culvert calculations were completed using the FHWA HY-8 Program to analyze performance.
- Data on topography and elevation was taken from existing GIS models and site reconnaissance.
- Any recommendations in this memo that are implemented should be field adjusted to match the exact conditions found during installation.

Flow Calculations (See attached Drainage Area Maps for details)

- Site #1 – This site receives the flows from an area of approximately 8.3 acres in a slice up Bordeaux Mountain Road (Rt. 108).
- Site #2 - This site receives the flows from an area of approximately 16.1 acres. A large portion of this flow comes from the roadway itself that intercepts water that would naturally be going in another direction (sheet flowing further down the hills). This site is analyzed in both Pre and Post construction conditions to show the reduction in flows to this area by constructing the improvements at Site #3.
- Site#3 – This area receives flows from an area that currently drains to Site#2. An existing ghut system was interrupted by construction of the road, and the flow is intercepted by the roadway and flows down to the pipe at Site#2. The area that contributes to the proposed crossing at this point is approximately 8.0 acres.
- Peak Flows are calculated using the rational Method formula – $Q=CiA$, where $C=0.7$, $i=10.33$ and A is based on the table below:

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Engineering Design Recommendation Memo

Flow Summary Table

Site	Area (ac)		Flow (cfs)	
1	8.3		60	
2	Pre-16.1	Post 8.1	Pre-116	Post-59
3	8.0		58	

- Based on this table, sizing for the required culvert for both sites#1 and #3 can use a value of 60 cfs for the design flow.

Culvert and Stilling Basin Design

- Required culvert size is 4' wide by 3' high with a trench drain. It is recommended to use the attached specifications for Neenah Foundry R-4999-OX Heavy Duty Trench system. The system is a cast in place concrete trench with a Heavy Duty cast iron grate.
- Based on the HY-8 design, a stilling basin that is 21' wide by 25' long with a 9' long pool 2' deep is warranted below the culverts to reduce velocities. This is feasible at Site #1, and can be implemented immediately downstream of the existing concrete structure. Additionally, in this area, it would be suitable to construct a series of gabion basked baffles in the mangroves to further reduce velocity and slow the flow. For Site #3, due to the slopes, this full pool system is not feasible, so it is recommended to install a rip-rap apron 20' wide by 25' long to address the flow issues.
- Design was completed using the FHWA HY-8 program. The following report was generated to document the design and data.

HY-8 Culvert Analysis Report

Table 1 - Summary of Culvert Flows at Crossing: Bordeaux Mtn Rd/Rt 107

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
10.40	0.00	0.00	0.00	1
11.38	10.00	10.00	0.00	1
11.96	20.00	20.00	0.00	1
12.43	30.00	30.00	0.00	1
12.85	40.00	40.00	0.00	1
13.25	50.00	50.00	0.00	1
13.65	60.00	60.00	0.00	1
14.06	70.00	70.00	0.00	1
14.50	80.00	79.93	0.00	14
14.69	90.00	83.93	5.98	6
14.82	100.00	86.61	13.32	5
14.50	79.95	79.95	0.00	Overtopping

Table 2 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	10.40	0.000	0.0*	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
10.00	10.00	11.38	0.984	0.0*	1-S2n	0.459	0.580	0.470	0.372	5.316	5.378
20.00	20.00	11.96	1.558	0.179	1-S2n	0.739	0.921	0.746	0.579	6.700	6.908
30.00	30.00	12.43	2.029	0.355	1-S2n	0.979	1.207	0.986	0.755	7.607	7.951

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40.00	40.00	12.85	2.451	0.514	1-S2n	1.200	1.462	1.204	0.914	8.309	8.754
50.00	50.00	13.25	2.850	0.664	1-S2n	1.405	1.697	1.412	1.064	8.855	9.400
60.00	60.00	13.65	3.248	0.805	5-S2n	1.604	1.916	1.654	1.205	9.070	9.962
70.00	70.00	14.06	3.660	0.941	5-S2n	1.798	2.123	1.852	1.341	9.448	10.444
80.00	79.93	14.50	4.099	1.073	5-S2n	1.984	2.320	2.043	1.473	9.783	10.862
90.00	83.93	14.69	4.287	1.201	5-S2n	2.058	2.396	2.117	1.601	9.910	11.243
100.00	86.61	14.82	4.416	1.325	5-S2n	2.108	2.447	2.167	1.725	9.992	11.592

* theoretical depth is impractical. Depth reported is corrected.

****
Inlet Elevation (invert): 10.40 ft, Outlet Elevation (invert): 10.00 ft
Culvert Length: 34.00 ft, Culvert Slope: 0.0118
****

Site Data - Culvert 1
Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 10.40 ft
Outlet Station: 34.00 ft
Outlet Elevation: 10.00 ft
Number of Barrels: 1

Culvert Data Summary - Culvert 1
Barrel Shape: Concrete Box
Barrel Span: 4.00 ft
Barrel Rise: 3.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0160
Inlet Type: Conventional
Inlet Edge Condition: Square Edge (90º) Headwall
Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: Bordeaux Mtn Rd/Rt 107)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.00	10.00	0.00	0.00	0.00	0.00
10.00	10.37	0.37	5.38	0.23	1.55
20.00	10.58	0.58	6.91	0.36	1.60
30.00	10.75	0.75	7.95	0.47	1.61
40.00	10.91	0.91	8.75	0.57	1.61
50.00	11.06	1.06	9.40	0.66	1.61
60.00	11.20	1.20	9.96	0.75	1.60
70.00	11.34	1.34	10.44	0.84	1.59
80.00	11.47	1.47	10.86	0.92	1.58
90.00	11.60	1.60	11.24	1.00	1.57
100.00	11.73	1.73	11.59	1.08	1.56

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Engineering Design Recommendation Memo

Tailwater Channel Data - Bordeaux Mtn Rd/Rt 107

Tailwater Channel Option: Rectangular Channel
Bottom Width: 5.00 ft
Channel Slope: 0.0100
Channel Manning's n: 0.0130
Channel Invert Elevation: 10.00 ft

Roadway Data for Crossing: Bordeaux Mtn Rd/Rt 107

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 25.00 ft
Crest Elevation: 14.50 ft
Roadway Surface: Paved
Roadway Top Width: 30.00 ft

HY-8 Energy Dissipation /Stilling Basin Design Report

Parameter	Value	Units
Select Culvert and Flow		
Crossing	Bordeaux Mtn Rd/Rt 107	
Culvert	Culvert 1	
Flow	60.00	cfs
Culvert Data		
Culvert Width (including multiple barrels)	4.0	ft
Culvert Height	3.0	ft
Outlet Depth	1.65	ft
Outlet Velocity	9.07	ft/s
Froude Number	1.24	
Tailwater Depth	1.20	ft
Tailwater Velocity	9.96	ft/s
Tailwater Slope (SO)	0.0118	
External Dissipator Data		
External Dissipator Category	Streambed Level Structures	
External Dissipator Type	Riprap Basin	
Restrictions		
Froude Number	<3	
Input Data		
Condition to be used to Compute Basin Outlet Velocity	Best Fit Curve	
D50 of the Riprap Mixture		
Note:	Minimum HS/D50 = 2 is Obtained if D50 = 0.367 ft	
D50 of the Riprap Mixture	0.250	ft
DMax of the Riprap Mixture	0.500	ft
Results		
Brink Depth	1.654	ft

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Brink Velocity	9.070	ft/s
Depth (YE)	1.654	ft
Riprap Thickness	0.750	ft
Riprap Foreslope	1.0000	ft
Check HS/D50		
Note:	OK if HS/D50 > 2.0	
HS/D50	6.757	
HS/D50 Check	HS/D50 is OK	
Check HS/D50		
Note:	OK if 0.1 < D50/YE < 0.7	
Check D50/YE	0.151	
D50/YE Check	D50/YE is OK	
Basin Length (LB)	25.340	ft
Basin Width	20.893	ft
Apron Length	8.447	ft
Pool Length	16.893	ft
Pool Depth (HS)	1.689	ft
TW/YE	0.728	
Tailwater Depth (TW)	1.205	ft
Average Velocity with TW	2.138	ft/s
Critical Depth (Yc)	0.623	ft
Average Velocity with Yc	4.354	ft/s

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Engineering Design Recommendation Memo

From: Joseph A. Mina, P.E. **Date:** Sept. 18, 2009

Revised: Christopher S. Laude, P.E. **Rev Date:** Sept. 18, 2009

Subject Property: Bordeaux Mountain Road (Route 108) & Route 107 Intersection

Specific Issue: Detailed Recommendations for Ghut crossing roads and Blocked pipe culvert under Rt. 107

Project No: B-1&2-09

Attachments: Site Location & Drainage Area Map
Neenah Foundry R-4999 Heavy Duty Trench Specs
Details & Specifications for Trenches

This memo is an expansion on issues brought up in Engineering Recommendation Memos #7 and #10. Upon further study, some estimates for flow are included herein and a product is presented in this memo to address the issue of getting large volumes of water across the road while still maintaining the ability to easily clean out the debris and sediment that causes the culverts to clog.

Design Considerations & Methods of Analysis

- Three areas were analyzed. A Site Location Map is included with this memo.
  - Site #1 is the intersection of Rt. 107 and Rt. 108 at the blocked pipe.
  - Site #2 is the location of an existing pipe culvert under Rt. 108. This pipe was put in as part of the recent (2007) paving, and has caused some water flow damage and issues downstream on an estate road. .
  - Site#3 is where a ghut is intercepted by the road just above Site#2 and the roadside swale water should be redirected across the road to this existing ghut on or adjacent to 10-25-A Carolina to alleviate the large volumes going to Site#2.
- Flow estimates were completed using the Rational Method, and using IDF curves for Florida Zone 1 since none are readily available for the Islands. The 50 year storm intensity of 10.33 in/hr from these IDF curves was used as the base for the model, and an analysis was run for a range of flows to determine how the culvert would perform and when the flow would overtop the road/device.
- Times of Concentration were generally assumed to be 5 minutes to maintain a conservative estimate of flows, and due to the extreme steep slopes and quickly travelling water along the roadway in this watershed.
- The cover condition 'C' value was assumed to be .7. Actual values would likely come out lower if calculated on existing cover, but this assumption was made to adequately size the system to consider future development of ½ acre sites in this area.
- Culvert calculations were completed using the FHWA HY-8 Program to analyze performance.
- Data on topography and elevation was taken from existing GIS models and site reconnaissance.
- Any recommendations in this memo that are implemented should be field adjusted to match the exact conditions found during installation.

Flow Calculations (See attached Drainage Area Maps for details)

- Site #1 – This site receives the flows from an area of approximately 8.3 acres in a slice up Bordeaux Mountain Road (Rt. 108).
- Site #2 - This site receives the flows from an area of approximately 16.1 acres. A large portion of this flow comes from the roadway itself that intercepts water that would naturally be going in another direction (sheet flowing further down the hills). This site is analyzed in both Pre and Post construction conditions to show the reduction in flows to this area by constructing the improvements at Site #3.
- Site#3 – This area receives flows from an area that currently drains to Site#2. An existing ghut system was interrupted by construction of the road, and the flow is intercepted by the roadway and flows down to the pipe at Site#2. The area that contributes to the proposed crossing at this point is approximately 8.0 acres.
- Peak Flows are calculated using the rational Method formula – $Q=CiA$, where $C=0.7$, $i=10.33$ and A is based on the table below:

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Engineering Design Recommendation Memo

Flow Summary Table

Site	Area (ac)		Flow (cfs)	
1	8.3		60	
2	Pre-16.1	Post 8.1	Pre-116	Post-59
3	8.0		58	

- Based on this table, sizing for the required culvert for both sites#1 and #3 can use a value of 60 cfs for the design flow.

Culvert and Stilling Basin Design

- Required culvert size is 4' wide by 3' high with a trench drain. It is recommended to use the attached specifications for Neenah Foundry R-4999-OX Heavy Duty Trench system. The system is a cast in place concrete trench with a Heavy Duty cast iron grate. **REV: Installing a trench drain at the upper switchback will reduce the required culvert size to 3' wide by 3' deep.**
- Based on the HY-8 design, a stilling basin that is 21' wide by 25' long with a 9' long pool 2' deep is warranted below the culverts to reduce velocities. This is feasible at Site #1, and can be implemented immediately downstream of the existing concrete structure. Additionally, in this area, it would be suitable to construct a series of gabion basked baffles in the mangroves to further reduce velocity and slow the flow. For Site #3, due to the slopes, this full pool system is not feasible, so it is recommended to install a rip-rap apron 20' wide by 25' long to address the flow issues.
- Design was completed using the FHWA HY-8 program. The following report was generated to document the design and data.

HY-8 Culvert Analysis Report

Table 1 - Summary of Culvert Flows at Crossing: Bordeaux Mtn Rd/Rt 107

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
10.40	0.00	0.00	0.00	1
11.38	10.00	10.00	0.00	1
11.96	20.00	20.00	0.00	1
12.43	30.00	30.00	0.00	1
12.85	40.00	40.00	0.00	1
13.25	50.00	50.00	0.00	1
13.65	60.00	60.00	0.00	1
14.06	70.00	70.00	0.00	1
14.50	80.00	79.93	0.00	14
14.69	90.00	83.93	5.98	6
14.82	100.00	86.61	13.32	5
14.50	79.95	79.95	0.00	Overtopping

Table 2 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	10.40	0.000	0.0*	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
10.00	10.00	11.38	0.984	0.0*	1-S2n	0.459	0.580	0.470	0.372	5.316	5.378
20.00	20.00	11.96	1.558	0.179	1-S2n	0.739	0.921	0.746	0.579	6.700	6.908

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30.00	30.00	12.43	2.029	0.355	1-S2n	0.979	1.207	0.986	0.755	7.607	7.951
40.00	40.00	12.85	2.451	0.514	1-S2n	1.200	1.462	1.204	0.914	8.309	8.754
50.00	50.00	13.25	2.850	0.664	1-S2n	1.405	1.697	1.412	1.064	8.855	9.400
60.00	60.00	13.65	3.248	0.805	5-S2n	1.604	1.916	1.654	1.205	9.070	9.962
70.00	70.00	14.06	3.660	0.941	5-S2n	1.798	2.123	1.852	1.341	9.448	10.444
80.00	79.93	14.50	4.099	1.073	5-S2n	1.984	2.320	2.043	1.473	9.783	10.862
90.00	83.93	14.69	4.287	1.201	5-S2n	2.058	2.396	2.117	1.601	9.910	11.243
100.00	86.61	14.82	4.416	1.325	5-S2n	2.108	2.447	2.167	1.725	9.992	11.592

* theoretical depth is impractical. Depth reported is corrected.

****

Inlet Elevation (invert): 10.40 ft, Outlet Elevation (invert): 10.00 ft
Culvert Length: 34.00 ft, Culvert Slope: 0.0118

****

Site Data - Culvert 1

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 10.40 ft
Outlet Station: 34.00 ft
Outlet Elevation: 10.00 ft
Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Concrete Box
Barrel Span: 4.00 ft
Barrel Rise: 3.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0160
Inlet Type: Conventional
Inlet Edge Condition: Square Edge (90º) Headwall
Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: Bordeaux Mtn Rd/Rt 107)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.00	10.00	0.00	0.00	0.00	0.00
10.00	10.37	0.37	5.38	0.23	1.55
20.00	10.58	0.58	6.91	0.36	1.60
30.00	10.75	0.75	7.95	0.47	1.61
40.00	10.91	0.91	8.75	0.57	1.61
50.00	11.06	1.06	9.40	0.66	1.61
60.00	11.20	1.20	9.96	0.75	1.60
70.00	11.34	1.34	10.44	0.84	1.59
80.00	11.47	1.47	10.86	0.92	1.58
90.00	11.60	1.60	11.24	1.00	1.57
100.00	11.73	1.73	11.59	1.08	1.56

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Engineering Design Recommendation Memo

Tailwater Channel Data - Bordeaux Mtn Rd/Rt 107

Tailwater Channel Option: Rectangular Channel
Bottom Width: 5.00 ft
Channel Slope: 0.0100
Channel Manning's n: 0.0130
Channel Invert Elevation: 10.00 ft

Roadway Data for Crossing: Bordeaux Mtn Rd/Rt 107

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 25.00 ft
Crest Elevation: 14.50 ft
Roadway Surface: Paved
Roadway Top Width: 30.00 ft

HY-8 Energy Dissipation /Stilling Basin Design Report

Parameter	Value	Units
Select Culvert and Flow		
Crossing	Bordeaux Mtn Rd/Rt 107	
Culvert	Culvert 1	
Flow	60.00	cfs
Culvert Data		
Culvert Width (including multiple barrels)	4.0	ft
Culvert Height	3.0	ft
Outlet Depth	1.65	ft
Outlet Velocity	9.07	ft/s
Froude Number	1.24	
Tailwater Depth	1.20	ft
Tailwater Velocity	9.96	ft/s
Tailwater Slope (SO)	0.0118	
External Dissipator Data		
External Dissipator Category	Streambed Level Structures	
External Dissipator Type	Riprap Basin	
Restrictions		
Froude Number	<3	
Input Data		
Condition to be used to Compute Basin Outlet Velocity	Best Fit Curve	
D50 of the Riprap Mixture		
Note:	Minimum HS/D50 = 2 is Obtained if D50 = 0.367 ft	
D50 of the Riprap Mixture	0.250	ft
DMax of the Riprap Mixture	0.500	ft
Results		
Brink Depth	1.654	ft

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Engineering Design Recommendation Memo

Brink Velocity	9.070	ft/s
Depth (YE)	1.654	ft
Riprap Thickness	0.750	ft
Riprap Foreslope	1.0000	ft
Check HS/D50		
Note:	OK if HS/D50 > 2.0	
HS/D50	6.757	
HS/D50 Check	HS/D50 is OK	
Check HS/D50		
Note:	OK if 0.1 < D50/YE < 0.7	
Check D50/YE	0.151	
D50/YE Check	D50/YE is OK	
Basin Length (LB)	25.340	ft
Basin Width	20.893	ft
Apron Length	8.447	ft
Pool Length	16.893	ft
Pool Depth (HS)	1.689	ft
TW/YE	0.728	
Tailwater Depth (TW)	1.205	ft
Average Velocity with TW	2.138	ft/s
Critical Depth (Yc)	0.623	ft
Average Velocity with Yc	4.354	ft/s

CORAL BAY COMMUNITY COUNCIL, INC.
Mailing: 9901 Estate Emmaus, St. John, VI 00830 E-mail: coralbaycommunitycouncil@hotmail.com
Office: 8-1 Estate Emmaus, Coral Bay, St. John, U.S. Virgin Islands Phone/Fax: 340-776-2099

Engineering Design Recommendation Memo

From: Joseph A. Mina, P.E. **Date:** January 8, 2010

Subject Property: Bordeaux Mountain Road (Route 108) & Route 107 Intersection

Specific Issue: Detailed Recommendations for Ghut crossing roads and Blocked pipe culvert under Rt. 107

Project No: B-1&2-09

Attachments: Site Location & Drainage Area Map
Neenah Foundry R-4999 Heavy Duty Trench Specs
Sketch of Site #1 and #3 Trench Drain Improvements

This memo is an expansion on issues brought up in Engineering Recommendation Memos #7 and #10. Upon further study, some estimates for flow are included herein and a product is presented in this memo to address the issue of getting large volumes of water across the road while still maintaining the ability to easily clean out the debris and sediment that causes the culverts to clog.

Design Considerations & Methods of Analysis

- Three areas were analyzed. A Site Location Map is included with this memo.
    - Site #1 is the intersection of Rt. 107 and Rt. 108 at the blocked pipe.
    - Site #2 is the location of an existing pipe culvert under Rt. 108. This pipe was put in as part of the recent (2007) paving, and has caused some water flow damage and issues downstream on an estate road. .
    - Site#3 is where a ghut is intercepted by the road just above Site#2 and the roadside swale water should be redirected across the road to this existing ghut on or adjacent to 10-25-A Carolina to alleviate the large volumes going to Site#2.
- Flow estimates were completed using the Rational Method, and using IDF curves for Florida Zone 1 since none are readily available for the Islands. The 50 year storm intensity of 10.33 in/hr from these IDF curves was used as the base for the model, and an analysis was run for a range of flows to determine how the culvert would perform and when the flow would overtop the road/device.
- Times of Concentration were generally assumed to be 5 minutes to maintain a conservative estimate of flows, and due to the extreme steep slopes and quickly travelling water along the roadway in this watershed.
- The cover condition ‘C’ value was assumed to be .7. Actual values would likely come out lower if calculated on existing cover, but this assumption was made to adequately size the system to consider future development of ½ acre sites in this area.
- Culvert calculations were completed using the FHWA HY-8 Program to analyze performance.
- Data on topography and elevation was taken from existing GIS models and site reconnaissance.
- Any recommendations in this memo that are implemented should be field adjusted to match the exact conditions found during installation.

Flow Calculations (See attached Drainage Area Maps for details)

- Site #1 – This site receives the flows from an area of approximately 8.3 acres in a slice up Bordeaux Mountain Road (Rt. 108).
- Site #2 - This site receives the flows from an area of approximately 16.1 acres. A large portion of this flow comes from the roadway itself that intercepts water that would naturally be going in another direction (sheet flowing further down the hills). This site is analyzed in both Pre and Post construction conditions to show the reduction in flows to this area by constructing the improvements at Site #3.
- Site#3 – This area receives flows from an area that currently drains to Site#2. An existing ghut system was interrupted by construction of the road, and the flow is intercepted by the roadway and flows down to the pipe at Site#2. The area that contributes to the proposed crossing at this point is approximately 8.0 acres.
- Peak Flows are calculated using the rational Method formula – $Q=CiA$, where $C=0.7$, $i=10.33$ and A is based on the table below:

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Engineering Design Recommendation Memo

Flow Summary Table

Site	Area (ac)		Flow (cfs)	
1	8.3		60	
2	Pre-16.1	Post 8.1	Pre-116	Post-59
3	8.0		58	

- Based on this table, sizing for the required culvert for both sites#1 and #3 can use a value of 60 cfs for the design flow.

Culvert and Outlet Protection Design

- Required culvert size is 4' wide by 3' high with a trench drain. It is recommended to use the attached specifications for Neenah Foundry R-4999-OX Heavy Duty Trench system. The system is a cast in place concrete trench with a Heavy Duty cast iron grate.
- A concrete cable mat and concrete A Jacks system should be installed at the outfall of the trenches at both sites to provide protection from erosion and to dissipate the energy.
- Design was completed using the FHWA HY-8 program. The following report was generated to document the design and data.

HY-8 Culvert Analysis Report

Table 1 - Summary of Culvert Flows at Crossing: Bordeaux Mtn Rd/Rt 107

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
10.40	0.00	0.00	0.00	1
11.38	10.00	10.00	0.00	1
11.96	20.00	20.00	0.00	1
12.43	30.00	30.00	0.00	1
12.85	40.00	40.00	0.00	1
13.25	50.00	50.00	0.00	1
13.65	60.00	60.00	0.00	1
14.06	70.00	70.00	0.00	1
14.50	80.00	79.93	0.00	14
14.69	90.00	83.93	5.98	6
14.82	100.00	86.61	13.32	5
14.50	79.95	79.95	0.00	Overtopping

Table 2 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	10.40	0.000	0.0*	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
10.00	10.00	11.38	0.984	0.0*	1-S2n	0.459	0.580	0.470	0.372	5.316	5.378
20.00	20.00	11.96	1.558	0.179	1-S2n	0.739	0.921	0.746	0.579	6.700	6.908
30.00	30.00	12.43	2.029	0.355	1-S2n	0.979	1.207	0.986	0.755	7.607	7.951
40.00	40.00	12.85	2.451	0.514	1-S2n	1.200	1.462	1.204	0.914	8.309	8.754
50.00	50.00	13.25	2.850	0.664	1-S2n	1.405	1.697	1.412	1.064	8.855	9.400

CORAL BAY COMMUNITY COUNCIL, INC.
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Engineering Design Recommendation Memo

60.00	60.00	13.65	3.248	0.805	5-S2n	1.604	1.916	1.654	1.205	9.070	9.962
70.00	70.00	14.06	3.660	0.941	5-S2n	1.798	2.123	1.852	1.341	9.448	10.444
80.00	79.93	14.50	4.099	1.073	5-S2n	1.984	2.320	2.043	1.473	9.783	10.862
90.00	83.93	14.69	4.287	1.201	5-S2n	2.058	2.396	2.117	1.601	9.910	11.243
100.00	86.61	14.82	4.416	1.325	5-S2n	2.108	2.447	2.167	1.725	9.992	11.592

* theoretical depth is impractical. Depth reported is corrected.

****

Inlet Elevation (invert): 10.40 ft, Outlet Elevation (invert): 10.00 ft
Culvert Length: 34.00 ft, Culvert Slope: 0.0118

****

Site Data - Culvert 1

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 10.40 ft
Outlet Station: 34.00 ft
Outlet Elevation: 10.00 ft
Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Concrete Box
Barrel Span: 4.00 ft
Barrel Rise: 3.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0160
Inlet Type: Conventional
Inlet Edge Condition: Square Edge (90º) Headwall
Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: Bordeaux Mtn Rd/Rt 107)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.00	10.00	0.00	0.00	0.00	0.00
10.00	10.37	0.37	5.38	0.23	1.55
20.00	10.58	0.58	6.91	0.36	1.60
30.00	10.75	0.75	7.95	0.47	1.61
40.00	10.91	0.91	8.75	0.57	1.61
50.00	11.06	1.06	9.40	0.66	1.61
60.00	11.20	1.20	9.96	0.75	1.60
70.00	11.34	1.34	10.44	0.84	1.59
80.00	11.47	1.47	10.86	0.92	1.58
90.00	11.60	1.60	11.24	1.00	1.57
100.00	11.73	1.73	11.59	1.08	1.56

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Engineering Design Recommendation Memo

Tailwater Channel Data - Bordeaux Mtn Rd/Rt 107

Tailwater Channel Option: Rectangular Channel
Bottom Width: 5.00 ft
Channel Slope: 0.0100
Channel Manning's n: 0.0130
Channel Invert Elevation: 10.00 ft

Roadway Data for Crossing: Bordeaux Mtn Rd/Rt 107

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 25.00 ft
Crest Elevation: 14.50 ft
Roadway Surface: Paved
Roadway Top Width: 30.00 ft

Bordeaux Mountain Road
Trench Drain Improvements
Plans & Specifications

PROJECT NO. B001-09

SITUATE IN

CORAL BAY, ST. JOHN
US VIRGIN ISLANDS

February 3, 2010

PREPARED FOR:

Coral Bay Community Council, Inc.
&
Virgin Islands Resource Conservation and Development Council, Inc.
NOAA-ARRA Grant
9901 Emmaus
St. John, USVI 00830

PREPARED BY:

JAM Engineering Associates LLC
Stormwater ∞ Civil Engineering ∞ Planning
Joseph A. Mina, P.E.

TABLE OF CONTENTS

1.0 NARRATIVE

Project is located in Coral Bay on St. John USVI. Locations are as shown on the enclosed Site Location Map, along Bordeaux Mountain Road (Rt. 108). Exact location for installation of trenches to be determined in the field in conjunction with Public Works ("PW"), and the Coral Bay Community Council ("CBCC").

a. Project will consist of the installation of two trench drains approximately 3' deep by 4' wide and extending across the road sufficiently to interface with the downstream erosion protection and stabilization installation shown on the plan.

b. Trench drains will be approximately 16' to 20' long as determine by field conditions, and field adjusted and fit to allow for specific site conditions encountered.

c. Inlet box to be installed on the upstream side of the drain will consist of a 4000psi (min) poured concrete structure equipped with an 18" sump and field adjusted to divert all flow from the adjacent roadside swale into the trench drain structure.

d. Inlet box to be fit with a welded steel trash/debris rack field adjusted to protect the inlet from large debris greater than 4", and shall be positioned on 2" (min) legs to allow flow to go both under and over the trash rack. Specific dimensions and configuration of the rack to be determined in the field in conjunction with the CBCC inspector.

e. Downstream area will be reinforced with Armorflex Cellular Concrete Blocks installed per manufacturers requirements, and be field fit to match topography and installed trench drain.

f. If necessary, a concrete endwall will be installed at the trench outlet, depending on site conditions and topography.

g. Armorflex to be installed to minimum lengths as shown on plan, <u>OR</u> to toe of road fill slope, whichever is greater.

h. A-Jacks Concrete Armor Units to be installed at downstream interface of Armorflex and natural, undisturbed ground one unit wide at the length and configuration specified on the plans.

i. Pyramat Landlok 300 High Performance Turf Reinforcement Mat will be used to stabilize all disturbed areas not protected by installation of Armor Flex, A-Jacks or other permanent paved surface, and shall be installed per manufacturers' specifications.

j. Roadway repairs to paving and concrete to be in accordance with all Public Works Standards, and shall at a minimum replace the paving/concrete to match the existing profile and shall be installed so as not to create any uneven surfaces unsuitable for driving upon.

k. Upon final grading of an area, all exposed dirt surfaces shall be seeded with a mixture of appropriate grass seeds suitable for the conditions, and readily obtainable or able to be delivered to the island. Additional specifications for seeding and final stabilization vegetation will be provided by the CBCC upon award of the contract.

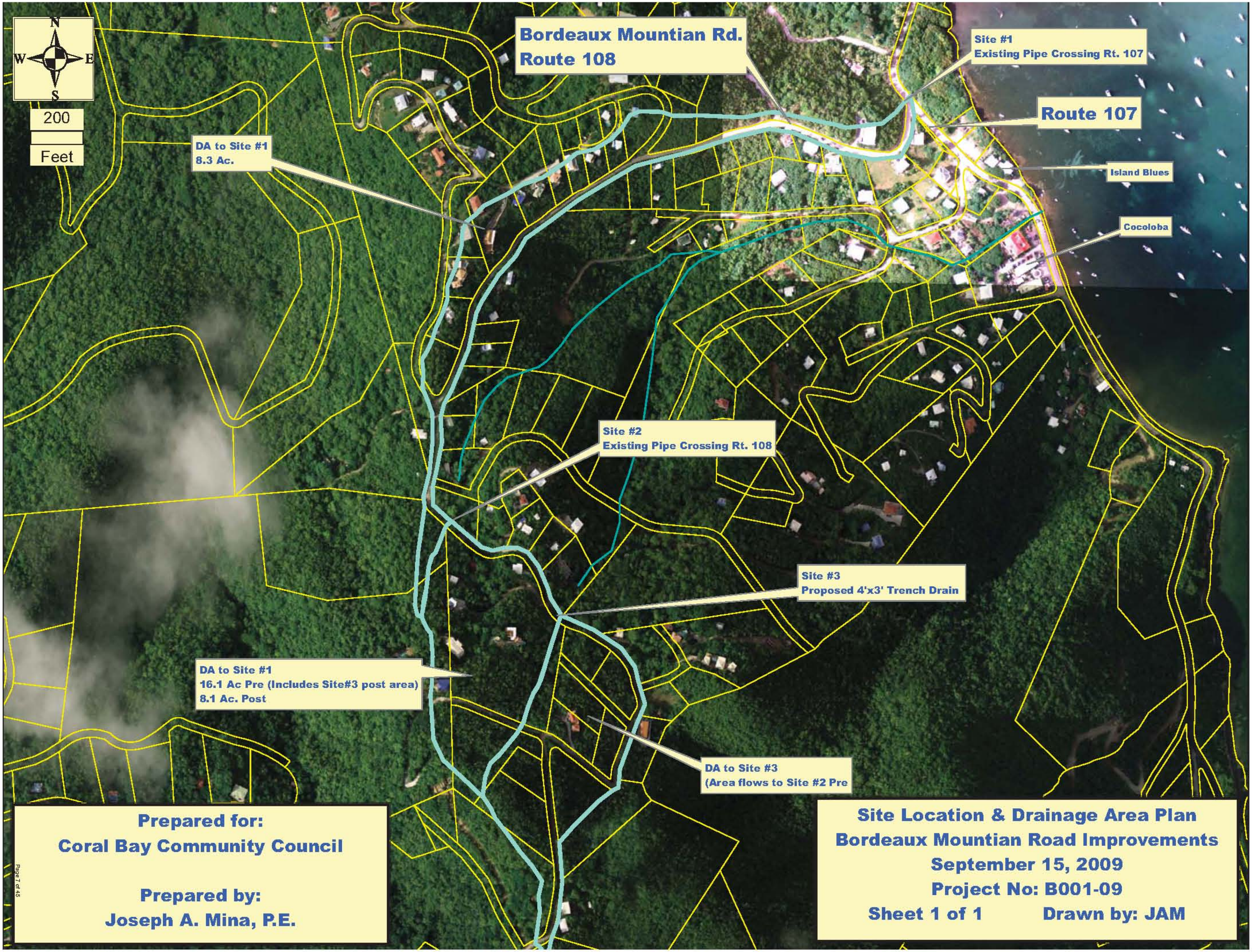
l. Any discrepancies between plans, specifications and site conditions shall be addressed by the CBCC Inspector at the time of installation or upon receiving notification of the discrepancy from the contractor.

m. Additional specifications and adjustments, at the discretion of the CBCC Inspector shall be field implemented to adequately install devices and provide protection and stabilization. Contractor shall be responsible for implementing any such adjustments as deemed necessary by the Inspector that are reasonably similar to the written specifications.

n. Erosion Control Matting & anchors, A-Jacks, Armorflex and Neenah Trench Grates to be provided by VIRC&D/CBCC. All other materials and supplies including but not limited to rock, concrete, and geotextile are to be provided by the contractor.

BUY AMERICAN CLAUSE:

Contractors are hereby notified that they are encouraged, to the greatest extent practicable, to purchase American-made equipment and products with funding provided under this award.

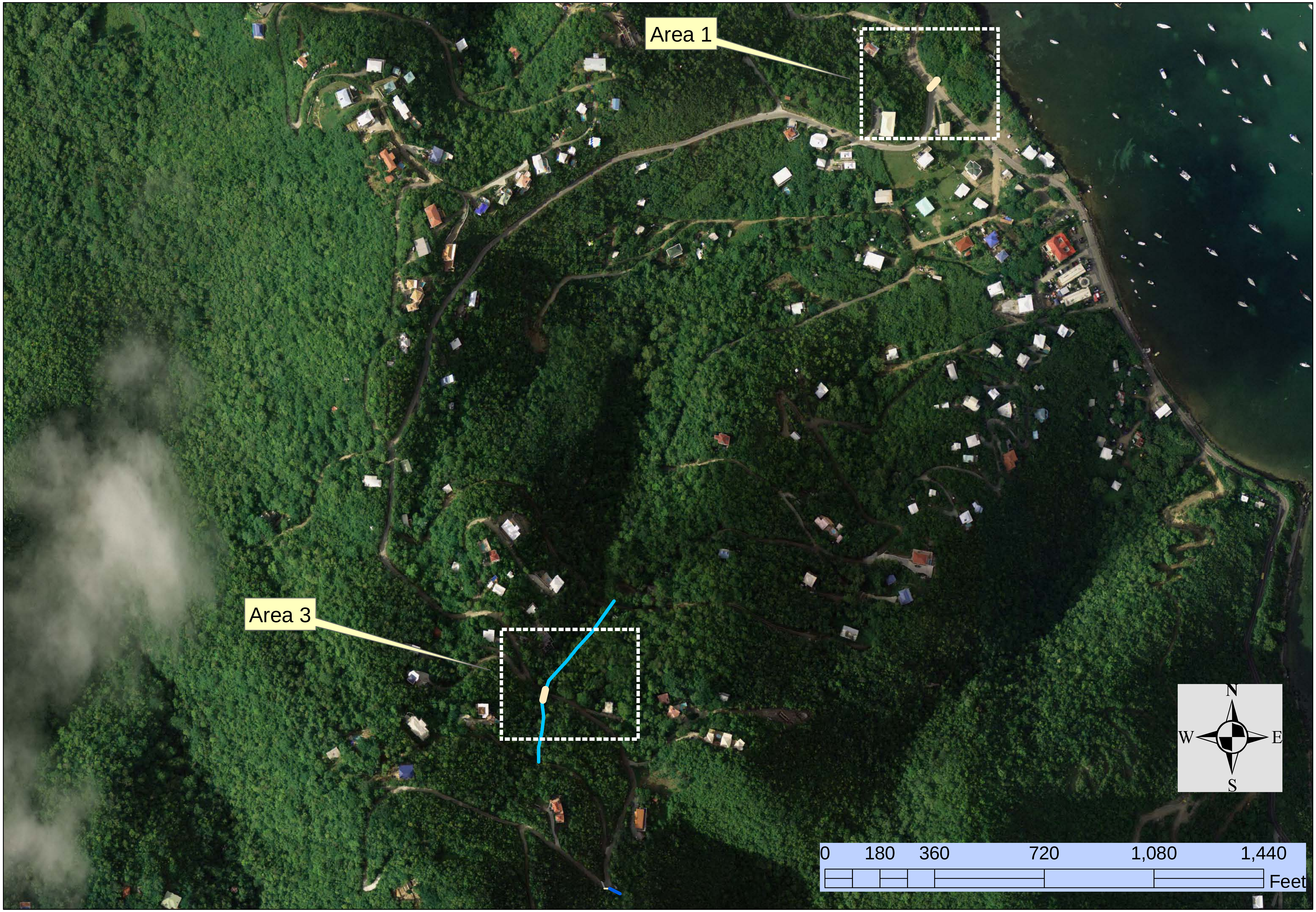


Prepared for:
Coral Bay Community Council

Prepared by:
Joseph A. Mina, P.E.

Site Location & Drainage Area Plan
Bordeaux Mountian Road Improvements
September 15, 2009
Project No: B001-09
Sheet 1 of 1 Drawn by: JAM

Bordeaux Mountain Road
Project Areas



Revised Bordeaux Mountain Road Trench Drain Improvements Scope of Work, Details & Specifications

PROJECT NO. B001-09

SITUATE IN

CORAL BAY, ST. JOHN
US VIRGIN ISLANDS

April 29, 2010
Rev: December 8, 2010

PREPARED FOR:

Coral Bay Community Council, Inc., and:
Virgin Islands Resource Conservation and Development Council, Inc.
NOAA-ARRA Grant
9901 Emmaus
St. John, USVI 00830

PREPARED BY:

JAM Engineering Associates LLC
Stormwater ∞ Civil Engineering ∞ Planning
Joseph A. Mina, P.E.

REVISED BY:

Christopher S. Laude, PE
9901 Emmaus
St John, VI 00830
910/615-5990

TABLE OF CONTENTS

1.0 SCOPE OF WORK

Project is located in Coral Bay on St. John USVI. Locations are as shown on the enclosed Site Location Map (**REV**), along Bordeaux Mountain Road (Rt. 108). Site #1 and Site #3 will be installed as part of this Scope of Work. Exact location for installation of trenches to be indicated in the field by the VIRC&D Inspector. **REV: Switchback area trench drain and ditch also will be installed as part of this Scope of Work.**

Site #1 Intersection of Route 107 & 108.

This section totally replaces the corresponding section in the March 24, 2010 document.

Project will consist of the cleaning out of an existing clogged pipe crossing Rt. 107; installation of a modified grate; and erosion protection devices at the outfall location prior to entrance into the mangroves. The construction shall proceed as follows:

1. Install Silt Fence. **(REV: Delete this item)**
2. Sawcut existing roadside swale at location and at angle to be determined by VI RC&D inspector; remove concrete debris, pour new concrete with rock sticking out of concrete 6" from concrete surface, with rock to be embedded 6" in poured concrete (see detail). **(REV: Delete this item)**
3. Clean out existing inlet and existing pipe. Dispose of removed materials in accordance with Territorial Regulations. Removed material shall not remain on-site and shall not be spread in the mangroves. **(REV: clean out both pipes at the drainage structure. Removed material may be used for rip rap, if determined to be suitable by the VI RC & D inspector.)**
4. Replace or reuse existing Inlet grate fit with 2" (min) legs to allow flow to go both under and over as a trash rack. Specific dimensions and configuration of the rack to be determined in the field in conjunction with the VIRC&D inspector. Inlet grate installed on inlet box. **(REV: Delete grate legs. Install approved silt sacks in accordance with the manufacturer's specifications in the 3 catch basins that comprise the drainage system as shown on the revised project drawings.)**
5. Clear existing outlet box of debris & vegetation. Removed material shall not remain on-site. **(REV: Removed material shall not remain on-site unless approved by the VI RC & D inspector.)**
6. Install Armorflex Cellular Concrete Blocks (per manufacturer's specifications) below outlet structure as shown on the plan. **(REV: Delete this item)**
7. Install A-Jacks Concrete Armor Units at downstream interface of Armorflex and natural, undisturbed ground one unit wide at the length and configuration specified on the plans. **(REV: Delete this Item)**
8. Seed and stabilize all remaining disturbed areas. Upon final grading of an area, all disturbed earth surfaces shall be seeded with Bermuda grass (98% purity) at a rate of to be determined by VI RC&D inspector.

SITE #3 Trench Drain adjacent to Parcel 10-25-A Carolina.
Project will consist of installation of an inlet box and a trench drain 3' deep by 4' wide and concrete endwall along with erosion protection devices at the outfall location. The construction shall proceed as follows: **(REV: Trench Drain shall be 3' wide by 3' deep.)**

1. Saw cut roadway and install 28' long 3' deep by 4' wide Concrete Trench Drain & 4' Wide Neenah R-4999-OX Trench Grate. **(REV: Trench Shall be 3' wide and 3' deep and fitted with a Neenah R-4999-LX Type C bolted grate.)** Install Concrete Trench in accordance with structural design detail. Roadway repairs to be in accordance with all Public Works Standards, and shall at a minimum replace the paving/concrete to match the existing profile and shall be installed so as not to create any uneven surfaces unsuitable for driving upon. Traffic Flow must be maintained in at least one lane at all times, and when lane restrictions are required flag men and/or other appropriate traffic control methods will be used in accordance with all Public Works requirements.
2. Install 2'x4' inlet box on the upstream side of the trench drain field adjusted to divert all flow from the adjacent roadside swale into the inlet and/or trench drain structure. Inlet box to consist of rebar reinforced (12" O.C.) 3000 psi concrete with a welded steel trash/debris rack to protect the inlet from large debris greater than 4", and rack shall be positioned on 2" (min) legs to allow flow to go both under and over the trash rack. **(REV: Delete inlet box. Extend trench to rock face as shown on the revised details. Delete 2" legs.)**
3. Install endwall per detail. **(REV: Delete this item.)**
4. Install Armorflex Cellular Concrete Blocks per manufacturer's requirements. **(REV: Delete this item.)**
5. Install A-Jacks Concrete Armor Units at downstream interface of Armorflex and natural, undisturbed ground one unit wide at the length and configuration specified on the plans. **(REV: Replace this item with A-Jacks and large rock rip rap placed at the trench drain discharge as directed by the VIRC&D Inspector.)**
6. Seed and stabilize all remaining disturbed areas. Upon final grading of an area, all exposed dirt surfaces shall be seeded with Bermuda grass (98% purity) at a rate of 10lbs per acre.

NOTES AND CONDITIONS

1. Additional specifications and adjustments, at the discretion of the VIRC&D Inspector shall be field implemented to adequately install devices and provide protection and stabilization. Contractor shall be responsible for implementing any such adjustments as deemed necessary by the Inspector that are reasonably similar to the written specifications.
2. A-Jacks and Armorflex concrete block to be provided by VIRC&D. All other materials and supplies including but not limited to trench grates, rock, concrete, and geotextile are to be provided by the contractor.

3. While concrete is curing, at the end of the work day and overnight, Traffic shall be provided for by placement of ¾" steel plates over the trenches. **(REV: Plates shall be min ¾" steel, and shall be installed an anchored in accordance with FHWA, DOT and VI DPW requirements.)** No Traffic will be allowed to drive directly over freshly poured concrete for a minimum of 48 hours from the end of pour. Steel plates must remain in place for 7 days. No protection is required after 7 days, and plates may be removed.
4. Excess material excavated shall be removed from the site or used to fill roadside areas where scour has eroded the areas adjacent to the roadside swales and is undermining the road. All areas filled and repaired shall be protected with Erosion Control Blanket and seeded with Bermuda grass (98% purity) at 20lbs. per acre. No material other than that used for roadside repairs shall remain onsite. **(REV: VIRCD shall provide Erosion Control Blanket, contractor shall install erosion control blanket and seed with Bermuda grass at specified rate.)**
5. Traffic Flow must be maintained in at least one lane at all times, appropriate traffic control methods will be used in accordance with all Public Works requirements.
6. During grading & excavation work, sufficient water will be kept onsite to ensure that exposed soil and road surfaces can be sprayed down to control dust.
7. All workmanship shall comply with VI DPW specifications and FP-2006 specifications.
8. All grading and excavation included on this job shall include all rock and ledge removal necessary to install items as specified. No additional fees shall be charged for rock work.
9. Contractor shall be responsible for installing up to four sign posts consisting of a 4" x 4" post set 2' into the ground and extending 6' above grade at locations to be determined upon the start of construction. Signs will be provided by VIRCD and mounted on the signpost by the contractor.
10. BUY AMERICAN CLAUSE: Contractors are hereby notified that they are encouraged, to the greatest extent practicable, to purchase American-made equipment and products with funding provided under this award.
11. Contractor must have a VI business license to do the type of work that is being performed.
12. Contractor must have a DUNS number.
13. All workers on the projects must legally be able to work in the VI.
14. Notify Project manager, CBCC and all abutters at least 24 hours prior to beginning work.
15. Contractor must conduct a weekly safety meeting for all on site personnel
16. Provide $ 1 million liability insurance with CBCC and VIRC&D as named insured
17. Comply with all Federal and VI, DPW and DPNR regulations and requirements.

Bordeaux Mountain Road
Trench Drain Improvements
Plans & Specifications
PROJECT NO. B001-09

2.0 PLANS & DETAILS

JAM Engineering Associates LLC
Stormwater ∞ Civil Engineering ∞ Planning

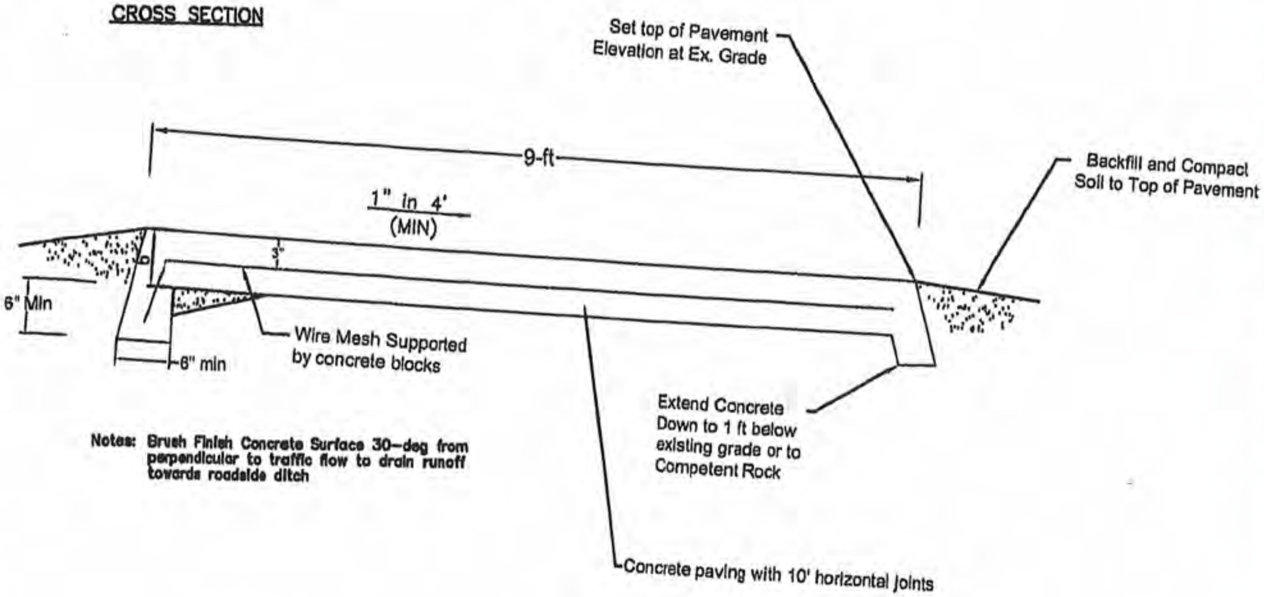
APPENDIX A

SPECIFICATIONS

CONCRETE PAVING DETAIL

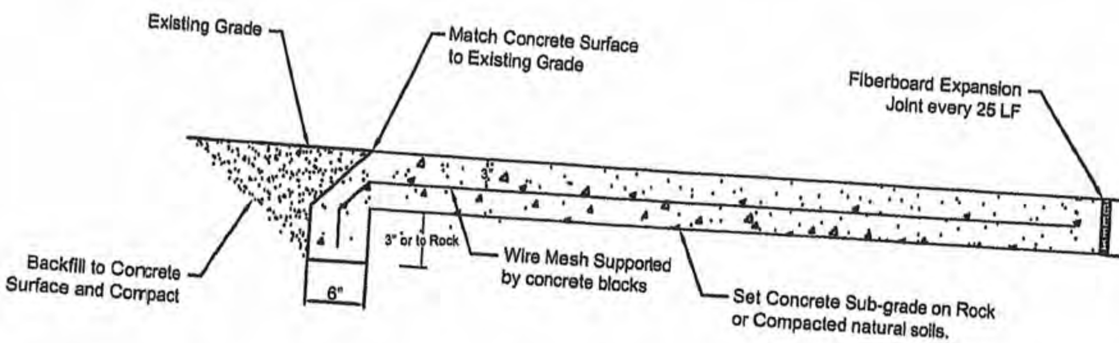
N.T.S.

CROSS SECTION



Notes: Brush Finish Concrete Surface 30–deg from perpendicular to traffic flow to drain runoff towards roadside ditch

PROFILE VIEW



VIRGIN ISLANDS GOVERNMENT
DEPARTMENT of PLANNING & NATURAL RESOURCES
COASTAL ZONE PERMIT NO 5-11-11L

This permit is approved, subject to conditions, if pursuant to Chapter 21, Title 12, Virgin Islands Code.
CONDITIONS: NO
✓ Yes, on this plan or on attached Permit document.

Commissioner

6/1/2011
Date

PROFESSIONAL ENGINEER
CHRISTOPHER S. LAUDE
1125E
2-1-2011
U.S. VIRGIN ISLANDS

Pavement Details

Drainage Maintenance
Spring Garden Ghut
Coral Bay, St John, USVI

Coral Bay Community Council

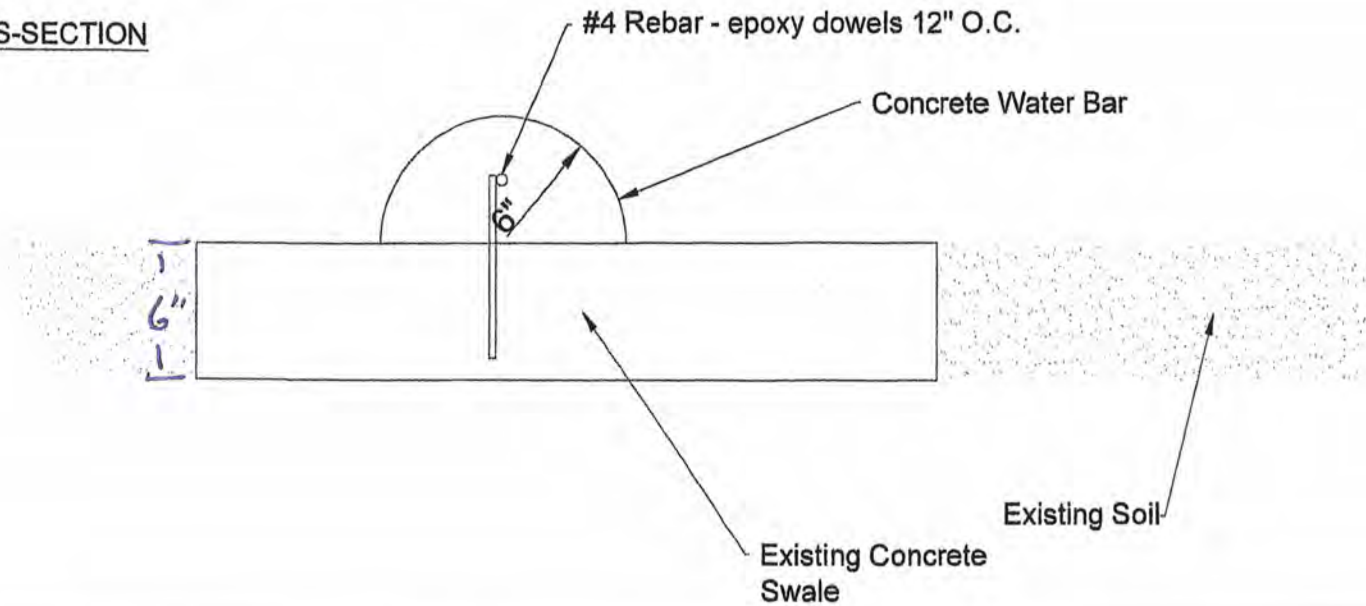
Date: 02/01/2011
Project No: B4
CSL
Sheet 4 of 4
Not To Scale

Christopher S Laude, P.E.

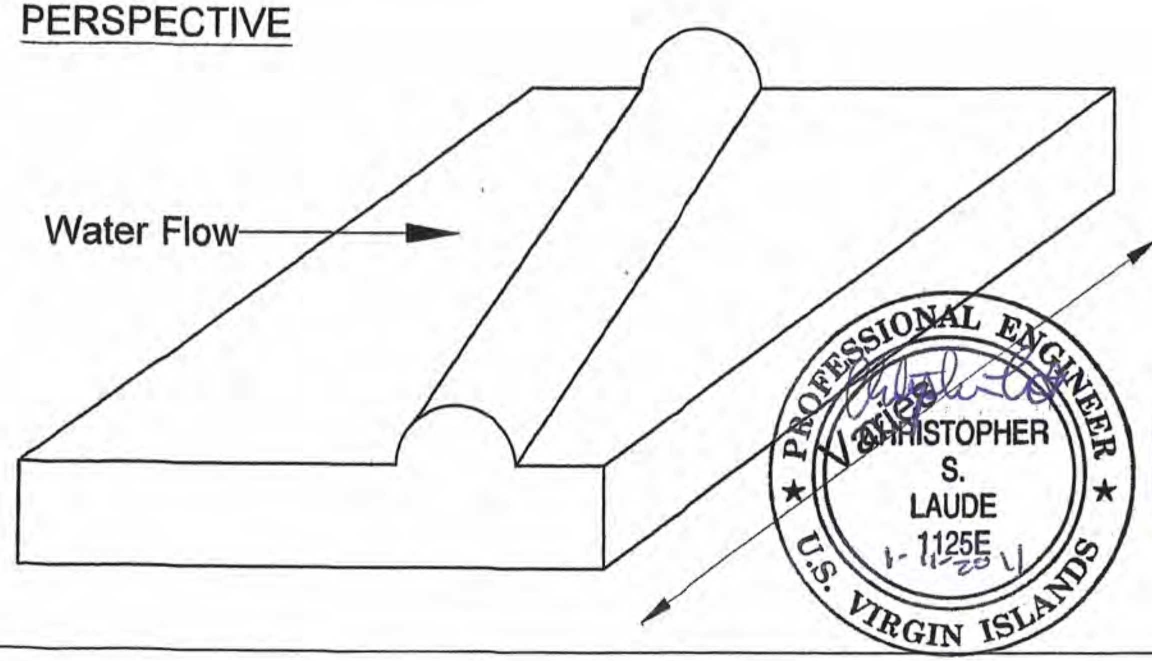
CONCRETE WATERBAR DETAILS

N.T.S.

CROSS-SECTION



PERSPECTIVE



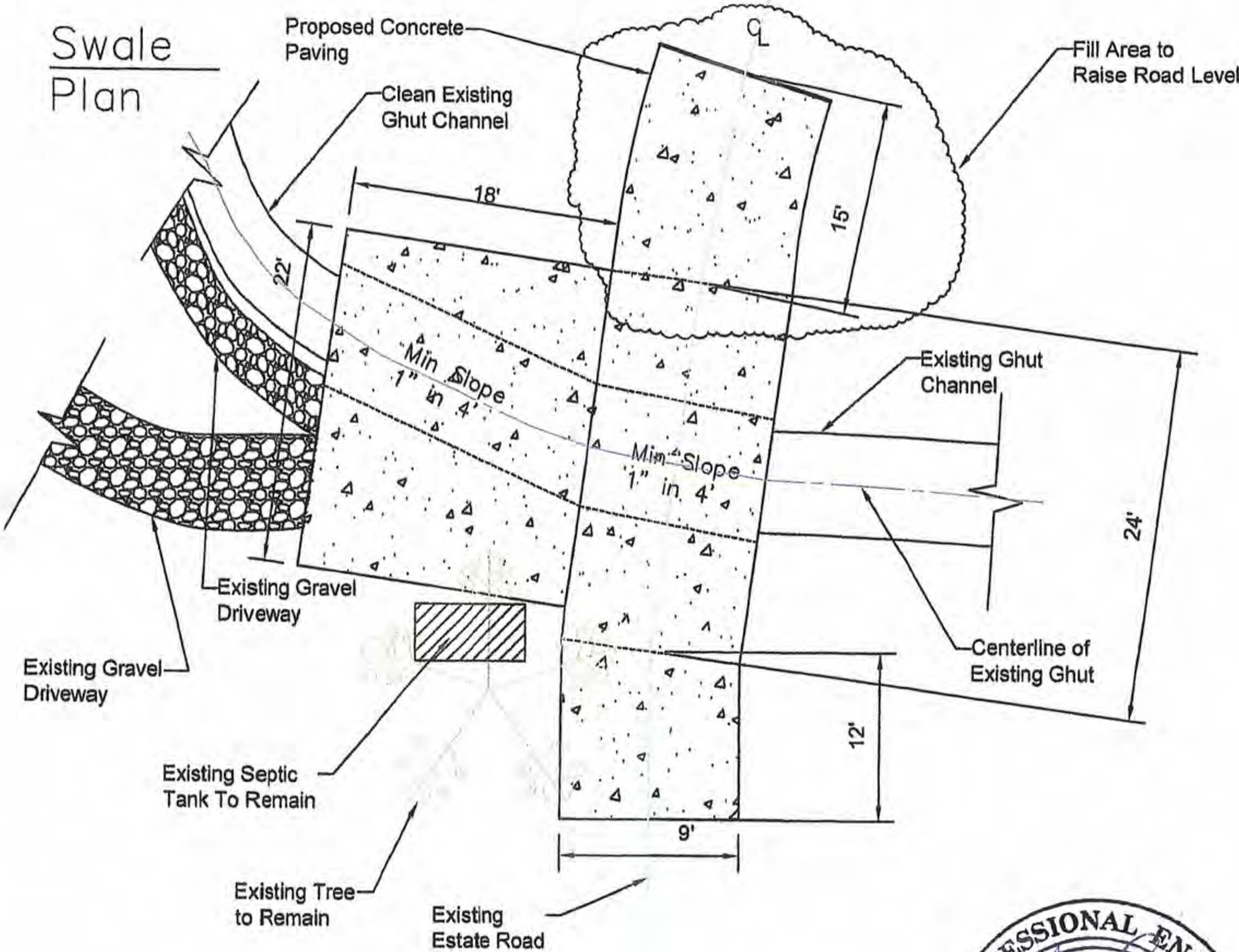
PROFESSIONAL ENGINEER ★ CHRISTOPHER S. LAUDE 1125E ★ U.S. VIRGIN ISLANDS

1-11-2011

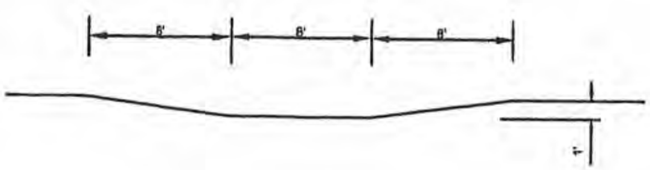
RECEIVED APR 12 2011 D.P.N.R. CZM PROGRAM

Drainage Maintenance Spring Garden Ghut Coral Bay, St John, USVI	Waterbar Details
Date: 01/11/2011	CSL
Project No: B4	Sheet 1 of 4
Not To Scale	
Coral Bay Community Council	Christopher S Laude, P.E.

Swale Plan



Swale X-Section



Swale Details

Christopher S Laude, P.E.

Drainage Maintenance
Spring Garden Ghut
Coral Bay, St John, USVI

Coral Bay Community Council

Date: 02/01/2011

Project No: BA

CSL

Sheet 3 of 4

Not To Scale

Spring Garden
Drainage Improvements
Scope of Work, Details & Specifications

PROJECT NO. F1

SITUATE IN

CORAL BAY, ST. JOHN
US VIRGIN ISLANDS

May 4, 2011

PREPARED FOR:

Coral Bay Community Council, Inc., and:
Virgin Islands Resource Conservation
& Development Council, Inc.
NOAA-ARRA Grant
9901 Emmaus
St. John, USVI 00830

PREPARED BY:

Christopher S. Laude, PE
9901 Emmaus
St John, VI 00830
(910) 612-5990

1.0 SCOPE OF WORK

Project is located in Coral Bay on St. John USVI. The project entails work in the Spring Garden residential area. Approximate locations are shown on the enclosed Site Location Map. Exact installation locations for work items shall be indicated in the field by the VIRC&D Inspector.

Works shall consist of excavating accumulated ghut sand and placing and compacting on existing road alignment, installing a concrete low water crossing (swale), placing concrete paving, and installing a concrete water bar.

Ghut excavation and road backfill

Approximate work area is shown on the attached Location Map. Work proposed for this area is to excavate accumulated material within the natural ghut and placing the excavated material on the existing road alignment. The construction shall proceed as follows:

1. Excavate/clean out the gut for a distance of about 150 LF above the location of the proposed swale and excavate for the low water crossing (swale) and approaches.
2. Materials excavated shall be first spread to create a soil ramp on the low-side of the road crossing; then backfill and compact on the road and driveway in the approximate area shown on the attached Project Layout sketch (Road Regrade Area).
2. (alt) If provided by VIRC&D, place and compact excavated material on the road and driveway to within 8" of final grade in the areas determined by the VIRC&D inspector. Then install Geoweb in those areas and backfill the geoweb with the the excavated material. Backfill all other areas to final grade. Note: Geotextile is not required beneath the Geoweb. Contractor shall provide sufficient #4 rebar to install the geoweb (approximately 300 pieces, each 2-ft long). We anticipate about 200 linear feet of Geoweb will be installed.

Concrete Low Water Crossing and Paving

Work proposed is to construct a concrete low water crossing (swale) of the gut in the approximate area shown on the Site Location map. The construction shall proceed as follows:

3. Construct the concrete low water crossing (swale) at the location indicated by the VI RCD Inspector. (See attached Swale Details sheet).
4. Pave low water crossing approaches (See attached Paving Details sheet).

Waterbar installation

Work to be performed consists of installation of a waterbar. The construction shall proceed as follows:

5. Install water bar on top of existing concrete paving at the location indicated by the VIRC&D inspector. (See attached Water Bar Details sheet).
6. Seed and stabilize all disturbed areas. Upon final grading of an area, all disturbed earth surfaces shall be seeded with Bermuda grass (98% purity) at a rate of to be determined by VI RC&D inspector.

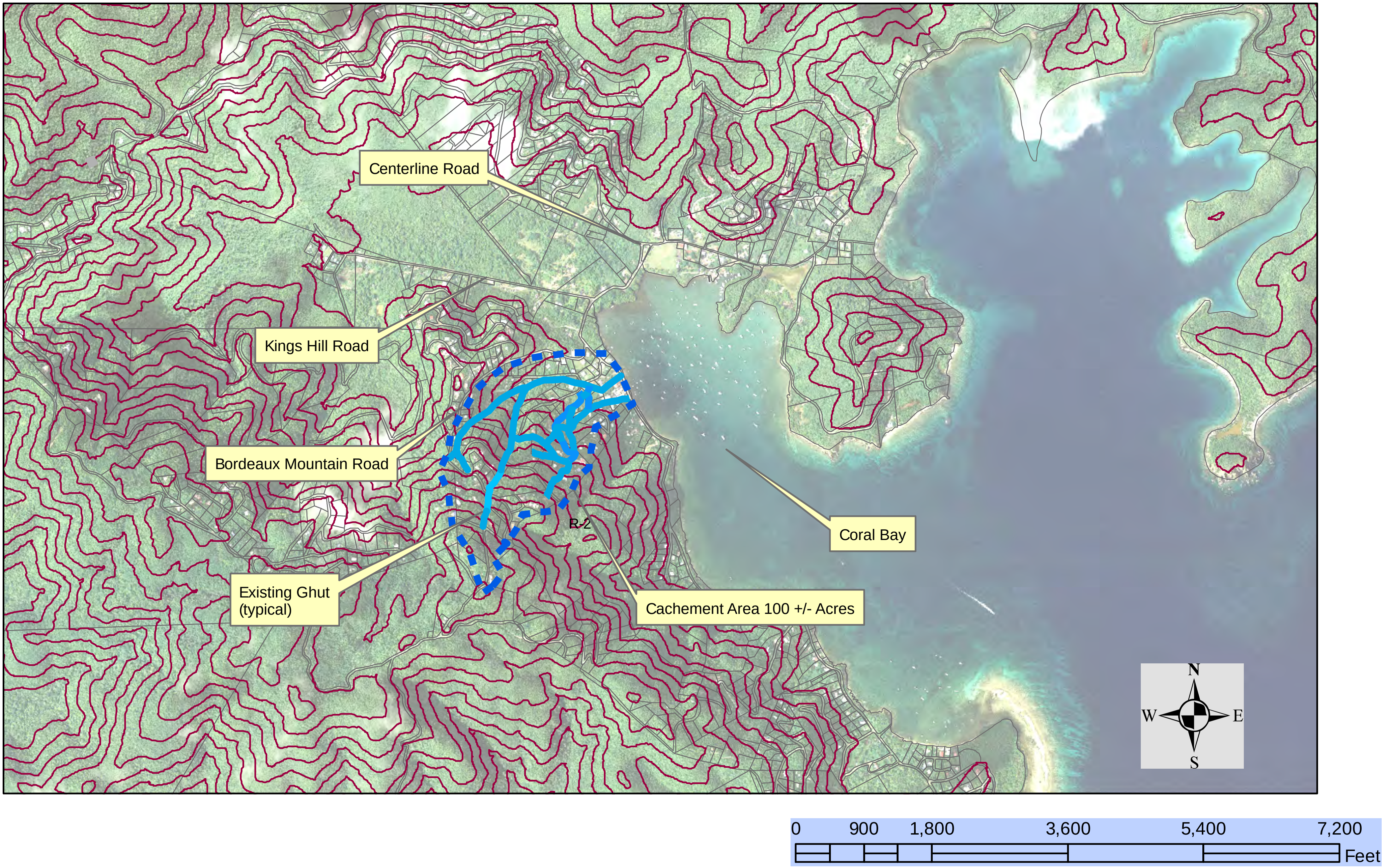
NOTES AND CONDITIONS

Additional specifications and adjustments, at the discretion of the VIRC&D Inspector, shall be field implemented to adequately install devices and provide protection and stabilization. Contractor shall be responsible for implementing any such adjustments as deemed necessary by the Inspector that are reasonably similar to the written specifications.

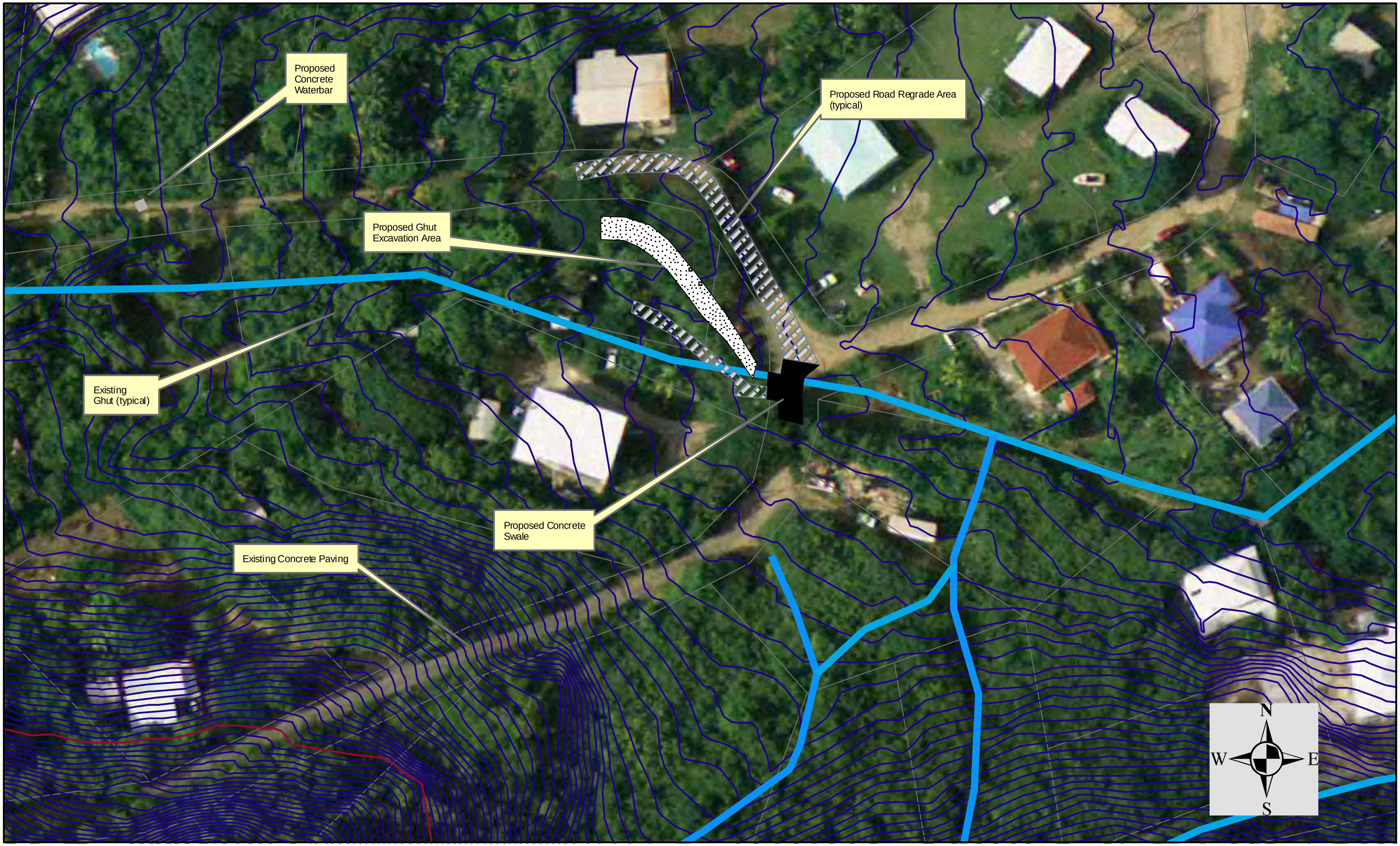
a. All materials and supplies including but not limited to rock, concrete, and geotextile are to be provided by the contractor.
b. Contractor shall barricade freshly poured concrete for a minimum of 48 hours from the end of pour to prevent damage from traffic. All concrete shall have a minimum compressive strength at 28-days of 3,000 pounds per square inch (psi). Contractor shall notify VI RC&D Inspector at least 24-hours in advance of each and every concrete pour so that the Inspector may verify construction. Contractor shall not pour any concrete unless the work has been observed and approved by the Inspector.
c. Contractor shall remove excess excavated material from the site. At the direction of the VI RC&D inspector, contractor may use such material to fill eroded roadway and roadside areas. All non-traffic areas filled and repaired, and all other disturbed areas shall be protected with Erosion Control Blanket (at the direction of the VI RC&D inspector) and seeded with Bermuda grass (98% purity) at 20lbs. per acre. No material other than that used for roadside repairs shall remain onsite. VIRCD shall provide Erosion Control Blanket, contractor shall install erosion control blanket and seed with Bermuda grass at specified rate.
d. Contractor shall maintain traffic flow in at least one lane at all times using appropriate traffic control methods in accordance with all Public Works requirements.
e. During grading & excavation work, sufficient water will be kept onsite to ensure that exposed soil and road surfaces can be sprayed down to control dust.
f. All workmanship shall comply with VI DPW specifications and FP-2006 specifications.
g. All grading and excavation included on this job shall include all rock and ledge removal necessary to install items as specified. No additional fees shall be charged for rock work.
h. Contractor shall be responsible for installing prior to start of construction up to four sign posts consisting of a 4" x 4" post set 2' into the ground and extending 6' above grade at locations to be determined upon the start of construction. Signs will be provided by VIRCD and mounted on the signpost by the contractor.
i. BUY AMERICAN CLAUSE: Contractors are hereby notified that they are encouraged, to the greatest extent practicable, to purchase American-made equipment and products with funding provided under this award.

j. Contractor shall have a VI business license to do the type of work that is being performed.
k. Contractor shall provide a valid DUNS number.
l. All workers on the projects must legally be able to work in the VI.
m. Contractor shall notify Project manager, CBCC and all abutters at least 4 days prior to beginning work. DPNR/CZM shall be notified 72 hours prior to beginning work.
n. Contractor must conduct a weekly safety meeting for all on site personnel
o. Provide $ 1 million liability insurance with CBCC and VIRC&D as named insured
p. Comply with all Federal and VI, DPW and DPNR regulations and requirements.

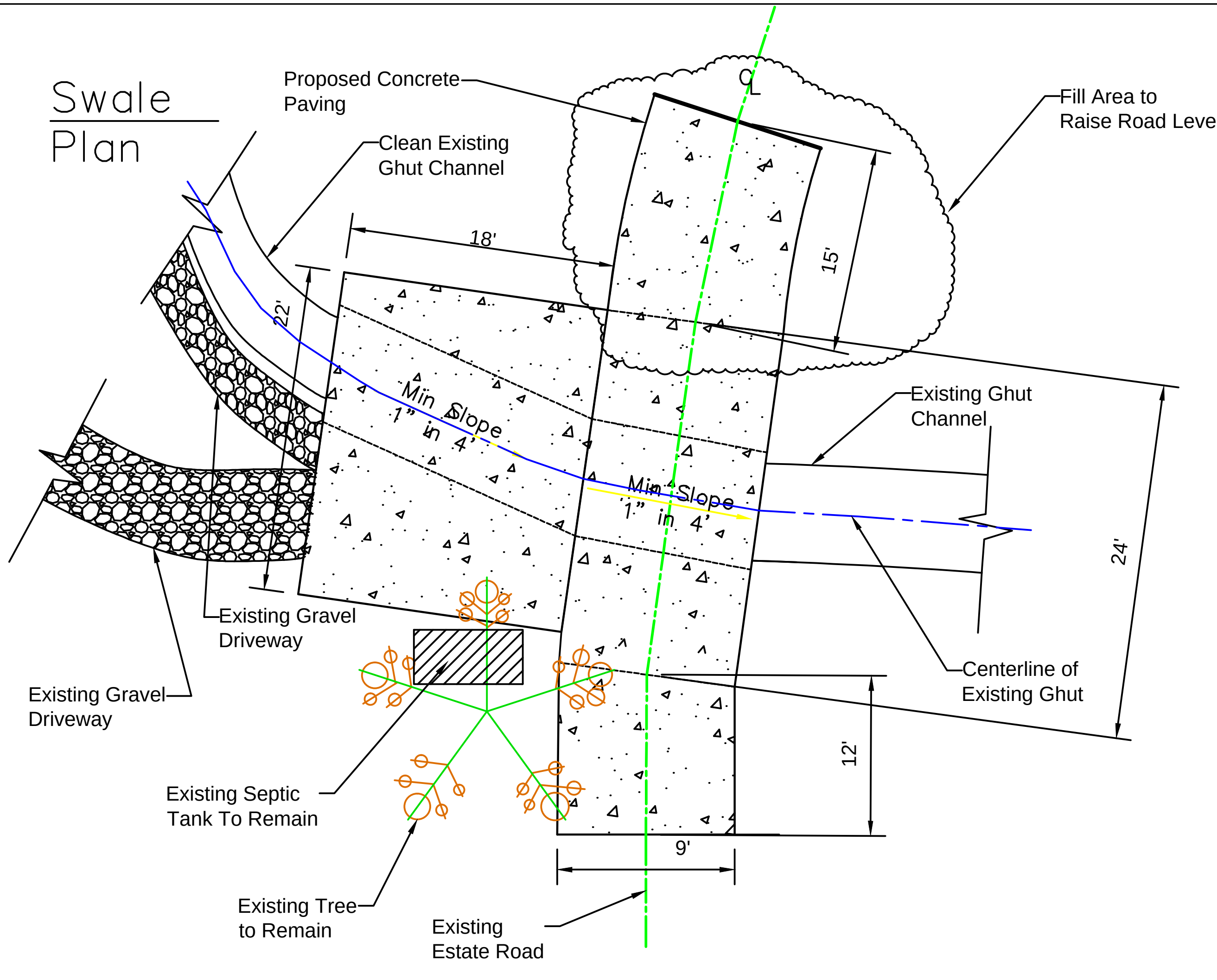
Spring Garden Ghut
Project Vicinity

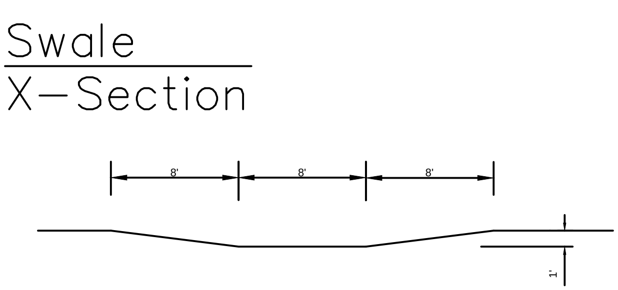


Spring Garden Ghut
Project Layout



0 40 80 160 240 320 Feet





Drainage Maintenance
Spring Garden Ghut
Coral Bay, St John, USVI

Swale Details

Prepared for:
Coral Bay Community Council
- CBCC is a 501(c)(3) nonprofit organization -
Physical Address: 8-1 Emmaus, St. John, VI, 340-776-2099
Mailing Address: 9901 Emmaus, St. John, VI 00830, cbcc@coralbaycommunitycouncil.com

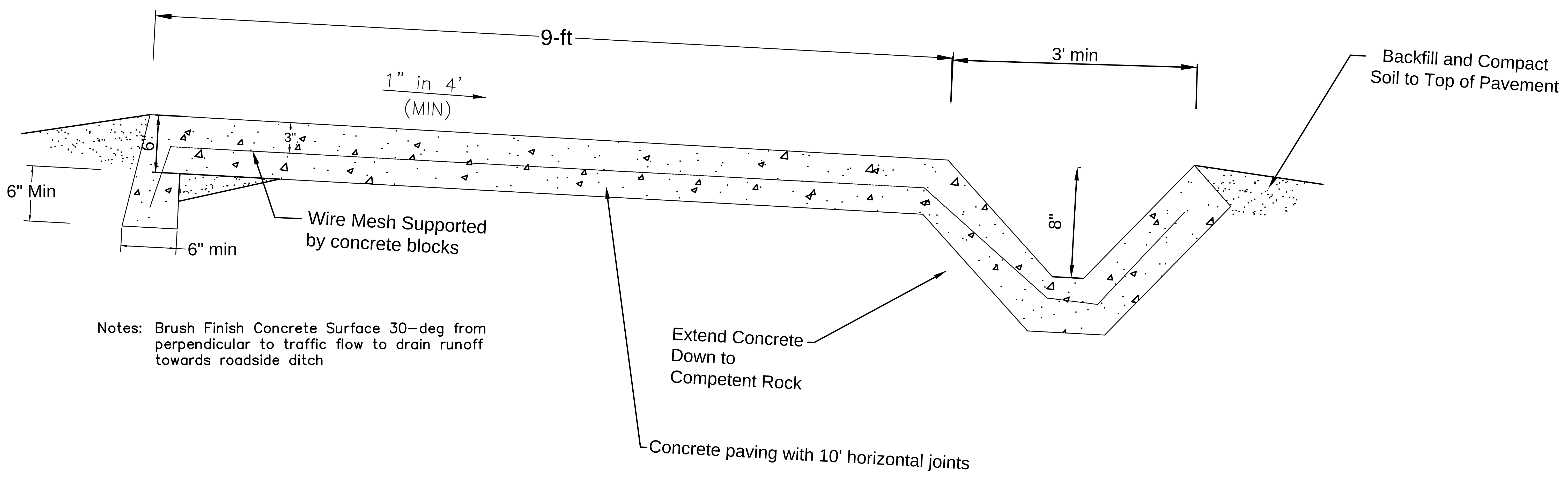
Date: 05/04/2011
Project No: B4
CSL
Sheet 3 of 4
Not To Scale

Prepared by:
Christopher S Laude , P.E.
Stormwater Đ Civil Đ Planning
Physical Address: 8-1 Emmaus, St. John, VI, 910-612-5990
Mailing Address: 9901 Emmaus, St. John, VI 00830, cslaude@mac.com

CONCRETE PAVING DETAIL

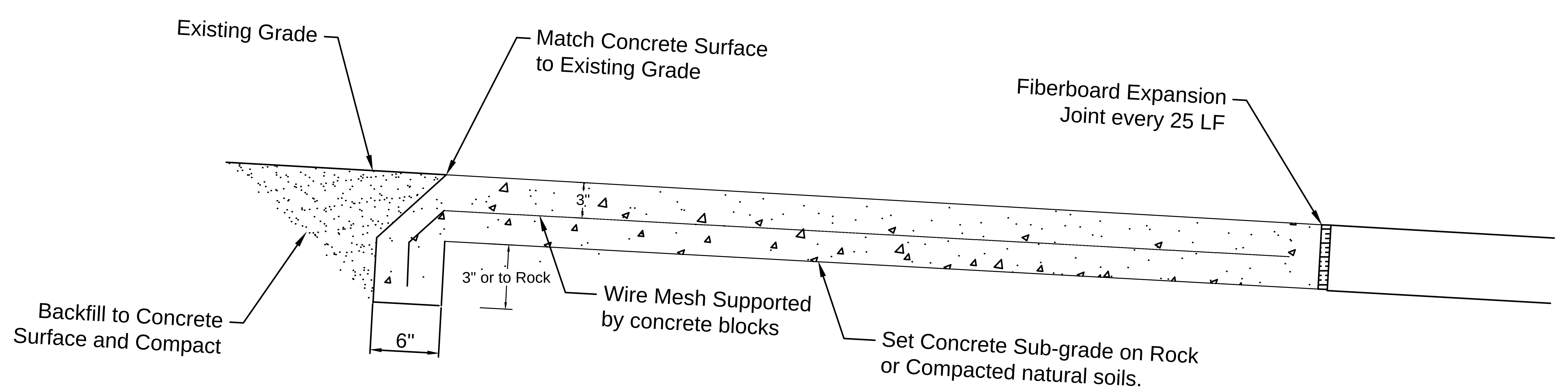
N.T.S.

CROSS SECTION



Notes: Brush Finish Concrete Surface 30-deg from perpendicular to traffic flow to drain runoff towards roadside ditch

PROFILE VIEW



Pavement Details

Drainage Maintenance
Spring Garden Ghut
Coral Bay, St John, USVI

CSL

Sheet 4 of 4

Date: 02/01/2011

Project No: B4

Not To Scale

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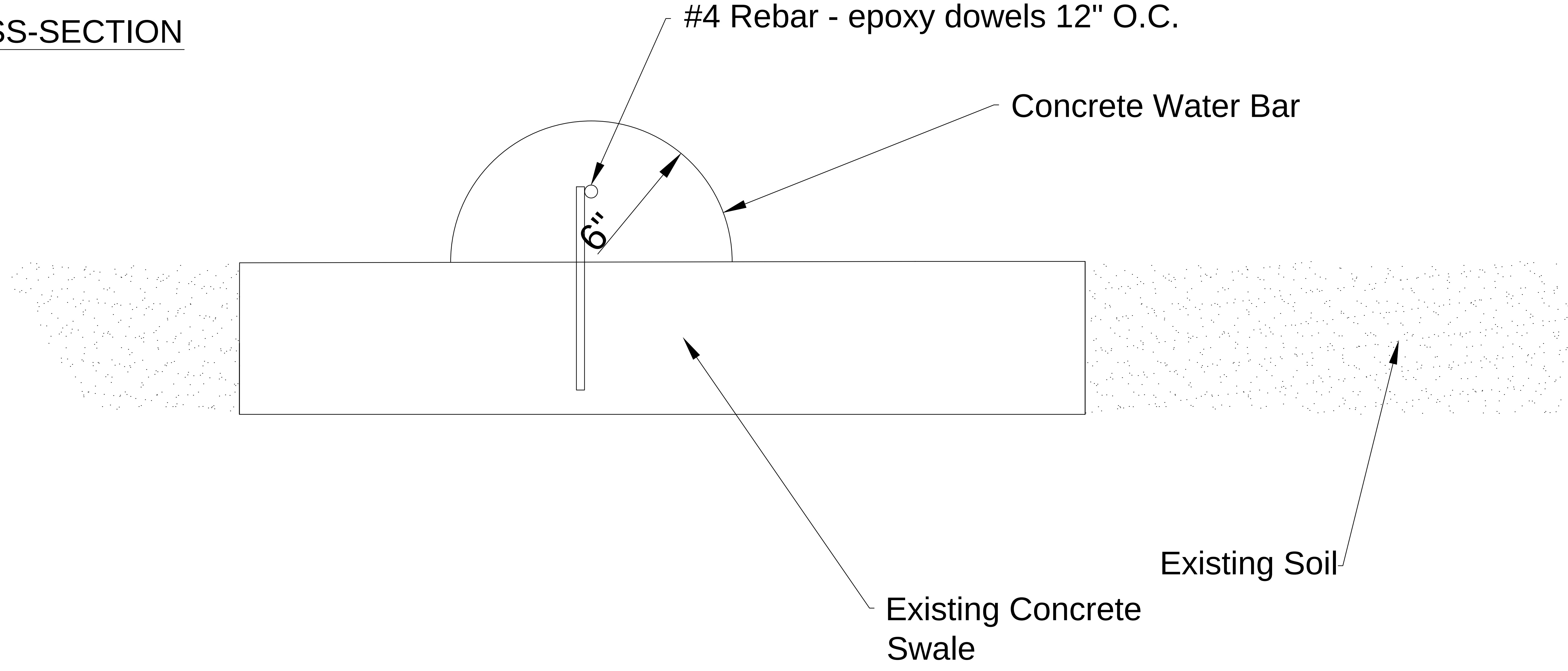
Mailing Address: 9901 Emmaus, St. John, VI 00830, cbcc@coralbaycommunitycouncil.com

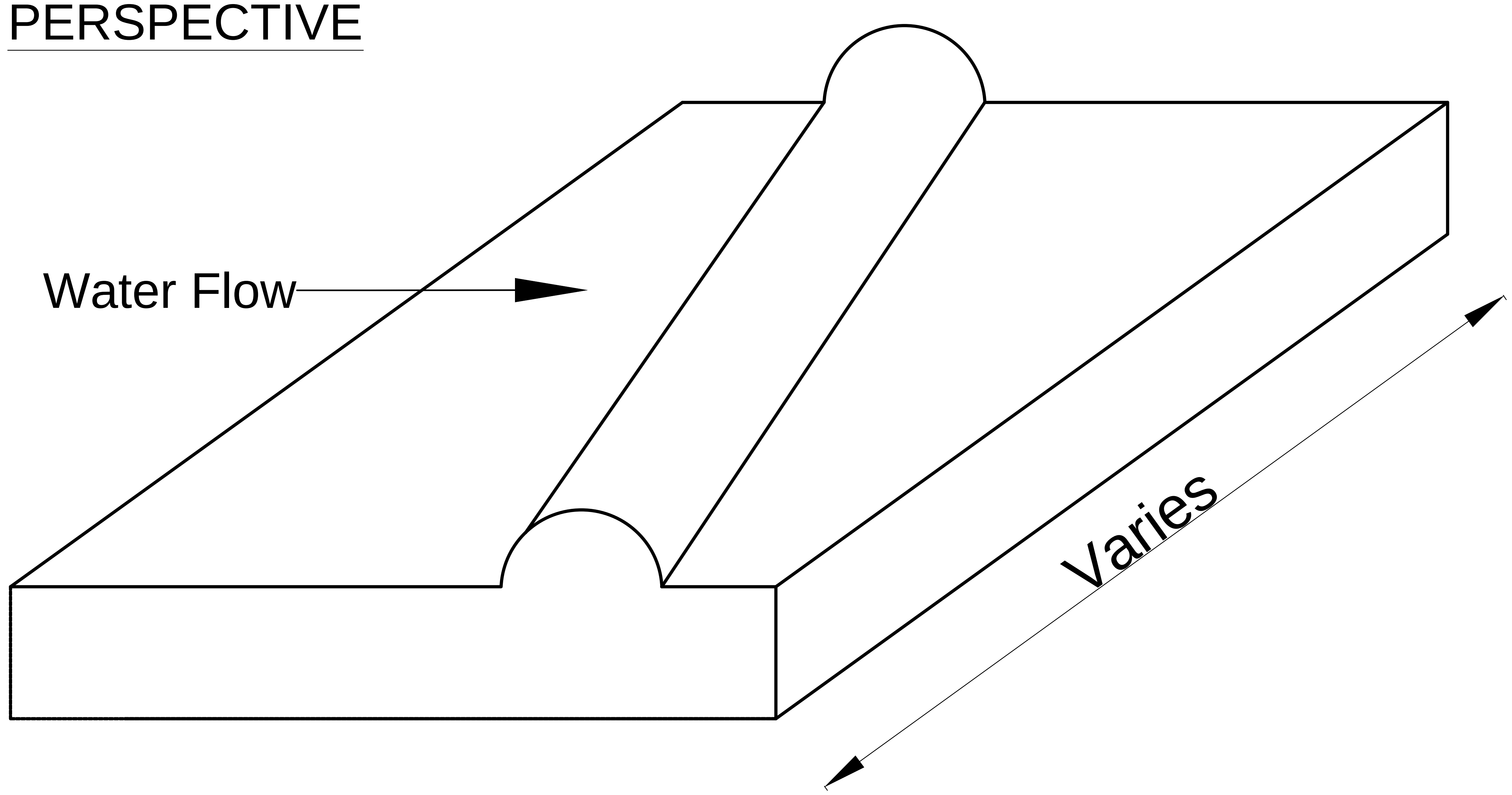
CONCRETE WATERBAR DETAILS

N.T.S.

CROSS-SECTION



PERSPECTIVE



Waterbar Details

Drainage Maintenance
Spring Garden Ghut
Coral Bay, St John, USVI

CSL

Sheet 1 of 4

Date: 01/11/2011

Project No: B4

Not To Scale

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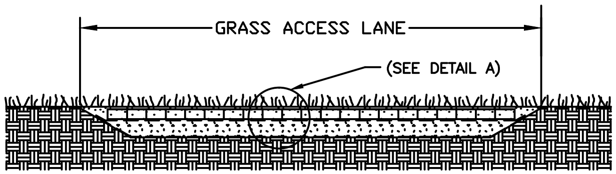
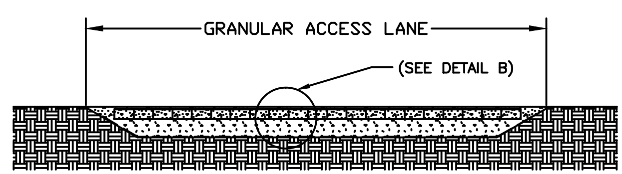
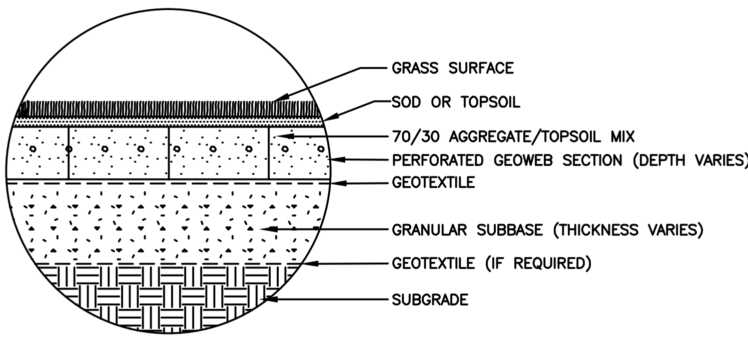


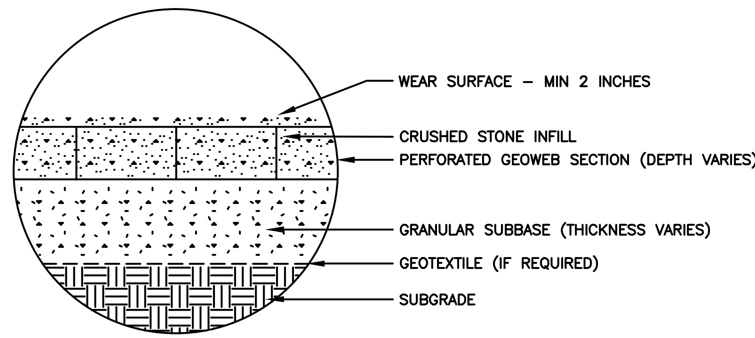
SECTION A – A



SECTION B – B



DETAIL A



DETAIL B

TYPICAL GRASS PAVEMENT DETAILS

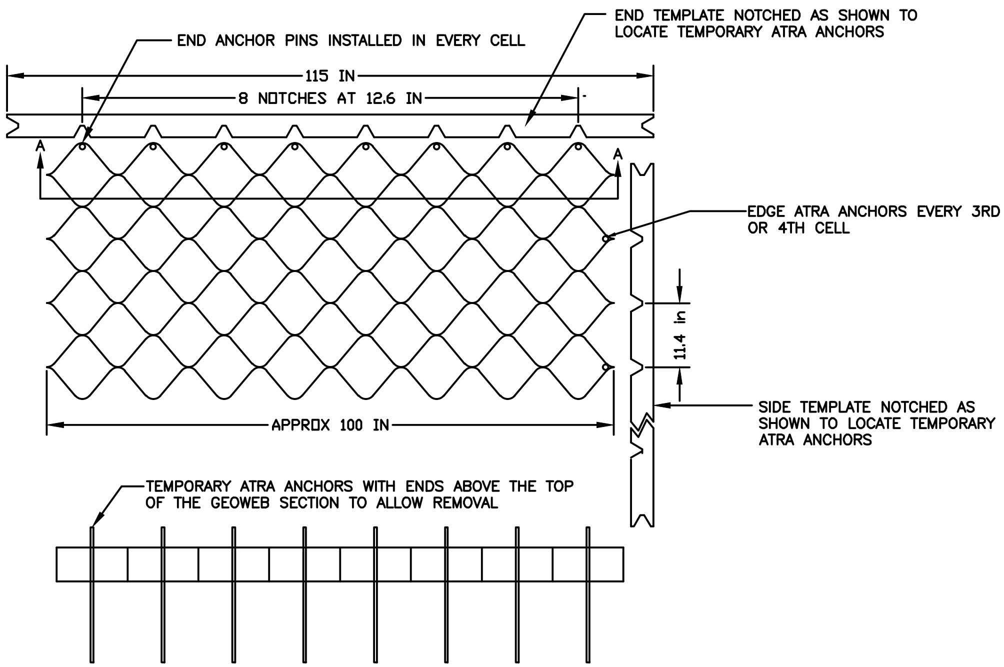
TYPICAL GRANULAR PAVEMENT DETAILS

PRESTO® PRODUCTS CO.
670 NORTH PERKINS STREET
APPLETON, WI 54914
920-738-1342
WWW.PRESTOGEO.COM

GENUINE GEOWEB®
PAVEMENT DETAILS

DATE	APRIL 2010	FILE NAME	GWLD2F.DWG
SCALE	NTS	SHEET 1	© 2010 PRESTO GEOSYSTEMS

TEMPORARY STAKING METHOD FOR GW30V

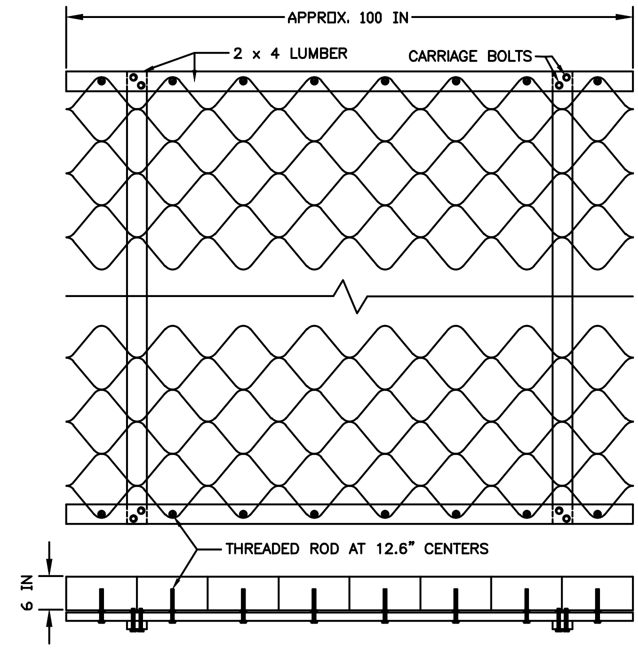


SECTION A–A

PARTS LIST FOR TEMPORARY STAKING METHOD:

1. 16 – 24" ATRA ANCHORS
2. 1 – END TEMPLATE FROM 2 X 4 LUMBER
3. 1 – SIDE TEMPLATE FROM 2 X 4 LUMBER

TYPICAL WOOD STRETCHER FRAME FOR GW30V



PARTS LIST FOR WOOD STRETCHER FRAME:

1. 16 – 1/2" THREADED ROD
2. 8 – 3/8" CARRIAGE BOLTS
3. 48 – FLAT WASHERS
4. 48 – HEX NUTS
5. 3 – 2 X 4 X 8 FT LUMBER

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APPLETON, WI 54914
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WWW.PRESTOGEO.COM

NOTES:

1. END TEMPLATES ARE USED TO ANCHOR THE ENDS OF EXPANDED GEOWEB SECTIONS.
2. NOTCHES OF END TEMPLATES ARE AT 10.2" CENTERS FOR GW20V AND 20" CENTERS FOR GW40V GEOWEB SECTIONS.
3. NOTCHES FOR SIDE TEMPLATES ARE AT 8.9" CENTERS FOR GW20V AND 18.9" FOR GW40V GEOWEB SECTIONS.

GENUINE GEOWEB® INSTALLATION TOOLS

DATE MARCH 2010		FILE NAME GWGEN5F.DWG	
SCALE NTS	SHEET 1	© 2010 PRESTO GEOSYSTEMS	

GEOWEB® CELL SIZES

	NOMINAL CELL AREA IN²(CM²)	CELL EXPANSION RANGE MINIMUM LENGTH IN (CM)	MINIMUM WIDTH IN (CM)	MAXIMUM LENGTH IN (CM)	MAXIMUM WIDTH IN (CM)
20V (CELL LENGTH, CELL WIDTH)	44.8 (289)	8.02 (204)	9.2 (234)	9.65 (245)	11.07 (281)
30V (CELL LENGTH, CELL WIDTH)	71.3 (460)	10.25 (260)	11.39 (289)	12.39 (315)	13.77 (360)
40V (CELL LENGTH, CELL WIDTH)	187.0 (1206)	16.92 (430)	18.01 (457)	20.66 (522)	21.88 (556)

NOTE: ALL DIMENSIONS ARE NOMINAL AND ARE WITHIN MANUFACTURING TOLERANCES

GEOWEB® SECTION SIZES

GW20V – 10 CELLS WIDE

CELLS LONG	MIN EXPANSION LENGTH ft	m	WIDTH ft	m	MAX EXPANSION LENGTH ft	m	WIDTH ft	m	NOMINAL AREA ft²	m²
18	12.0	3.7	9.2	2.8	14.5	4.4	7.7	2.3	112	10.4
21	14.0	4.3			16.9	5.1			131	12.1
25	16.7	5.1			20.1	6.1			156	14.5
29	19.4	5.9			23.3	7.1			181	16.8
34	22.7	6.9			27.3	8.3			212	19.7

GW30V – 8 CELLS WIDE

CELLS LONG	MIN EXPANSION LENGTH ft	m	WIDTH ft	m	MAX EXPANSION LENGTH ft	m	WIDTH ft	m	NOMINAL AREA ft²	m²
18	15.4	4.7	9.2	2.8	18.6	5.7	7.6	2.3	143	13.3
21	18.0	5.5			21.7	6.6			167	15.5
25	21.4	6.5			25.8	7.9			198	18.4
29	24.8	7.6			30.0	9.1			230	21.4
34	29.1	8.9			35.1	10.7			270	25.0

GW40V – 5 CELLS WIDE

CELLS LONG	MIN EXPANSION LENGTH ft	m	WIDTH ft	m	MAX EXPANSION LENGTH ft	m	WIDTH ft	m	NOMINAL AREA ft²	m²
18	25.4	7.70	9.1	2.8	30.8	9.40	7.5	2.3	234	21.7
21	29.6	9.00			36.0	11.0			273	25.3
25	35.2	10.7			42.8	13.1			325	30.2
29	40.9	12.5			49.7	15.1			377	35.0
34	47.9	14.6			58.2	17.8			441	41.0

GEOWEB® PRODUCT CODE FORMAT

GWTTVDWWLL + MODIFICATIONS

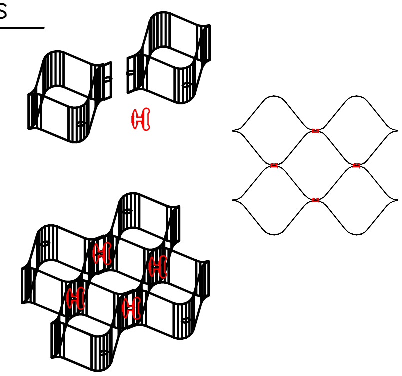
WHERE:
- TT: CELL TYPE – 20, 30 or 40
- V: DESIGNATES V SERIES
- D: CELL DEPTH – 3, 4, 6, 8 or 12"
- WW: SECTION WIDTH 10, 20V; 8 30V & 5 40V
- LL: SECTION CELL LENGTH – 18, 21, 25, 29 & 34

MODIFICATIONS:
- P: PERFORATED STRIP
- S1: SAND COLOR FASCIA STRIP ONLY
- G1: GREEN COLOR FASCIA STRIP ONLY
- T: INTEGRAL I–SLOT

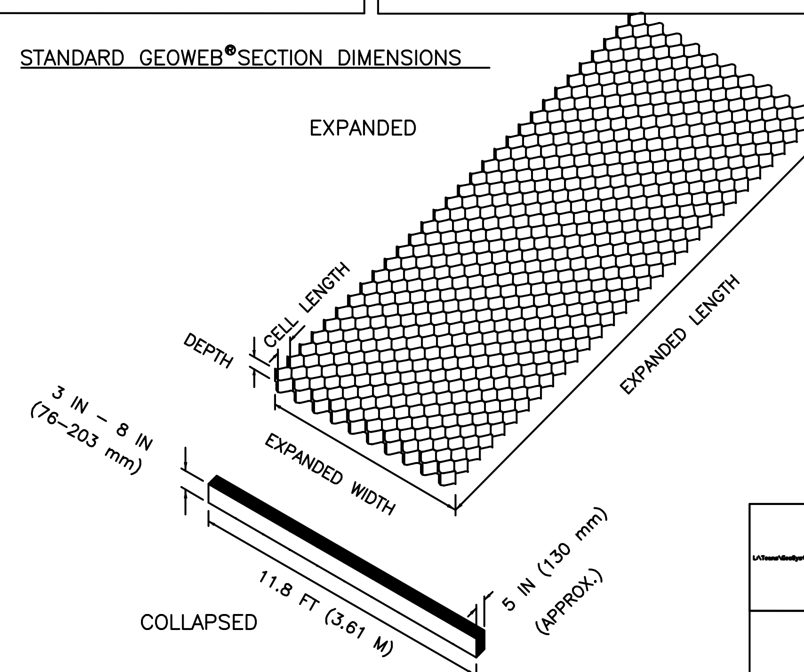
EXAMPLE:
GW30V61029PT
30V CELL TYPE, 6" DEPTH, 10 CELLS WIDE, 29 CELLS LONG, PERFORATED STRIP WITH I–SLOTS

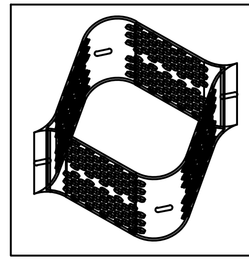
ATRA® KEY CONNECTION DETAILS

GEOWEB CONNECTION NOTES:
1. THE TOP EDGES OF ADJACENT CELL WALLS SHALL BE FLUSH WHEN CONNECTING.
2. ALIGN THE I–SLOTS FOR INTERLEAF AND END TO END CONNECTIONS.
3. THE GEOWEB PANELS SHALL BE CONNECTED WITH ATRA KEYS AT EACH INTERLEAF AND END TO END CONNECTION.



STANDARD GEOWEB® SECTION DIMENSIONS





ISOMETRIC VIEW OF PERFORATED STRIP WITH I–SLOT

PRESTO® PRODUCTS CO.
670 NORTH PERKINS STREET
APPLETON, WI 54914
920–738–1342
WWW.PRESTOGEO.COM

GENUINE GEOWEB® PLAN AND SECTIONS

DATE	MARCH 2010	FILE NAME	GWGEN1F.DWG
SCALE	NTS	SHEET	1