Horsley Witten Group
Sustainable Environmental Solutions
90 Route 6A • Unit 1 • Sandwich, MA 02563
508-833-6600 • horsleywitten.com

MEMORANDUM

To: Rob Ferguson and Marie Auyong (NOAA)

From: Ben Wollman, Janelle Veary, Michelle West (HW)

Date: October 26, 2022

Re: Manell-Geus Watershed Inventory – Field Findings

cc: Margaret Aguilar, Guam EPA
Farron Taijeron, The Nature Conservancy
Christine Fejeran, Guam Department of Agriculture

This memorandum summarizes data collection and key findings from a rapid watershed assessment of the Manell and Geus watersheds conducted by HW, Guam EPA, Department of Agriculture, The Nature Conservancy, NOAA, and others the week of August 4 – 9, 2022. The purpose of the assessment was to map drainage infrastructure, identify problem areas (pollution sources, flooding, damage, etc.), and identify potential restoration project opportunities. During this effort, the field team:

- Verified and updated watershed boundaries—we identified a few changes to the WERI watershed boundaries (**Map 1**)
- Mapped and assessed 77 drainage structures
- Toured revegetation & other existing watershed projects
- Identified 35 potential restoration opportunities (15 preliminary high-ranking sites)
- Met with agencies (several meetings were canceled due to COVID-19)
- Developed an online inventory map

Attachment A includes our itinerary (we had some last-minute changes due to COVID-related impacts), data collection "cheat sheet", and field notes. The cheat sheet provides a generalized list of the types of watershed projects field crews were considering during field inventories, the data collected at each site, and the watershed benefits presented by each opportunity.

Potential Restoration Projects

We identified 35 sites for potential restoration projects (**Map 2)**. **Table 1** summarizes the type, site name, proposed project, and initial ranking of these sites. An online map showing the locations of these sites with photos can be accessed at https://arcg.is/1nKzeL1, but will also be linked through the project website 2023 Manell-Geus Watershed Management Plan (arcgis.com). **Attachment B** contains the field sheets from each potential restoration site, including concept sketches, where applicable. Depending on stakeholder input, a few of these projects will rise to the top for further conceptual design and implementation planning.

Horsley Witten Group
Sustainable Environmental Solutions

Date: 10/21/2022
Data Sources: Water and Environmental Research Institute of the Western Pacific (WERI), USGS, NOAA, ESRI

This map is for informational purposes and may not be suitable for legal, engineering, or surveying purposes.

- Rivers (NHD)
- Manell Geus WS Revised (HW)
- Manell Geus WS (WERI Boundaries)

Feet
0 1,500 3,000

Map 1
Watershed Boundary Adjustments.

Path: H:\Projects\NOAA\CRCP_2017Rebid\21105 PO430_Manell Geus Watershed\GIS\Maps\Manell_Geus_WMP_ProjectSites.mxd

Horsley Witten Group
Sustainable Environmental Solutions

Date: 10/25/2022
Data Sources: Water and Environmental Research Institute of the Western Pacific (WERI), USGS, NOAA, ESRI

This map is for informational purposes and may not be suitable for legal, engineering, or surveying purposes.

Project Ranking

- High
- Medium - Low
- Rivers (NHD)
- Manell Geus WS Revised (HW)

Map 2
Project Site Locations.

Table 1. Potential Restoration Projects in the Manell-Geus Watershed.

Site ID	Type of Potential Project	Site Name	Proposed Solution	Preliminary Ranking
R-01	Coastal Shoreline Stabilization	Ajayan Bay Shoreline Restoration	Bank stabilization and mangrove restoration	High
R-02	Coastal Shoreline Stabilization	Asgadao Creek Mouth - Shoreline Stabilization	Coastal bank stabilization and revegetation (does not look like appropriate mangrove reveg location) between point at utility pole and utility pole ~ 200 ft west of ME-102	Medium
R-03	Coastal Shoreline Stabilization	Santa Marian Kamalen Park Coastal Bank Stabilization	Bank stabilization and revegetation (possible mangrove restoration, but long-term views may be a factor)	Medium
R-04	Stormwater Retrofit	Geus Road Wet Swale	Proposed solution is to convert grassy area into a storm water retrofit such as a wet swale.	Medium
R-05	Hotspot Pollution Prevention	Shell Gas Station Pollution Prevention	Proposed solution here is to block the drainage channel and reroute flows around fueling station to prevent leaks.	Medium
R-06	Residential Stewardship	Quinene Residential Stewardship	Residential stewardship in this area would be helpful. Work with neighborhood to improve these conditions and make changes on their personal properties to complement a larger roadside project.	Medium
R-07	Residential Stewardship	Route 4 Residential Stewardship	Rain gardens would be a good option for these homes given the direct connection of roof runoff into the adjacent infrastructure. Existing lawn areas could be converted to rain gardens.	Medium
R-08	UP Road Improvement	Merizo Pier Park Street Parking	Convert paved and grass area use for parking to permeable pavers. Swale along edge of pavers.	High
R-09	UP Road Improvement	Water Tank Paving	Proposed solution here is to pave the driveway for the water tower and add stabilized paver parking for the ballpark.	Medium
R-10	Stormwater Retrofit	School Courtyard	Install cutoff trench along base of adjacent steep slope to intercept groundwater flowing through this area and divert it to proposed stormwater features for R-20. Stabilize steep slope with vegetation to better hold soil in place.	High
R-11	Stormwater Retrofit	Boat Ramp Rain Gardens	Two rain gardens with public educational signage.	High
R-12	Stormwater Retrofit	Santa Marian Kamalen Park Parking Lot Bio	Shift parking towards road on east side to line up with road alignment. Add Bioretention system to southeast corner of parking lot.	High
R-13	Stormwater Retrofit	Rosa Aguigui Reyes Memorial Library, Merizo Branch	Proposed project here is a swale to a bioretention system. Also, great opportunity for public education.	High
R-14	Stormwater Retrofit	Merizo Mayors Office Constructed Wetland	Propose to turn the existing depression into a constructed wetland for additional treatment and storage in this location.	High
R-15	Stormwater Retrofit	Route 4 Roadside Wet Swale	Stormwater retrofit here should be a wet swale in the right of way area to treat runoff before discharging into the Asgadao Creek.	High
R-16	Stormwater Retrofit	Merizo Pier Park Court Parking lot	Direct flows from parking lot and courts into two bioretention areas at each downgradient corner of the parking lot. Opportunities here to stabilize shoreline, improve amenities (picnic table area, trash collection), and provide public education.	High

Site ID	Type of Potential Project	Site Name	Proposed Solution	Preliminary Ranking
R-17	Stormwater Retrofit	Merizo Community Center Roof Rain Garden	Formalize drip line around building and drain to low point at back of building. Direct water into rain garden.	High
R-18	Stormwater Retrofit	Merizo Pier Parking Lot Bio West	Divert parking lot area and shower runoff into a bioretention in park area. Add educational signage. Create speed hump across boat ramp to direct water to bioretention system. Direct downstream catch basin from the upper parking lot to bioretention system.	High
R-19	Stormwater Retrofit	Merizo Pier Parking Lot Bio East	Divert upgradient catch basin pipe to bioretention system in grass area on east side of sidewalk. Divert runoff from concrete paths and ramp to bioretention. Add educational signage.	High
R-20	Stormwater Retrofit	School Parking Lot Bio	Install a bioretention/dry swale system along the school entrance and road. Integrate with R-10 concept. Good location for educational signage.	High
R-21	Stormwater Retrofit	Helmani's Apartments Rain Gardens	Divert flows to grassy areas on either side of the entrance in rain gardens.	Medium
R-22	Stormwater Retrofit	Route 4 Roadside Swales	Water quality Swales on both sides of the road to minimize flooding treat water and help convey it to the stream where there's erosion around the existing headwalls.	Medium
R-23	Stormwater Retrofit	Dometro Meno Bus Stop Bio	Stormwater practice behind bus stop. Pavement removal. Speed bump for diverting flow.	Medium
R-24	Stormwater Retrofit	Dometro Meno ROW Bio	Bring runoff from conc swale across the road via pipe to rain garden. Used to slow water down reduce erosion and treat stormwater. The discharge would continue on down the slope and may need to be stabilized.	Medium
R-25	Stream/Wetland Restoration	Geus River Floodplain Restoration	Private grassy area where floodwaters already go should be stabilized and restored as floodplain.	Medium
R-26	Stormwater Retrofit	N Doyle St Complex SW Opportunities	Implement green infrastructure measures to the complex, including converting concrete swales to grassed swales, constructed rain gardens, and installing cisterns for harvesting of roof runoff.	Medium
R-27	Stream/Wetland Restoration	Ajayan River Restoration	Proposed restoration at the site includes stream bank hardening to protect the roadway infrastructure and reduce sediment source out to the bay here. Likely a hardened type structure with gabion baskets and some plants as well.	High
R-28	Stream/Wetland Restoration	Redirect Tributary Along Quinene	Redirect tributary to the natural path of crossing the road and going directly to the stream before running through the neighborhood.	High
R-29	Stream/Wetland Restoration	Manell River Relocation	Restore a more natural river path closer to historic location by constructing a culvert crossing immediately before the upstream 90-degree bent culvert and recreating a naturally shaped channel downstream of Route 4 to the ocean.	High
R-30	Stream/Wetland Restoration	Quinene Bamboo Removal	Invasive species management. Remove bamboo and treat cut stems with herbicide. Remove fallen bamboo and other debris from stream.	Medium
R-31	Stream/Wetland Restoration	Geus River Bamboo Site	Clearing of bamboo.	Medium

Site ID	Type of Potential Project	Site Name	Proposed Solution	Preliminary Ranking
R-32	Stream/Wetland Restoration	Manell River Bamboo Site	Continued invasive mgmt, bank stabilization/revegetation.	Medium
R-33	Stream/Wetland Restoration	Quinene Wetland Enhancement	Enhance and protect wetland from additional development/alteration. Provide better conveyance from steep slopes on mountain side of Quinene Rd to this area.	Low
R-34	Upland Revegetation	Dometro Meno Revegetation North	Revegetate sloped area to stabilize slope and reduce sediment runoff.	Medium
R-35	Upland Revegetation	Dometro Meno Revegetation South	Revegetate slope.	Medium

General Findings

Some of the key land-based pollution issues that we observed during our assessment are summarized below. There are several active requests for additional information to help clarify some of these issues prior to drafting of preliminary watershed recommendations.

1. Flooding of roads and residences.

Through observations in the field and discussions with residents and community members, the field team identified areas where roads and residential properties are flooding. The most significant flooding appears to be occurring along the roadway and adjacent properties where the Manell River crosses Route 4. A combination of potential solutions will likely be required to alleviate the flooding in this area, including alternative routing options, stormwater infrastructure upgrades/improvements, and maintenance equipment provisions (**Photos 1 & 2**).

Photo 1 (LEFT). Bridge/culvert crossing where the Manell River flows along the north side of Route 4. Photo 2 (RIGHT). Looking south from the Manell River channel where the river is forced to make a ninety degree turn to the west along the north side of Route 4.

2. Land use planning gaps.

There are several important factors related to land use planning that will be important for watershed planning:

- Parcel maps – lack of readily available parcel mapping makes it challenging to understand the ownership of the parcels (public vs. private), which has implications for implementation feasibility and funding. We also don't know which areas have already been subdivided for future development perhaps affecting availability of those areas for restoration projects. Public easement locations would be helpful for determining where access exists for infrastructure maintenance or restoration sites.
- Zoning—lack of zoning in southern Guam makes is difficult to assess Buildout/Development potential of the watersheds or to account for resiliency, pollutant load modeling, and infrastructure capacity planning.
- Land Acquisition– Land acquisition of private properties may be needed to implement proposed watershed and community planning projects. Understanding where this is needed and the process and tools that existing for acquisition may be important.
- Drainage Flow Paths – Accounting for drainage flow paths that exist within the watersheds, beyond that of the mapped stream network.

Photo 3. HW Team meeting with Forestry to discuss existing and potential land planning issues.

3. Badland fire safety and erosion impacts.

Areas within the mountain regions of the Manell-Geus watersheds where vegetation is sparse or lacking entirely (i.e., badlands) are hotspots for erosion, which leads to sedimentation issues further downstream (**Photo 4**). These badlands area can be initiated and/or exacerbated by wildfires that are primarily anthropocentric in nature. The Guam Department of Agriculture's Forestry Division has implemented two, ongoing badland restoration projects within the Manell watershed which

helps to reduce erosion impacts (**Photo 5**). The Forestry Division is also the sole entity responsible for fighting wildfires in Guam. Given the importance and impact of these restoration projects and the capacity to limit wildfires and the damage they cause. HW believes the following elements will be important in addressing impacts from the Badlands and wildfires:

- The Guam Department of Agriculture should continue and/or increase investment in the Forestry Division's staffing needs.
- The Forestry Division should continue progress with the planning, implementation, maintenance, and performance monitoring of the revegetation/restoration projects.
- The appropriate authorities should develop and initiate additional enforcement capabilities related to wildfires that are intentional and unauthorized.
- Additional strategic areas should be identified for revegetation/restoration based on sedimentation priorities and visibility.
- Consideration should be given to any alternative erosion control methods that have low- or non-combustible potential.

Photo 4 (LEFT). View of a badland area of minimal vegetation near the Asgadao restoration site. Photo 5 (RIGHT). Christine Fejeran, Forestry Chief of the Guam Department of Agriculture, giving the field team a tour of the Quinene reforestation site in the Manell Watershed.

4. **Drainage infrastructure condition.**

We observed and collected data on existing drainage infrastructure while on-site. **Map 3** shows locations of all structures, with red showing ones in most need of maintenance. **Attachment C** contains a summary table of the various structures (e.g., type, dimensions, key elevations) and an assessment of condition and maintenance needs. Of the structures mapped, 53% need repair or replacement and 28% need routine maintenance. Existing drainage infrastructure, such as culverts, swales, and pipes range in condition and efficacy for the function they are intended to provide (**Photos 6 & 7**). Guam's Department of Public Works (DPW) produced a list of priority drainage infrastructure projects several years ago, which will benefit the watersheds if implemented. Additional infrastructure elements observed during the field team's site work should be added to the DPW's inventory. Additionally, there are other potential steps that could be taken to facilitate management efforts, such as provision of on-call equipment to manage blockages at critical impact points (e.g., removal of debris at the Manell River culverts along Route 4).

Path: H:\Projects\NOAA\CRCP_2017Rebid\21105 PO430_Manell Geus Watershed\GIS\Maps\Manell_Geus_WMP_Infrastructure.mxd

Horsley Witten Group
Sustainable Environmental Solutions

Date: 10/25/2022
Data Sources: Water and Environmental Research Institute of the Western Pacific (WERI), USGS, NOAA, ESRI

This map is for informational purposes and may not be suitable for legal, engineering, or surveying purposes.

Severity

- Low (1 - 3)
- High (4 - 5)
- Rivers (NHD)
- Manell Geus WS Revised (HW)

Feet
0 1,500 3,000

Map 3
Infrastructure Locations.

Photo 6. HW field team members collecting data on a culvert section passing under Route 4 at the east end of the Manell Watershed.

Photo 7. Bridge/culvert infrastructure along Route 4 at the north end of the Merizo Pier Park.

5. Wastewater and water infrastructure repairs.

During the site visit, desktop/background research, and discussion with various stakeholders, the field team has documented existing wastewater infrastructure, including sewer and septic systems. There appears to be at least on instance of a sanitary sewer overflow (SSO) occurring during storm events along Highway 4 within the Geus Watershed (**Photo 8**). Overall, the watersheds would benefit from maintenance/repairs and expansion of the existing sewer system and upgrades to existing, outdated septic systems.

Photo 8. Sewer system located beneath Highway 4 near CJ's. Potential location of SSO.

6. Invasive species management.

Within the Manell-Geus watersheds, common bamboo (*Bambusa vulgaris*) is the most prevalent and problematic invasive species of concern, as it relates to watershed planning. The bamboo was observed to be growing along the riverbanks throughout the watersheds, in large, mono-specific stands (**Photo 9**). These invasive plant stands cause issues with stream bank erosion/downstream sedimentation, habitat/biodiversity loss, and flooding, as they outcompete and take over areas of native species. Large sections of these bamboo stands often break free from the stream banks or fall across the streams, causing blockages to the stream's flow, which is most problematic within the Manell and Geus River systems. Previous efforts led by Patrick Keeler (Guam Coral Reef Initiative Watershed Coordinator) to remove and manage the bamboo stands in Manell-Geus watersheds have been made with some limited success (**Photo 10**). Increased funding and efforts should be considered for continued progress in removing and managing this invasive species, and reduce downstream flooding, within these watersheds.

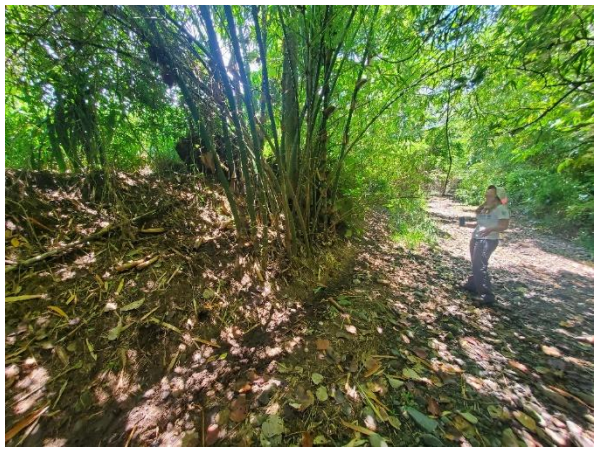



Photo 9 (LEFT). Large stands of bamboo growing along the bank of the Manell River, north of Route 4. Photo 10 (RIGHT). Previously treated section of bamboo along the banks of the Manell River.

7. Pollution hotspots.

At least one pollution hotspot was observed—where stormwater flows through the Shell gas station located west of Nicholas Reyes Street on Route 4 (**Photo 11**). Stormwater runoff should be managed in this location to prevent pollutant loading from the higher concentration of hydrocarbons and oil present at the gas station property.

Photo 11. Shell gas station hot spot along Highway 4 in the Geus watershed (photo sourced from Google maps).

8. On-site stormwater management opportunities.

There are numerous locations within the Manell-Geus watersheds where on-site stormwater management practices could be implemented in public spaces to provide water quality treatment or volume reduction (**Photos 12 & 13**). There is potential for various types of green infrastructure, such as bioretention basins, wet swales, rain gardens, and constructed wetlands, to be designed and implemented at sites that include the Merizo Elementary School, the Merizo Mayor's Office, the Merizo Library, the Santa Marian Kamalen Park, and the Merizo Pier Park.

Photo 12. Location for potential on-site stormwater management practice adjacent to the Merizo Mayor's office.

Photo 13. Santa Marian Kamalen Park location for potential on-site stormwater management practice(s) along Route 4.

9. Wetland/floodplain restoration opportunities.

There are some low-lying areas in and around the stream floodplains within the Manell-Geus watersheds which are mapped as (or appear to be supporting) wetlands (**Photo 14**). These wetlands provide ecosystem services that benefit the watersheds, such as nutrient/pollutant filtration, wildlife habitat, and floodwater storage. These services have the potential to be enhanced through restoration or preservation and should be considered as an option in the overall watershed plan.

Photo 14. Wetland area adjacent to Route 4 with potential for enhancement/preservation.

10. Shoreline/stream bank restoration opportunities.

Certain sections of the Manell-Geus watershed coastal shorelines, along the waters of Achang Bay and Cocos Lagoon, as well as sections of stream banks, were observed to be unstable, actively eroding, lacking vegetation or other stabilization structures (e.g., bulkheads, revetments, etc.) (**Photos 15 & 16**). The erosion in these sections causes sedimentation issues in the receiving Achang Bay and Cocos Lagoon waters, but also threatens to compromise roadway infrastructure, as well as other public and private land assets adjacent to the eroding edge. The watersheds would benefit from bank stabilization projects in these areas, which would potentially include mangrove restoration and other bioengineering elements that utilize vegetation as the primary means for long-term stabilization.

Photo 15 (LEFT). Unstable coastal shoreline section near the bridge at the north end of the Merizo Pier Park. Photo 16 (RIGHT). Eroding section of the Manell riverbank, north of concrete channel.

Next Steps

This memo serves to document field findings and to communicate those findings with project partners and other interested stakeholders. The next steps of this effort will be to:

1. Continue virtual discussions with agencies that we were unable to connect with in person during our site visit
2. fill in any remaining data gaps that were identified.
3. Modeling watershed pollutant load and reduction potential to estimate the benefit of potential project implementation.
4. Conduct public and agency meetings to get guidance on watershed management priorities and to identify up to 10 projects for further development.
5. For priority projects, we will develop concepts and planning-level cost estimates.
6. Ultimately, findings, watershed priorities, and BMPs will be incorporated into a watershed plan for Manell-Geus.

Given the delayed timing of field work, outstanfding public engagement options, and schedules of local partners, we will need to determine if we should request a 6-month extension from NOAA CRCP on this planning project.

ATTACHMENT A - Field Itinerary, Cheat Sheet, & Notes

Evolving Watershed Assessment Itinerary—Manell-Geus
7/26/2022

Date	Activity	What we need
Saturday, July 30	HW Meet @ 6 AM Green Shuttle at office to get to BOS airport-go to Hawaii (Maui project site meetings Sunday/Monday)	
Wednesday, Aug 3	Arrive at 6 PM on Guam Check in to Merizo B&B	- Finalize ESRI Field Map setup and mapping
Thursday, Aug 4	**9 AM Watershed tour** to get our bearings Meet Marie/ Farron (and others interested) at Merizo B&B @ 9AM **Meet with DPW and/or MS4 on site?** --take a look at road infrastructure projects that were identified as part of capital improvements **Meet with Army Corps/CMP?** -- Manell river realignment proposal	- Marie, can you set up meeting with DPW, MS4, ACOE (in the field if possible)? - Meet up with Patrick to talk about school raingarden project (on site)? - Meet up with Romina about mangrove assessments and GIS?
Friday, Aug 5	**Field day with Christine** --where to meet? --look at reveg and other restoration sites; learn about future projects planned for watershed; -understand property ownership/what is public vs private --concept brainstorming for other upland veg and stream projects **Farron/Community meeting?**	- Anne to confirm with Christine --Marie, can you connect with Brent to see if he is available for some stream discussions?
Saturday, Aug 6	**Retrofit inventory around town** --map drainage infrastructure and develop concepts for restoration projects in roads/infrastructure --go to schools, parks, beach access sites, etc, parking lots, etc --talk with residents we informally run into **Closer look at shoreline** --concept brainstorming for shoreline stabilization, coastal resiliency **Explore Cocos Lagoon** in-water habitats and restoration sites via kayak; maybe mangrove tour with Romina	- Do we have access to school? - Farron, can you let mayor know we will be walking around? Locations mayor wants us to look at? Where should we NOT go? - Marie, check on kayaking/tides
Sunday, Aug 7	**Meet up with Peter Houk**	Anne to schedule

	-understand his modeling and wq studies in MG; UOG monitoring capacity	
Monday, Aug 8	**10 AM Meet with GEPA in Barrigada** —understand new stormwater policies and watershed planning initiatives **Swap hotels/check out Piti Raingarden**	- Anne to connect with Vangie to see if we could meet with Waterworks in the AM
Tuesday, Aug 9	**8 or 9 AM Meet with Guam Waterworks?** --are there activities planned for Merizo, service area estimates and known ww problems Go back to sites as needed; sketch out project concepts and rank; schedule any additional meetings needed	
Wednesday Aug 10	**HW Fly out @ 8:10 AM**	

WATERSHED ASSESSMENT CHEAT SHEET

Go to ESRI FIELD MAP APP
Search for 21105_Fieldwork
Make it a favorite (click …)

DRAINAGE INFRASTRUCTURE

End product will be a drainage network map and list of structures in need of maintenance, repair, or replacement. Maps and lists will be included in report and passed along directly to DPW/MS4.

1. Use **21105 Data Collection-Infrastructure New Feature** to collect a point
2. Enter site ID/name (only if you need to, there is a hidden auto ID and we can name later), your initials and todays date
3. Select structure type from drop-down menu and complete remaining questions (Table 1)
4. Use **Field Lines New Feature** to connect structures and create pipe network, if possible
5. Use **Field Points New Feature** to delineate contributing drainage areas, if needed

Table 1. Drainage Infrastructure Form Information

Type	Info Needed	Opportunities
Culvert **Outfall** (not stream mouth or outlet) **Inlet/Catch basin (CB)** **Manhole** **BMP** **Other**	• Location name or ID (if helpful) • Your name (if needed) • Date (should auto-populate) • Type of structure (choose from drop down) • Material structure made of (select primary from drop down) • Dimensions (typically of pipe width or grate, but this is open text. • Pipe invert or other critical elevations (top of road) and if there is a sump in a CB • Observations- is it full of sediment, damaged, is there flow, erosion? • Maintenance needs- routine, repair, or replacement (pls describe) • Severity of damage (1 to 5 scale, 5 being severe due to safety or vulnerability) • Notes and photos	• Routine maintenance, repair, or replacement • Reduced flooding • Public health & safety • Infrastructure protection • Part of bigger project • Improved resiliency • Reduced erosion or impacts on resources • Water quality improvement • Fish/aquatic insect passage

RESTORATION OPPORTUNITIES (POTENTIAL PROJECTS):

End product will be a map and list of all the potential projects we identified. We will have an online map where points can be clicked on to see info collected, auto-populated factsheets on each project in a report appendix, and summary tables in the report that will help us to prioritize projects.

1. Use **Field Point New Feature** to collect points
2. Enter Site ID/Name (try to come up with a name, like Talafofo Car Wash), your name, date, and type of project. This feature can also be used for point of interest, high point, low point, etc.
3. Describe existing conditions and proposed solutions. Use Table 2 to help you think of what information to collect.
4. Draw a sketch if you are able.
5. Make sure to identify any potential constraints and include contact information for site owner.
6. Use **Field Line New Feature** or **Field Polygon New Feature** to delineate footprints, contributing drainage areas, etc as needed

Table 2. Restoration Opportunities Form Information

Project type	Info Needed	Opportunities
Stormwater Retrofits Projects to better manage stormwater from existing impervious cover using green stormwater infrastructure (bios, infiltration, permeable pavers, etc)	• Describe existing condition and what proposed restoration might entail • Contributing drainage area • Source of problem, pollutants of concern and description of land use activities • Type of practice • Conveyance mechanism and pretreatment • Constraints: soils, groundwater issues, utilities, etc • Space available/footprint of practice • Public vs. private—who will do O&M? • Access and visibility	• Upgrade existing BMP • Improve water quality or flood control using new BMP • Encourage GI • Add trees or provide other co-benefits • Education opportunity
Unpaved Road Improvement Projects to regrade or install drainage practices like dips, check dams, cross drains, strategic paving) on existing unpaved roads or parking lots	• Length of segment • Type and location of erosion (surface, ditch) • Is there offsite drainage • Shoulder and road dimensions • Slope (flat-steep) and pitch (crowned, inside, outside) of segment • Are there places to discharge? • Traffic volume • Public or private road	• Diversions, • cross drains, water bars, • dips, • turnouts • traps • slope stabilization • resurfacing
Coastal Shoreline Stabilization Projects to address eroding shorelines or restore mangroves/ coastal vegetation	• Length/height of eroded area • High or low energy area • Substrate and surrounding vegetation • Access • Upland land use	• Living shoreline • Replanting/vegetate upland • Infrastructure protection • Hard structure or combo • Repair existing feature • Retreat?
Stream/Wetland Restoration Projects to stabilize stream channels, improve buffers, and/or freshwater wetlands	• Cross section dimensions and length of impacted area • Rate bank erosion/bed scour • Channelization • Trash/debris • Invasives • Buffer impacts • Access and other constraints • Cause of problem?	• Habitat restoration • Infrastructure protection • Reduced erosion, bank stabilization • Link to upland volume controls • Improve buffer • Invasives removal • Replant vs natural revegetation • Reconnect to floodplain
Upland Revegetation or invasive management For projects mostly outside of the stream or shoreline buffer; bad land restoration; hydroseeding	• Description of area & Cause of problem • Ownership info • Estimated size • Access limitations	• Invasives removal • Replant vs natural revegetation • education
Wastewater Improvement System improvements (pump stations, service extensions, package systems) or onsite septic upgrades, illicit discharges	• Specific location • Residential vs other use • Dry or Wet weather, Smell, Color, Suds • Discharge point • Source, if known • Public vs. private • Type: Violation (intentional dumping) or accident (unintended spill)	• WQ improvement • Health and safety • SSO or pump repair • Upgrade or repair OSDS • IDDE and monitoring • Behavior change/education (dumping washwater) • Connect to sewer • WWTP upgrade or package system

Project type	Info Needed	Opportunities
Construction Site ESC Issues specific to construction activities or site clearing	• Site name/location • Contractor • Permit # • Describe BMPs in use/failures • downstream/offsite impacts	• Propose BMP installation or maintenance recommendations • Report problems
Hotspot Pollution Prevention/site remediation Mostly non-structural opportunities (non-retrofit) to reduce pollutants at commerical and industrial properties	• Land use/description of activities at site • Observed pollutants • Violations? • Contact info • Storm drains on-site • Nearby wetlands/water resources? • Do they have a SWPP or NPDES permit?	• Structural and non-structural • Monitoring • Trash cleanups/Dumpster cover • Spill prevention • Outdoor material storage • Landscaping • Vehicle maintenance/ washwater-dedicated areas • Animal waste management • Buffer encroachment/restoration
Residential Stewardship If able to generalize about a group of homes/neighborhood's potential to collectively reduce pollution (non-retrofits)	• Neighborhood/area delineation • Project contact (HOA)/advocate • Community gathering place? • Confirm sewer/septic • Curb/gutter? SW BMPs?	• Lawn care • Pet waste • Connect to sewer • Downspouts or driveway disconnection • Buffer enhancement • Vehicle maintenance • Trash management • Common space mgmt
Watershed Education/Signage Any spot outside of a specific project site that would be good for signage or to target with messaging?	• Describe location • Who is target audience? • What is the message? • Describe activity or signage?	• Improve watershed awareness • Build community support • Incorporate into E&O plan
Land Conservation This may be hard to see in the field, but maybe during conversations with stakeholders areas are identified.	• Public vs. Private • Surrounding Land Use • Replanting vs Natural Regen • Use (park vs. natural) • Goal (e.g., education, expand buffer, flood control, habitat) • Contact info	• Habitat protection • Preserving hydrologic functions • Improved resiliency

REMEMBER

1. Open the FIELD APP up before going out in field to make sure it loads and that it can work offline if you lose cell coverage.
2. Refresh the FIELD APP to see updates or what other teams are simultaneously collecting.
3. Take at least one photo at each site.
4. Be quantitative where possible.
5. Think about restoration options and feasibility (what would we need to know to implement and to rank).
6. Use the DICTATION function to help speed up typing—clean it up later.
7. SUBMIT
8. Sketches help. You can take a screen shot and mark up photo on the ipad and then attach the file to the point in FIELD MAPS APP, use a sharpie on the blow ups provided, or just sketch it old school on a blank piece of paper.

Manell-Geus Watershed Plan

Field Findings NOTES

8/4/22 – 8/9/22

Wednesday, August 3, 2022

- Horsley Witten Group, Inc. (HW – Michelle West, Janelle Veary, and Ben Wollman) arrival in Guam and check-in to Merizo B&B

Thursday, August 4, 2022

- Morning meeting
    - Attendees
        - Marie Auyong (NOAA),
        - Farron Taijeron (TNC),
        - Patrick Keeler (Guam Bureau of Statistics and Plans – Coral Reef Conservation Program)
        - Horsley Witten Group, Inc. (HW) – Michelle West, Janelle Veary, and Ben Wollman
    - The group met at HW's B&B and discussed environmental issues and projects related to the Manell-Geus watesheds, including:
        - Chaetomorpah blooms occurring in Cocos Lagoon since 2012
            - "Angel-hair/spaghetti" green algae
            - Last bloom noted to be in 2017/2018
            - Tangles in boat props
            - Creeping north along coast from southern Guam
        - Invasive, Clumping Bamboo
            - Most prevalent species is common bamboo (*Bambusa vulgaris*)
                - Streambanks growth is the biggest concern/problem – creates obstructions/dams in streams – most problematic is growth on the banks of the Manell and Geus rivers – leads to flooding
                - Bamboo also causes streambank erosion issues
                - Spread is primarily via vegetative means
                - Spread is relatively slow, but existing stands are very old/mature/well established
            - Patrick Keeler has been the lead on removal/management projects
                - Strategy has been to perform initial removals by cutting stems at the base and treating with herbicide, then following up with

cut-stem treatments at regular intervals (based on growth rates).
        - Patrick says that management effort has grown in scope and become unsustainable for the existing resources available – effective removal and management requires significant effort/resource/time commitment over a multi-year period for effective control. Would need a full-time person to manage an effective control program – Patrick did/does not have enough time on his own.
- Reforestation Project(s)
    - Ongoing reforestation projects by Guam Forestry Department
        - Currently two project areas in Manell watershed
    - Savannah areas in higher elevation mountains areas
    - Restoration species focuses on a limited number of nitrogen fixing tree species
    - Guam forest health issues and threats to re-forestation include:
        - Pig and deer herbivory
        - Natural seed dispersal is a minimal due to invasive snake predation of the local bird populations
        - The Coconut Rhinoceros Beetle
        - Permitting
            - Archeological surveys needed for work to move forward (Section 106?)
            - Farron says that the regulatory agencies are under-staffed, which causes huge delays in permitting/arch surveys – Farron has had funded projects not move forward because the didn't get permits in time and they lost the funding.
            - Potential here to recommend regulatory action items to try to streamline restoration efforts – needs to/should be exceptions/exemptions for certain activities and/or standards/best practices that area incorporated to allow beneficial work like re-forestation to have an easier path to move forward
        - Accessibility
            - Restoration project areas can be difficult to perform due to inaccessibility, related to privately-owned or undeveloped properties that need to be traversed/by-passed

- After the morning discussion, HW went with Patrick Keeler, Farron Taijeron, and Marie Auyong to the Merizo Elementary School, located in the Pigua area on the west side of the Geus watershed. Patrick is planning to implement a rain garden project at the school within a stormwater channel that flows through the property. HW reviewed the

stormwater channel and looked for additional potential stormwater management projects that could be considered on the schools property.

- After the visit to the Merizo Elementary School, HW took a driving tour around the accessible locations of the Manell-Geus watersheds, lead by Farron Taijeron and Marie Auyong. During the tour, HW was shown some existing stream conditions, stormwater infrastructure, and mangrove forests sites. Some of the sites on the tour included:

    - Paloma residence – flooding issue – Yard was filled with water
    - Agricultural Experimental Station – Student research, not used very often. Not a great understanding of what happens here

- After a lunch break, Farron Taijeron, Marie Auyong, and HW met with Brent Tibbatts (Guam Department of Agriculture, Division of Aquatic and Wildlife Resources) to take a walk up the Geus River channel and discuss his knowledge of the local wildlife and environmental issues in the local watersheds. Ultimately, a rainstorm prevented the group from hiking up the stream (flash flooding potential), but items discussed included:

    - Introduced wildlife – Cane toads and barking frogs – supported by aquaculture ponds
    - Inventory and Atlas of Aquatic Ecosystems of the Marianas Achipelago (1981)
        - Additional source for wildlife data
    - Dam impact study (Geus River only?)
        - Results show negative impacts downstream
        - Reservoir is the actual barrier for wildlife, not the dam itself
    - Protected/Rare wildlife
        - One Atyidae shrimp species only found in Guam
        - Two Gobiidae fish species only found in limited region (Marianas Islands)
    - Other dams within the Manell-Geus Watershed – Brent did not know, but said he could ask Dave Otts (?) if he knows of any other dams
    - Tallest waterfall in Guam – located at the headwaters of the Ajagan river
    - Brents “wish list” of actions/needs related to river/watershed improvements/restoration
        - Bamboo management!!!
        - Management of erosion hot spots feeding into streams that end up in the Marine Protected Area (MPA)
    - Additional Invasive Plants
        - Ginger – found further up stream than bamboo – both species like their “feet” wet but ginger may be favored where this is more sunlight
        - Chain-of-Love (*Antigonon leptopus*)
        - Mile-a-minute vine (*Mikania micrantha*)
        - Aquatic invasives

        - Water Hydrilla (*Hydrilla verticillata*) – growth prevents faunal migration
    - Brent recommended checking with Guam EPA about other invasive species
- Stream Bank Project on the Masso River (in Piti, central west coast of Guam)
    - Gabions installed, covered with soil, and vegetated
    - Installed approximately 10 years ago and has done well
- Pipeline Site (don't have location)
    - Live stakes with Pago/Hibiscus
- Fauna
    - Moorhens found near ponds along Tonguan River and east of Manell watershed (on either end of Manell-Geus Watershed Study Area)
- Coastal Erosion Hot Spots
    - Manell River mouth – near Happy Landing Marina
    - Ajagan River mouth

Friday, August 5, 2022

- HW met with Christine Fejeran (Guam Department of Agriculture- Forestry and Soil Resources Division), Margaret Aguilar (Guam EPA), Johnathan, Farron, and Marie to visit and discuss the Guam Forestry re-forestation project sites in the Manell watershed
    - Reforestation Projects
        - Quinene and As Gadao Sites
        - The project is spearheaded by the Department of Agriculture, Forestry and Soil Resources Division and supported by partners from the Bureau of Statistics and Plans and NOAA - under Guam's Coral Program and NOAA's Habitat Blueprint initiative. The reforestation work is designed to accomplish a number of goals, including:
            - reduce erosion and sedimentation to protect reefs and other marine resources;
            - restore tree cover to hillsides to shade out fire-prone grasses and to promote soil health for native tree restoration;
            - restore vegetation other than grass to hold more water on the hillsides and help reduce flooding incidents in the village.
        - Acacia trees (native to Australia) are planted around the perimeter as a fire-resistant species (a natural fire break), which are also nitrogen fixers (provides soil amendments), and other natives are then planted in the interior. As the Acacias and other natives grow larger, the Acacias are selectively pruned/removed as needed to facilitate transition to more native forest stands.
            - Native tree species planted include Pandan (*Pandanus tectorius*) and Lada/noni (*Morinda citrifolia*)

        - Access through private property – Christine developed a good relationship with the families and offered to provide them with access to the site – no formal written agreements in place
            - Maria is working with Christine to develop a database, so Guam Forestry knows who owns the properties in the Manell-Geus watersheds, so that they know who to talk to about additional potential project locations and access areas
        - Site #1 – Quinene
            - This site was originally planted in 2015. There was a big fire in 2016 that destroyed 75% of the restoration efforts. Fire was set by neighbors when attempted to burn their own brush on their property. Fire spread to the hills.
            - Site was replanted with a fire break on the most vulnerable side. They then received funding to create a full perimeter fire break 7,000+ LF.
            - Approximately 12,000 trees planted in total, installed in phases at 1,000+ per phase
        - Site #2 – As Gadao
            - Tina Tango Family – provides access permission (informally)
            - Fire recently burned through a planted area in 2021 – flames >25' height! 75% of the planted area was burned. Crew is currently working on clearing dead trees from the burned areas to remove fuel sources that could potentially feed future fires.
            - >7,000 LF of fire breaks installed
            - Goal was to plant ~12,000 trees (22 acres) per year for a three year period – currently 50 acres planted
    - Fire Issues
        - Both forest project sites have been subject to fires in recent years
        - Municipal Fire Department does not come out to help with any off-road fires (they don't have the equipment necessary)
        - Guam has 7 people in total (primarily from Forestry) that are trained and equipped to fight wildland fires on the island.
        - Fires are mostly intentionally set by humans
            - Clearing site lines for hunting
            - Arsonists

Saturday, August 6, 2022

- HW met with Farron and Marie in the morning and travelled to the park landing across the street from Quinene Road. HW kayaked with Farron along the shoreline of the Cocos Lagoon from the landing at Quinene Road to the Merizo Pier (approximately 2 miles). HW observed the existing conditions of the shoreline along this stretch, looking for erosion hot spots or any other points of interest/concern relative to watershed issues and potential projects.

- After kayaking the shoreline, HW snorkeled with Farron and Marie at a coral reef restoration site in the Cocos Lagoon.

- In the late afternoon, HW visited some local residents (Linda & Stanley) to discuss their perspective on watershed issues within the Manell-Geus Watersheds:

    - Linda and Stanley live on a property located on Rt. 4, right on the shoreline, just west of the Geus Watershed boundary.
    - Linda believes that off-roading activities and fires are the major issues within the Geus watershed, but did not have an understanding or opinion about the issues in the Manell watershed.

Sunday, August 7, 2022

- HW spent the full day collecting data on stormwater infrastructure and areas of interest/concern within the Manell-Geus watersheds. The focus was to capture all stormwater infrastructure elements and identify potential watershed improvement projects. Areas covered during the day included the western half of the Manell watershed and most of the Geus watershed (except for the areas along Highway 4).

Monday, August 8, 2022

- HW travelled from Merizo to Barrigada to meet with Margaret Aguilar (Guam EPA) and Marie Auyong. Discussion items included:
    - GEPA's interest in 303d list
        - How's My Waterway App has Guam's info (https://mywaterway.epa.gov/community/Guam/overview)
        - Cocos Lagoon – PCBs
        - 3 Waterbodies in the Manell-Geus Watershed w/ impairments related to dissolved oxygen and suspended solids
            - Ajayan River, Hudzu (?), Sumay (?)
    - Peter (Houk) has been collecting water samples at the mouths of rivers – his sampling has indicated that nitrates impairment should be added to one of the above rivers
    - TMDL's
        - Non-point source is the primary focus
    - GEPA is identifying sources and issues, but then need to work with contractors to run/manage implementation projects
    - GEPA has $6k (per year?) to work with public education (e.g. artificial reef removal project)
        - Discussed use of this money to fund a potential disposal facility for fishing gear and/or trade for something else of value
    - GEPA has constraints with funding and staffing – need help from volunteers sometimes

- Local governments lack of understanding/awareness of permits required (USACE, etc.) to implement activities/projects in the water – the DPW previously performed emergency actions without getting permits or applying for permits retroactively – they received a 401 permit (after the fact), but the Agencies still need more data/information or will have to issue a Notice of Violation.
- 319 Funding
    - GEPA currently using 319 funding to develop TMDL's
    - $400K/year
        - 50% needs to be used for on-the-ground projects (toward restoration of impaired waters)
        - Funding level has been pretty stable over the last 5 years
    - Generally, 6-month turn-around period from RFP release to implementation of projects
    - GEPA was focused on funding a Tumon Bay project during 2022, which also included funding from US EPA
    - Projects typically run for about 1 year and some are additionally funded for multiple phases
    - GEPA is trying to use funds to help Guam DPW – MS4 program is having trouble getting off the ground
        - Guam MS4 staff (Christopher?) leaving position soon – was only there for < 1 year)
- Guam Nature Alliance (https://www.facebook.com/guamnaturealliance/?ref=page_internal)
    - The Guam Nature Alliance is made up of government, private and non-profit groups dedicated to education about Guam's natural resources.
    - 3 groups – Terrestrial, Freshwater, and Marine

- Chris Lund (GBB Solid Waste Management – handles Guam Solid Waste
    - Closing "dump"
    - Opening new landfill
- Watershed Planning Committee
    - Working on a plan similar to HW
    - Group meets 4 times per year
    - Includes internal (GEPA) and external (DPW) partners
    - GEPA very interested in HW's Watershed Plan to see if there's anything they missed or can add to move toward actionable projects
- Pete Asau Watershed Plan (completed in 2012)
    - GEPA hasn't thoroughly reviewed it yet
- Guam Coastal non-point source plan approved by EPA and NOAA in 2007 (began planning in 1990's)
    - The program has not been staffed
- Local roads in Manell-Geus water shed (including Rt. 4) may not be eligible for federal funding – not considered federal roadways

- Potential for DPW to develop a program/policy to collect a fee for stormwater (Stormwater Utility)
- Jason (USACE) is the regulatory staff for stormwater-related issues on Guam
- Edwin was the one that pulled in USACE for the study on flooding issues and potential projects (e.g. relocation of the Manell River)
    - Would still need to apply for more funding toward implementation
- Sewer issues during flooding events
    - SW line goes into sewer (GEPA thinks)
    - HW thinks maybe sewer pipe is craked, letting SW in during flooding

Tuesday, August 9, 2022

- HW met with Christine Fejeran at the Guam Department of Agriculture headquarters in Mangilao in the morning to review field locations of the forest planting sites visited on 8/5/22 and take a tour of the nursery where they are growing restoration plantings.

- HW spent the rest of the day collecting data on stormwater infrastructure and areas of interest/concern within the Manell-Geus watersheds. The focus was to capture all stormwater infrastructure elements and identify potential watershed improvement projects. Areas covered during the day included the eastern half of the Manell watershed and the areas along Highway 4 within the Geus watershed.

LIST of PROJECT TYPES IDENTIFIED

Stormwater Retrofits

- Roadside Swale
- Wet Swales
- Rain Gardens
- Retention Basins
- Re-locate Parking/Impervious Surface
- Bioretention
- Constructed Wetland

Coastal Shoreline Stabilization

- Bank Stabilization
- Mangrove Restoration

Stream/Wetland Restoration

- Bank Stabilization
- Existing Wetland Area Enhancements

- Re-directing Streams or Tributaries

Upland Revegetation or Invasive Management

- Bamboo Removal & Management
- River Buffer Plantings
- Slope Revegetation

Unpaved Road Improvement

- Paving
- Stabilized Pavers

Residential Stewardship

- Rain Gardens (for roof runoff)

Hotspot Pollution Prevention/Site Remediation

- Re-route Stormwater Flows (around gas station hotspot)

Site Name: Ajayan Bay Shoreline Restoration	ID#: R-01
DESCRIPTION	
Type of Project: Coastal Shoreline Stabilization	**Preliminary Ranking:** High
Existing Conditions: Eroding shoreline (some veg), minimal mangrove presence.	**Site Location:** 
Proposed Solution: Bank stabilization and mangrove restoration	
Site Constraints: Tight site between bay and road	**Other Notes:**
PHOTOS/SKETCHES	
	
Photo Caption: Lack of vegetation in this narrow strip along the road.	**Photo Caption:** Very few mangroves currently growing here.

Photo Caption: Existing shoreline is actively eroding, even where vegetation is growing.

Date Assessed:8/7/2022 12:41:08 AM **Assessed by:** BW

Site Name: Asgadao Creek Mouth – Shoreline Stabilization ID#: R-02

DESCRIPTION

Type of Project: Coastal Shoreline Stabilization

Preliminary Ranking: Medium

Existing Conditions: Steep eroded bank on ocean side of road, between utility pole and bridge. Bank grade gradually declines moving from pole toward bridge. Mix of sandy beach, veg (grass/trees), and rock shoreline downgradient of bank. Sandy beach is 75% of stretch near bridge.

Site Location:

Proposed Solution: Coastal bank stabilization and revegetation (does not look like appropriate mangrove reveg location) between point at utility pole and utility pole ~ 200 ft west of ME-102.

Site Constraints: Site between bay and road. Overhead powerlines at east end.

Other Notes:

PHOTOS/SKETCHES

Photo Caption: Existing vegetation and erosion along shore – Route 4 is in the background (note utility pole).

Photo Caption: Existing vegetation and erosion.

Date Assessed:8/7/2022 1:35:27 AM

Assessed by: BW

Site Name: Santa Marian Kamalen Park Shoreline Stabilization	ID#: R-03
DESCRIPTION	
Type of Project: Coastal Shoreline Stabilization	**Preliminary Ranking:** Medium
Existing Conditions: Park area - eroding bank seaward of park, except where existing wall remains in place at east side.	**Site Location:** 
Proposed Solution: Bank stabilization and revegetation (possible mangrove restoration, but long-term views may be a factor).	
Site Constraints: Sewer, parking lot, historical park features, water	**Other Notes:**
PHOTOS/SKETCHES	
	
Photo Caption: Eroding shoreline. Placed rock is starting to fall in from undermining.	**Photo Caption:** Eroding shoreline. Little vegetation in this area.

	
Photo Caption: Eroding shoreline with displaced rocks.	**Photo Caption:** Undermined section of wall that collapsed. See adjacent mangroves in the background.

Date Assessed:8/9/2022 6:44:49 AM

Assessed by: BW

Site Name: Geus Road Wet Swale — ID#: R-04

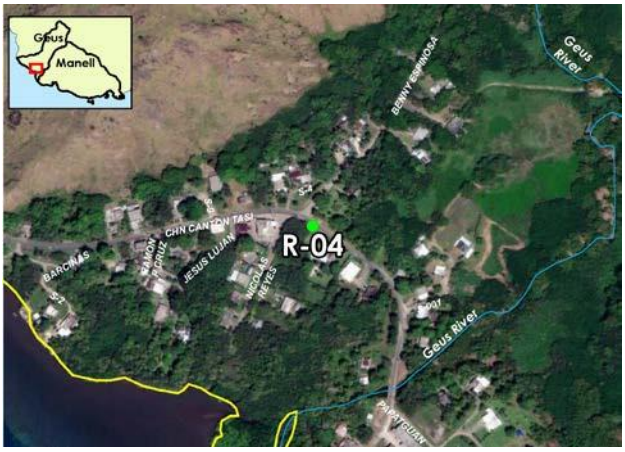
DESCRIPTION

Type of Project: Stormwater Retrofit

Preliminary Ranking: Medium

Existing Conditions: Runoff flows off Geus Road into this grassy area on the water side of Route 4.

Site Location:



Proposed Solution: Proposed solution is to convert grassy area into a storm water retrofit such as a wet swale.

Site Constraints: Site constraints are overhead wires sewer and water as well as private property.

Other Notes:

PHOTOS/SKETCHES

Photo Caption: Evidence of stormwater flows in this grassy area. Convert into a formalized wet swale.

Photo Caption: Existing erosion where runoff from Geus Rd is flowing into this area, bypassing the upgradient paved channel and culvert (see yellow headwalls).

Date Assessed:8/9/2022 6:21:30 AM

Assessed by: MW

Site Name: Shell Gas Station Pollution Prevention — ID#: R-05

DESCRIPTION

Type of Project: Hotspot Pollution Prevention

Preliminary Ranking: Medium

Existing Conditions: This is the only gas station in Merizo as well as a mini mart. Concrete channel carries flows underneath where people park as well as where people get gas. Potential for gas and other hydrocarbons to drip into the drainage channel and flow downstream.

Proposed Solution: Proposed solution here is to block the drainage channel and reroute flows around fueling station to prevent leaks from entering stormwater.

Site Location:

Site Constraints: Commercial property with limited space and existing infrastructure. Overhead wires sewer water and gas for the pumps.

Other Notes: Opportunity here for public education on watershed issues as this is the only gas station in Merizo area. Also there are drainage issues along the edge of the road in this area where erosion is evident.

PHOTOS/SKETCHES

Photo Caption: Parking in front of the mart next to gas station. Stormwater flows toward gas pumps along curb.

Photo Caption: Stormwater flows in the V-shaped paved channel from front parking area through fueling area. This increases opportunity for runoff to carry spills and leaks downstream toward water.

Date Assessed:8/9/2022 6:25:34 AM

Assessed by: MW

Site Name: Quinene Residential Stewardship — ID#: R-06

DESCRIPTION

Type of Project: Residential Stewardship

Preliminary Ranking: Medium

Existing Conditions: Tributary stream channel clogged with both vegetative debris and household waste including burn piles. Likely, flows from drainage area are diverted onto road, adding to road flooding issues, due to this clogging.

Proposed Solution: Residential stewardship in this area would be helpful. Work with neighborhood to improve these conditions and make changes on their personal properties to complement a larger roadside project.

Site Location:

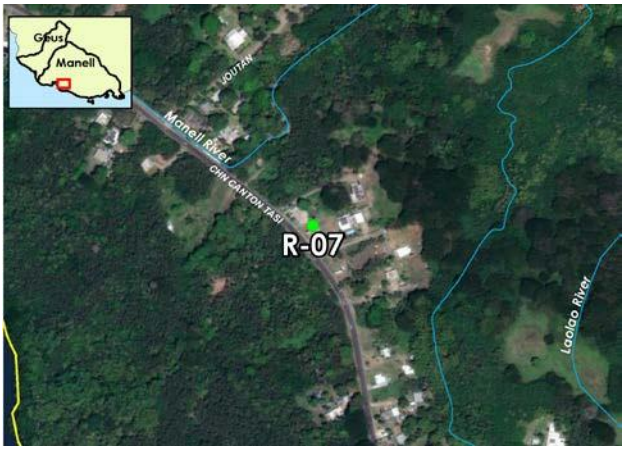
Site Constraints: Private property. Overhead wires. Sewer.

Other Notes:

PHOTOS/SKETCHES

Photo Caption: Example of drainage flow path (looking upgradient from headwall) clogged with debris.

Date Assessed:8/9/2022 4:00:58 AM **Assessed by:** MW

Site Name: Route 4 Near Babauta St Residential Stewardship	ID#: R-07
DESCRIPTION	
Type of Project: Residential Stewardship	**Preliminary Ranking:** Low
Existing Conditions: Two homes along Route 4 next to 1 Babauta St. with direct connection of roof runoff into adjacent infrastructure.	**Site Location:** 
Proposed Solution: Rain gardens would be a good option for these homes. Existing lawn areas are available and could be converted to rain gardens.	
Site Constraints: Rain gardens should not be implemented until the Manell River Relocation project constructed because these homes flood when river floods.	**Other Notes:**
PHOTOS/SKETCHES	
	
Photo Caption: House roof and yard drain to inlet structure along road.	**Photo Caption:** This house's roof and yard drain to culvert that discharges on other side of Route 4.

Date Assessed:8/9/2022 1:49:46 AM **Assessed by:** JLV

Site Name: Merizo Pier Park - Street Parking Improvements ID#: R-08

DESCRIPTION

Type of Project: UP Road Improvement

Preliminary Ranking: High

Existing Conditions: Very muddy and puddles on pavement and grass interface. See Line data for photos.

Site Location:

Proposed Solution: Convert paved and grass area use for parking to stabilized pavers. Swale along edge of pavers.

Site Constraints: Water drains across pavers so need to think about stormwater conveyance.

Other Notes: DPW built a berm along hillside to divert runoff from badlands away from parking area. Now, it flows the other direction towards nearby culvert.

PHOTOS/SKETCHES

Photo Caption: Paved and unpaved roadside parking that could be converted to stabilized pavers.

Photo Caption: Hillside berm redirecting runoff from badlands. This feature should be evaluated and improved as needed to ensure safe flows and sediment capture.

Date Assessed:8/8/2022 8:06:38 PM

Assessed by: JLV/MW

Site Name: Water Tank Paving	ID#: R-09
DESCRIPTION	
Type of Project: UP Road Improvement	**Preliminary Ranking:** Medium
Existing Conditions: Area in front of the water tower is unpaved and eroded, likely exacerbated from parking for the ballpark.	**Site Location:** 
Proposed Solution: Proposed solution here is to pave the driveway for the water tower and add stabilized paver parking for the ballpark. Addressing this source of sediment will reduce impacts to downstream practices (e.g., Mayor's Office site – R-14).	
Site Constraints: Waterline. Large trees.	**Other Notes:**
PHOTOS/SKETCHES	
	
Photo Caption: Eroded parking area for adjacent ballpark.	**Photo Caption:** Unpaved driveway for water tower.
Date Assessed:8/7/2022 5:09:42 AM	**Assessed by:** JLV/MW

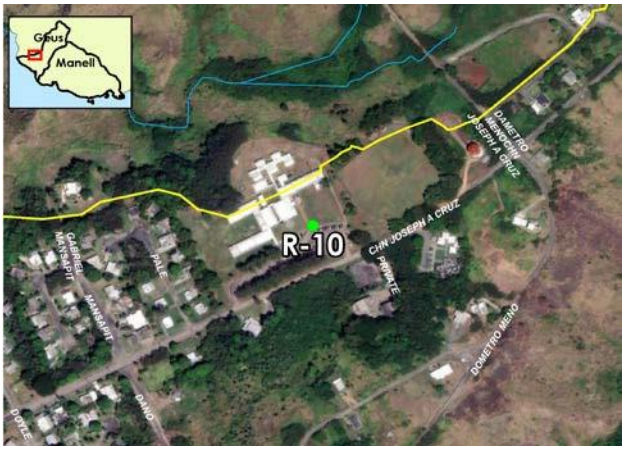
Site Name: School Courtyard Cutoff Trench	ID#: R-10
DESCRIPTION	
Type of Project: Stormwater Retrofit	**Preliminary Ranking:** High
Existing Conditions: Staff informed us the field gets soggy and brown water runs off from grassed courtyard into the parking lot and road. Trucks will drive through field, get stuck, making muddy holes.	**Site Location:** 
Proposed Solution: Install cutoff trench along base of adjacent steep slope to intercept groundwater flowing through this area and divert it to proposed stormwater features for R-20. Stabilize steep slope with vegetation to better hold soil in place.	
Site Constraints: Adjacent ballpark, access road and school fields.	**Other Notes:**
PHOTOS/SKETCHES	
	
Photo Caption: Grassy field looking up towards ballpark and steep, eroded slope.	**Photo Caption:** Parking lot staining where flow discharges from grassy field.

Photo Caption: Access road along edge of grassy field and steep, eroding slope. Proposed cutoff trench as shown.

Date Assessed:8/4/2022 12:47:06 AM **Assessed by:** JLV

Site Name: Boat Ramp Rain Gardens	ID#: R-11
DESCRIPTION	
Type of Project: Stormwater Retrofit	**Preliminary Ranking:** High
Existing Conditions: Runoff coming from Quinene Road and boat ramp parking. Boat ramp eroding, particularly near water. Some ponding at corner of pavement.	**Site Location:** 
Proposed Solution: Two rain gardens with public educational signage. See sketch.	
Site Constraints: Waterline in grassy area between two driveways.	**Other Notes:** Potential site for education.
PHOTOS/SKETCHES	
	
Photo Caption: Looking up western driveway toward Route 4 from boat ramp parking.	**Photo Caption:** Looking toward boat ramp from parking.

Photo Caption: Looking up eastern driveway toward Route 4 from boat ramp parking. Waterline marked out with stakes.

Site Sketch

Date Assessed:8/9/2022 4:21:52 AM

Assessed by: JLV

Site Name: Santa Marian Kamalen Park Parking Lot Bio	ID#:R-12
DESCRIPTION	
Type of Project: Stormwater Retrofit	**Preliminary Ranking:** High
Existing Conditions: Low point at left front parking space.Total parking - eight spaces; one handicap-accessible space.	**Site Location:** 
Proposed Solution: Shift parking towards road on east side to line up with road alignment. Add bioretention system to southeast corner of parking lot.	
Site Constraints: Coastal bank, utilities	**Other Notes:** Noddy roost in large tree in parking lot. Hundreds of birds roosting here – need to be protected.
PHOTOS/SKETCHES	
	
Photo Caption: Parking lot with sediment buildup, staining, and bird droppings visible.	**Photo Caption:** This edge of the parking lot can be pulled back from the shoreline for a bioretention.

Photo Caption: This area can be adjusted for stormwater management.

Site Sketch

Date Assessed:8/9/2022 6:44:57 AM

Assessed by: JLV

Site Name: Rosa Aguigui Reyes Memorial Library, Merizo Branch — ID#: R-13

DESCRIPTION

Type of Project: Stormwater Retrofit

Preliminary Ranking: High

Existing Conditions: Parking lot drains to a grassy area in front of the library building. Runoff also flows from the rooftop in a drip line in this area. There also seems to be flow coming from the main road down into the grassy area from the parking lot entrance.

Proposed Solution: Proposed project here is a swale to a bioretention system. Also, great opportunity for public education.

Site Location:

Site Constraints: Overhead wires. Water and sewer. Existing sidewalk that we would need to add conveyance underneath (i.e., pipe).

Other Notes: There are seven regular parking spaces and one handicap space in the lot. Sediment build up at the driveway entrance from the main road.

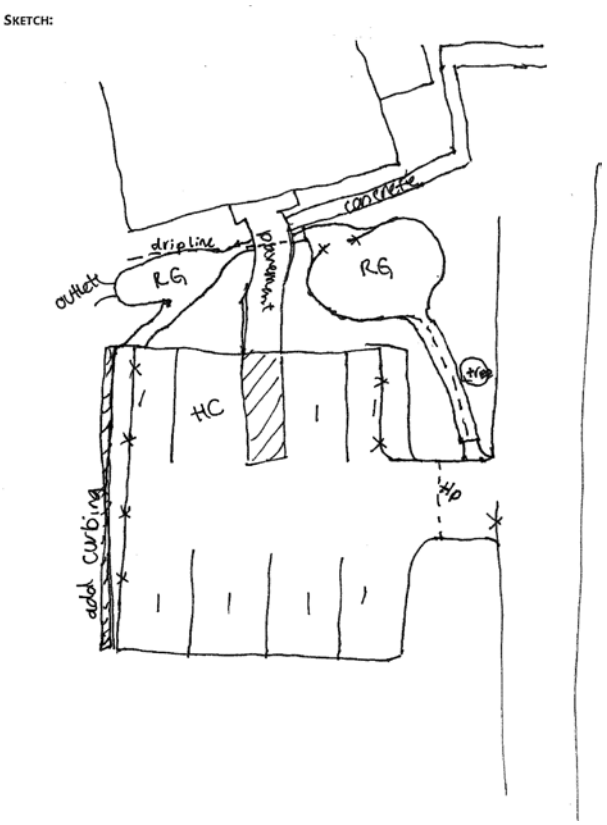
PHOTOS/SKETCHES

Photo Caption: Walkway to library; proposed rain gardens for both sides of walkway (see sketch).

Photo Caption: Looking back at library parking lot from front of library. Note eroded ditch in the grassy area proposed for a rain garden.

Photo Caption: Looking toward road and school beyond from front of library. Note eroded ditch and clogged culvert in the grassy area proposed for another rain garden.

SKETCH:



Site Sketch

Date Assessed:8/9/2022 7:08:42 AM

Assessed by: JLV/MW

Site Name: Merizo Mayor's Office Constructed Wetland — ID#: R-14

DESCRIPTION

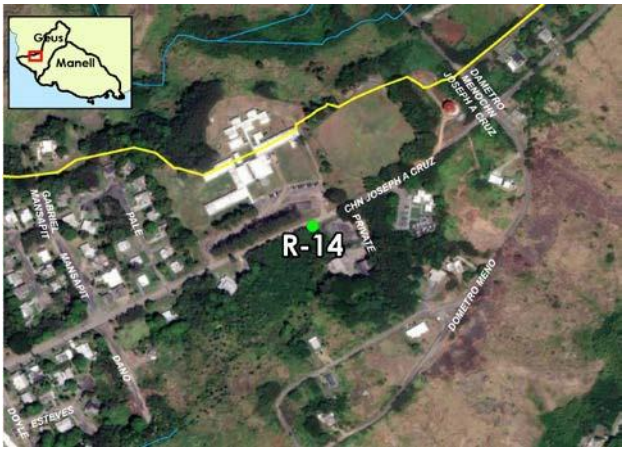
Type of Project: Stormwater Retrofit

Preliminary Ranking: High

Existing Conditions: Low point just down from tennis courts at mayors office and community center. Indications of ponding in this area from road runoff as well as school parking lot. Sediment buildup and cracking along the edge of the road here as well as staining from the ponding.

Proposed Solution: Propose to turn the existing depression into a constructed wetland for additional treatment and storage in this location.

Site Location:



Site Constraints: Constraints include overhead wires, wate,r and sewer as well as proximity to the recreation and mayor's facilities.

Other Notes: Need to confirm localized topography in this area to fine-tune the actual drainage area.

PHOTOS/SKETCHES

Photo Caption: Looking across the road at the school. Note sediment build-up in road.

Photo Caption: Looking upgradient at drainage area. Recreational courts located at chainlink fence on the right.

Photo Caption: Existing depression for proposed constructed wetland, shown in blue

Date Assessed:8/9/2022 7:24:00 AM **Assessed by:** MW

Site Name: Route 4 Roadside Wet Swale — ID#: R-15

DESCRIPTION

Type of Project: Stormwater Retrofit

Preliminary Ranking: High

Existing Conditions: Existing road is superelevated towards mountain side with a paved channel. Channel is mostly filled with sediment and grasses. It carries flow down towards the Asgadao Creek. Before runoff reaches the river, area flattens out in a wide cleared right of way area.

Proposed Solution: Stormwater retrofit here should be a wet swale in the right of way area to treat runoff before discharging into the Asgadao Creek.

Site Location:

Site Constraints: Overhead wires, water

Other Notes:

PHOTOS/SKETCHES

Photo Caption: Looking upgradient at where clogged paved channel brings flow into grassy area.

Photo Caption: Looking downgradient where grassy area flattens out before reaching Asgadao Creek. Proposed wet swale shown in blue.

Date Assessed:8/7/2022 1:43:02 AM

Assessed by: JLV

Site Name: Merizo Pier Park Court Parking Lot Bioretentions	ID#: R-16
DESCRIPTION	
Type of Project: Stormwater Retrofit	**Preliminary Ranking:** High
Existing Conditions: Grass overgrown on edges of pavement. Flow path appears to flow down across grass to picnic table at the shoreline. Causing erosion around the picnic table and on the shoreline down to the water. Puddling at back of parking lot.	**Site Location:** 
Proposed Solution: Direct flows from parking lot and courts into two bioretention areas at each downgradient corner of the parking lot. Opportunities here to stabilize shoreline, improve amenities (picnic table area, trash collection), and provide public eductation.	
Site Constraints: Close to eroding shoreline and recreational amenities. Need to ensure access for park users as well as maintenance staff.	**Other Notes:** Runoff flowing from Road onto parking lot. 82.5' x 58' paved parking lot.
PHOTOS/SKETCHES	
	
Photo Caption: Grassy area and erosion near picnic table along shoreline.	**Photo Caption:** View of parking lot from road with ocean in the background.

Photo Caption: Existing ponding along parking lot edges.

Site Sketch: See sketch above for this site identified with 1, as well as R-17 shown as 2, R-18 & 19 shown as 3, and R-08 as 4.

Date Assessed:8/7/2022 9:22:45 PM **Assessed by:** JLV/MW

Site Name: Merizo Community Center Roof Rain Garden — ID#: R-17

DESCRIPTION

Type of Project: Stormwater Retrofit

Preliminary Ranking: High

Existing Conditions: Drip line along perimeter of building. Some evidence of stone. Low point appears to be at back middle of building. Puddling behind building.

Site Location:

Proposed Solution: Formalize drip line around building and drain to low point at back of building. Direct water into rain garden.

Site Constraints: Adjacent to coastal bank

Other Notes:

PHOTOS/SKETCHES

Photo Caption: Grassy dripline along front of building.

Photo Caption: Somewhat eroded dripline along side.

Photo Caption: Wet, muddy area where runoff ponds behind building.

Site Sketch – see sketch for R-16

Date Assessed:8/7/2022 9:49:45 PM

Assessed by: JLV

Site Name: Merizo Pier Park Parking Lot Bio West	ID#: R-18
DESCRIPTION	
Type of Project: Stormwater Retrofit	**Preliminary Ranking:** High
Existing Conditions: Portion of parking lot and shower runoff directly going down boat ramp. Catch basin captures parking lot runoff and outlets it to the ocean (not able to find outfall).	**Site Location:** 
Proposed Solution: Divert parking lot area and shower runoff into a bioretention system in park area. Add educational signage. Create speed hump across boat ramp to direct water to bioretention system. Direct downstream catch basin from the upper parking lot to bioretention system.	
Site Constraints: Boat Ramp, Utilities	**Other Notes:**
PHOTOS/SKETCHES	
	
Photo Caption: Downstream Catch basin in upper parking lot	**Photo Caption:** Grassy area in park to be the proposed area for Bioretention system.

Photo Caption: View of parking lot area looking toward boat ramp. Area to be directed to Bioretention system.

Site Sketch - see sketch for R-16

Date Assessed:8/7/2022 10:08:55 PM

Assessed by: JLV

Site Name: Merizo Pier Parking Lot Bio East	ID#: R-19
DESCRIPTION	
Type of Project: Stormwater Retrofit	**Preliminary Ranking:** High
Existing Conditions: Upgradient catch basin in the upper parking lot connects to downgradient carch basin. Unclear where they outlets to but suspect pipe runs to the riprap bank.	**Site Location:** 
Proposed Solution: Divert upgradient catch basin pipe to bioretention system in grass area on east side of sidewalk. Divert runoff from concrete paths and ramp to bioretention system. Add educational signage.	
Site Constraints: Utilities	**Other Notes:**
PHOTOS/SKETCHES	
	
Photo Caption: Looking upgradient of second catch basin.	**Photo Caption:** Looking upgradient toward second catch basin and to grassy area to the east of the parking lot.

	
Photo Caption: Looking downgradient from bottom of concrete ramp. Eroded flow path that outlets to ocean.	**Site Sketch - see sketch for R-16**

Date Assessed:8/8/2022 8:09:40 PM **Assessed by:** JLV/MW

Site Name: School Parking Lot Bio	ID#: R-20
DESCRIPTION	
Type of Project: Stormwater Retrofit	**Preliminary Ranking:** High
Existing Conditions: Paved parking lot. No stormwater management. Flat. Some vegetation growing on pavement along curb line.	**Site Location:** 
Proposed Solution: Install a bioretention/dry swale system along the school entrance and road. Integrate with R-10 concept. Good location for educational signage.	
Site Constraints: Fence along road, mature trees, proximity to school.	**Other Notes:**
PHOTOS/SKETCHES	
	
Photo Caption: Parking lot island	**Photo Caption:** Sidewalk along parking lot looking toward eroded slope from R-10.

Photo Caption: Grassy area between parking lot and road where stormwater can be managed.

Site Sketch

Date Assessed:8/7/2022 8:23:45 PM

Assessed by: MW

Site Name: Helmani's Apartments Rain Gardens	ID#: R-21
DESCRIPTION	
Type of Project: Stormwater Retrofit	**Preliminary Ranking:** Medium
Existing Conditions: Apartment complex with large parking area and some ponding in the driveway.	**Site Location:** 
Proposed Solution: Proposed solution is to divert the flows to grassy areas on either side of the entrance in rain gardens.	
Site Constraints: Constraints are overhead wires, pump station across the street, and water in this area as well.	**Other Notes:**
PHOTOS/SKETCHES	
	
Photo Caption: Ponded water in the parking lot.	**Photo Caption:** Open grassy area where a rain garden could be installed.

	
Photo Caption: Looking towards Route 4 from parking lot.	**Site Sketch:** Direct runoff into rain gardens on either side of parking lot.

Date Assessed:8/9/2022 5:48:32 AM **Assessed by:** MW

Site Name: Route 4 Roadside Swales — ID#: R-22

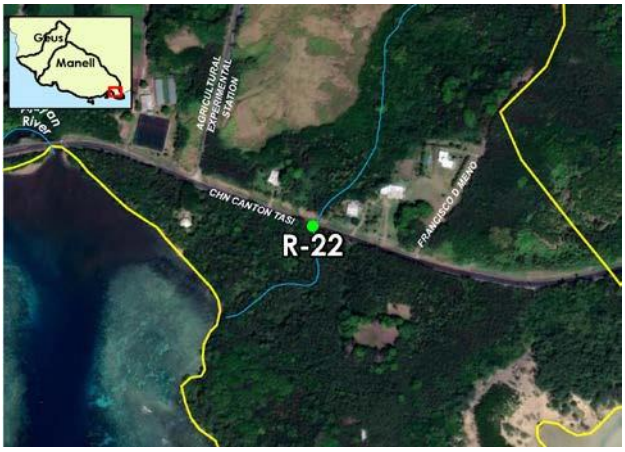
DESCRIPTION

Type of Project: Stormwater Retrofit

Preliminary Ranking: Medium

Existing Conditions: Flat stretch of road, not crowned but superelevated. Visible signs of ponding on both sides of the road. Probably floods during rain events.

Site Location:



Proposed Solution: Water quality swales on both sides of the road to minimize flooding, treat water, and help convey it to the stream where there's currently erosion around the existing headwalls.

Site Constraints: Existing constraints include a water line on the mountain side of the road and possible underground electrical line on the ocean side of the road. Overhead wires on the mountain side.

Other Notes: Road is 20 feet wide. 12 1/2 grass strip on mountain side 14 1/2 grass strip. Indication that road shoulder is paved with grass growing over it

PHOTOS/SKETCHES

Photo Caption: Open, grassy shoulder on ocean-side of road where a stormwater swale could be installed.

Photo Caption: Open, grassy shoulder on mountain-side of road where a stormwater swale could be installed.

	
Photo Caption: Visible paved shoulder in this section with grass growing on top – likely more pavement than visible in other sections as well.	**Site Sketch:** Location of very shallow roadside swale for managing runoff.

Date Assessed:8/7/2022 12:02:16 AM **Assessed by:** JLV

Site Name: Dometro Meno Bus Stop Bio — ID#: R-23

DESCRIPTION

Type of Project: Stormwater Retrofit

Preliminary Ranking: Medium

Existing Conditions: 19' Road and 18' road intersection. Curbs on both sides uphill. Extra pavement in intersection. Steep slope.

Site Location:

Proposed Solution: Stormwater practice behind bus stop. Pavement removal. Speed bump for diverting flow.

Site Constraints: Steep slope. Overhead wires. Waterline.

Other Notes:

PHOTOS/SKETCHES

Photo Caption: Looking at site from across the road.

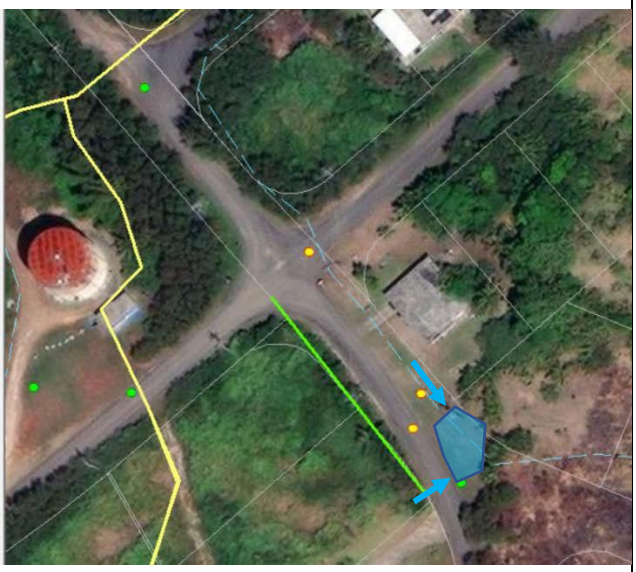
Photo Caption: Retrofit location behind bus stop.

Date Assessed:8/7/2022 4:47:01 AM

Assessed by: JLV

Site Name: Dometro Meno ROW Bio	ID#: R-24
DESCRIPTION	
Type of Project: Stormwater Retrofit	**Preliminary Ranking:** Medium
Existing Conditions: This site is downstream from a culvert across the road from a paved swale. Flat open grassy area within the public right away.	**Site Location:** 
Proposed Solution: Bring runoff from concrete swale across the road via pipe to bioretention. Use to slow water down, reduce erosion and runoff volume, and treat stormwater. The discharge would continue on down the slope and may need to be stabilized. This practice would help reduce downstream flooding and sediment issues on Geus Road.	
Site Constraints: Overhead wires, utility pole and steep slopes.	**Other Notes:** Resident at adjacent house informed us the water tank across the street leaks and flows into his yard occasionally.
PHOTOS/SKETCHES	
	
Photo Caption: Looking downhill at proposed BMP location, from adjacent yard.	**Photo Caption:** Looking back at proposed BMP location.

Photo Caption: Existing eroded ditch where runoff flows down towards the badlands.



Site Sketch: Proposed bioretention shown in blue. Flow directed into bio as shown with blue arrows.

Date Assessed:8/7/2022 5:01:54 AM

Assessed by: JLV

Site Name: Geus River Floodplain Restoration — ID#: R-25

DESCRIPTION

Type of Project: Stream/Wetland Restoration

Preliminary Ranking: Medium

Existing Conditions: Cleared empty lot. Currently where storm water/river water flows to when Geus River culvert is clogged or just overwhelmed.

Site Location:

Proposed Solution: Use this area for floodplain restoration/retention.

Site Constraints:
Private property.

Other Notes:

PHOTOS/SKETCHES

Photo Caption: Open grassy area for floodplain restoration behind chainlink/barb wire fence. During heavy rains, evidence that floodwaters already come here.

Photo Caption: Culvert for Geus River with bamboo floating and clogging this area.

Date Assessed:8/9/2022 5:55:23 AM

Assessed by: JLV

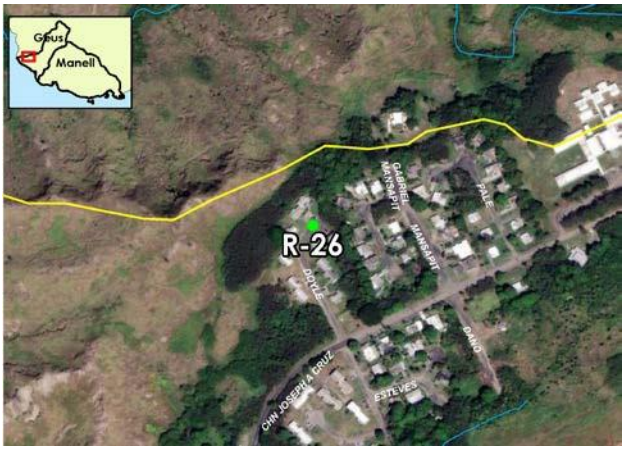
Site Name: N Doyle St Complex SW Opportunities	ID#: R-26
DESCRIPTION	
Type of Project: Stormwater Retrofit	**Preliminary Ranking:** Medium
Existing Conditions: Housing complex with a network of concrete swales/catch basins collecting roof and pavement runoff.	**Site Location:** 
Proposed Solution: Implement green infrastructure measures to the complex, including converting concrete swales to grassed swales, constructed rain gardens, and installing cisterns for rainwater harvesting of roof runoff.	
Site Constraints: Private property, utilities	**Other Notes:**
PHOTOS/SKETCHES	
	
Photo Caption: Parking and buildings in development.	**Photo Caption:** Concrete channel directing road and roof runoff.

Photo Caption: Concrete channel directing road and roof runoff.

Site Sketch: Proposed green infrastructure for development, including grassed swale (green), cisterns (dark blue), rain garden (light blue).

Date Assessed:8/7/2022 7:55:28 PM

Assessed by: JLV

Site Name: Ajayan River Restoration — ID#: R-27

DESCRIPTION

Type of Project: Stream/Wetland Restoration

Preliminary Ranking: High

Existing Conditions: Extensive sediment deposit downstream of bridge. Major stream bank erosion where river comes out to the bay at route four. River takes 90° turn before bridge and the bank is being scoured away. Existing water line is leaking at a future connection point.

Proposed Solution: Proposed restoration at the site includes stream bank hardening to protect the roadway infrastructure and reduce sediment source out to the bay here. Likely a hardened type structure with gabion baskets and some plants as well.

Site Location:

Site Constraints: Overhead wires, Water, private property

Other Notes: Look for additional upland restoration and management opportunities to reduce total runoff to this river. Erosion is evident on both sides of river not just at 90° bend.

PHOTOS/SKETCHES

Photo Caption: Eroding bank of Ajayan River.

Photo Caption: Erosion along road.

	
Photo Caption: Erosion along road.	**Photo Caption:** Riverbank erosion.

Date Assessed:8/6/2022 8:34:27 PM

Assessed by: JV/MW

Site Name: Redirect Tributary along Quinene — ID#: R-28

DESCRIPTION

Type of Project: Stream/Wetland Restoration

Preliminary Ranking: High

Existing Conditions: Tributary has been rerouted to run along road. Resident says entire road floods often.

Site Location:

Proposed Solution: Redirect tributary to the natural path of crossing the road and going directly to the stream prior to neighborhood.

Site Constraints: Residential houses. Utilities. Overhead wires.

Other Notes: See concrete channel and culvert infrastructure points for additional photos.

PHOTOS/SKETCHES

Photo Caption: Clogged culvert at downgradient side of road crossing.

Photo Caption: Concrete diversion channel full of sediment and debris. Downgradient of tributary redirection.

Date Assessed:8/9/2022 4:00:41 AM

Assessed by: JLV

Site Name: Manell River Relocation — ID#: R-29

DESCRIPTION

Type of Project: Stream/Wetland Restoration

Preliminary Ranking: High

Existing Conditions: The Manell River currently makes a 90-degree turn immediately upstream of Route 4, flows parallel to the road in large concrete channel, then makes another 90-degree turn before crossing under the road in two locations. Diversion causes major flooding and debris build up for the whole neighborhood and Route 4.

Site Location:

Proposed Solution: Restore a more natural river path closer to historic location by constructing a culvert crossing immediately before the upstream 90-degree bent culvert and recreating a naturally shaped channel downstream of Route 4 to the ocean.

Site Constraints: Private property, Utilities

Other Notes:

PHOTOS/SKETCHES

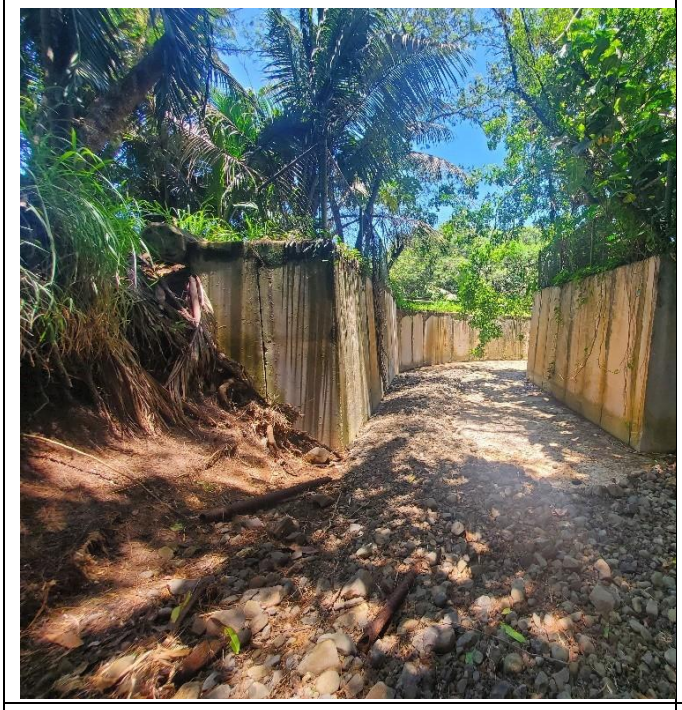
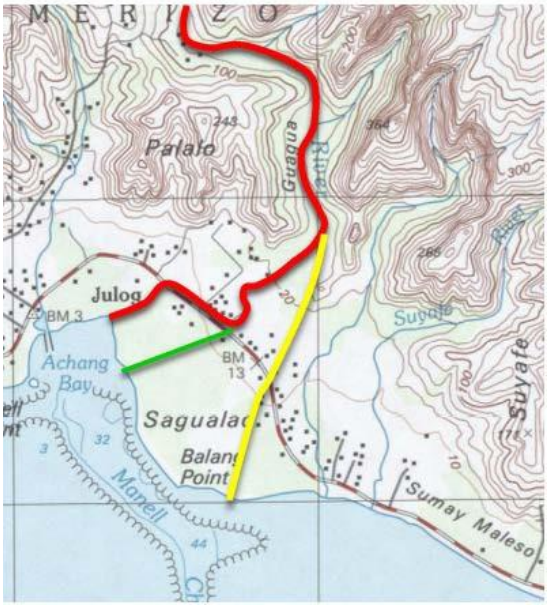


Photo Caption: Standing in river, looking toward 90-degree bend in concrete channel that runs along the road.

Photo Caption: Looking at culverts just downstream of upstream 90-degree bend.

Photo Caption: Looking at culverts just upstream of the downstream 90-degree bend.



Site Sketch: Current (Red), Potential (Green), and Historic (Yellow) Path of the Nelansa/Manell River (U.S. Army Corps of Engineers, 2020b)

Date Assessed:

Assessed by: JLV

Site Name: Quinene Bamboo Removal — ID#: R-30

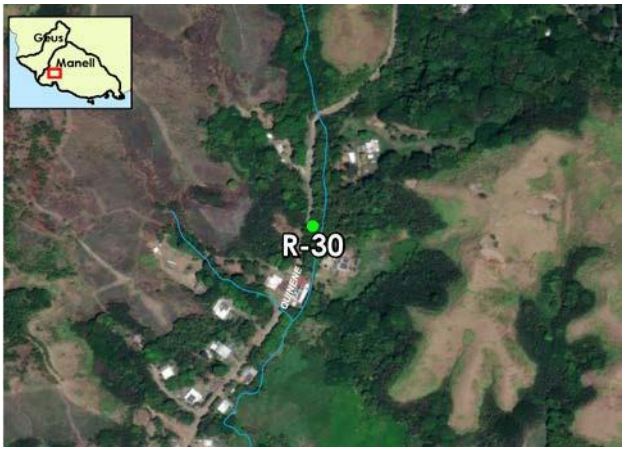
DESCRIPTION

Type of Project: Stream/Wetland Restoration

Preliminary Ranking: Medium

Existing Conditions: At least 3 to 4 large clumps of bamboo right along the banks of the river.

Site Location:



Proposed Solution: Invasive species management. Remove bamboo and treat cut stems with herbicide. Remove fallen bamboo and other debris from stream.

Site Constraints: Private property. Proximity to road. Water line.

Other Notes:

PHOTOS/SKETCHES

Photo Caption: Large clumps of bamboo on riverbank along Quinene Rd.

Date Assessed:8/9/2022 3:39:36 AM **Assessed by:** MW

Site Name: Geus River Bamboo Site — ID#: R-31

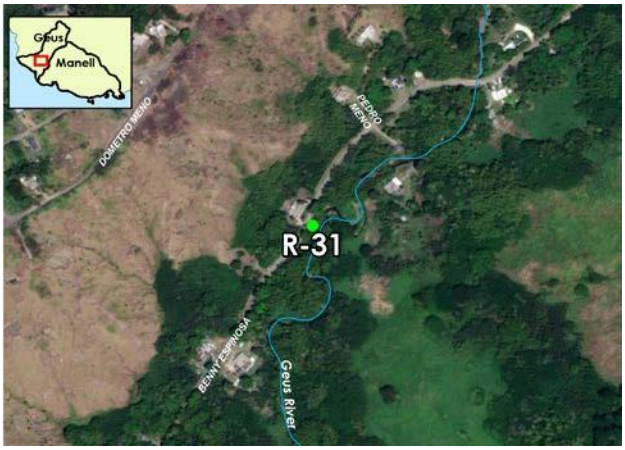
DESCRIPTION

Type of Project: Stream/Wetland Restoration

Preliminary Ranking: Medium

Existing Conditions: Clumping bamboo falling into river.

Site Location:



Proposed Solution: Clearing of bamboo.

Site Constraints: Difficult to access.

Other Notes:

PHOTOS/SKETCHES

Photo Caption: Collapsed bamboo clump along river.

Date Assessed:8/7/2022 7:26:10 AM **Assessed by:** JLV

Site Name: Manell River Bamboo Removal — ID#: R-32

DESCRIPTION

Type of Project: Stream/Wetland Restoration

Preliminary Ranking: Unsure

Existing Conditions: Steep, bare bank. Invasive bamboo and vines. Previous bamboo treatments done.

Site Location:

Proposed Solution: Continued invasive mgmt, bank stabilization/revegetation

Site Constraints: Access through private property. Commitment to invasive work.

Other Notes:

PHOTOS/SKETCHES

Photo Caption: Large stand of bamboo in area near past bamboo removal site.

Date Assessed:8/4/2022 2:52:01 AM **Assessed by:** BW

Site Name: Quinene Wetland Enhancement — ID#: R-33

DESCRIPTION

Type of Project: Stream/Wetland Restoration

Preliminary Ranking: Low

Existing Conditions: Wetland area along Quinene adjacent to river. Several drainage paths converge at this location.

Site Location:

Proposed Solution: Enhance and protect wetland from additional development/alteration. Provide better conveyance from steep slopes on mountain side of Quinene Rd to this area.

Site Constraints:
Private property.

Other Notes:

PHOTOS/SKETCHES

Photo Caption: Existing wetland area along private driveway.

Date Assessed:8/9/2022 4:10:31 AM **Assessed by:** JLV

Site Name: Dometro Meno Revegetation North — ID#: R-34

DESCRIPTION

Type of Project: Upland Revegetation

Preliminary Ranking: Medium

Existing Conditions: Culvert at bottom of slope and outlets down steep hill across the road. Potentially high erosion downhill of culvert; very steep. Steep hill with bare soil. Some short grass. Looks like a point of high sediment runoff.

Proposed Solution: Revegetate sloped area to stabilize slope and reduce sediment runoff.

Site Location:

Site Constraints: Overhead wires. Fire hydrant. Steep slopes.

Other Notes:

PHOTOS/SKETCHES

Photo Caption: Looking toward upgradient end of culvert and bare sloped area.

Site Sketch: Approximate area to be revegetated.

Date Assessed:8/7/2022 5:36:35 AM

Assessed by: JLV

Site Name: Dometro Meno Revegetation South — ID#: R-35

DESCRIPTION

Type of Project: Upland Revegetation

Preliminary Ranking: Medium

Existing Conditions: Bare soil and short grass on slope.

Site Location:

Proposed Solution: Revegetate slope.

Site Constraints: Private property. Waterline

Other Notes:

PHOTOS/SKETCHES

Photo Caption:

Site Sketch: Approximate area to be revegetated.

Date Assessed:8/7/2022 5:49:41 AM

Assessed by: JLV

ATTACHMENT C: DRAINGE INFRASTRUCTURE INVENTORY

Table C1. Manell-Geus Watersheds Existing Infrastructure Inventory

IDs starting with "ME" or "IV" are structures previously mapped by DPW (same ID#s). IDs starting with "I" are other structures added by HW.

ID	Structure	Description / Notes	Sediment	Damage	Flow	Erosion	Severity	Maintenance Needed
ME-103	Bridge	Concrete. Total height: 14.8', clearance: 6.5'. Indications of problems upstream. Appears that river occasionally flows over bridge.	Some	Yes	Constant Stream	Severe	4	Repair
I-03	Bridge	Concrete, 15' span, height: ~6'. Clear out veg and sediment. Resident said it fills but doesn't flood.	None	Yes	Constant Stream	Moderate	2	Repair
ME 130, IV 120	Bridge	Concrete. Stabilization around bridge needed. This project was marked as complete by the DPW; however, it looks like they did some work but not all the work described. There has been some riprap added but more maintenance needed.	N/A	Yes	Constant Stream	Moderate	2	Repair
I-39	Bridge	Concrete, 73' bridge span. 28' wide. Three sections. Wing walls in middle. Sediment removal. Bamboo removal. Debris removal. Slight damage and undermining along the edge of the slabs and headwall. Not as bad as bridges along Route 4.	Some	No	Constant Stream	Low	1	Routine Maintenance
ME-106	Bridge	Concrete, Bridgespan 48'. Clearance 6.5'. Evaluate flow to determine if bridge spans should be longer. DPW priority project. Road undermined at all four corners.	Some	Yes	Constant Stream	Severe	4	Repair
I-53	Bridge	Tainatongo Private Bridge. Unable to observe.	N/A	N/A	N/A	N/A	N/A	N/A
I-35	Concrete swale	Concrete, total width: 4', base width: 1'. Swale needs to be cleaned out and vegetation cut down.	Full	Yes	None	None	4	Repair
ME-108	Culvert	Concrete, 4' w x 3' h. Severe road undermining.	Some	Yes	Constant Stream	Severe	4	Replace
I-01	Culvert	Concrete, 3 culverts at 6'w x 5' h. Clear debris. Depths of channel 6.5 feet. Major flooding issue.	Some	No	None	None	5	Routine Maintenance
I-02	Culvert	Concrete, 3 culverts at 6'w x 2.5' h. Trickling water. Debris on upstream side.	Some	No	Constant Stream	Low	5	Repair
ME-102	Culvert	Concrete, 2 culverts at 36" diameter. Evaluate to determine if culvert should be replaced with bridge. Small amount of water flowing.	Full	Yes	Constant Stream	Severe	5	Replace
I-04	Culvert	Metal, 12" diameter. Concrete swale along ROW (filling in with grass), leading to culvert. Culvert outlets to vegetated hillside.	None	No	No	None	N/A	None Needed
I-05	Culvert	PVC, 12" diameter. Culvert under road. Outfalls to vegetated slope.	Some	No	No	None	N/A	None Needed
I-06	Culvert	Concrete, 2 culverts of 18" diameter.	Some	No	No	Low	1	Routine Maintenance

ID	Structure	Description / Notes	Sediment	Damage	Flow	Erosion	Severity	Maintenance Needed
I-09	Culvert	Concrete, 24" diameter. Pipe half full w sediment and needs clearing of debris. A lot of debris and sediment upstream and downstream.	Some	No	None	None	1	Routine Maintenance
I-10	Culvert	Concrete, 18" diameter (x3) + 36" (x4) - 8' length from upstream side. Bridge section - 18' W x 17' L x 5.5' H. Clear out sediment, debris, and concrete. Repair concrete headwall/bridge structure. clearance is 4'8" from downstream pipe but only 4' at concrete "beam" in center. Concrete debris underneath. Constant trickle flow. One of 18"ers totally blocked by concrete; other two partially blocked.	None	No	Constant Stream	Low	4	Repair
I-19	Culvert	Concrete, 12" diameter.	Some	No	No	None	N/A	None Needed
ME-122	Culvert	Concrete, 10’ w x 5’ h . Clear out culvert. Stabilize slopes. Wall along downstream end of headwall. Rip rap on upstream side of headwall. Erosion along channel after riprap.	Some	Yes	Constant Stream	Low	2	Repair
ME-115	Culvert	Concrete, 5.5’ w x 3’h. Undermining on corners of headwalls. Formalize channel from road runoff. Swale on mountain side of the road. This is one of three culverts covered by ME-115.	Some	Yes	Constant Stream	Moderate	3	Repair
ME-115	Culvert	Concrete, 5.5’ w x 3’ h . Runoff from road made ditch to upstream side of culvert. Stabilize slopes. Clear debris and sediment. River makes 90° left turn at end of culvert. This is one of three culverts covered by ME-115.	Some	Yes	Constant Stream	Moderate	4	Repair
I-20	Culvert	Concrete, 24” diameter. Culvert is clogged on the downstream side with sediment and debris. Channel has filled with a lot of vegetation and should be cleared out. Culvert is under the Quinene Road. The road is 14 feet wide.	Some	Yes	None	Low	3	Repair
ME-116	Culvert	Concrete, 6'x3'. Need to stabilize erosion at the north mountain side wing wall. There is standing water in this area because mangroves are holding the water. Must flow only during wet weather. This is the outlet for the Achang River.	Some	No	No	Low	2	Repair
ME-115	Culvert	Concrete, 3'x5'. This is a channel dug to go around a home. Will need routine maintenance to keep clear of debris. Channel takes a few 90° turns to go through culvert. Area is impacted when Manell River floods. Resident has built wall to protect front door from flooding. This is one of three culverts covered by ME-115.	Some	No	Constant Stream	Low	1	Routine Maintenance

ID	Structure	Description / Notes	Sediment	Damage	Flow	Erosion	Severity	Maintenance Needed
I-21	Culvert	Concrete, 18” diameter. Maintenance required at this location is just routine maintenance of keeping the vegetation and debris clear of the culvert. Crosses Jose Pop Tonico Reyes Street and connects into a catch basin via a concrete channel along Route 4 before it crosses the road.	Some	No	None	None	1	Routine Maintenance
I-22	Culvert	Concrete, 2 culverts at 18” diameter. Routine maintenance needed at this site to make sure downstream end of culvert is clear of debris so that it can flow out to the bay. We were not able to observe the downstream end of this culvert due to private property and a chain-link fence.	None	No	No	None	1	Routine Maintenance
I-23	Culvert	Concrete, 24” diameter. Routine maintenance needed at this culvert. Sediment removal on upstream side and stabilization around the headwalls. Vegetation debris removal at the downstream side to open up the channel to the water. Stabilize road runoff down into the culvert.	Some	No	No	Low	1	Routine Maintenance
I-24	Culvert	Metal, 2 culverts at 28” diameter. This culvert needs maintenance to clear vegetation that has built up on both upstream and downstream sides. There's some erosion around the edges. And someone has built a berm on the Geus side of the channel likely to prevent flooding of a home. There are two culverts here but one is filled in with sediment; it was hard to see on the upstream side.	Some	Yes	None	Low	3	Repair
I-25	Culvert	Metal, 2 culverts at 18” diameter. Clear veg and sediment on upstream side. Downstream outfall not observed. Must discharge into a channel past about 100 foot stretch of grassy area. Could consider opening up the channel to give more flow capacity and storage in this area. Likely gets flow when the Geus floods.	Some	No	No	Low	1	Routine Maintenance
I-26	Culvert	Concrete, 2.5x4’. Routine maintenance needed on this culvert. Sediment removal and clearing debris. This culvert goes under Geus road. Much of the runoff from the road actually flows across the intersection of Route 4 and into a grass channel on the other side of Route 4. May need to reconfigure/enlarge infrastructure to better capture runoff from Geus Rd.	Some	No	None	Low	1	Routine Maintenance

ID	Structure	Description / Notes	Sediment	Damage	Flow	Erosion	Severity	Maintenance Needed
I-27	Culvert	Concrete, 2 culverts at 20" diameter. Clear debris, shore up head walls, stabilize slopes on both upstream and downstream sides. Water depth in culvert is 20" on the downstream side. Further down from the culvert, there's a buildup of sediment. Downstream would flow in heavy rain. Undercutting at upstream end of culvert (and high side of road) indicates water from the bay is backing up to the culvert, spilling over the road and to the upstream end of the culvert.	Some	Yes	Constant Stream	Moderate	3	Repair
I-28	Culvert	Concrete, 24" diameter. Clean out culvert. Grass has recently been cut and trimmings are in front of culvert.	Some	Yes	None	Low	1	Routine Maintenance
IV-118, IV-119	Culvert	Concrete, 24" diameter. Add stabilized way for the runoff to get to the stream from the road. Standing water on upstream and downstream of culvert; blocked by sediment. There is currently no way for the runoff from the road to get to the culvert, causing erosion on both sides of the headwall.	Some	Yes	Unsure	Moderate	3	Repair
I-29	Culvert	Concrete, 2 culverts at 30" diameter. Stabilize sides of culvert headwall. 12 inch water depth; culvert half full.	Some	Yes	Constant Stream	Moderate	3	Repair
ME 101	Culvert	Concrete, 2 culverts at 36" diameter, 1 culvert at 24" diameter. Stabilization needed on both sides of headwall upstream. Downstream end of culvert is rock lined on slopes; no maintenance needed. Water service line goes through culvert to house.Water is flowing couple inches deep. 24" culvert is set higher than the 2x36" culvert. Water line crosses right in front of the culvert, which could create blockages.	None	Yes	Constant Stream	Moderate	3	Repair
I-30	Culvert	PVC, 20" diameter. Culvert to be replaced and upsized	Some	Yes	None	Moderate	5	Replace
I-31	Culvert	Concrete, 2 culverts at 24" diameter. Culverts are blocked by sediment, rocks, branches, and debris. Needs to be cleared out and perhaps culvert capacity assessed to determine if larger ones are needed. Erosion visible at the site.	Full	Yes	None	Moderate	4	Repair
I-32	Culvert	Concrete, 3 culverts at 24" diameter. Recommend bridge. Tidal influence.	Full	Yes	Constant Stream	Severe	4	Replace
I-33	Culvert	Concrete, 2 culverts at 24" diameter. Sediment removal on downstream end.	Some	No	None	Low	1	Routine Maintenance

ID	Structure	Description / Notes	Sediment	Damage	Flow	Erosion	Severity	Maintenance Needed
I-34	Culvert	Concrete, 24" diameter. End of culvert is crumbling. Sediment needs to be cleaned out. Erosion on slopes at downstream end. Upstream end of culvert looks decent.	Some	Yes	None	Moderate	3	Repair
ME-105	Culvert	Concrete, 4'wx 3' h. The structure needs to be replaced. There is severe erosion on both water and mountain side. Bank erosion is visible in both upstream and downstream directions. Headwall with wing walls. Some debris at upstream and downstream side. DPW inventory has this listed incorrectly as 4'x4' culvert.	None	Yes	Constant Stream	Severe	4	Replace
I-41	Culvert	Concrete, 6' w x 2' h. Roadside erosion. Not much bank erosion. Evaluate flow to determine if culvert should be upsized. Bankside erosion on upstream side of culvert.	Some	Yes	Constant Stream	Moderate	3	Repair
ME-110	Culvert	Concrete, 2 culverts at 6' w x 3' h. Evaluate flow to determine if culvert should be replaced with the bridge. Stabilize sides of headwall.	Some	Yes	Constant Stream	Severe	5	Replace
ME-113	Culvert	Concrete, 2 culverts at 6' w x 3' h. Clear debris and vegetation. Pipe going north from grate. Grate appears to be in good condition. Erosion on both sides of head wall. Filled of sediment in culvert about 6 inches.	Some	Yes	None	Moderate	3	Repair
ME-112	Culvert	Concrete, 6' w x 4' h. Clear debris and sediment. About 6 inches of sediment in culvert. Standing water at downstream end of culvert. Upstream of culvert is dry. Some erosion on downstream side. Upstream side in good condition.	Some	Yes	Constant Stream	Low	1	Routine Maintenance
I-42	Culvert	Concrete, 3 culverts at 6' w x 4' h. Clear debris. Low flow diversion structure sending flow to this culvert from main Manell River culvert. Some debris build-up.	Some	Yes	None	Low	5	Replace
I-43	Culvert	Concrete, 3 culverts at 6' w x 3' h. Remove debris and vegetation. Standing water upstream and downstream culvert. Some debris.	Some	No	None	None	1	Routine Maintenance
I-44	Culvert	Concrete, 6' w x 4' h . Remove debris and sediment.	None	No	Constant Stream	Low	1	Routine Maintenance
I-45	Culvert	Concrete, 36" diameter. Repair headwall. Remove debris. Trickle of water flowing.	None	No	Constant Stream	Low	2	Repair
I-46	Culvert	Metal, 54" diameter. Repair guardrail, stabilize slopes.	None	Yes	Constant Stream	Moderate	3	Repair
I-47	Culvert	Concrete, 2 culverts at 36" diameter.	None	Yes	Constant Stream	Moderate	2	Repair

ID	Structure	Description / Notes	Sediment	Damage	Flow	Erosion	Severity	Maintenance Needed
I-48	Culvert	Concrete, 36” diameter. Remove debris. Resident says not too much water comes down this culvert.	Some	No	Constant Stream	Low	1	Routine Maintenance
I-49	Culvert	Concrete, 18” diameter. Used to be an issue for downstream side but filled with dirt. Culvert 75% full. Resident says culvert does not flow. When it does, little water ponds on their property. Doesn't cause any damage. Looks like it would be an issue for the upstream side.	Full	No	No	None	3	Repair
I-50	Culvert	Concrete, 15” diameter. Stabilize slopes. Repair headwall. Standing water.	None	Yes	Constant Stream	Moderate	3	Repair
I-51	Culvert	Concrete, 24” diameter. Dry. Erosion on downstream end, sandbags on bank.	Some	No	No	Moderate	2	Repair
ME-117	Culvert	Concrete, 2 culverts at 24” diameter. Stabilization on sides of headwall. Clear some debris Standing water downstream and upstream of culvert. Grass swale leading into upstream side of culvert.	None	No	Constant Stream	Low	1	Routine Maintenance
ME-118	Culvert	Concrete, 4 box culverts at 12’ x 8’. Remove bamboo debris on upstream side. Clean out sediment. Sewer line running along bridge. Upstream side of culvert seems to back up and flow to the east creating a ditch. Evidence of ponding on adjacent road.	Some	No	Constant Stream	Low	3	Repair
ME-119	Culvert	Concrete, 3 culverts at 36” diameter. Remove sediment from pipes and stabilize banks. Upstream end of culvert at back of resident's house.	Full	No	Constant Stream	Moderate	4	Repair
I-52	Culvert	Concrete. Can only see top of headwall; can't see culvert. Channel filled with sediment and debris. Erosion along road. Unsure where other end of culvert is.	Full	Yes	No	Severe	5	Replace
ME-121	Culvert	Concrete, 10’w x 5’h. Stabilize banks. Repair headwall on downstream side. Remove debris.	None	Yes	No	Moderate	3	Repair
I-55	Culvert	Concrete, 18" diameter. Add a headwall for stabilization. Remove debris.	Some	No	No	Moderate	2	Routine Maintenance
I-56	Culvert	Concrete, 24" diameter. Culvert completely filled in - can only see the red headwall remaining. Flow re-directed down swale along road.	Full	Yes	No	None	5	Replace
I-57	Culvert	Concrete, 30" diameter. Culvert damaged, with severe erosion. Larger culvert needed with stabilized headwall. Culvert managing a lot more flow than designed, due to clogged upstream culvert.	Some	Yes	No	Severe	4	Replace
I-07	Inlet Catchbasin	Concrete, unknown sump. Debris and sediment to be cleaned out. Appears to be deep.	Some	No	No	None	1	Routine Maintenance

ID	Structure	Description / Notes	Sediment	Damage	Flow	Erosion	Severity	Maintenance Needed
I-11	Inlet Catchbasin	Concrete, unknown sump. Clean out debris.	Unknown	No	No	None	1	Routine Maintenance
I-12	Inlet Catchbasin	Concrete, sump. Clean out sediment and debris.	None	No	No	None	1	Routine Maintenance
I-13	Inlet Catchbasin	Concrete, unknown sump.Large amount of grass has grown around the catch basin from the build up of sediment. Resident said their property doesn't flood but flooding ponds up to top of curb.	Unknown	No	No	None	5	Repair
I-14	Inlet Catchbasin	Concrete, unknown sump. Debris and sediment to be cleaned out. Catch basin appears to be deep.	Some	No	No	None	1	Routine Maintenance
I-15	Inlet Catchbasin	Concrete, unknown sump.	Unknown	No	No	None	N/A	None Needed
I-16	Inlet Catchbasin	Concrete, no sump.	Unknown	No	No	None	N/A	None Needed
I-17	Inlet Catchbasin	Concrete, unknown sump.	Unknown	No	No	None	N/A	None Needed
I-18	Inlet Catchbasin	Concrete, unknown sump. Debris and sediment to be cleaned out. Needs a more formal transition from channel to catch basin. Should go underneath sidewalk. Concrete channel from development outlets into catch basin.	Some	No	No	None	3	Repair
I-36	Inlet Catchbasin	Concrete, Yes sump. Debris and sediment to be cleaned out.	Some	No	None	None	1	Routine Maintenance
I-37	Inlet Catchbasin	Concrete, no sump. Debris and sediment to be cleaned out. Catch basin appears to be quite deep.	Unknown	No	Constant Stream	None	1	Routine Maintenance
I-38	Inlet Catchbasin	Concrete, unknown sump. Clear grate of veg and sediment.	Some	No	None	None	3	Repair
I-54	Inlet Catchbasin	Concrete, unknown sump.	Unknown	No	No	None	N/A	None Needed
I-08	Outfall	Concrete, 28" diameter. Debris and sediment to be cleaned out and slopes stabilized.	Some	Yes	No	Moderate	3	Repair
I-40	Sewer Pump Station	Pump station located on Geus Rd.	NA	No	NA	NA	1	Routine Maintenance