2010

STORM WATER DRAINAGE MASTER PLAN

DEPARTMENT OF PUBLIC WORKS

GUAM

2010

PARSONS
Parsons Transportation Group Inc.

The Honorable
Felix P. Camacho
Governor

The Honorable
Michael W. Cruz, M.D.
Lieutenant Governor

public works
DIPATTAMENTON CHE'CHO PUPBLEKO
Andrew S. Leon Guerrero
Director
Jesse G. Garcia
Deputy Director

December 17, 2010

Mr. Gene Niemasz
Project Manager
Parsons Transportation Group Inc.
590 South Marine Corps Drive
ITC Building Ste 403
Tamuning, Guam 96913

Subject: Storm Water Drainage Master Plan

Dear Gene,

The Guam Department of Public Works has reviewed and approves the Stormwater Drainage Master Plan dated December 2010.

Sincerely,

FOR ANDREW S. LEON GUERRERO
Director

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Guam Islandwide Program Management Services
PTG DPW FHWA – GU-NH-IPMS(002)

Storm Water Drainage Master Plan

December 2010

The Honorable Felix P. Camacho, Governor
The Honorable Michael W. Cruz, M.D., Lieutenant Governor

public works
DIPATTAMENTON CHE'CHO PUPBLEKO

I HEREBY CERTIFY THAT THIS REPORT WAS PREPARED
BY ME OR UNDER MY DIRECT SUPERVISION

Prepared by:
Parsons Transportation Group Inc.
590 South Marine Corps Drive
ITC Building, Suite 403
Tamuning, Guam 96913 -

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Executive Summary

The Government of Guam Department of Public Works (DPW) has prepared the Guam Storm Water Drainage Master Plan (SWDMP) to present a systematic approach for identifying existing storm water runoff patterns, existing storm water drainage systems, and assessing and prioritizing additional drainage improvements throughout the island of Guam. The SWDMP focuses on drainage improvements at the village level, as well as routed roads. This report documents:

- Methodology of defining drainage improvements;
- Criteria used to evaluate needed drainage improvements;
- Probable costs of improvements;
- Prioritization of projects for Capital Improvement Program (CIP) inclusion; and
- Available funding.

Some drainage improvement sites were initially identified in the Flood Control Master Plan (Earth Tech 1997) and the Village Streets Master Plan (Parsons 2009). Additional drainage improvement sites were obtained by letters and e-mails to the SWDMP team, which were usually sent to DPW and forwarded for inclusion in the SWDMP, as well as information received by the team during meetings with village mayors or mayor's delegated staff during the field effort. These drainage improvement sites were organized into a series of drainage improvement lists on a per village basis and guided the field effort.

The field effort began in mid January 2010 and was completed in early February 2010. During this timeframe, the SWDMP team conducted onsite inspections to evaluate the drainage improvement sites. Approximately 300 locations were evaluated. The field effort had two goals. The first goal was to document drainage deficiencies for later prioritization of potential CIP projects. The second goal was to recommend drainage improvements for generating project cost estimates. At each location, necessary drainage improvements were determined by evaluating and identifying the following:

- Deficiencies in drainage conveyance and storm drain systems;
- Issues regarding hillside, channel, and shoreline erosion;
- Potential undermining at bridges;
- Areas prone to severe sediment and/or debris deposition; and
- Maintenance issues.

Project Prioritization

Drainage improvements were organized into ten categories, including (1) Public Safety Risk; (2) Environmental Severity; (3) Maintainability; (4) Flooding Severity; (5) Floodplain; (6) Erosion Severity; (7) Number of Affected Properties; (8) Roadway Type; (9) Right-of–Way (ROW) Requirements; and (10) Estimated Cost. The evaluation categories and their associated scoring criteria displayed in Table ES-1 were used to develop a prioritized list of projects for each village. For each project, the sum of each criterion multiplied by its ranking factor yielded a prioritized score. Projects with the highest total scores are considered the highest priority projects and will likely be completed first when funding is available.

Table ES-1. Project Evaluation Criteria

	PRIORITY SCORE	CRITERIA	RANKING FACTORS			
			HIGHEST SCORE (X3)	MODERATE SCORE (X2)	LOW SCORE (X1)	NO SCORE (X0)
EVALUATION CATEGORIES	10	Public Safety Risk	Inaction poses significant risk to public safety, potential loss of life.	Inaction poses moderate risk to public safety, potential injury.	Inaction poses low risk to public safety.	No risk to public safety.
	20	Environmental Severity	Directly impacts aquifer.	Directly impacts coastal area (within immediate area of shoreline).	Directly impacts surface water (e.g., river, stream, or lake).	No environmental risk.
	3	Maintainability	Low maintenance projects with easy accessibility.	Moderate maintenance requirement, moderately accessible.	Difficult to maintain and/or difficult to access.	Very difficult to maintain and/or very difficult to access.
	3	Flooding Severity	Unacceptable damage caused by flood events.	Moderate damage caused by flood events.	Flood events cause nuisance damage.	No flood hazard.
	3	Floodplain	Inside floodplain.	N/A	N/A	Outside floodplain.
	3	Erosion Severity	Unacceptable damage caused by erosion.	Moderate damage caused by erosion.	Erosion damage considered nuisance.	No erosion hazard.
	3	Number of Affected Properties	Greater than 4 properties affected.	3 to 4 properties affected.	1 to 2 properties affected.	No properties affected.
	3	Type of Roadway	Highway	Arterial	Collector	Private
	3	Right-of-Way Requirement	Requires no ROW.	N/A	N/A	Requires ROW.
	10	Estimated Cost	Cost < $200,000	$200,000 < Cost < $1,000,000	$1,000,000 < Cost < $10,000,000	Cost >$10,000,000

Project Work Type

For documentation and cost estimating purposes, drainage improvements were identified using eight separate categories. These categories were later characterized as the drainage work type. The eight work types are displayed in Table ES-2.

Table ES-2. Drainage Improvement Work Types

Improvement Type	
Erosion Control	**Coastal Protection**
Conveyance Improvements	**Conveyance Maintenance**
Storm Drain Improvements	**Storm Drain Maintenance**
Treatment BMP Improvements	**Treatment BMP Maintenance**

Project Cost Estimating

Costs were estimated based on planning-level cost estimates prepared for standardized improvements (e.g., gabion walls, culvert replacement, riprap revetment) and projecting those costs to the identified location using information obtained during the site visit.

Project Funding

The design, construction, operation, and maintenance of drainage control systems can involve a significant expense, especially when flood concerns, water quality issues, and population growth are factored in. Typically, government agencies can rely on stable sources of funding that are available from an already established storm water utility. For example, communities with an established storm water utility can utilize service fees, property taxes/general fund monies, system development charges, and special assessment districts to fund storm water programs. Given that a storm water utility is not established in Guam, the local government and the Federal Highway Administration (FHWA), as well as private land owners, will need to rely on grants and low-interest loans that are designated for flood control and water quality protection projects. Information on such grants and low-interest loans is provided at the end of the report.

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1.0 Introduction

The Government of Guam Department of Public Works (DPW) has prepared the Guam Storm Water Drainage Master Plan (SWDMP) to present a systematic approach for improving drainage throughout the island of Guam.

1.1 Report Objectives and Organization

The SWDMP is one of the key programs developed by DPW to develop criteria, a ranking system, and a prioritization methodology for identifying storm water improvement projects for drainage system upgrades, rehabilitation, and system extensions. Equally important to the prioritization methodology was a process for developing Capital Improvement Program (CIP) storm water projects that would effectively address roadway flooding and other drainage problems. An extensive process was used to analyze the storm water system and identify potential CIP projects.

This report documents the methodology of characterizing drainage system improvements, erosion control improvements, and water quality treatment improvements, along with criteria used to evaluate these improvements, the probable costs of improvements, and available funding. Lastly, it presents a verifiable and repeatable process for prioritizing projects and ensuring that the available funding is used effectively.

The report is divided into five sections, along with references provided in Appendix A and supplemental information provided in the remaining appendices. The report organization is indicated in Table 1-1.

Table 1-1. Report Organization

Section	Description
Introduction	Presents report objectives and project purpose and need.
Watershed Overview	Summarizes watershed characteristics for north and south Guam.
Methodology	Methodology for gathering data, prioritizing projects and estimating costs.
Ranking	Overall project ranking per village, summaries of project costs and results.
Appendices	Supporting information on proposed projects, including site visit data, watershed and site maps, project summaries, cost estimates, and prioritization spreadsheets.

1.2 Project Purpose and Need

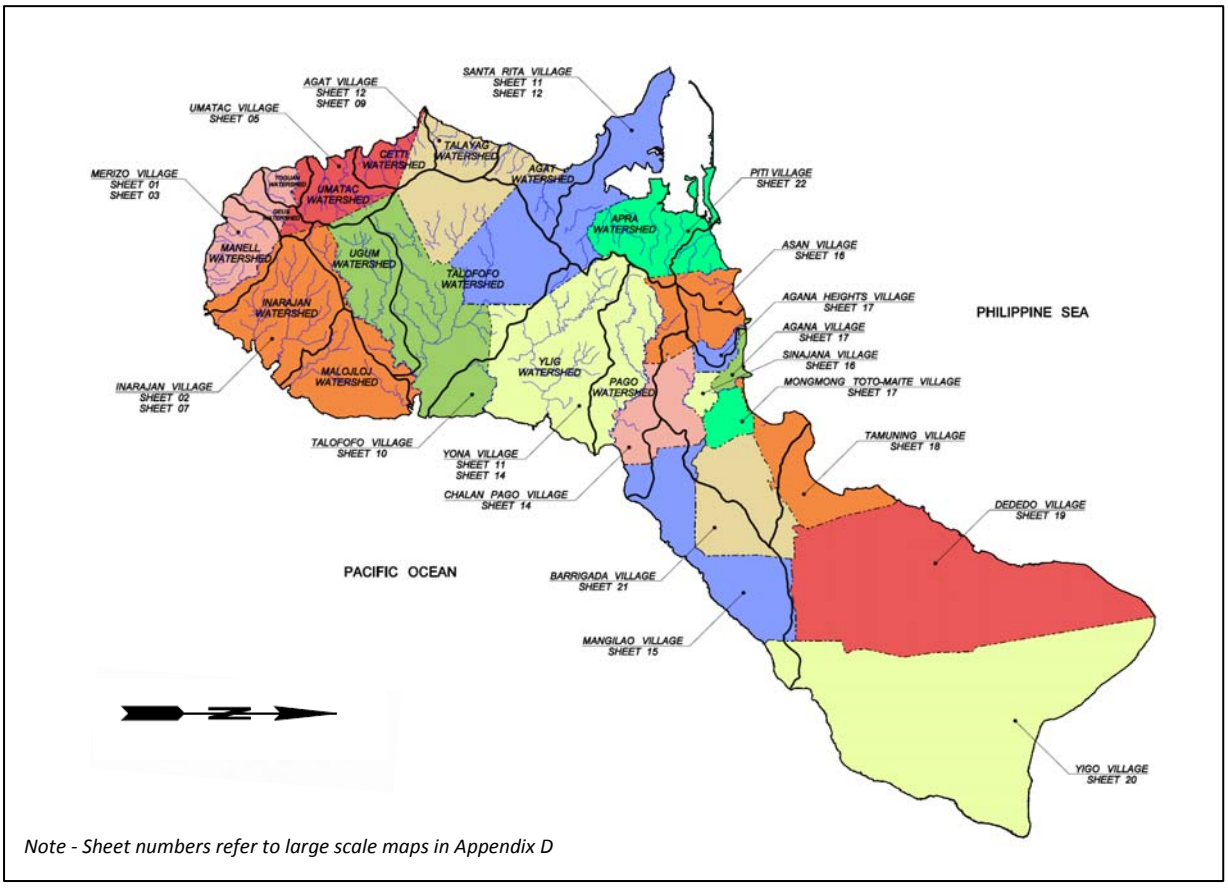
The purpose of the SWDMP is to:

- Identify existing storm water runoff patterns;
- Identify existing storm water conveyance systems;
- Characterize drainage, erosion control, and treatment BMP improvements;
- Prioritize potential CIP projects; and
- Provide potential funding sources.

The SWDMP focuses on drainage and erosion control facilities at the village level and along routed roads and offers a generalized description of drainage or erosion control issues. The SWDMP team will work closely with DPW and the Federal Highway Administration (FHWA) to package and schedule these various drainage needs into viable projects as appropriate to the various identified funding sources.

2.0 Watershed Overview

This section summarizes Guam's watershed characteristics and provides information regarding existing surface drainage characteristics in the northern and southern portions of Guam. Guam is the largest and southernmost island in the Mariana Islands chain. It is approximately 30 miles long and 9 miles wide with a total of 116.5 miles of shoreline. The island is divided into two distinct geological formations by a central fault line. The northern half is mainly a broad sloping limestone plateau that is bordered by steep seaward cliffs and fringed by narrow coral reefs. The southern half is mountainous and composed of eroded volcanic formations with well-defined watersheds, as shown in Figure 2-1.



Note - Sheet numbers refer to large scale maps in Appendix D

Figure 2-1 – Watershed and Village Map of Guam

2.1 North Guam Watershed

The surface in North Guam is relatively flat, and heavy precipitation generally flows by sheets into swales, then into depressions/retention basins (sinks), where it percolates into the ground. The subsoil is composed of highly porous limestone covered with a soil layer generally less than 2 feet thick. Percolation rates are high, generally from 8 to 24 feet per day. The villages of North Guam include the north portions of Tamuning and Barrigada, and Dededo, Yigo, and Mangilao (see Figure 2-1). Within the rural areas of the villages, roadway runoff either sheet flows through grass strips located along the edge of pavement or it ponds at low points. In the more urban locations, the road cross section is generally curbed with roadway runoff conveyed through a storm drain system that outlets into the sinks or existing infiltration basins. There are numerous infiltration basins owned and maintained by the Government of Guam DPW in this area that are currently being used as outlets for the roadway drainage systems in North Guam. Because the area is underlain by the North Guam Lens, which is a groundwater aquifer that is the primary source of potable water on the island, the surface water quality that percolates into the groundwater in this area is regulated by the Guam Environmental Protection Agency (GEPA). Note that locations of many of the sinks found in North Guam can be identified from the flood zone boundaries shown on the watershed maps provided in Appendix B.

2.2 South Guam Watershed

Unlike northern Guam's relatively flat limestone plateau, surface drainage in the Southern Guam Watershed is accommodated by the numerous rivers that dissect the mountainous uplands in this watershed area. Volcanic rock forms the foundation of the island and is exposed over approximately 35 percent of the island's surface, predominantly in southern Guam. This portion of the island is vegetated with a mix of grassland and patchy forest. The villages of South Guam include the south portions of Tamuning and Barrigada, and Maite (Mongmong), Hagatna (Agana), Agana Heights, Sinajana, Ordot, Chalan Pago, Asan, Piti, Yona, Talofofo, Inarajan, Merizo, Umatac, Agat, and Santa Rita (see Figure 2-1). The existing drainage systems within the villages in south Guam consist of earthen and riprap-lined channels, infiltration (i.e., ponding) basins, underground injection chambers, gabion-lined channels, grass-lined ditches, and storm drain networks in some of the more urban environments.

In general, the west side of southern Guam is traversed by rivers that are short with steep gradients and drainage areas of less than 3 square miles each. Route 1 is located very close to the mouths of several of these streams, which outlet into several bays connected to the

Philippine Sea or Apra Harbor. Several rivers are designated as floodways by the Federal Emergency Management Agency (FEMA), while others are designated as Flood Hazard Zone X (i.e., areas with minimal flooding potential). Several locations along the coast are designated within FEMA Flood Hazard Zone V or VE, which is defined as a coastal flood zone with velocity hazard due to wave action. Floodplain boundaries are shown on the watershed maps provided in Appendix B. The east side of southern Guam is traversed by rivers that are much longer with lesser gradients than the west side but with much larger watersheds. Route 4 is located very close to the mouths of these rivers, which outlet into several bays connected to the Pacific Ocean.

3.0 Methodology

Parsons Transportation Group Inc. (PTG) has assembled the SWDMP as part of the services provided to DPW under the Island-wide Program Management Services contract. A schematic that summarizes the overall approach for development of the SWDMP is indicated in Figure 3-1. Collectively, the project approach included the following:

- Identifying drainage needs;
- Conducting site visits;
- Classifying drainage work types;
- Prioritizing drainage improvements on a village-level basis;
- Performing cost estimates; and
- Ranking projects.

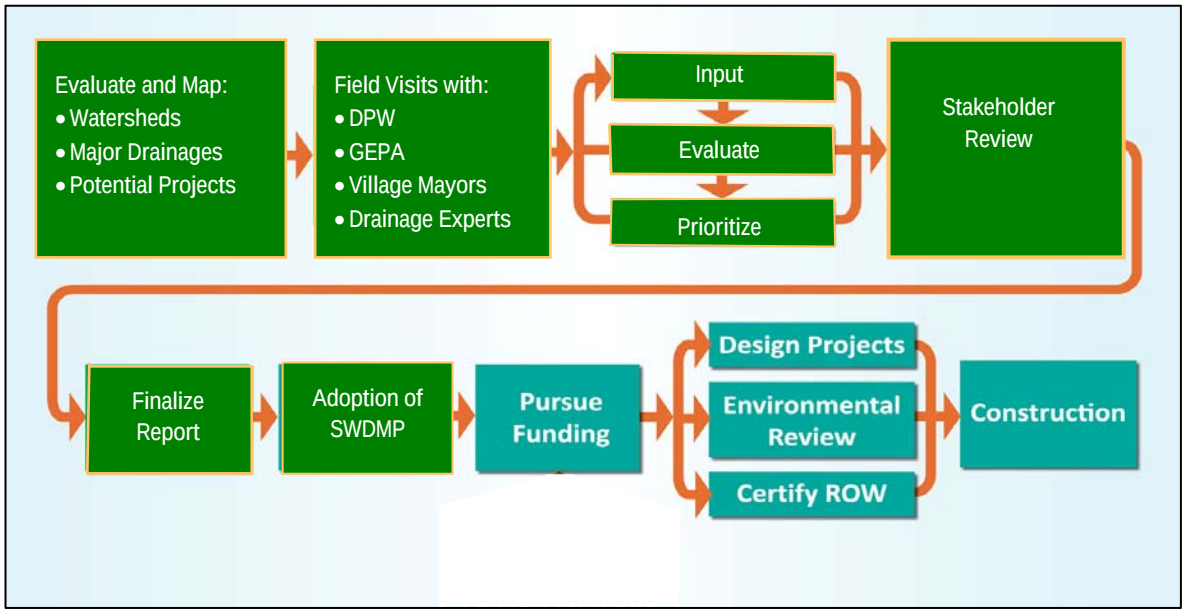


Figure 3-1. Methodology of the Storm Water Drainage Master Plan Effort

The drainage needs evaluated as part of the SWDMP were identified from the following sources:

- Flood Control Master Plan
- DPW direction on specific higher-priority drainage issues
- Projects identified by Village Mayors and/or their representatives
- Others, identified by DPW and their consultants

The methodology associated with the development of the SWDMP involved an understanding of the following:

- Overall watershed characteristics;
- Existing drainage facilities;
- Deficiencies in drainage facilities;
- Erosion potential;
- Input from others; and
- Prioritization of drainage improvements on a village-level basis.

3.1 Meetings with Agencies and Village Representatives

The SWDMP team initiated site visits on January 20, 2010. The initial drainage deficiency list used for the site visits was organized by village and was developed based on the Flood Control Master Plan (Earth Tech 1997), the Village Streets Master Plan (Parsons 2009), and existing geographic information system (GIS) mapping. Additional drainage deficiencies were obtained by letters and e-mails to the SWDMP team, which were usually sent to DPW and forwarded for inclusion in the SWDMP. Each day, prior to mobilizing, the SWDMP team contacted each village mayor to introduce the SWDMP team to the mayor and to:

- Make them aware of scheduled daily activities;
- Discuss initial list of deficiencies;
- Obtain additional information regarding drainage problems; and
- Invite the mayor and/or the mayor's representative to accompany the team.

Table 3-1 displays the field effort schedule and the level of participation by the mayors and the different agency representatives.

Table 3-1. Village Mobilization Schedule

DATE	VILLAGE	MAYOR STAFF MEETING	SWDMP TEAM			COMMENTS
			PTG	DPW	GEPA	
1/19/2010	Tamuning		X	X	X	Site added by DPW based on e-mail from owner
1/20/2010	Barrigada	X	X	X	X	Sites were added by the Mayor
1/21/2010	Piti		X	X	X	
1/21/2010	Agana Heights		X	X	X	Sites were added by DPW
	Agana		X	X	X	
1/22/2010	Asan		X	X	X	
	Piti		X	X	X	
1/25/2010	Dededo		X	X	X	Mayor provided list to DPW
	Yigo	X	X	X	X	Sites were added by Mayor's Representative
1/26/2010	Mangilao		X	X	X	Sites were added by DPW
1/27/2010	Talofofo	X	X	X		Sites were added by the Mayor
	Chalan Pago Ordot	X	X	X		Verified site list submitted by the Mayor
	Yona		X	X		Sites were added by DPW
1/28/2010	Inarajan		X	X		
1/29/2010	Agat	X	X			
1/31/2010	Merizo		X			
2/1/2010	Umatac	X	X	X		
2/2/2010	Mongmong-Toto-Maite		X			Site added by DPW based on e-mail from owner
2/3/2010	Barrigada		X	X		
	Santa Rita	X	X	X	X	Sites were added by DPW
2/4/2010	Barrigada		X			
	Chalan Pago Ordot		X			Site added by DPW
	Piti		X			
2/5/2010	Sinajana		X			
	Inarajan		X			Site added by DPW based on e-mail from owner

3.2 Site Visits

During site visits, it was noted that areas where improvements were required were generally related to maintenance, erosion control, conveyance capacity, or storm drain system issues. The SWDMP team, along with the mayor and/or his/her delegated staff, conducted onsite inspections at approximately 298 locations using a checklist and an evaluation guideline developed specifically for the SWDMP. Use of the checklist facilitated a systematic approach to define the priorities in each village. Later, prioritization was determined by assigning scores and ranking factors to the evaluation criteria.

Generally, the mayor or agency representative directed the SWDMP team to the drainage site and described in detail the deficiencies and problems they were experiencing. The PTG team inspected the site and recorded details of the existing drainage facilities and materials/activities required to resolve any recorded deficiencies. Information regarding the need for drainage easements and right-of-way (ROW) issues, as well as ponding or flooding incidents, was also documented. Projects were not scored in the field but were evaluated in

the office at a later time. A photo log was developed for all drainage sites visited, allowing further review to be performed. These photos are incorporated in the project summaries (see Appendix C).

Data collection was among the most critical aspect of this process. Field visits were conducted not only to gather information for prioritization and cost estimating purposes, but also to verify information provided on the initial drainage improvement list. Sump locations and overland flow paths were identified and documented. Approximate limits of ponding and potential for roadway flooding were noted. Open channels and cross sections were observed, and an estimate on their size was documented. In some instances, discussions with local property and land owners were held regarding past flooding events. Field checklists and digital photographs were used to collect and organize the field data. This extensive data collection process ensured that the analysis was accurate, which is vital for the planning-level cost analyses and project priority process.

3.3 Classification of Drainage Work Types

The SWDMP team began with a list of sites in need of drainage improvements and then added other sites based on visual reconnaissance during the site visits. Other sites were added to the list based on communication from property owners, village mayors or their delegated representatives, and DPW. Collectively, 298 sites were inspected for drainage improvements during the 3-week field effort. For items that were not on the initial list but were provided to PTG in writing after completion of the field effort, such as through personal communication to DPW, the PTG team interpreted the deficiency and added it to the list. The drainage improvements identified during the field effort considers the necessary maintenance, rehabilitation, and/or repair that are required to facilitate storm water runoff conveyance, minimize roadside ponding and adjacent property flooding issues, minimize erosion, and provide treatment for storm water runoff where needed. These drainage improvement categories translated into the project's drainage work types. Translating the drainage improvement categories into drainage work types allowed the PTG team to succinctly describe a drainage improvement at a particular location. This classification scheme also facilitated the project cost estimating process to be conducted in a manageable and efficient manner. The eight drainage work types are described in Table 3-2.

Table 3-2. Work Types

WORK TYPE	DESCRIPTION
Erosion Control	Locations where stream bank erosion, channel deformation, and down cutting were observed. Erosion control includes streambank protection, such as riprap revetment or installation of gabion retaining walls along steep cliff sides, control of hillside erosion with hydroseed, and mulch and/or bonded fiber matrix to control mass erosion.
Conveyance Improvements	Locations where the design and installation of offsite drainage conveyance structures, such as culverts, associated headwalls and wingwalls, channels, ditches, cross culverts, and bridges, are required. Examples include providing increased capacity, as well as replacing structures that are beyond repair.
Conveyance Maintenance	Locations where rehabilitation of conveyance structures or maintenance within conveyance structures is required. Examples include headwall and/or wingwall repair, removal of sediment and debris within and around culverts, and utility encasement or relocation within the conveyance facility.
Treatment BMP Improvements	Includes the design and installation of biofiltration strips/swales, detention devices, media filters, and infiltration trenches/basins for treatment of storm water runoff.
Treatment BMP Maintenance	Includes vegetation management, debris removal, sediment or vegetation removal, and/or side slope stabilization at locations where treatment best management practices (BMPs), such as infiltration basins, are present.
Coastal Protection[1]	Locations where the coastline is within the limits of a routed road and the road has little to no protection. In areas that exhibit coastal erosion encroaching within the roadway ROW, coastal erosion protection in the form of riprap revetment or gabions has been recommended.
Storm Drain Maintenance	Includes locations where sediment/debris removal is required within the storm drain system.
Storm Drain Improvements	All locations where capacity improvements or storm drain replacement is required. Examples include design and installation of storm drain systems, including catch basins, roadway ditches, storm drain pipelines, and storm drain outlets to offsite conveyance systems. Also included are storm drain outlet structures that convey flow to the groundwater regime, such as infiltration basins, infiltration trenches, or underground injection chambers.

3.4 Prioritization

With approximately 298 sites requiring drainage improvements, priorities were established to develop a feasible improvement program. A systematic approach was developed to define the priorities in each village. Prioritization was determined by assigning scores and ranking factors to the evaluation categories. Projects that received the highest score ultimately received highest priority. Table 3-3 shows the developed evaluation criteria. The most important criteria are listed with the highest priority weight and the least important are listed with the lowest. These values range from 3 to 20. Each criterion has a ranking

[1] The sea level in Guam is expected to rise by 4.27 feet over the next 100 years.

multiplication factor ranging from 0 to 3. Multiplying the priority weights by the ranking factor provided the final score for the individual work type. After the priority weights were multiplied by the ranking factor for each work type, the final scores for the individual work type values were added together to provide a combined score. The combined score was used in the final prioritization of projects. The ten evaluation categories, along with the respective priority weighting factors, are described below.

Table 3-3. Project Evaluation Criteria

	PRIORITY SCORE	CRITERIA	RANKING FACTORS			
			HIGHEST SCORE (X3)	MODERATE SCORE (X2)	LOW SCORE (X1)	NO SCORE (X0)
EVALUATION CATEGORIES	10	Public Safety Risk	Inaction poses significant risk to public safety, potential loss of life.	Inaction poses moderate risk to public safety, potential injury.	Inaction poses low risk to public safety.	No risk to public safety.
	20	Environmental Severity	Directly Impacts aquifer.	Directly impacts coastal area (within immediate area of shoreline)..	Directly impacts surface water (e.g., river, stream, or lake)	No environmental risk.
	3	Maintainability	Low maintenance projects with easy accessibility.	Moderate maintenance requirement, moderately accessible.	Difficult to maintain and/or difficult to access.	Very difficult to maintain and/or very difficult to access.
	3	Flooding Severity	Unacceptable damage caused by flood events.	Moderate damage caused by flood events.	Flood events cause nuisance damage.	No flood hazard.
	3	Floodplain	Inside floodplain.	N/A	N/A	Outside floodplain.
	3	Erosion Severity	Unacceptable damage caused by erosion.	Moderate damage caused by erosion.	Erosion damage considered nuisance.	No erosion hazard.
	3	Number of Affected Properties	Greater than 4 properties affected.	3 to 4 properties affected.	1 to 2 properties affected.	No properties affected.
	3	Type of Roadway	Highway	Arterial	Collector	Private
	3	Right-of-Way Requirement	Requires no ROW.	N/A	N/A	Requires ROW.
	10	Estimated Cost	Cost < $200,000	$200,000 < Cost < $1,000,000	$1,000,000 < Cost < $10,000,000	Cost >$10,000,000

Public Safety Risk (Weight = 10)

The safety and protection of human life is of the utmost importance. The highest rated projects are those where inaction may result in the loss of human life. A medium rating may result in injuries. A low rating indicates there is a minor safety risk involved with inaction. Three example scenarios are described below.

High Severity: Undermining of roadway has progressed to near collapse. Without repair, a motorist could be on pavement section during collapse event.

Medium Severity: Low point in roadway experiences ponding after a storm event. Without routing runoff, a motorist could hydroplane and suffer an accident.

Low Severity: Standing water accumulates at the corner of an intersection after every storm event. Pavement begins to deteriorate creating a pothole, which may result in an unsafe road condition if resurfacing is not implemented in a timely manner.

Environmental Severity (Weight = 20)

Guam's quality of life is closely linked to the environmental integrity of its local water resources. As with flooding and erosion, water quality problems primarily stem from changing land use conditions (i.e., urbanization) that modify watershed hydrology and the level of pollutants in local waterways. The water quality assessments evaluated existing and future problem areas based on problem areas provided by DPW and GEPA. Water quality priorities are established based on the resource value of the receiving water and the severity of identified current and future water quality problems as described below.

Affected Water Body: Scoring is based on quality of water source, which is consistent with DPW/FHWA priorities.

Maintainability (Weight = 3)

Overall, DPW oversees and maintains the storm drainage network throughout the island. Maintainability plays an important role in the overall effectiveness of proposed improvements over time. Projects that are difficult to maintain or difficult to access will require greater operation and maintenance costs and may tend toward ineffectiveness in time if not appropriately maintained. The highest rated projects are those where maintenance is relatively easy, requiring maintenance activities that are not labor intensive, not very frequent, and easy to access by required maintenance vehicles. A low rating indicates significant maintenance issues related to the proposed improvements where accessibility may be difficult or where frequent/costly maintenance activities are required to keep the facilities working effectively.

Flooding Severity (Weight = 3)

This guideline is used to identify flooding and infrastructure-related problems and to quantify their causes. The term flooding is used for localized flooding that occurs due to failure of the secondary drainage system. The identification and prioritization of localized flooding problem areas will be based on DPW-provided data. Unlike the creek flooding studies, the prioritization of localized flooding areas will not be based on hydrologic and hydraulic models, but rather on the severity of the damage that occurs. Flooding simulation

models are not available for the extensive storm drain system due to incomplete information on the location, size, and condition of the system. This evaluation category is based on three performance factors, as described below.

Probable Cause of Flooding: Higher score where the cause of flooding can be easily remedied, such as maintenance-related projects that improve safety and protection of existing infrastructure with immediate relief and minimal cost.

Number of Properties Affected: Score is based on population served.

Flooding Frequency: Score is reflective of the severity of the problem. Flood Insurance Rate Maps (FIRMs), information provided, and engineering judgment will be used.

Floodplain (Weight = 3)

All other criteria being equal, projects within Flood Zone A take precedence over those outside the floodplain.

Erosion Severity (Weight = 3)

This evaluation category is used to identify current erosion problems along roads, bridges, and culverts on the road. Damage to roads is caused by water flowing over the top of the roadway and eroding road surfaces, shoulders, and embankments. Inadequate hydraulic capacity of a bridge may result in erosion of the streambed under piers and abutment footings and erosion of the embankments. Damage or failure of a culvert is caused by erosion of the embankment at its entrance and/or outlet, or around the outside of the culvert. Erosion problems primarily result from changing land use conditions (i.e., urbanization) that modify watershed hydrology, significantly increasing storm flows in creeks for even small rainfall events. The change in watershed hydrology, and sediment load, greatly increases the frequency, magnitude, and duration of "erosive" flows. These changes in stream flow have resulted in changes in local creek characteristics. The identification and prioritization of localized erosion problem areas will be based on DPW-provided data, drainage basin maps, and site visits. The prioritization of erosion areas will be based on three performance factors, which are described below.

Types of Erosion: Scoring is according to the severity of the problem and safety issues.

Probable Cause of Erosion: Higher score for maintenance-related issues that provide safety and protection of existing infrastructure with immediate relief and minimal cost.

Affected Area: Score is based on the overall area requiring erosion protection and the erosive nature of the area given soil and hydrologic/hydraulic conditions.

Number of Affected Properties (Weight = 3)

The number of affected properties helps assess the magnitude of drainage deficiencies. The score is based on population served. The ranges used to determine importance factors are as follows:

- **3** = greater than four properties affected
- **2** = three to four properties affected
- **1** = one to two properties affected
- **0** = no properties affected

Type of Roadway (Weight = 3)

The roadway classification helps assess the magnitude of drainage deficiencies. The score is based on level of service, access, and population served.

Right-of-Way Requirement (Weight = 3)

Adequate property owned by the Government of Guam needs to be available at each project location. Sufficient ROW is necessary to ensure that drainage systems are properly maintained and facilities can be upgraded as necessary. While many of the projects will likely require temporary construction easements, this level of detail is not known at this time; therefore, if ROW issues have not been identified, it is assumed that ROW is available. In this way, the projects requiring no ROW take precedence over those requiring ROW.

Estimated Cost (Weight = 10)

The cost of a project is the financial investment required to implement the particular drainage improvement. Cost will include all facets, including the engineering design, construction, and construction management, to complete the project. Lower-cost projects were ranked higher on the premise that more projects benefitting a wider cross section of properties/residents could be completed with limited funds. The cost ranges used to determine importance factors are as follows:

- **3** = project costing under $200,000
- **2** = project cost ranging from $200,000 to ≤$1 million
- **1** = project cost ranging from $1 million to ≤$10 million
- **0** = project costing over $10 million

3.5 Cost Estimates

By examining aerial mapping, site photos, and other available information, a conceptual-level plan was developed for each of the sample projects, including all of the various items

of work inherent in the work types. As an example, for each improvement project, utility relocation, erosion control, replacement of reinforced concrete pipes (RCPs) and reinforced concrete boxes (RCBs) were determined. Unit costs were based on recent estimates for other drainage improvement projects in Guam. The project cost estimates can be found in Appendix D.

3.5.1 Work Elements

The unit costs per site for the various work types were derived from standard elements used in storm water interception, treatment, conveyance, erosion control, and storage. These work elements include excavation, hydroseeding, rock slope protection, slope paving, landscape planting, fencing, removing culverts, installing pipe culverts, adjusting inlets, installing inlets, installing underground injection chambers, and installing minor concrete for channels, ditches, concrete aprons, concrete box culverts, headwalls, and wingwalls.

Additional minor items, such as surveying and construction-related activities, such as testing, erosion control, dust control, clearing and grubbing, and traffic control, were added to each of the work element costs when deemed appropriate for the project. Finally, percentage factors were applied for miscellaneous items, mobilization, contingencies, design, and construction engineering, which is a standard practice. These factors are as follows:

- Miscellaneous items — 10 percent of base + minor
- Mobilization — 10 percent of base +minor
- Contingency — 20 percent of base + minor
- Design, Environmental, Permitting — 15 percent of construction cost
- Construction Management, Oversight — 15 percent of construction cost

Each drainage improvement was broken down into work elements and unit types. The cost was calculated by multiplying the quantity by the cost per unit (see Table 3-4). The total drainage improvement cost was then calculated from the sum of the work elements. In general, unit costs were derived from contract bid item estimates in 2010 U.S. dollars for projects of similar magnitude on the island of Guam. Where unit costs were not available from the contract estimates, unit prices were computed using the Caltrans Contract Cost Data Book (CCDB) (California Department of Transportation 2009), escalated to 2010 at 7 percent per year and then multiplied by a uniform markup for the island of Guam of 2.23. The uniform markup factor was derived from the difference between the Guam unit bid item estimates for existing contracts and the CCDB estimates.

Because of the approximations made in this planning-level estimate, it must be recognized that some individual cost estimates may be higher than anticipated for a particular location, while others may be lower. In the aggregate, the costs offset each other for a reasonable program-level cost estimate.

Table 3-4. Drainage Improvement Unit Costs

Drainage Improvement Work Element	Unit	Unit Cost ($/Unit)
- Concrete (for Channel Lining)	CY	815
- Concrete (for Culvert)	CY	1,105
- Concrete (for Ditch Lining, Aprons, Pipe Encasement)	CY	635
- Concrete (for Retaining Walls)	CY	1,005
- Concrete (for Slope Protection, Cross-Gutter)	CY	245
- ¾" Rock	CY	45
- Rock Slope Protection	CY	745
- Modify Inlet	EA	3,000
- Adjust Sewer Manhole	EA	1,800
- Catch Basin	EA	3,500
- AC Spillway	EA	1,000
- Headwall for Box Culvert	EA	5,000
- Headwall with Wingwalls	EA	10,000
- Erosion Control [Bonded Fiber Matrix]	SF	1.00
- Erosion Control [Hydroseed]	SF	5.00
- Erosion Control (Blanket)	SF	0.80
- Erosion Control (Netting)	SF	0.50
- Filter Fabric	SF	1.50
- Excavation (for ditches, channels, infiltration basins, trenches)	SF	28
- Clearing/ Debris Removal	AC	4,250
- Gabions	CY	710
- Chain Link Fence	LF	15
- Chain Link Gate	EA	715
- 24" RCP (Installed)	LF	555
- 30" RCP (Installed)	LF	680
- 36" RCP (Installed)	LF	715
- 48" RCP (Installed)	LF	745
- 54" RCP (Installed)	LF	1,160
- Injection Well (Installed)	LF	1,000
- Silt Fence	LF	2.80

CY = cubic yards; EA = each; LF = linear feet; SF = square feet

3.5.2 Cost Basis

Due to the large number of drainage improvements to be included in the cost estimate, and limited time to research as-built plans, the cost estimates used channel length and width, pipe diameters, approximate dimensions of culverts, and approximate areas needing erosion control based on estimates that were made during the site visits. Where size estimates were not directly available, average size estimates were used.

4.0 Summary of Projects

Approximately 298 sites were evaluated using the initial lists, along with information provided by village mayors or their delegated representatives, property owners, and DPW. Overall, there was no difference between the drainage deficiency documented on the initial list or communicated by the village mayors and others, and what was actually observed in the field. Based on the field observations, it was noted that drainage work types, in order of decreasing prevalence, were typically related to storm drain and conveyance structure improvements and maintenance, followed by erosion control, treatment best management practice (BMP) improvement and maintenance, and finally coastal protection.

Of the 298 sites assessed, 112 were characterized as having a direct impact on the aquifer. Of these, approximately twenty-two sites include infiltration trenches, fourteen include infiltration basins, six include routing additional storm water runoff to existing infiltration basins, three include infiltration galleys (i.e. infiltration wells within an infiltration basin), eight include bioswales, one includes an injection well and one includes abandonment of an existing injection well and constructing bioswales. Although another sixty projects were identified as having a direct impact on the aquifer, the use of infiltration BMPs as a drainage improvement strategy was not recommended. The reason for this is that infiltration BMPs were recommended in areas, typically in North Guam, characterized by soils with good infiltration characteristics and sufficiently low groundwater. Within the South Guam Region, where soils exhibit poor infiltration/permeability characteristics and/or groundwater levels are high, such as near the coastline, infiltration basins are not considered feasible.

With the exception of the regional projects, which are discussed later in this section, the frequency of observing drainage work types recommended for one village were similar to the prevalence of observing drainage work types in other villages (i.e., there were no significant differences between one village or another). The only thing that differed was the magnitude of the problem. For example, in Dededo a site was identified as needing erosion control and conveyance maintenance improvements. The project cost for this particular site was estimated at $1,940, whereas in Merizo, a project requiring the same types of improvements was estimated at $7.63 million.

A prioritized list of projects was developed for each village according to the evaluation and scoring criteria discussed in Section 3. For each project, the sum of each criterion times its importance factor yielded a prioritized score. Projects with the highest total scores are the highest priority projects and may be completed first when funding is available. The prioritization spreadsheets in Appendix E provide the ranking of projects within each village.

The location for each project is indicated on the cost estimation spreadsheets, which are provided in Appendix D, and detailed recommendations combined with a project photo are provided on the project summary data fact sheets in Appendix C.

It is important to note that the prioritized list of projects is not intended to serve as an implementation plan. Rather, the list is a result of an iterative and interactive process by the SWDMP team to identify locations where drainage deficiencies were observed and to rank and prioritize these projects using the evaluation and scoring criteria discussed in Section 3. Although development of the lists followed a logical and systematic process, the lists can be revised if it is found that it may be more cost effective to group or combine projects based on cost, size, location, or priority. A discussion regarding the organization of projects and contract execution is provided in Section 5.

4.1 Cost Estimates per Village

The final cost estimates by village in the SWDMP (derived from the cost estimating spreadsheets provided in Appendix D) are shown in Table 4-1. Total cost in 2010 U.S. dollars is estimated at $150 million for the 298 projects.

Table 4-1. Funding Allocation

VILLAGE	PROJECTED COST (million $)	% OF TOTAL
TOTAL ALL VILLAGES	**150**	**100**
Agana Heights	2.76	1.9
Agat	7.92	5.3
Asan	9.38	6.3
Barrigada	4.57	3.0
Chalan Pago-Ordot	5.50	3.7
Dededo	3.79	2.5
Hagatna	12.2	8.1
Inarajan	7.62	5.1
Mangilao	7.37	4.9
Merizo	13.2	8.8
Mongmong-Toto-Maite	1.08	0.7
Piti	36.6	24.4
Santa Rita	5.50	3.7
Sinajana	0.13	0.1
Talofofo	6.31	4.2
Tamuning	16.6	11.1
Umatac	7.58	5.1
Yigo	0.60	0.4
Yona	1.01	0.7

Some of these villages include regional-level projects that go beyond the individual village. Regional projects include: (1) TA-103 at the Tamuning Outlet Channel, which conveys runoff from the villages of Tamuning and Barrigada; (2) PI-119 along Route 1 at Apra Harbor located within the villages of Piti and Santa Rita; (3) ME-114 at the Manell Channel, which conveys runoff from the villages of Merizo and Inarajan; and (4) AS-102 along the coast between Fonte and Asan rivers located within the villages of Asan and Agana. Total cost in 2010 U.S. dollars is estimated at $61 million for these regional projects.

4.2 Village Priority Projects

While Appendix E provides the spreadsheet results showing the prioritization of projects for each village, Table 4-2 provides a list of the high-priority projects for each village (up to 5 projects per village). Detailed descriptions for these projects are included in Appendix C.

Table 4-2. High Priority Projects

VILLAGE	Priority Projects
Agana Heights	AG-103,, AG-102 AG-101, AG-104
Agat	AV-128, AV-109, AV-125, AV-121, AV-111
Asan	AS-112, AS-111, AS-109, AS-104, AS-102
Barrigada	BV-116, BV-112, BV-131, BV-110, BV-130
Chalan Pago-Ordot	CP-111, CP-112, CP-102, CP-107, CP-104
Dededo	DE-101, DE-102, DE-103, DE-106, DE-105
Hagatna	HA-109, HA-105, HA-103, HA-110,HA-119
Inarajan	IV-116, I-102, IV-124, IV-104, IV-120
Mangilao	MO-111, MO-106, MO-107, MO-108, MO-102
Merizo	ME-102, ME-119, ME-128, ME-103, ME-129,
Mongmong-Toto-Maite	MM-101
Piti	PI-107, PI-103, PI-108, PI-111, PI-102
Santa Rita	SR-107, SR-109, SR-105, SR-108, SR-102
Sinajana	SV-102, SV-101
Talofofo	TA-102, TA-108, TA-113, TA-116, TA-112
Tamuning	TV-109, TV-110, TV-103, TV-108, TV-105
Umatac	UM-101, UM-108, UM-112, UM-109, UM-106
Yigo	YI-101, YI-102, YI-103, YI-107, YI-109
Yona	YO-103, YO-107, YO-105, YO-101, YO-108

5.0 Implementation

As demonstrated in previous sections, the need for improving storm water conveyance is great, and opportunities for funding are limited. Successful implementation of the SWDMP will require initiative and perseverance. This report presents a strategy for continuing with the highest-priority projects, as funding is available.

5.1 Existing and Potential Funding Sources

The design, construction, operation, and maintenance of drainage control systems can involve a significant expense, especially when flood concerns, water quality issues, and population growth are factored in. Typically, government agencies can rely on stable sources of funding that are available from an already established storm water utility. For example, communities with an established storm water utility can utilize service fees, property taxes/general fund monies, system development charges, and special assessment districts to fund storm water programs. Given that a storm water utility is not established in Guam, the local government and FHWA, as well as private landowners, can rely on grants and low-interest loans.

There are many resources that local and Federal government agencies, along with private land owners, can consider when seeking financial assistance for their storm water system improvement projects. For example, the United States Environmental Protection Agency (EPA) Catalog of Federal Funding Sources for Watershed Protection offers a searchable database of financial assistance sources (i.e., grants, loans, cost-sharing) available to fund a variety of watershed protection projects. Some of the funding sources identified within the database are displayed in Table 5-1. The agencies listed in this table administer or provide grant monies for government agencies and/or private land owners to pursue projects much like those identified in this SWDMP.

Table 5-1. Federal Funding Sources for Watershed Protection

Program Name	Overview
Aquatic Ecosystem Restoration (CAP 206)	Work under this authority may carry out aquatic ecosystem restoration projects that will improve the quality of the environment, are in the public interest, and are cost effective. There is no requirement that an existing United States Army Corps of Engineers (USACE) project be involved.
Clean Water State Revolving Fund	EPA awards grants to states to capitalize their Clean Water State Revolving Funds (CWSRFs). The states, through the CWSRF, make loans for high-priority water quality activities. As loan recipients make payments back into the fund, money is available for new loans to be issued to other recipients. Eligible projects include point source, nonpoint source, and estuary protection projects. Point source projects typically include building wastewater treatment facilities; combined sewer overflow and sanitary sewer overflow correction; urban stormwater control; and water quality aspects of landfill projects. Nonpoint source projects include agricultural, silviculture, rural, and some urban runoff control; onsite wastewater disposal systems (i.e., septic tanks); land conservation and riparian buffers; and leaking underground storage tank remediation. Estuary protection projects include all of the above point and nonpoint source projects, as well as habitat restoration and other unique estuary projects.
Coastal Program	The United States Fish and Wildlife Service (USFWS) Coastal Program works to conserve healthy coastal habitats on public or private land for the benefit of fish, wildlife, and people in 22 specific coastal areas. The program forms cooperative partnerships designed to (1) protect coastal habitats by providing technical assistance for conservation easements and acquisitions; (2) restore coastal wetlands, uplands, and riparian areas; and (3) remove barriers to fish passage in coastal watersheds and estuaries. Program biologists provide restoration expertise and financial assistance to federal and state agencies, local and tribal governments, businesses, private landowners, and conservation organizations, such as local land trusts and watershed councils.
Coastal Services Center Cooperative Agreements	The National Oceanic and Atmospheric Administration (NOAA) guides the conservation and management of coastal resources through a variety of mechanisms, including collaboration with the coastal resource management programs of the nation's states and territories. The mission of the NOAA Coastal Services Center (CSC) is to support the environmental, social, and economic well being of the coast by linking people, information, and technology. The vision of the NOAA CSC is to be the most useful government organization to those who manage and care for our nation's coasts.
Community Development Block & Entitlement Grants	The objective of this program is to develop viable urban communities by providing decent housing and a suitable living environment and by expanding economic opportunities, principally for persons of low and moderate income. Recipients may undertake a wide range of activities directed toward neighborhood revitalization, economic development, and provision of improved community facilities and services.

Table 5-1. Federal Funding Sources for Watershed Protection

Program Name	Overview
Coral Reef Conservation Fund	The National Fish and Wildlife Foundation's Coral Reef Conservation Fund supports projects that build public-private partnerships to reduce and prevent degradation of coral reefs and associated reef habitats (e.g., seagrass beds, mangroves). Projects may address causes of coral reef degradation wherever they occur, from inland areas to coastal watersheds to the reefs and surrounding marine environment.
Emergency Watershed Protection	The United States Department of Agriculture (USDA) Natural Resources Conservation Service's Emergency Watershed Protection (EWP) program helps protect lives and property threatened by natural disasters such as floods, hurricanes, tornadoes, droughts, and wildfires. EWP provides funding for such work as clearing debris from clogged waterways, restoring vegetation, and stabilizing river banks. The measures that are taken must be environmentally and economically sound and generally benefit more than one property owner. EWP also provides funds to purchase floodplain easements as an emergency measure. Floodplain easements restore, protect, maintain, and enhance the functions of the floodplain; conserve natural values including fish and wildlife habitat, water quality, floodwater retention, groundwater recharge, and open space; reduce long-term federal disaster assistance; and safeguard lives and property from floods, drought, and the products of erosion. EWP can provide up to 90 percent cost share in limited resource areas as determined by the U.S. Census.
Flood Mitigation Assistance Program	The Flood Mitigation Assistance (FMA) program provides funding to states, federally recognized Indian tribal governments, and communities so that cost-effective measures are taken to reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other structures insured under the National Flood Insurance Program (NFIP). The long-term goal of FMA is to reduce or eliminate claims under the NFIP through mitigation activities. Three types of grants are available under FMA: Planning, Project, and Technical Assistance.
Hazard Mitigation Grant Program	FEMA's Hazard Mitigation Grant Program (HMGP) aims to provide states and communities with resources to invest in long-term actions that help reduce the toll from potential natural and manmade hazards. The program also supports implementation of mitigation measures during the immediate recovery from a disaster. The HMGP funds projects to protect either public or private property, as long as the project fits within the state's and local government's overall mitigation strategy and complies with program guidelines. In response to flood hazards, eligible projects include the elevation, relocation, or acquisition and demolition of flood-prone structures, stormwater management projects, and certain types of minor flood control projects. The state is responsible for setting priorities for funding and administering the HMGP. Eligible applicants must apply for the program through the state. Individuals, businesses, or other organizations should contact their State Hazard Mitigation Officer and local government official for specific details.

Table 5-1. Federal Funding Sources for Watershed Protection

Program Name	Overview
Nonpoint Source Implementation Grants (319 Program)	Through its 319 Program, EPA provides formula grants to states and tribes to implement nonpoint source projects and programs in accordance with Section 319 of the Clean Water Act (CWA). Nonpoint source pollution reduction projects can be used to protect source water areas and the general quality of water resources in a watershed. Examples of previously funded projects include installation of BMPs for animal waste; design and implementation of BMP systems for stream, lake, and estuary watersheds; basin-wide landowner education programs; and lake projects previously funded under the CWA Section 314 Clean Lakes Program.
Partners for Fish and Wildlife Program	The Partners for Fish and Wildlife Program provides technical and financial assistance to private landowners to restore fish and wildlife habitats on their lands. Since 1987, the program has partnered with more than 37,700 landowners to restore 765,400 acres of wetlands; more than 1.9 million acres of grasslands and other upland habitats; and 6,560 miles of in-stream and streamside habitat. In addition, the program has reopened stream habitat for fish and other aquatic species by removing barriers to passage.
Pre-Disaster Mitigation Program	The Pre-Disaster Mitigation Program will provide funds to states, territories, Indian tribes, communities, colleges, and universities for pre-disaster mitigation planning and implementation of cost-effective mitigation projects prior to a disaster event. Funding these plans and projects reduces overall risks to the population and structures, while also reducing reliance on funding from actual disaster declarations.
Project Modifications for Improvement of the Environment (CAP Section 1135)	Work under this authority provides modifications in the structures and operations of water resources projects constructed by USACE to improve the quality of the environment. Additionally, USACE may undertake restoration projects at locations where an existing USACE project has contributed to the degradation. The primary goal of these projects is ecosystem restoration with an emphasis on projects benefiting fish and wildlife. The project must be consistent with the authorized purposes of the project being modified, environmentally acceptable, and complete within itself.
Public Works and Development Facilities Program	This program provides assistance to help distressed communities attract new industry, encourage business expansion, diversify local economies, and generate long-term, private-sector jobs. Among the types of projects funded are water and sewer facilities, primarily serving industry and commerce; access roads to industrial parks or sites; port improvements; business incubator facilities; technology infrastructure; sustainable development activities; export programs; brownfields redevelopment; aquaculture facilities; and other infrastructure projects. Specific activities may include demolition, renovation, and construction of public facilities; provision of water or sewer infrastructure; or development of stormwater control mechanisms (e.g., a retention pond) as part of an industrial park or other eligible project.

5.2 Other Environmental Financing Sources

Access to many types of environmental financing information is available for local government programs and projects through the Environmental Financing Information Network (EFIN). EFIN maintains a Web site of environmental financial tools, including links to *A Guidebook of Financial Tools*, publications, and links to resources elsewhere on the Internet. Additional financing resources are provided in Table 5-2.

Table 5-2. Resources for Financing Storm Water/Water Quality Projects

Resource	Description	Internet Site
Sustainable Financing from the National Estuary Program	The National Estuary Program has employed multiple funding mechanisms to increase their capacity. Their Web site highlights examples of funding mechanisms such as real estate taxes, special appeals, and license plate programs.	http://www.epa.gov/owow/estuaries/fundexamples.html
Watershed Information	This Web site offers a roadmap to information services for protecting and restoring water resources, including resources on financial, technical, and hands-on assistance to support watershed efforts.	http://www.epa.gov/owow/watershed/
Environmental Finance Center (EFC) Network	The EFC Network is a university-based program that provides financial outreach services to regulated communities. The Network consists of ten EFCs that provide advisory services; education, publications, and training; technical assistance; and analyses on financing alternatives.	http://www.epa.gov/efinpage/efcn.htm
Internet Guide to Financing Storm Water Management	This Web site is designed to help communities find ways to pay for storm water management projects. The site includes an annotated bibliography of existing storm water finance materials; a manual that discusses the financing options available to communities for storm water management programs; a set of case studies that describe successful finance mechanisms that have been used in seven communities around the country; and links to other useful Web sites about storm water management.	http://stormwaterfinance.urbancenter.iupui.edu/
U.S. State and Local Gateway	The Gateway Web site is designed to give state and local government officials and employees easy access to federal funding information, including grant-writing tools, links to grants, and links to other funding directories.	http://www.usa.gov/Government/State_Local.shtml

As part of the Islandwide Program Management Services contract (GU-NH-IPMS[002]), in 2009, PB Americas, Inc., in association with Hobbs, Ong and Associates, Inc., began a comprehensive study of funding mechanisms for Guam. The grant funding sources being evaluated by the PB Americas, Hobbs, Ong and Associates team include the United States

Department of Interior and the United States Department of Agriculture. The study was in process at the time this report was prepared, so detailed information was not yet available.

5.3 Project Application

Nineteen (19) villages from across the island were studied. The final Prioritization Ranking Worksheet was applied to each of the proposed projects that had been created to address drainage system problems. The drainage improvement projects identified and prioritized through the SWDMP project will allow DPW to prepare a proactive drainage improvement program, rather than a program that merely reacts as problems occur. The SWDMP ensures that funds will be spent on drainage infrastructure that is in the most need of replacement due to structural deficiencies, lack of capacity, or lack of an overland flow path, which may cause flooding. The prioritization methodology and criteria used to select the drainage improvement projects will be very helpful to DPW staff in explaining the short- and long-term need for the drainage improvement projects to the elected officials, as well as the general public. The DPW can now incorporate the remaining drainage improvement projects identified through this study into its future CIP for design and construction at a later date.

Once available funding amounts are defined, a detailed implementation plan can be developed to proceed with the highest priority projects in each village. Funding may be allocated to projects in proportion to the need in each village. This allocation would be based on the final cost estimates by village in the SWDMP, as shown in Table 4-1. Administrative adjustments to this approach would allow for moving money between villages and between projects.

As another option, combining projects in contracts by cost, size, prioritization, and/or location may be more efficient than implementing projects on a per village basis. For example, implementation of all projects along a routed road, which may even extend into other villages, could be more cost effective because it would minimize fragmenting large projects into smaller units just because they extend beyond the village boundary. In other instances, projects may be pursued on an individual basis based on available funding, such as grant funding for coastal protection projects that reduce and prevent coral reef and associated reef habitat degradation.

Prior to organizing projects into contracts, a study would be needed to determine the funding mechanism. Once funding is established, the next step would be to identify projects in each village that will receive funding and to set out an implementation plan for

completing the projects. As a first step, a project-specific detailed design would need to be developed. This would be followed by preliminary scoping to confirm elements of work, status of ROWs, and regulatory compliance issues. Cost estimating and environmental and regulatory permit work must also be conducted. A sample timeline for implementation of a regional project is provided in Figure 5-1. Table 5-3 provides an example of a potential operating budget based on grant funding, as well as federal and local resources.

Figure 5-1 – Sample Project Implementation Timeline

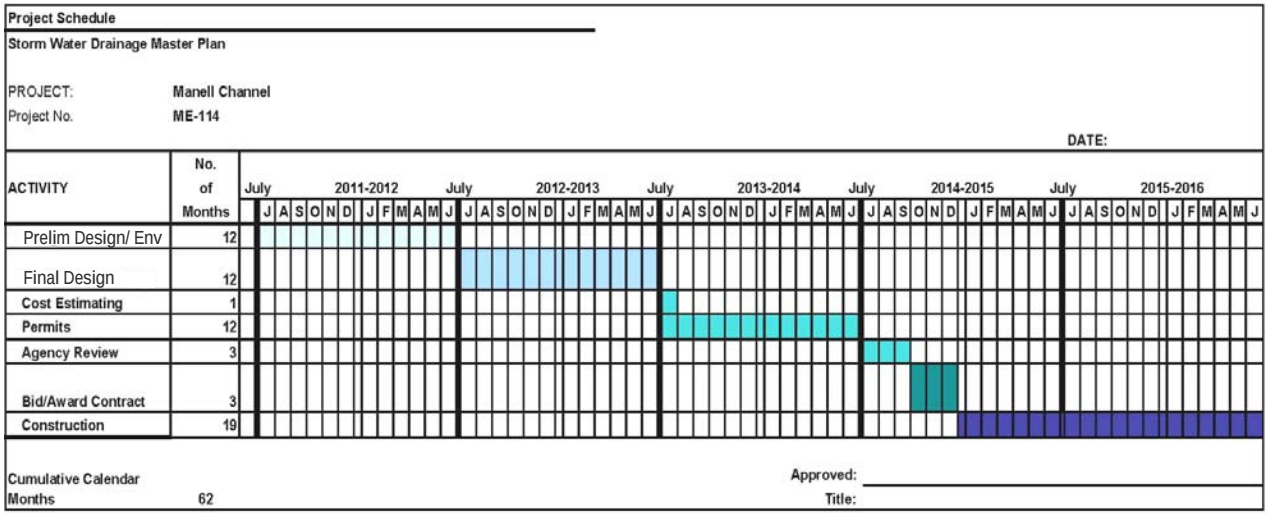


Table 5-3. Sample Operating Budget

Project Name: Mannell Channel
Project No.: ME -114
Project Commencement: 1-Jul-11

Description of Activity	Total Estimated Cost ($)	1st Year	2nd Year	3rd Year	4th Year	5th Year
	$7,630,000					
Prelim Design/ Environmental Docs		$250,000				
Final Design			$400,000			
Cost Estimating				$50,000		
Permits				$50,000		
Construction					$3,080,000	$3,800,000
Total	$7,630,000	$250,000	$400,000	$100,000	$3,080,000	$3,800,000
Funding Summary						
Federal Aid	$7,000,000	$150,000	$150,000	$35,000	$2,980,000	$3,685,000
Grant	$600,000	$100,000	$250,000	$50,000	$100,000	$100,000
Local Aid	$30,000			$15,000		$15,000
Other (please specify)						
Total Funding	$7,630,000	$250,000	$400,000	$100,000	$3,080,000	$3,800,000

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Appendices

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Appendix A

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Appendix B

Watershed Maps

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Appendix C

Project Summary Data Sheets

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Appendix D

Cost Estimation Spreadsheets

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Appendix E

Prioritization Spreadsheets

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