

# NOAA ARRA USVI Watershed Stabilization Project



## East End Bay, St. Croix Erosion Repairs, Trail Construction, and Drainage Improvements



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

Text taken directly from the NOAA ARRA East End Bay Workplan  
submitted by V.I. RC&D

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This report describes the East End Bay project undertaken with 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). 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

## **Acknowledgements**

Based on design work by Maguire Group, Inc. and project management 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

Photos provided by V.I. RC&D.

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.

Project management and project completion were facilitated by the technical expertise and project management skills of NOAA's Restoration Center, specifically staff members Daphne MacFarlan and Julia Royster.

## Executive Summary

The East End Bay, St. Croix, component of the overall USVI Watershed Stabilization Project had two main objectives: (1) repair existing erosion damage and reduce future erosion by improving runoff drainage conditions along pre-existing foot trails at East End Bay; and, (2) to establish a more environmentally friendly beach access to the adjacent Isaac Bay. Serious gully erosion due to the absence of drainage design severely damaged the trail leading to East End Bay (Photo 1), caused dangerous conditions for hikers, and posed a threat to the coastal and nearshore marine communities due to excessive runoff and pollution by sediments.



Photo 1: Severe gully erosion on the East Trail.

In order to accomplish these objectives, the Virgin Islands Resource Conservation and Development Council (V.I. RC&D) proposed the following actions in the 2009 National Oceanic and Atmospheric Administration (NOAA) American Recovery and Reinvestment Act (ARRA) East End Bay Workplan:

- Closing and stabilizing the East Trail;
- Creating a stabilized parking area;
- Clearing and installing drainage structures on the West Trail; and,
- Creating the Isaac Bay Spur Trail with drainage structures and beach access stairs.

Figure 1 shows the implemented actions. The net effects are:

1. Reduced trail erosion with implementation of drainage structures and better trail placement (closure of one trail and encouraging use of another);
2. Establishment of environmentally friendly beach access through proper trail design and installation of appropriate drainage features; and,
3. Reduced sediment loads to East End Bay.

### East End Bay Erosion Repairs and Trail Construction

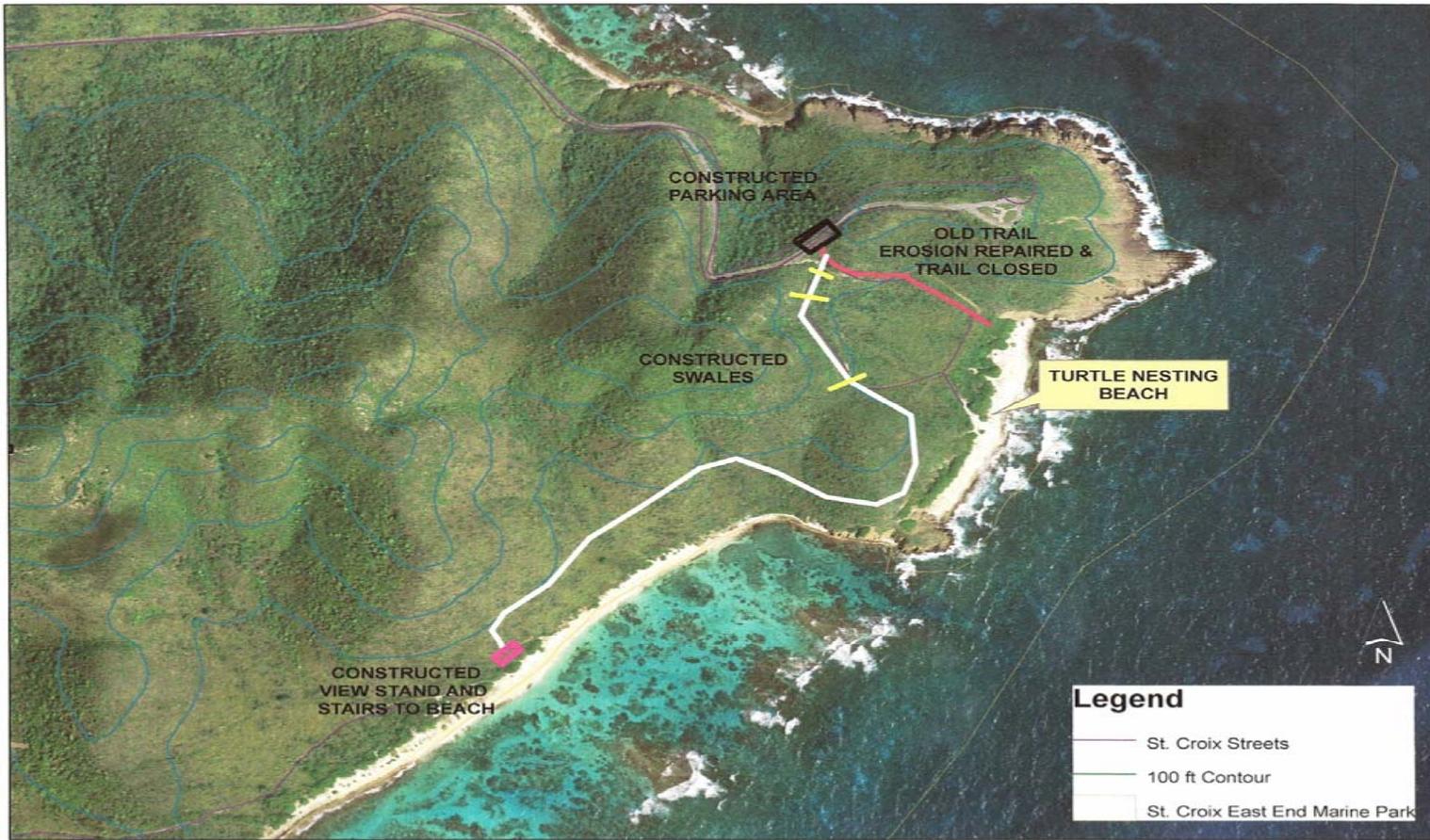


Figure 1: East End Bay Erosion Repairs and Trail Construction Actions

## 1. Watershed Description

The 0.16 square kilometer East End Bay (EEB) Watershed lies on the extreme southeastern point of St. Croix and is one of eight subwatersheds draining into to the St. Croix East End Marine Park. The watershed is owned by the Government of the Virgin Islands and managed by the Virgin Islands Department of Parks and Recreation.

Terrestrial habitat types found in the EEB Watershed include evergreen sub-desert shrubland, rocky shore, gravel, and sand beach. Vegetation of the evergreen sub-desert shrubland predominantly consists of a dry forest with cacti, such as the Turk's Cap or barrel cactus (*Melocactus intortus*) and organ pipe cactus (*Cephalocereus royenii*), and thorn scrub with crotons (*Croton spp.*), lantana (*Lantana insularis*), wild cotton (*Gossypium hirsutum*), tan-tan (*Leucaena leucocephala*), and acacia or 'casha' (*Acacia tortuosa*). These are all drought-tolerant species that have evolved to survive in the persistently dry conditions prevalent within the watershed. Some areas of the watershed are also overgrown with guinea grass (*Panicum maximum*). Tan-tan, casha, and guinea grass are all invasive exotic species common in the Virgin Islands.

Patch and barrier reefs and algal ridges can be found offshore. The coral reef communities of EEB are characterized by *Montastraea spp.*, *Porites spp.*, *Diploria spp.*, *Millepora spp.*, and isolated *Acropora palmata* colonies (P. Rothenberger pers. comm.). The beach is also an important nesting area for endangered green (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*) sea turtles demonstrated by the more than 200 green and hawksbill sea turtle nests identified in 2008 (Z. Hillis-Starr pers. comm.).

The vegetation discussed above grows on watershed slopes that vary from near vertical cliffs at Points Udall and Cudejarre to nearly flat at the base and beach. The soils found within the watershed are highly erosive and, when exposed by human activities, are the cause of the excessive and continual sedimentation observed in EEB. To exacerbate the problem, the watershed is located on the driest end of the island, receiving very little rainfall on an average daily basis, but subject to infrequent, intense storm events (Maguire 2004). This rainfall pattern aggravates erosion potential because low average rainfall limits vegetation growth while high rates of periodic rainfall caused by storm events produce significant water flow through the watershed (Maguire 2004). Maguire Group, Inc. (Maguire) estimated sediment loss rates within the EEB Watershed at approximately 512 tons per year or 422 cubic yards per year (Maguire 2005).

East End Bay beach was accessible by four-wheel drive vehicles in the past, but is now accessible only on foot because of the severe erosion along the access path (Photo 2). The beach itself is not a popular recreational area due to stoniness and heavy surf, but pedestrians frequently cross it to access the popular Isaac Bay beach.



Photo 2: Severe gully erosion on the East Trail.

These pedestrians frequently trample sea turtle nesting sites in addition to contributing to trail erosion.

## 2. Problem Statement

The most serious erosion problems in the watershed occur along three jeep trails that provided access from the public road to the beach: one down the center of the watershed, one down the west side, and one down the east side (Photo 3). All three trails typically have slopes of about 15%. Of these, the “East Trail” is now used exclusively and is therefore the most severely eroded. The other two trails have fallen into disuse, allowing partial re-establishment of vegetation, and reducing erosion on these trails.

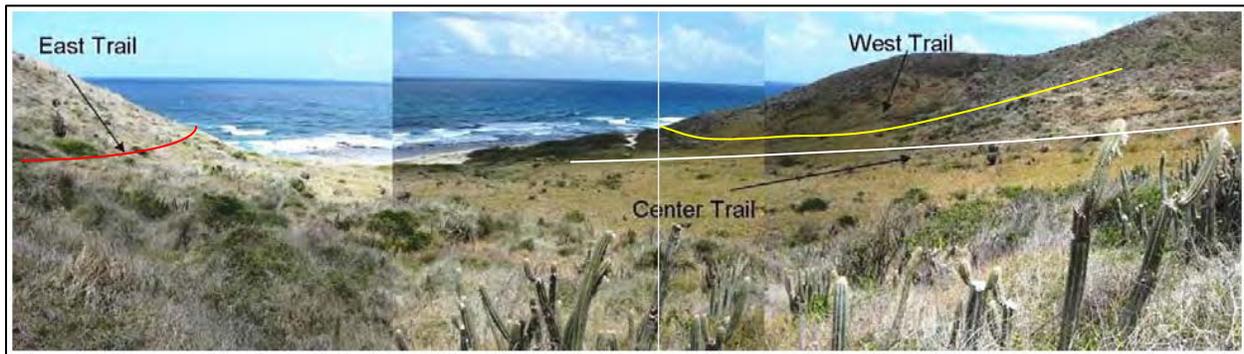


Photo 3: Composite photo of East End Bay Watershed trails.

A severe gully in the East Trail begins where the trail crosses North Ghut. The trail effectively intercepts North Ghut at this point, channeling ghut flow down the trail bed instead of allowing the ghut to cross the trail and dissipate in the flat area at the base of the watershed. The combination of intercepted ghut flow and accelerated stormwater flowing down the steep, upper portion of the trail has severely eroded the deeper soils in this area. This gully is over 100 feet long and has widened to approximately 3 feet in one location and deepened to almost five feet deep at its deepest point (Photo 1). Additionally, a newer gully has formed to the east of the original gully, in some areas threatening wholesale destruction of the entire trail section (Photo 2). These gullies have effectively rendered the trail impassable to all vehicles and will soon expand to cut off the trail. Eroded soil from these gullies and trails has been deposited several feet deep behind the beach at the base of each trail, partially burying vegetation. In addition, the sediment is being discharged into nearshore coastal habitats and threatening coral reef ecosystems.

## 3. Background and Project Planning

A three-decade long decline in live coral reef cover in the Caribbean region has been associated with anthropogenic stresses occurring at a local level, including stresses related to excess delivery of land-based sediments (Gardner et al. 2003). In order to reduce this stressor, the partner agencies: NOAA, the Virgin Islands Department of Planning and Natural Resources (DPNR), V.I. RC&D, and The Nature Conservancy (TNC), have spent the last decade planning and implementing actions to reduce sediment loads into East End Bay.

In spring 2009, V.I. RC&D secured NOAA ARRA grant funds to implement actions proposed in the NOAA ARRA East End Bay Workplan prepared for the grant application, based on expertise provided by Maguire (see Section 4.1). These NOAA ARRA funds allowed for the creation of environmentally conscious recreation facilities in order to reduce the sediment-laden stormwater runoff entering East End Bay.

## **4. Project Implementation**

### **4.1 Project Design**

In 2002, in recognition of the area's recreational and ecological value, DPNR Coastal Zone Management commissioned V.I. RC&D to develop a best management practice (BMP) implementation plan to mitigate erosion and sedimentation in the watershed. V.I. RC&D hired the engineering firm Maguire Group, Inc. to inventory problem areas and develop erosion and sediment BMPs. The plan included the documentation of site conditions, evaluation of topography and soil characteristics, and identification of the erosion problem areas presented in Section 2. It also presented drainage and sediment load calculations and recommended a suite of less invasive BMPs to mitigate erosion and the design and recommendation of locally relevant vegetative and structural BMPs for future implementation, as described below.

The *East End Bay Erosion & Sedimentation Controls: Best Management Practices* part of the overall plan (Maguire 2005), recommended controlling the visible erosion along the trails by employing solutions to address the underlying problem of trail grading based upon erosion control practices typically employed on narrow trails and pathways and/or dirt roads including water bars, dips or bleeders, cross-ditches and surface stabilization. While wholesale regrading of the trails back to a more natural terrain would have been the ultimate solution, it would have been highly damaging to the existing vegetation, creating a broad swath of raw earth in need of re-vegetation.

Both Maguire and TNC (owner of the Jack & Isaac Bays Nature Preserve that abuts the western boundary of East End Bay) recommended constructing a confined, stabilized parking area immediately adjacent to the roadside at the top of East End Bay. Construction of a confined, stabilized parking area would prevent inappropriate vehicle access, minimize further vehicle-induced erosion at the head of the watershed and reduce impacts to fragile soils and endangered native dry scrub vegetation.

TNC and Maguire also recommended closing the East Trail and routing pedestrian traffic west to their property at Isaac Bay by opening the upper portion (~500 feet) of the West Trail, which follows the contour of the watershed. They also recommended blazing a new spur westward to Isaac Bay, which is the destination of the majority of pedestrians currently utilizing the East Trail. The proposed new trail would be constructed to have less environmental impact than the existing trails while providing an easier route to Isaac Bay beach. The best erosion control methods would be utilized in the construction of this trail, but would require rigorous maintenance.

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The new trail would utilize the overgrown upper section of the West Trail, from where it branches off the East Trail westward to right before South Ghut to bypass the East End Bay beach – the most popular beach for nesting sea turtles on St. Croix. The benefits of closing this existing East Trail to East End Bay beach and opening a new trail to traverse the upper watershed to Isaac Bay beach included:

- Utilizing improved parking area on East End Road.
- Reducing/eliminating erosion and sediment runoff to coral reefs of East End and Isaac Bays.
- Reducing foot traffic and turtle disturbance on East End beach.
- Utilizing old road cuts to make new trail by removing invasive acacia trees.
- Creating a gradual and easy to navigate one-mile trail for school groups, elderly and beach-attired visitors.
- Providing a trail with beautiful vista of both bays with little disturbance.

## **4.2 BMP Selection Process**

As part of the V.I. RC&D work commissioned in 2002, Maguire completed design drawings and related details to stabilize and close the severely eroding East Trail in East End Bay. As of the development of the 2009 NOAA ARRA East End Bay Workplan, none of these recommended BMPs had been implemented in EEB. Since the 2005 Maguire report, additional design details to provide a confined, controlled, and stabilized parking area at the head of the trail to East End Bay were also developed and proposed for implementation. Conceptual plans for hand-cutting a pedestrian trail along the contour of the East End Bay Watershed to route beach traffic to TNC's popular Isaac Bay beach to reduce continued and emerging impacts from use of the area were also developed.

The NOAA ARRA East End Bay Workplan incorporated these designs as described in Table 1. During project scoping, TNC in coordination with V.I. RC&D's Subproject Engineer refined the designs regarding West Trail width, retaining wall height, and the construction of a viewing platform. These refinements were minor and are italicized and highlighted in gray in Table 2.

Tables 1 & 2 summarize the transition from actions proposed in the NOAA ARRA East End Bay Workplan to the implemented actions by including dates for proposal, dates for construction, and any additional comments necessary. All engineering design documents have been included in Appendix A.

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Location	Proposed Action	Status	Comments
East Trail	Bleeder trenches, rock spillways, drainage dips, cross-ditches, sediment traps, and boulder closures.	Refined and Constructed	
Parking Area	Parking area (1,200 square feet [ft <sup>2</sup> ]), retaining wall (175 linear feet [LF] by 4 feet high), and a roadside boulder closure.	Refined and Constructed	
West Trail/Isaac Spur Trail	For the West Trail, clear and grub all vegetation along the trail path, remove invasive species where possible, and stabilize with bleeders, drainage dips, waterbars, and cross-ditches. Construct a ford at the West Ghut and a bridge at the South Ghut. Construct a 1,600 LF by 2-3 feet wide Isaac Bay Spur Trail with appropriate water diversions and a set of stairs to the beach.	Refined and Constructed	The ford and bridge proposed actions were not necessary; therefore, they weren't included in the implemented actions.

Location	Implemented Action*	Status	Comments
East Trail	Bleeder trenches, rock spillways, drainage dips, cross-ditches, sediment traps, and boulder closures.	Constructed (August 2010)	These actions were armored to prevent vehicle passage down the path and make pedestrian traffic difficult.
Parking Area	Parking area ( <i>2,100 ft<sup>2</sup></i> ), retaining wall (175 LF by <i>5</i> feet high), and a roadside boulder closure.	Constructed (August 2010)	Size was increased to accommodate additional cars.
West Trail/Isaac Spur Trail	For the West Trail, clear, grub, remove invasives, and stabilize with bleeders, drainage dips, waterbars, and cross-ditches. Construct a <i>2,800</i> LF by <i>3-4 foot wide</i> Isaac Bay Spur Trail with appropriate water diversions, a set of stairs to the beach, and a <i>12' x 12' platform</i> .	Constructed (August 2010)	The ford and bridge discussed in the proposed actions were not needed base on the amount of water flow.

\*Refinements from proposed to implemented actions to are *italicized* and **highlighted in gray**.

### 4.3 Problems Encountered/Overcome

One problem encountered during this project was differing views on how the bleeders on the East Trail were to be installed and the type of equipment to be used versus doing it by hand. Because the contractor used larger equipment than envisioned, there was more vegetation lost during this process than anticipated. The trail was seeded after the work was complete and plant growth was re-established.

### 4.4 Project Costs & Construction

After taking into consideration site conditions, BMP costs, and available project funds, the final BMPs implemented included: (1) stabilizing and closing the East Trail; (2) construction of a

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parking area; (3) clearing the West Trail and providing water diversions; and, (4) creating a spur trail to Isaac Bay beach with water diversions, stairs, and viewing platform for a total cost of \$224,076. The sections below provide a more detailed description of construction activities. Appendix A has detailed design drawings.

### **East Trail Stabilization BMP Description**

#### Bleeder Trenches/Drainage Dips

A bleeder trench or drainage dip is a broad, gradual excavated trail feature designed to redirect water off the trail and prevent erosion. For EEB, the contractor constructed bleeder trenches, approximately two feet in width, along the East Trail at 100-foot intervals to route runoff intercepted by the trail back downslope. Bleeders were excavated by hand to the maximum



Photo 4: Construction of drainage structures along the East Trail.



Photo 5: Completed drainage structures along the East Trail.

extent practicable, supplemented by use of the smallest backhoe-equipped or skid-steer loader possible. Bleeder depth was only a few inches at the inside edge of the trail and proceeded diagonally across the trail with a base slope of 5 to 10%. The bleeder extended out through the existing earth berm, emerging through the outside of the downhill edge berm (Photos 4-5).

Local stone stabilization, a.k.a. a rock spillway, dissipated localized erosion at bleeder discharge points. Sediment carried by the runoff discharging from the bleeders was trapped in the vegetated slopes in the lower portions of the bowl in the same way naturally occurring sediments are trapped. Material excavated was stockpiled for use to fill small, adjacent gullies and other erosion features and to build a low-height earthen berm on the downhill side of the bleeder if necessary to assist in confining stormwater to the bleeder.

At the head of the West Trail, immediately south of the fork in the North and West trails and approximately 100 feet from the public road, a larger drainage dip approximately 4 feet wide was constructed. Methods of construction were generally the same as those for bleeders.

#### Cross-Ditch

Cross-ditches are used to intercept, direct, and disperse surface water flow off a road or trail and to a stable site on the downhill side. Where the North Ghut intersects the East Trail the natural flow pattern was re-established by construction of a cross-ditch. The cross-ditch is a

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broad sag in the trail, approximately 15 feet wide on the uphill side, excavated down to the original ground surface. As with the construction of bleeders, hand clearing and excavation was supplemented by small earth-moving equipment to construct the cross-ditch. Material excavated from the cross-ditch was used to fill in the large gullies that extend along the trail to the southeast. The newly filled gullies were then compacted to minimize future erosion potential.

Immediately downslope of the trail, a temporary sediment trap was installed until the reconstructed gully had a chance to stabilize. The sediment trap was constructed out of permeable materials such as large boulders, with gaps plugged by smaller cobbles.

**Gully Repair**

Rocks were piled and compacted in the existing eroded gullies towards the bottom of the trail to slow the flow going through the gullies, which allowed fine material to settle out of the water and will fill the gullies over time.

**Boulder Barrier**

Boulders, approximately 1 cubic yard in size, were placed at the top of the East Trail to prevent vehicles from accessing the trail.

The remainder of the adjacent roadside and the edge of the parking area were also blocked with large boulders to eliminate further erosion and damage to the dry scrub vegetation through inappropriate vehicle access.

**Parking Area BMP Description**

**Parking Area**

An approximately 30 foot deep by 70 foot long parking area for a total of 2100 ft<sup>2</sup> was constructed adjacent to the East End Road (Photo 6) in the same roadside area which was used for unauthorized and haphazard “pull-off” parking. The parking area was cleared and grubbed, excavated with minimum cut and fill, graded, and compacted, and covered with 6” gravel (Photos 7-8).



Photo 6: Overall layout of the Parking Area.



Photo 7: Completed Parking Area.



Photo 8: Completed Parking Area with trail entrance.

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Retaining Wall

The downslope perimeter of the parking area was stabilized, defined, and built up with an approximately 175-foot long by 5-foot high boulder retaining wall (Photos 9-10).



Photo 9: Construction of the Parking Area retaining wall.



Photo 10: Construction of the Parking Area retaining wall.

**West Trail Stabilization & Isaac Bay Spur Trail BMP Description**

Trail Construction

The opening and stabilization of the West Trail and construction of the Isaac Bay Spur Trail followed U.S. Department of Agriculture Forest Service Trail Management Handbook (2008) guidelines. The West Trail was cleared and grubbed by hand (Photo 11) along the contour, removing primarily the invasive exotic guinea grass and acacia that have colonized the trail cut. The reopened section of the West Trail was stabilized using bleeders/drainage dips, waterbars, cross-ditches, and other trail stabilization measures (Photo 12). Where necessary, the trail path was routed around any endangered plant species to avoid damage.

For the West Trail, prior to beginning work on the construction of the trail, the trail was marked by flagging, surveyor's tape, and/or paint. Nature Conservancy personnel monitored the trail work.

A 2,600± foot spur from the West Trail to Isaac Bay was marked out along the 60-90 foot



Photo 11: Newly constructed trail.



Photo 12: New trail stabilization measures.

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contour around Cudejarre Point and hand cut by the TNC land manager. The trail was cut three to four feet in width, with virtually no fills, except at small gullies and similar existing erosion features. Cuts were of a maximum one and a half to two feet in depth on the uphill side. Maximum grade on the trail was 15% to 20% (similar to the grades along much of the existing East Trail). It was a narrow, winding trail, constructed using sloped/angled trails, and regularly spaced water diversions to minimize erosion potential. Once in the Isaac Bay Watershed, the trail continued along the 60-90 foot contour, then followed an old bulldozer cut down the hillside. The rest of the trail was cut through guinea grass.

**Stairs**

There is a large *Lignum vitae* tree on the TNC property located in close proximity to the beach. From here, a 10-12 foot high set of stairs was constructed down the slope to the beach, instead of cutting a steep path prone to erosion (Photos 13-17).

**Viewing Platform**

A 12-foot-by-12-foot wooden viewing platform was constructed at approximately the top of the stairs (Photo 18).



Photo 13: Construction of the lower stair stringers and landing to Isaac Bay beach.



Photo 14: Construction of the stair stringers, landings, and treads to Isaac Bay beach.



Photo 15: Construction of the stair stringers and landings to Isaac Bay beach.



Photo 16: Construction of the stairs, including handrails, to Isaac Bay beach.

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Photo 17: Completed stairs to Isaac Bay beach.



Photo 18: Construction of the Isaac Bay viewing platform (shelter is temporary).

### 4.5 Achieved Results

Stabilization and closure of the East Trail reduced traffic through this area allowing the trail to re-vegetate and lessen the sediment off loading from this trail (Photos 19-21). Construction of the parking lot, clearing trails, and installing drainage structures for the West Trail and Isaac Spur Trail, and constructing steps and a viewing platform ensures that recreationists can enjoy the East End without damaging the environment and contributing more sediment to marine waters. For a total project cost of \$224,076 V.I. RC&D was able to reduce trail erosion; thus reducing sediment eventually discharged into East End and Isaac Bays.



Photo 19: Mulch and seeding of the East Trail.



Photo 20: Natural revegetation of the East Trail.



Photo 21: Natural revegetation of the East Trail.

## **5. Sediment Reduction Monitoring**

Dr. Carlos Ramos-Scharron and his team evaluated the effects of trail restoration activities on the rate of sediment production by surface erosion along the East End trails. Field activities extended from July 2009 until November 2011. Measurements included a pre-treatment phase in which the team observed trail conditions and erosion rates prior to trail restoration activities. Efforts also included observations immediately following and up to a year after trail restoration work.

Erosion rates from eight trail segments were measured for periods extending from one to thirteen months although most were monitored for at least 9 months. Four trail types:

- Type I: gently-sloped, actively used trails with sparse vegetation cover;
- Type II: steep and actively used trails with sparse vegetation cover;
- Type III: steep and actively used trails with dense vegetation cover; and,
- Type IV: steep and unused trails with dense vegetation cover

were represented. The geometrical dimensions and the physical characteristics of trail conditions were determined by a combination of field methods and interpretation of digital imagery captured in the field. The amount of sediment produced by individual trail segments was measured with filter-fabric sediment fences located below a point of concentrated trail drainage. Between one and six measurements were taken from each trap, or once every month to once every 2.2 months. Erosion rates also were measured from the two naturally occurring sources of sediment found in the East End Bay area: undisturbed hillslopes and the upper portions of the sea cliffs. Undisturbed hillslopes were represented by eight sites, while four sites were chosen to quantify erosion from cliff areas. Sediment traps were also used to measure the amount of sediment generated by each of the source areas.

Using field data collection, modeling, and other calculations, Dr. Ramos-Scharron concluded:

- "...that trail erosion rates represent a one- to three-order of magnitude increase in erosion rates relative to undisturbed conditions.
- Vegetation cover stands out as a key trail characteristic controlling erosion rate.
- Slope was also identified as a significant factor controlling trail erosion.
- ...the amount of sediment generated during the construction phase dominated the total quantity of sediment produced during the study period. ... Recognizing that most of the sediment generated from any disturbed surface occurs immediately following the disturbance is important in planning for special treatments that foment vegetation cover (e.g., seeding) reduce the energy available for erosion (e.g., proper drainage) and promote sediment retention in the proximity of the eroding surface (e.g., sediment traps) during the construction phase" (Ramos-Scharron et al. 2012).

Finally, Dr. Ramos-Scharron commented that:

“the long-term effect of the trail restoration work at East End Bay is likely to have reduced the amount of sediment delivered into the marine environment. First, is that the restoration activities will result in the disuse of a few problematic trail sections adjacent to [East End Bay]. Trail abandonment is likely to promote vegetation growth, which will likely reduce erosion and sediment delivery. Second, is that the work along the North Trail should protect it from the type of gullying that severely damaged it years ago. Finally, outcropping along the West Trail and the construction of water bars along both trails guide runoff into well-vegetated, flat areas where subsequent sediment transport and delivery into the bay are unlikely” (Ramos-Scharron et al. 2012).

## **6. Lessons Learned**

Constant supervision is needed for all projects regardless of the complexity.

The smallest equipment possible should be used to reduce impacts on and losses of vegetation.

## **7. Next Steps**

The Nature Conservancy will now maintain the trails as needed.

Additionally, educational signs along the trail and at the stairs at Isaac Bay could turn the area into an interpretative trail and help hikers appreciate the environment surrounding them. Recently, TNC and V.I. RC&D installed the sign included as Attachment A at the Isaac Bay beach stairs.

Also, a sign that discusses the problems with the old access points could discourage future use of the eastern access points and encourage people to use the new trail (the solution to the problem).

## **8. References**

Gardner TA, Cote IM, Gill JA, Grant A, Watkinson, AR. 2003. “*Longterm region-wide declines in Caribbean corals,*” *Science* 301: 958–960.

Maguire Group, Inc. 2004. *East End Bay Erosion & Sedimentation Controls: Inventory of Problem Areas Draft*, prepared for V.I. Resource Conservation & Development Council, Inc.

Maguire Group, Inc. 2005. *East End Bay Erosion & Sedimentation Controls: Best Management Practices*, prepared for V.I. Resource Conservation & Development Council, Inc.

Ramos-Scharron, Carlos E, Ph.D., Kynoch Reale Munroe, and Scott Atkinson. 2012. *Assessing the Impacts of Hiking Trail Restoration and Construction Activities on Soil Erosion- A Case Study at East End Bay, St. Croix, U.S. Virgin Islands*. Draft. Submitted to NOAA on behalf of VI-RC&D as part of: USVI Coastal Habitat Restoration through Watershed Stabilization Project. NOAA-ARRA: 2009-2012- Terrestrial Monitoring Component, East End, St. Croix. January.

V.I. Code Title 12, §98, September 2007. *St. Croix East End Marine Park Rules & Regulations, amendment to Virgin Islands Code, Title 12, §98, Chapters 1-12 plus Appendices*.

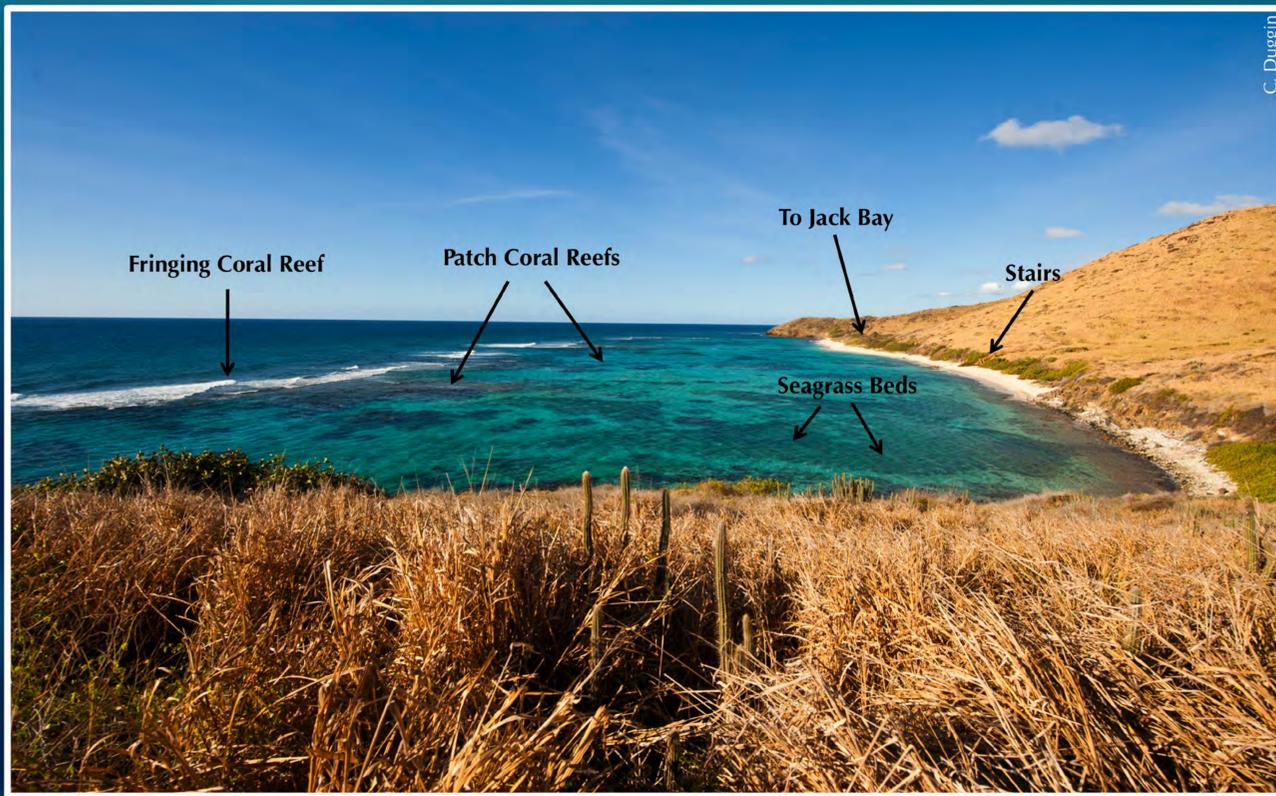
**Attachment A: Educational Poster**

# Jack and Isaac Bay Preserve



## Help Protect Marine and Coastal Wildlife!

- Enjoy the wildlife, but do not take or damage plants or animals in the Preserve
- Keep your dog leashed
- Please pack your trash or use the bags provided



The bays here are sheltered by fringing reefs. Snorkeling just inside these protective reefs, you'll see seagrass beds and coral reefs and all the fishes and animals that thrive in these clear waters.

**REMEMBER THE RULES**  
**NO FISHING OF ANY KIND**  
**NO CAMPING OR FIRES**

## East End Plants and Wildlife



Coral reefs provide food and shelter for a number of marine fishes and other organisms and are also relied upon by millions of people worldwide for food, jobs, recreation, and coastal protection.



These endangered mariners commonly feed in seagrass beds and nest on the beaches of Jack and Isaac Bays.



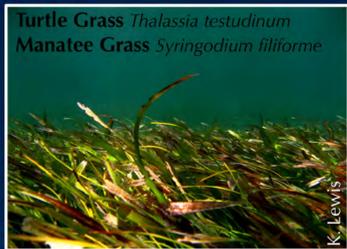
These bays are home to the endangered elkhorn coral. Thanks to proper land management and trail maintenance, these corals benefit from reduced sedimentation from stormwater runoff.



Once endangered in the United States, Brown Pelican populations have increased as a result of positive human actions.



The Ginger Thomas is the state flower of the US Virgin Islands. Many are found here at Jack and Isaac Bays.



These true plants are important food sources for green sea turtles. Seagrasses also trap sand – preventing beach erosion and improving water quality.



These herbivores remove algae from substrate providing space for coral larvae settlement.



These non-native invasive rodents were introduced to the islands to control snakes and now decimate sea turtle and seabird nests.



When hermit crabs out-grow their shells, they search the beach for another, discarded by a marine snail or other hermit crab; A perfect reason to leave shells on the beach!

# **Appendix A: Engineering Designs & Drawings**

## EAST END BAY VIRC&D-NOAA PROJECT WORK DESCRIPTION

### East Trail Stabilization BMP Description

- A. Install small "bleeder" trenches [otherwise known as drainage dips], approximately two feet in width, constructed along the active East Trail at 100-foot intervals to route runoff intercepted by the trail back down-slope where it can proceed in a more natural manner. (Figure 12.) Bleeders will be excavated by hand to the maximum extent practicable, supplemented by use of smallest backhoe-equipped, or skid-steer loader, (e.g. "Bobcat") possible. Bleeder depth will be only a few inches at the inside edge of the trail and proceed diagonally across the trail with a base slope of 5 to 10%. The bleeder will extend out through the existing earth berm, "daylighting" on the outside of the downhill edge berm. *Care shall be taken to disturb the existing plan life as little as possible while working on the trail.*

Localized erosion at bleeder discharge points will be dissipated with local stone stabilization, a.k.a. a rock spillway (Figure 13). Sediment carried by the runoff discharging from the bleeders will be trapped in the vegetated slopes in the lower portions of the bowl in the same way naturally occurring sediments are trapped. Material excavated will be stockpiled for use to fill small, adjacent gullies and other erosion features and to build a low-height earthen berm on the down hill side of the bleeder if necessary to assist in confining storm water to the bleeder.

- B. At the head of the West Trail, immediately south of the fork in the North and West Trails and approximately 100 feet from the public road, a larger diversion or "drainage dip" approximately 4 feet wide will be constructed. Methods of construction and other considerations would generally be the same as those for Bleeders.

Where the existing gut intersects the East Trail the natural flow pattern will be re-established by construction of a Cross-Ditch. This is a broad sag in the trail, approximately 15 feet wide on the uphill side, excavated down to the original ground surface (Figure 14). As with the construction of bleeders, hand-clearing and excavation, supplemented by small earth moving equipment will be utilized to construct the cross ditch. Material excavated from the cross ditch will be utilized to

fill in the large gullies that extend along the trail to the southeast. The newly-filled gullies will then be compacted to minimize further erosion potential.

Immediately down-slope of the trail, a temporary sediment trap will be installed until the reconstructed gut has a chance to stabilize. The sediment trap will be constructed out of permeable materials such as large boulders, chinked with smaller cobbles. The basin will slow runoff and disperse it out into the historic gut channel, while allowing larger soil and rock materials to be deposited.

- C. Rocks will be piled and compacted in the existing eroded gullies towards the bottom of the trail to slow the flow going through the gullies which will allow fine material to settle out of the water and fill the gullies over time.
- D. When the erosion & sediment control measures are complete boulders, approximately 1 cubic yard in size will be placed at the top of the trail to prevent vehicles from accessing the trail (Figure 15). The remainder of the adjacent roadside and the edge of the parking area will be blocked with large boulders to eliminate further erosion and damage to the dry scrub vegetation through inappropriate vehicle access.

#### **Parking Area BMP Description**

- E. A parking area will be constructed adjacent to the East End Road. The parking area will be approximately 30 foot deep and 70 feet along the road (2100 SF) in size and be constructed in the same roadside area which is currently used for unauthorized and haphazard "pull-off" parking (Figure 15). The parking area will be cleared and grubbed, excavated with minimum cut and fill, graded and compacted (Figure 16), and then paved (6" crusher run and 2" bituminous paving).
- F. The down-slope perimeter of the area will be stabilized, defined and built up with an approximately 175 foot long, 5 foot high boulder retaining wall (Figure 17). The remainder of the adjacent roadside will be blocked with large boulders to eliminate further erosion and damage to the dry scrub vegetation through inappropriate vehicle access.

#### **West Trail Stabilization & Isaacs Bay Spur BMP Description**

- G. Prior to beginning the work on the construction of the trail the trail will be marked by flagging, surveyor's tape and/or paint. The trail work will be monitored by Nature Conservancy personnel. It is anticipated that the trail work should take 3 men two-three weeks.

The opening and stabilization of the West Trail and construction of the Isaac Bay Trail Spur (Figure 18) will follow USDA Forest Service Trail Management Handbook guidelines (USDA-

FS, 2008). The West Trail will be cleared and grubbed by hand along the contour, removing primarily the invasive exotic species guinea grass and acacia that have colonized the trail cut (see Trail Clearing & Grubbing Detail, Figure 19, and Trailway Cross Section / Trailbed Slope Finish Details, Figure 20). The re-opened section of the West Trail will be stabilized using bleeders (Figure 13), drainage dips (Figure 21), water bars (Figure 22), and cross ditches (Figure 14). Where necessary, the trail path will be routed around any endangered plant species to avoid damage.

H. Stream fords will be built across West Gut and a small 5-foot bridge built across South Gut (see Stream Ford/Gully Cross Detail, Figure 23).

A 1,600± foot spur from the West Trail to Isaac Bay will then be cut by hand along the 60-90 foot contour and go around Cudejarre Point. The trail will be cut 3 to 4 feet in width, with virtually no fills, except at small gullies and similar existing erosion features, and cuts of a maximum 1.5 to two feet in depth on the uphill side. Maximum grade on the trail will be 15% to 20% (similar to the grades along much of the existing East Trail). It will be a narrow, winding trail, constructed using sloped/ angled trails (see Figure 20) and regularly spaced water diversions (see Figures 13, 14, 21 & 22) to minimize erosion potential.

Once in the Isaac Bay watershed, the trail will continue along the 60-90 foot contour then follow an old bulldozer cut down the hillside. The rest of the trail will be cut through guinea grass (*Uruchloa maxima*). There is a large *Lignum vitae* tree on the TNC property located in close proximity to the beach (Figure 24).

I. From here a 10-12 foot high set of stairs will be constructed down the slope to the beach, instead of cutting a steep path prone to erosion (Figure 25). Finally, interpretive signs will be installed (Figure 26), both at the trail head and Point Cudejarre overlook, describing both the marine and terrestrial habitats of East End and Isaac's Bays and the sediment reduction project and its goals to reduce sediment damage to the reefs.

J. A 12'x12' wooden viewing platform will be constructed at approximately the location of the top of the stairs.

SEE COASTAL ZONE CONSISTENCY CERTIFICATION\* ATTACHED, FOR ADDITIONAL INFORMATION AND DETAILS

## 5.0 ARRA Proposed Actions: Detailed implementation of BMPs

### 5.01 East Trail Stabilization & Closure

#### 5.01.1 East Trail Stabilization BMP Map

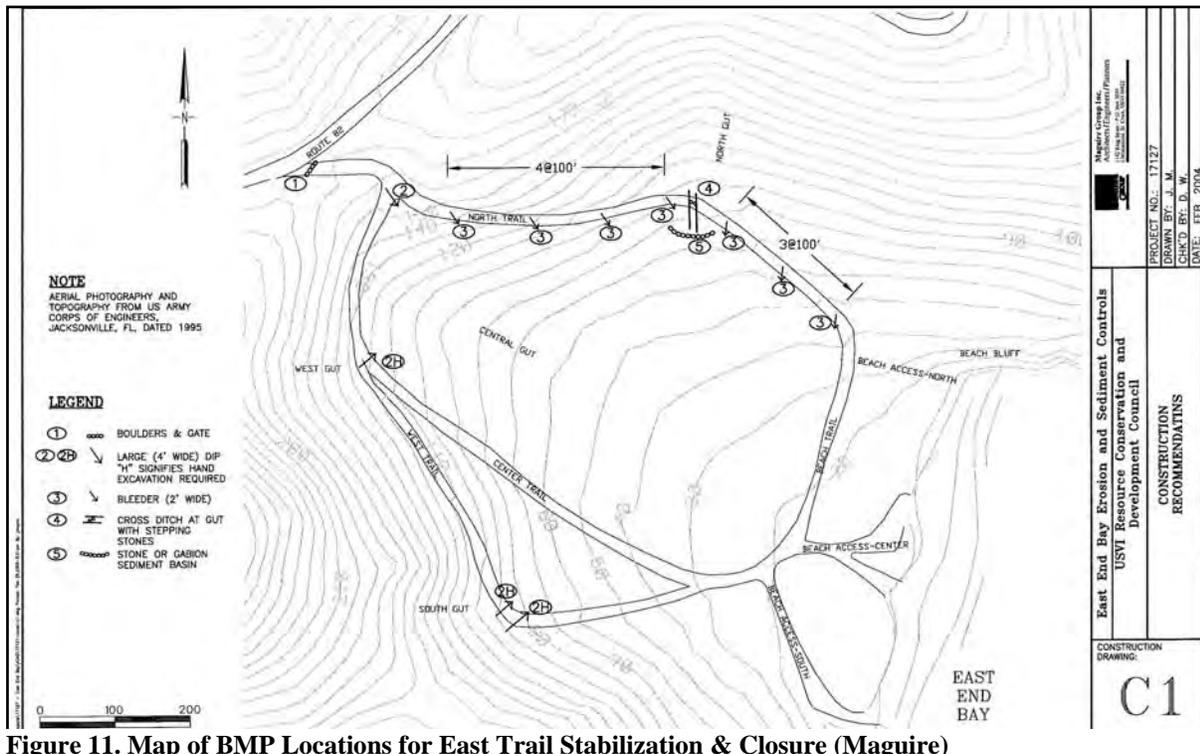


Figure 11. Map of BMP Locations for East Trail Stabilization & Closure (Maguire)

#### 5.01.2 East Trail Stabilization BMP Description

The following specific BMP implementation regime (BMP locations are indicated on Figure 11) was recommended by Maguire (2005) to stabilize and close the East Trail:

- Install small “bleeder” trenches [otherwise known as drainage dips], approximately two feet in width, constructed along the active East Trail at 100-foot intervals to route runoff intercepted by the trail back down-slope where it can proceed in a more natural manner. (Figure 12.) Bleeders will be excavated with a small backhoe-equipped, or skid-steer loader, (e.g. “Bobcat”) supplemented by hand-work. Bleeder depth will be only a few inches at the inside edge of the trail and proceed diagonally across the trail with a base slope of 5 to 10%. The bleeder will extend out through the existing earth berm, “daylighting” on the outside of the downhill edge berm.
- Localized erosion at bleeder discharge points will be dissipated with local stone stabilization, a.k.a. a rock spillway (Figure 13). Sediment carried by the runoff discharging from the bleeders will be trapped in the vegetated slopes in the lower portions of the bowl in the same way naturally occurring sediments are trapped. Material excavated would be used to fill small, adjacent gullies and other erosional features and to build a low-height earthen berm on the down hill side of the bleeder to assist in confining storm water to the bleeder.
- At the head of the West Trail, immediately south of the fork in the North and West Trails and approximately 100 feet from the public road, a larger diversion or “drainage dip”

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approximately 4 feet wide will be constructed. Methods of construction and other considerations would generally be the same as those for Bleeders.

- Where the existing gut intersects the East Trail the natural flow pattern will be re-established by construction of a Cross-Ditch. This is a broad sag in the trail, approximately 15 feet wide on the uphill side, excavated down to the original ground surface (Figure 14). As with the construction of bleeders, small earth moving equipment will be utilized to construct the cross ditch. Material excavated from the cross ditch will be utilized to fill in the large gullies that extend along the trail to the southeast. The newly-filled gullies will then be compacted to minimize further erosion potential.
- Immediately down-slope of the trail, a temporary sediment trap will be installed until the reconstructed gut has a chance to stabilize. The sediment trap will be constructed out of permeable materials such as large boulders, chinked with smaller cobbles; gabions, or similar materials. The basin will slow runoff and disperse it out into the historic gut channel, while allowing larger soil and rock materials to be deposited.
- Closing the East Trail to pedestrians may prove difficult due to its familiarity to residents. Obstacles such as large boulders will be installed across the head of the trail to reduce trail use. Planting and/or transplanting of thorny, indigenous plants to discourage pedestrian use may also be done depending upon availability of native plant species.

5.01.3 East Trail Stabilization BMP Design Detail Drawings

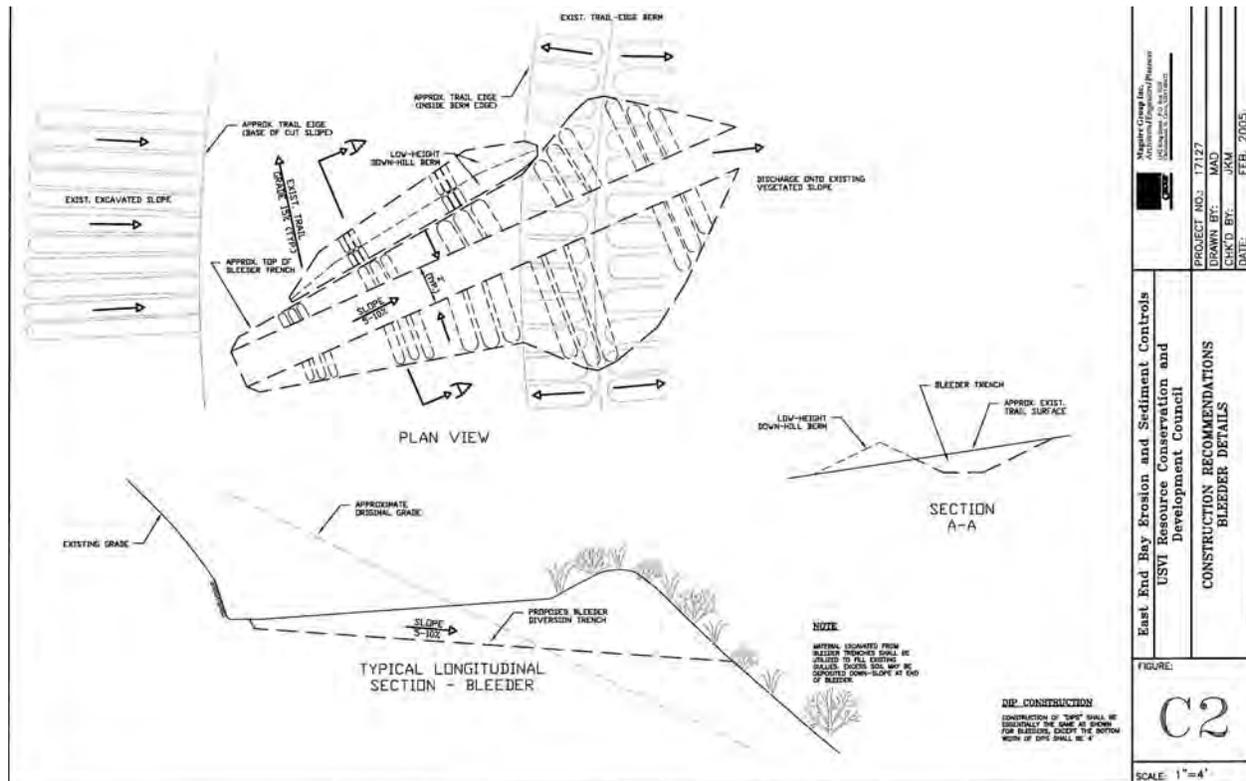


Figure 12. Design Detail for Bleeder BMP (Maguire)

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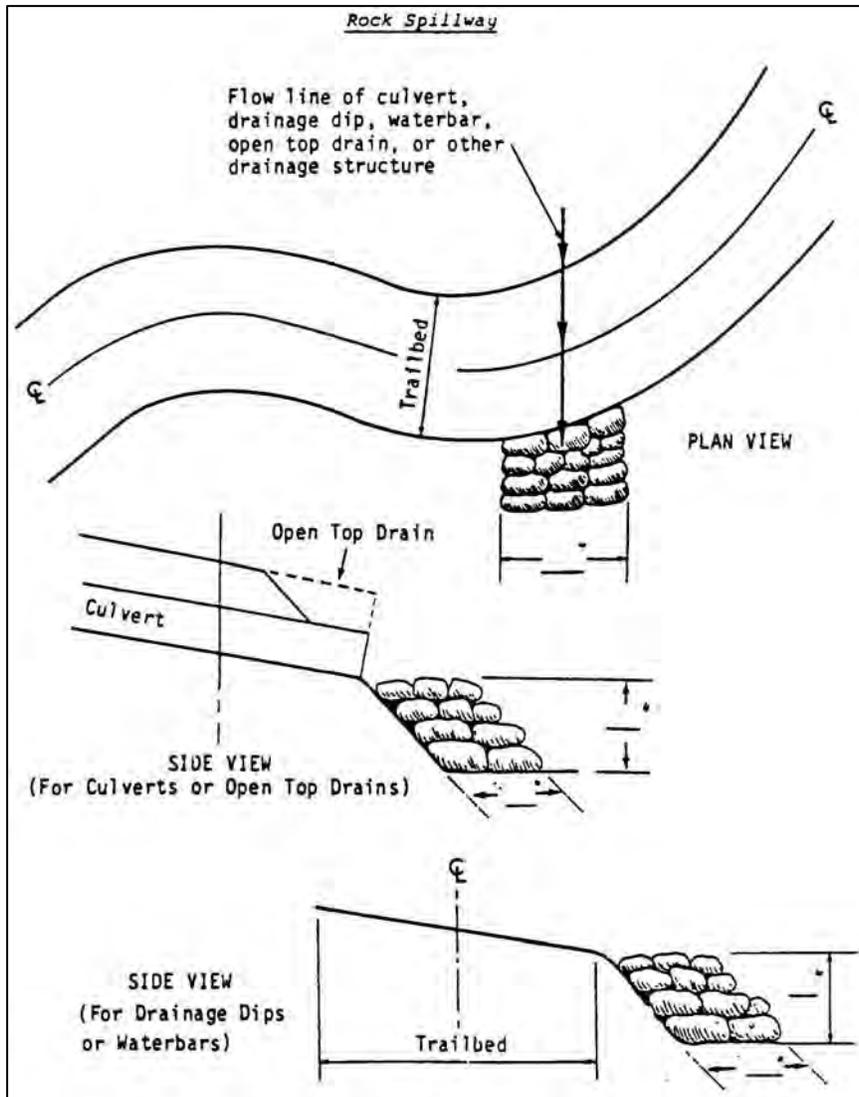


Figure 13. Rock spillway design & installation details (USDA-FS, 2008).

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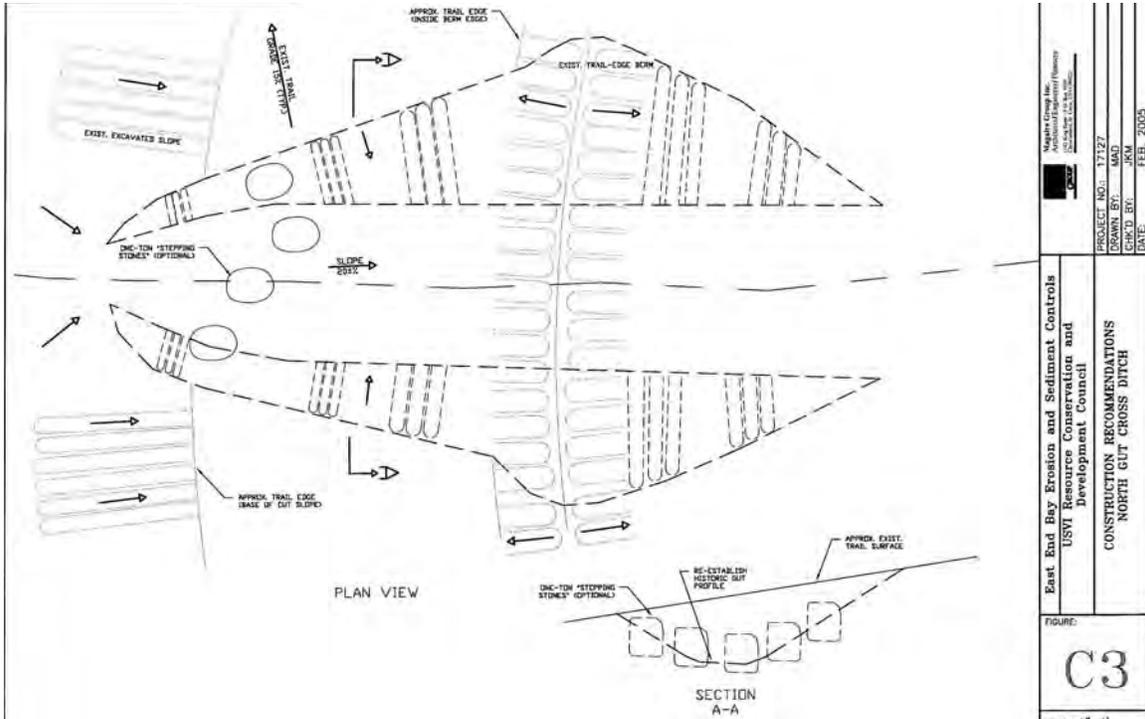


Figure 14. Design Detail for Cross Ditch BMP (Maguire).

5.02 Parking Area Stabilization & Confinement  
5.02.1 Parking Area BMP Map

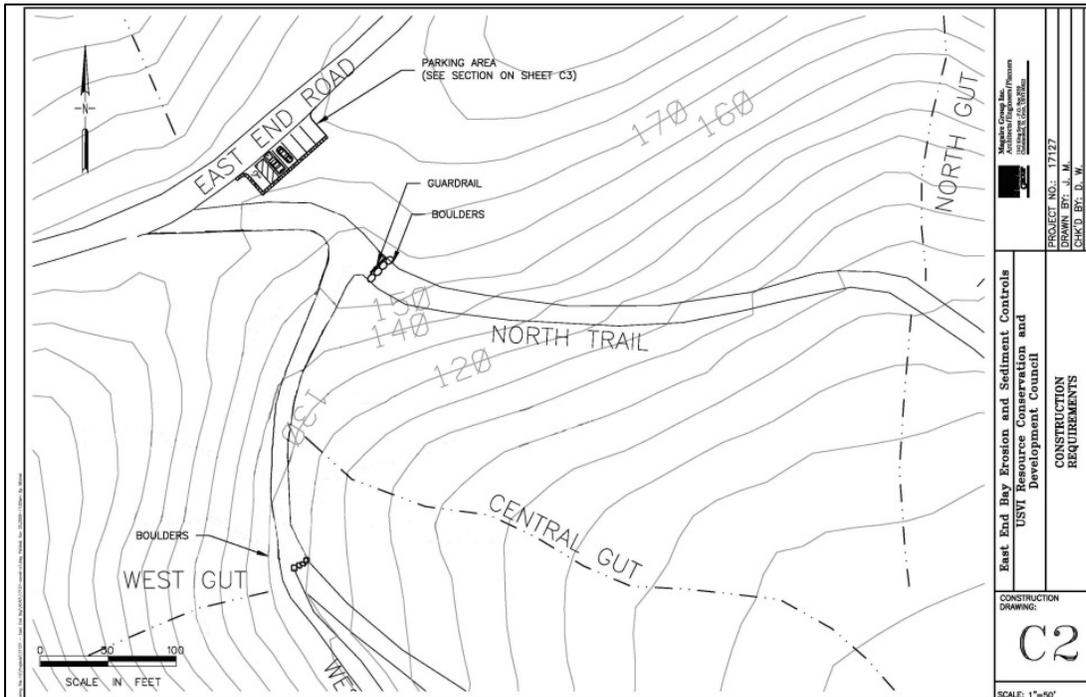


Figure 15. Map showing location of new stabilized & confined parking area for East End Bay Trail users (Maguire).

### 5.02.2 Parking Area BMP Description

At East End Road, parking will be provided for 6 cars in the relatively flat area immediately adjacent to East End Road, without the need for roadway improvements. The parking area will be approximately 1200 ft<sup>2</sup> in size and be constructed in the same roadside area which is currently used for unauthorized and haphazard “pull-off” parking (Figure 15). The parking area will be cleared and grubbed, excavated with minimum cut and fill and graded (Figure 16), and then paved (crushed stone base, aggregate base, bituminous paving). The down-slope perimeter of the area will be stabilized and defined with an approximately 175 foot long, 4 foot high stone retaining wall (see design detail, Figure 17). The remainder of the adjacent roadside will be blocked with large boulders to eliminate further erosion and damage to the dry scrub vegetation through inappropriate vehicle access. Installation of this stabilized and confined parking area would result in a minor increase in impervious area, minimal cut and fill, and minimize further soil erosion in the area.

### 5.02.3 Parking Area BMP Design Detail

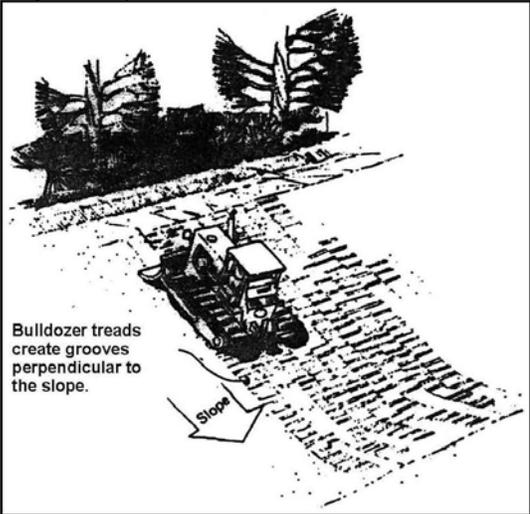
Construction Specifications	
<ol style="list-style-type: none"><li>1. Protect all graded or disturbed areas, including slopes, during clearing and construction in accordance with the approved sediment control plan and until they are permanently stabilized.</li><li>2. Construct, apply and maintain all sediment control practices and measures in accordance with the approved sediment control plan and the standards and specifications for Erosion and Sediment Control Practices as detailed in this Handbook.</li><li>3. Stockpile topsoil required for vegetation establishment in an amount necessary to complete finished grading of all exposed areas.</li><li>4. Clear, grub, and strip topsoil from all areas to be filled in order to remove trees, vegetation, roots or other objectionable material. Run the bulldozer up and down the slope to create grooves perpendicular to the slope (Figure B.8). This will minimize erosion by channeling water laterally across the slope instead of in grooves, or gullies, up and down the slope.</li><li>5. Compact all fills as required to reduce erosion, slippage, settlement, subsidence or other related problems. Fill intended to support buildings, structures, etc. shall be compacted in accordance with the V.I. building code.</li><li>6. Fill material must be free of brush, rubbish, rocks, logs, stumps, building debris, and other objectionable materials that would interfere with or prevent construction of satisfactory fills.</li><li>7. Do not incorporate soft or highly compressible materials into fill slopes or structural fills.</li><li>8. Keep all benches free of sediment during all phases of development.</li><li>9. Provide adequate drainage for seeps or springs encountered during construction so that excess water does not cause slope failure.</li><li>10. Permanently stabilize all graded areas immediately following finished grading.</li><li>11. Show all stockpiles, borrow areas, and spoil areas on the plans and stabilize according to the provisions of this Handbook.</li></ol>	 <p>Bulldozer treads create grooves perpendicular to the slope.</p> <p>Figure B.8. Bulldozer treads create grooves perpendicular to the slope.</p>

Figure 16. Clearing, grubbing and grading construction specifications (V.I. Environmental Protection Handbook, 2002).

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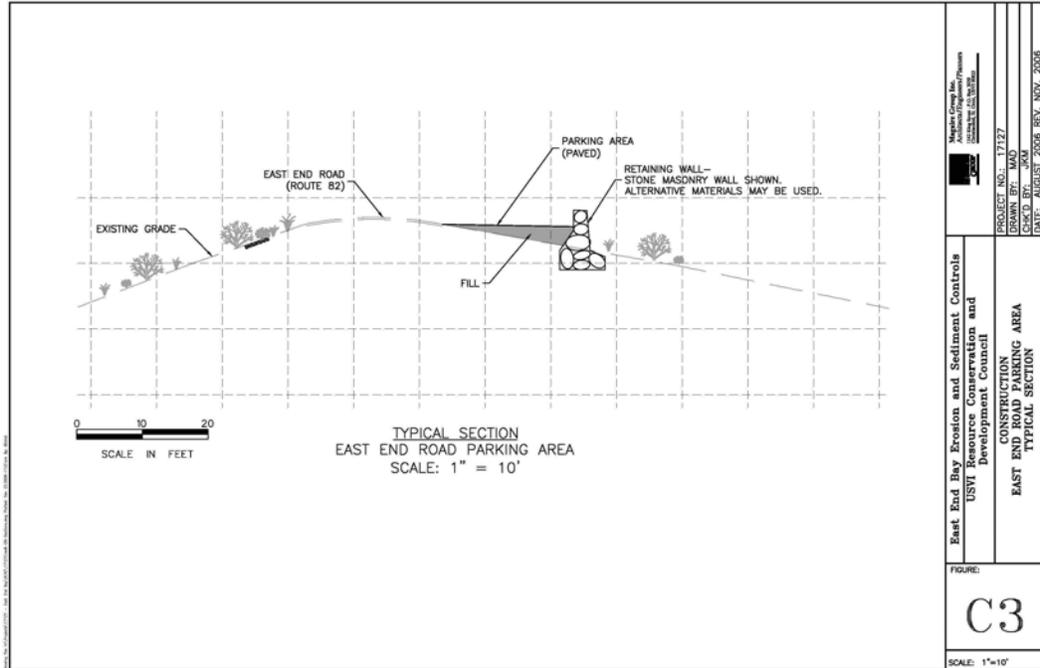


Figure 17. Design detail for parking area retaining wall BMP (Maguire).

5.03 Opening & Stabilization of Upper West Trail & Isaac's Bay Trail Spur  
5.03.1 West Trail / Isaac's Bay Spur Trail Map

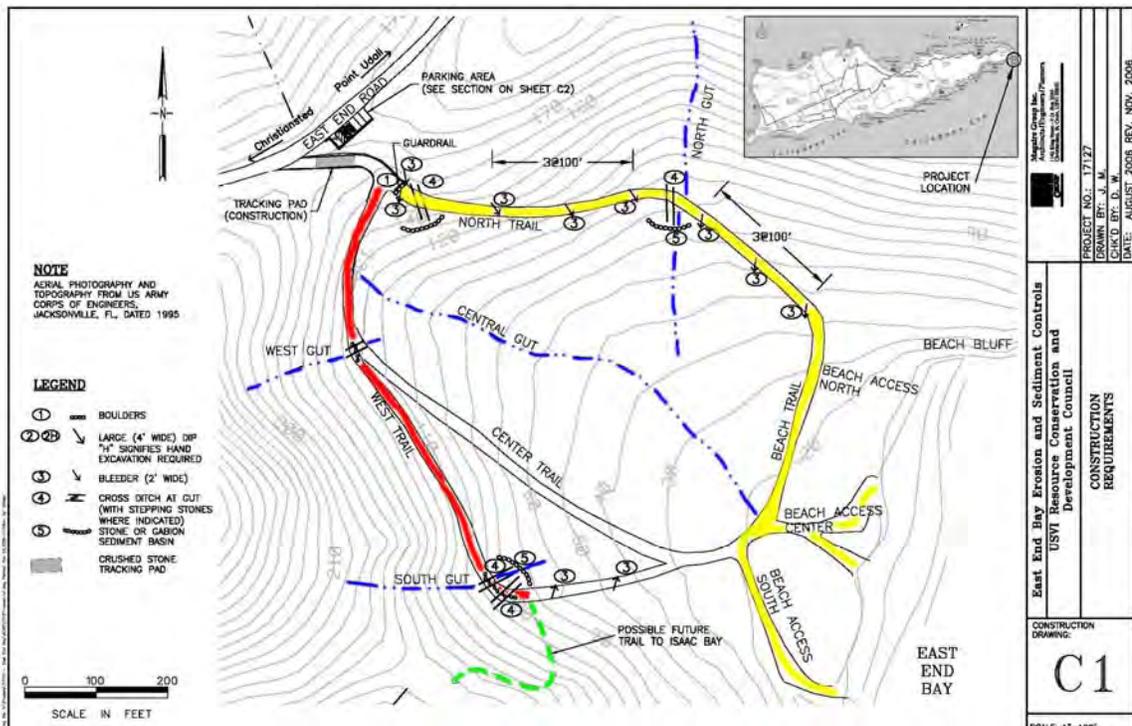


Figure 18. Topographic map of existing trails (East – Yellow, West – Red), guts, proposed Isaac's Bay Spur (Green dashed), and BMP locations.

### 5.03.2 West Trail Stabilization & Isaacs Bay Spur BMP Description

The opening and stabilization of the West Trail and construction of the Isaac Bay Trail Spur (Figure 18) will follow USDA Forest Service Trail Management Handbook guidelines (USDA-FS, 2008). The West Trail will be cleared and grubbed by hand along the contour, removing primarily the invasive exotic species guinea grass and acacia that have colonized the trail cut (see Trail Clearing & Grubbing Detail, Figure 19, and Trailway Cross Section / Trailbed Slope Finish Details, Figure 20). The re-opened section of the West Trail will be stabilized using bleeders (Figure 13), drainage dips (Figure 21), water bars (Figure 22), and cross ditches (Figure 14). Where necessary, the trail path will be routed around any endangered plant species to avoid damage. Stream fords will be built across West Gut and a small 5-foot bridge built across South Gut (see Stream Ford/Gully Cross Detail, Figure 23).

A 1,600± foot spur from the West Trail to Isaac Bay will then be cut by hand along the 60-90 foot contour and go around Cudejarre Point [there may also be a bench or vista point overlooking the southeast coastal area of St. Croix]. The trail will be cut 2 to 3 feet in width, with virtually no fills, except at small gullies and similar existing erosion features, and cuts of a maximum 1.5 to two feet in depth on the uphill side. Maximum grade on the trail will be 15% to 20% (similar to the grades along much of the existing East Trail). It will be a narrow, winding trail, constructed using sloped/ angled trails (see Figure 20) and regularly spaced water diversions (see Figures 13, 14, 21 & 22) to minimize erosion potential.

Once in the Isaac Bay watershed, the trail will continue along the 60-90 foot contour then follow an old bulldozer cut down the hillside. The rest of the trail will be cut through guinea grass (*Uruchloa maxima*). There is a large *Lignum vitae* tree on the TNC property located in close proximity to the beach (Figure 24). From here a 10-12 foot high set of stairs will be constructed down the slope to the beach, instead of cutting a steep path prone to erosion (Figure 25). Finally, interpretive signs will be installed (Figure 26), both at the trail head and Point Cudejarre overlook, describing both the marine and terrestrial habitats of East End and Isaac's Bays and the sediment reduction project and its goals to reduce sediment damage to the reefs (see Education & Outreach Section for more details).

### 5.03.3 West Trail / Isaac's Bay Spur Trail BMP Design Details

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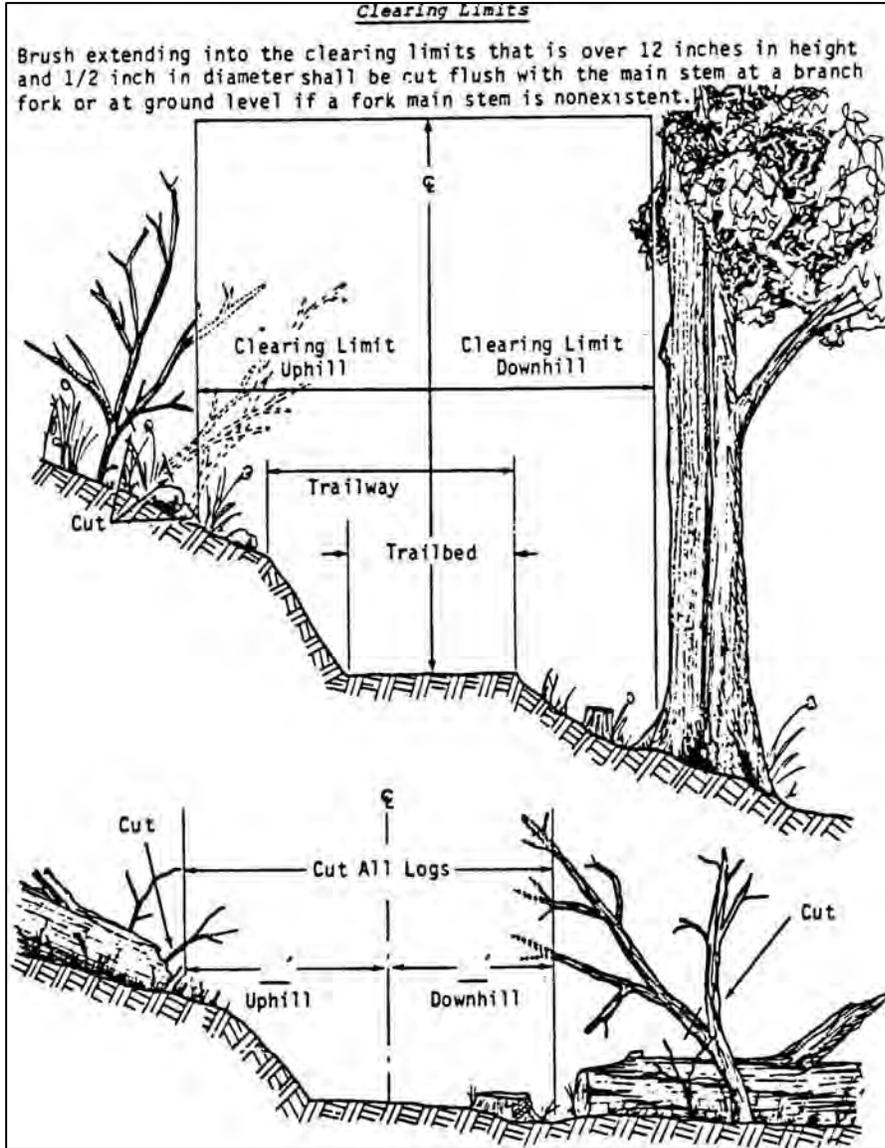


Figure 19. Trail clearing & grubbing BMP details (USDA-FS, 2008).

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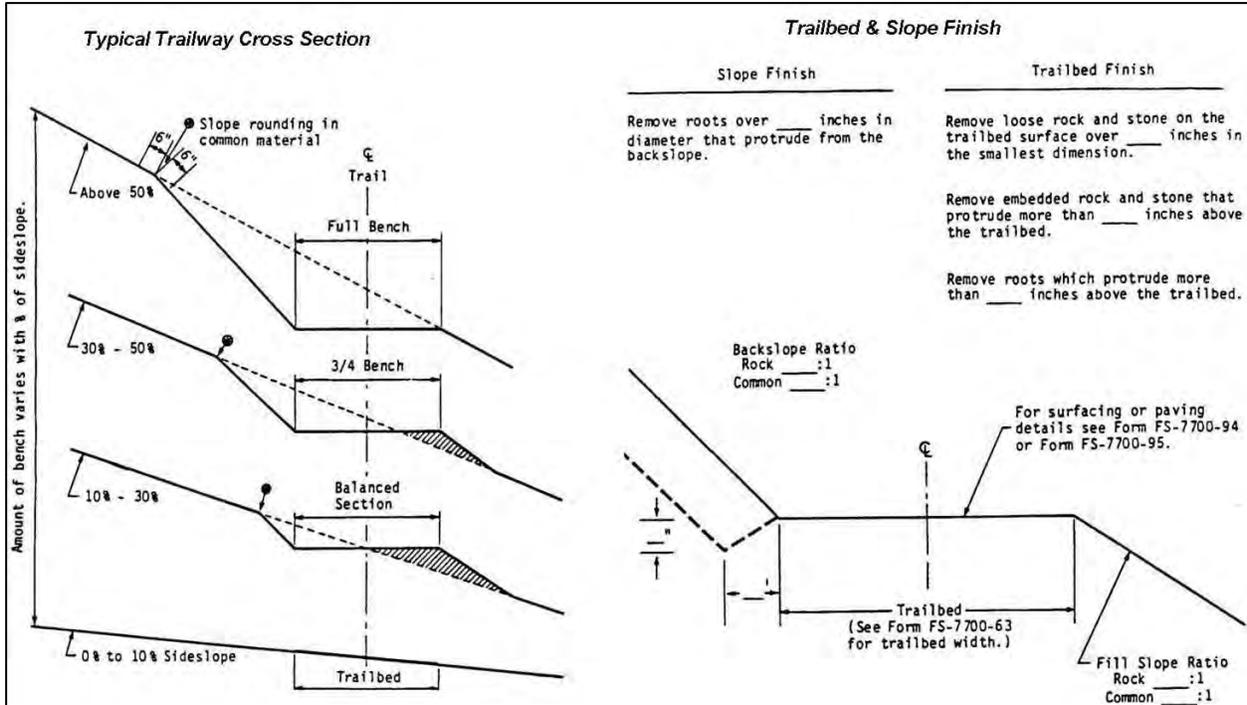


Figure 20. Trailway cross section and trailbed & slope finish design & installation details (USDA-FS, 2008).

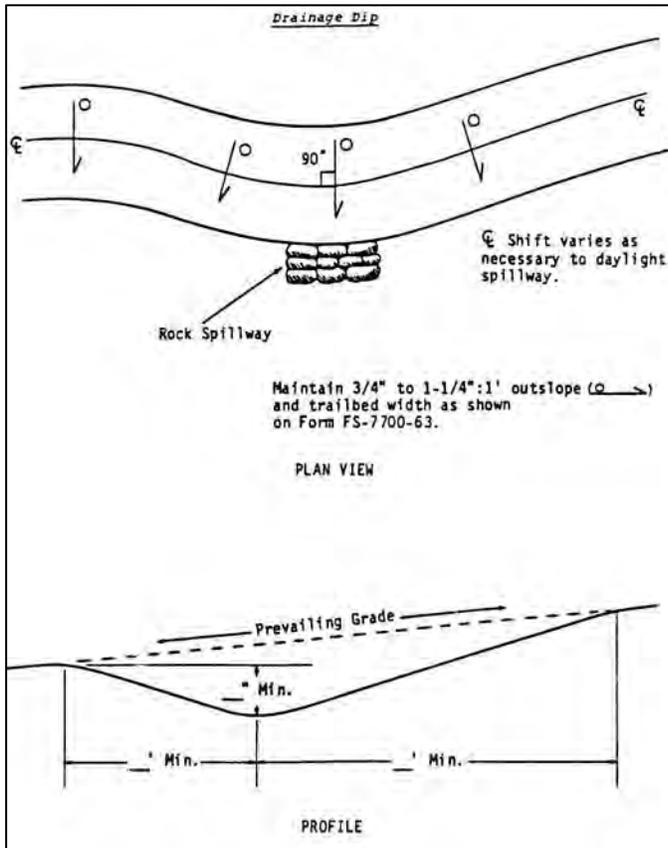


Figure 21. Drainage dip design & installation details (USDA-FS, 2008).

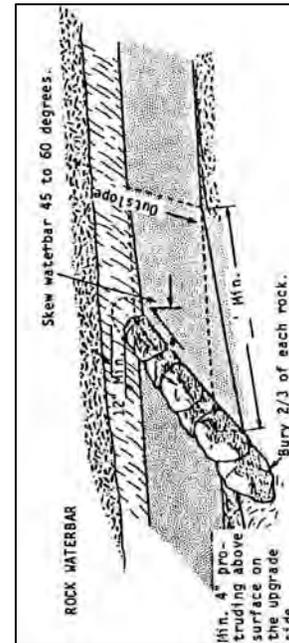


Figure 22. Water bar design & installation details (USDA-FS, 2008).

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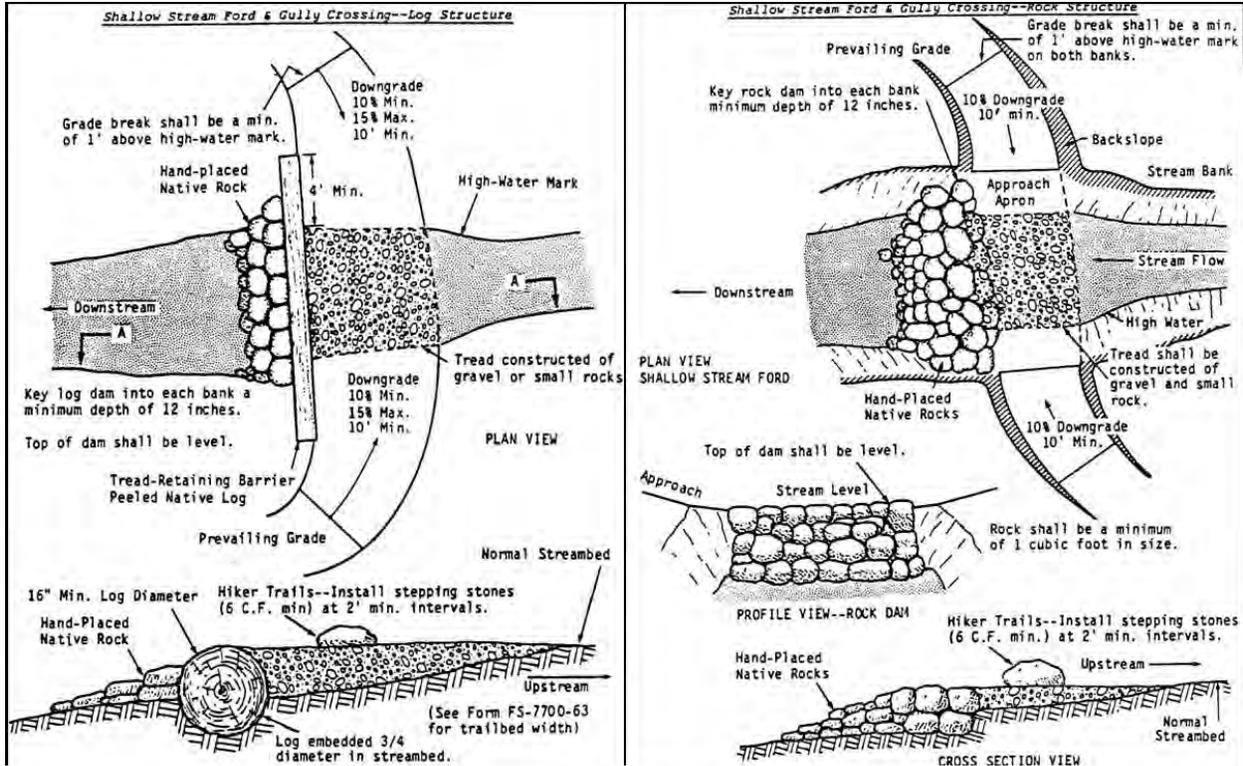


Figure 23. Stream Ford / Gully Crossing design & installation details – log & rock (USDA-FS, 2008).



Figure 24. Isaacs Bay beach and end of spur trail (green line) in steps to the beach.

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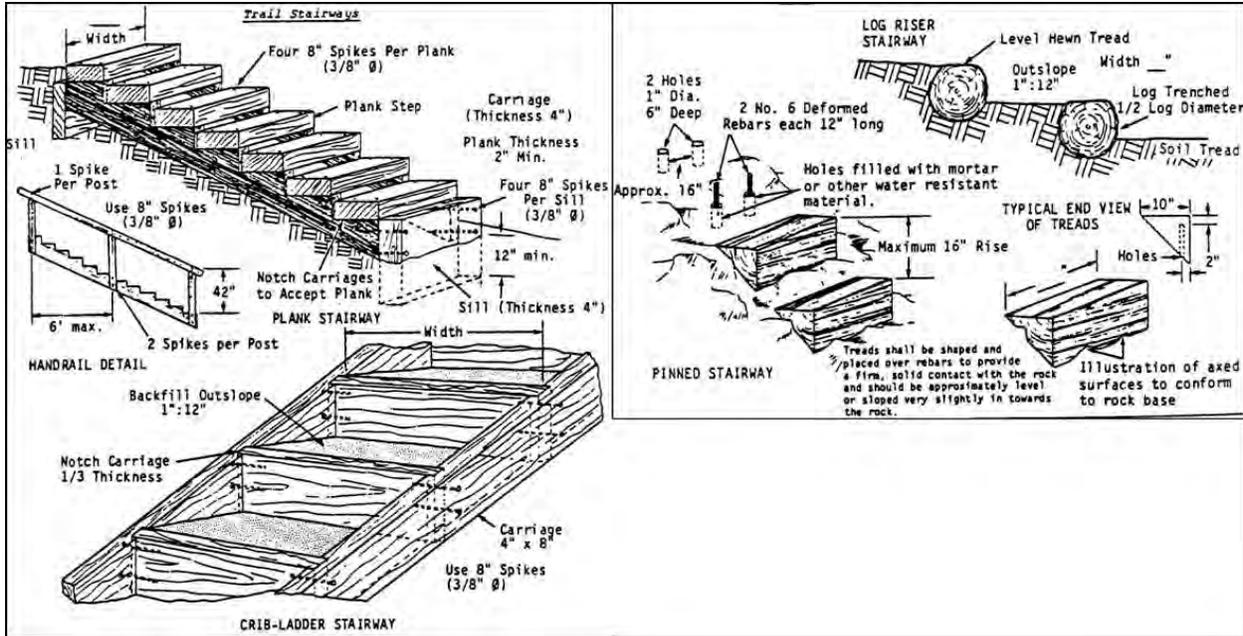


Figure 25. Wooden stair design & installation details (USDA-FS, 2008).

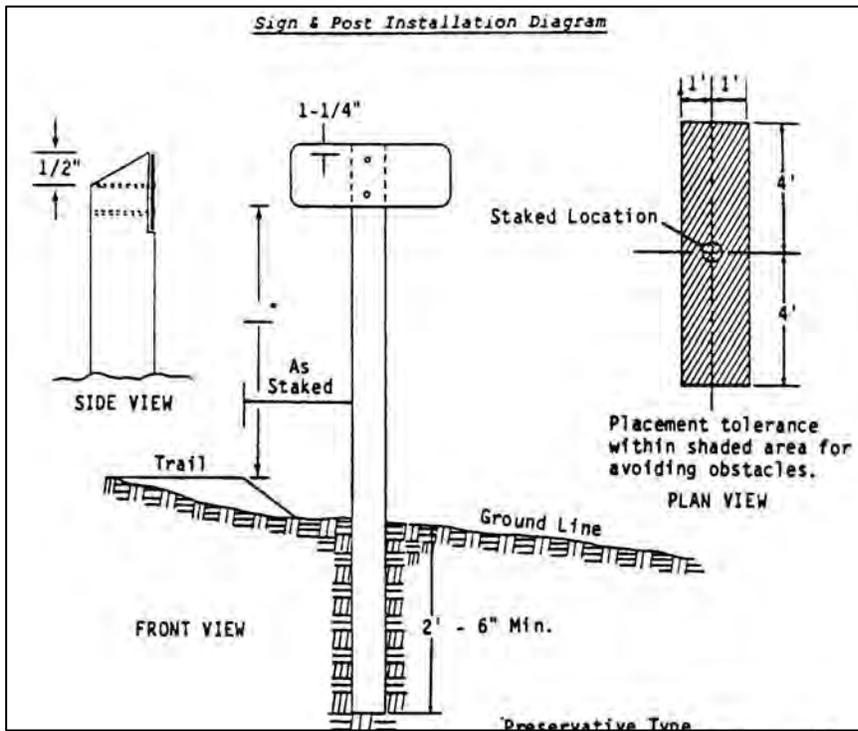


Figure 26. Wooden sign design & installation details (USDA-FS, 2008).