AMERICAN SAMOA
WATERSHED PROTECTION PLAN

Volume 3: Watersheds 36-41

Volume 1: Watersheds 1-23

Volume 2: Watersheds 24-35

Volume 4: Stormwater Management Evaluations

Prepared for:

American Samoa Environmental Protection Agency

and

American Samoa Coastal Zone Management Program

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INTRODUCTION

PURPOSE

The primary purpose of the Watershed Protection Plan is to help focus future resource management efforts of the American Samoa Government. Resource management programs are already being carried out by various agencies of the American Samoa Government and other agencies of the United States Government. The primary agencies of the American Samoa Government (ASG) and federal agencies of the U.S. Government that are involved in resource management programs include the following:

American Samoa Government

American Samoa Environmental Protection Agency
American Samoa Department of Commerce, Coastal Zone Management Program
American Samoa Power Authority
American Samoa Department of Marine and Wildlife Resources
American Samoa Department of Public Works
American Samoa Community College, Land Grant Program
American Samoa Department of Agriculture

U.S. Government

U.S. Environmental Protection Agency
U.S. Department of Agriculture, Natural Resources Conservation Service
U.S. Department of Interior, National Park Service
U.S. Department of Interior, Geological Survey

It is important that future resource management programs in the Territory are closely coordinated to avoid potential overlaps and conflicts in program objectives, and encourage a more cooperative, inter-agency approach to resource management. The Watershed Protection Plan is intended to provide a starting point for future cooperative efforts among these agencies.

SCOPE OF THE PLAN

A wealth of environmental data has been compiled by the American Samoa Government for, at least, the past 30 years. The Watershed Protection Plan brings together a significant amount of selected resource information for 41 watershed planning areas on the Islands of Tutuila, Aunuu, Ofu, Olosega and Tau. The inventory of historical and recent watershed characteristics and related environmental indicators provide the basis for conclusions regarding various resource management issues in each watershed, as well as recommended strategies for future resource management. Specific responsibilities are assigned to various ASG agencies for the implementation of specific resource management projects, as well as longer-term monitoring of selected resources and land uses.

Resource management issues that are addressed in the Plan for each watershed include:

- soil characteristics
- soil suitability for agricultural production, as well as soil-based wastewater treatment and disposal
- stream locations, drainage characteristics, and rates of stream flow
- surface water quality of streams and the nearshore waters
- wetlands
- coral communities and giant clam production
- wildlife habitat for birds and bats
- shoreline protection

- groundwater and surface water supplies
- resident population and land uses, as well as use of the nearshore waters for fishing and general water recreation
- anticipated land uses to the year 2015
- the impact of future population growth upon water consumption and wastewater generation
- flood potential
- stormwater runoff, sedimentation, and the relationship to surface water quality
- nearshore water quality and the marine environment

The level of evaluation associated with each of these issues varies considerably. This variation is dependent upon the availability and reliability of relevant information, as well as the perceived importance of each issue to overall resource management priorities in each watershed.

ORGANIZATION OF THE PLAN REPORT

The Watershed Protection Plan is a three-volume report. Each volume contains this introductory section, a glossary of Samoan words and agency acronyms, and a portion of the individual watershed evaluations. The watersheds included in each volume are as follows:

Volume 1 (watersheds 1-23): North and southeast coasts of Tutuila from Poloa through Laulii
Volume 2 (watersheds 24-35): Southcentral and southwest coasts of Tutuila from Pago Pago Harbor through Amanave, as well as the Island of Aunuu
Volume 3 (watersheds 36-41): Islands of Ofu, Olosega, and Tau

The names and location of each watershed are illustrated at the beginning of the Watershed Evaluations in each volume. The references associated with publications and personal communications, which were used in the preparation of the Watershed Protection Plan, are provided at the end of Volume 3.

PLAN METHODOLOGY

Compilation and Review of Available Information

Available information was gathered from a variety of sources concerning natural resources, land uses, resident population, and other relevant data. Relevant information was summarized for subsequent incorporation into the Plan.

The American Samoa Power Authority, for example, provided recent population, land use, as well as water and wastewater system evaluations that were developed for its draft Utility Master Plan. Soils information was gained from the Soil Survey of American Samoa that was published in 1984 by the U.S. Soil Conservation Service (now the Natural Resources Conservation Service). The ASG Department of Marine and Wildlife Resources and the ASG Department of Agriculture provided results from field surveys concerning wildlife resources and village agricultural activities.

Pedersen Planning Consultants was also assisted by AECOS, Inc. in Kaneohe, Hawaii. Aecos, Inc. provided a review of available water quality information. This information generally represented historical information from the U.S Geological Survey, U.S. Environmental Protection Agency, as well as the American Samoa Environmental Protection Agency.

Field Survey of Watershed Planning Areas

Available information was also supplemented by a field survey of each watershed planning area by Pedersen Planning Consultants (PPC) during April-May, 1996. Informal discussions with one or more residents of each watershed were made in conjunction with the field surveys. Residents that were typically contacted by PPC included village *matai,* or other knowledgeable long-term residents of

communities in the watershed. In some cases, residents toured PPC representatives in selected watershed areas to identify or clarify specific watershed issues. Photographs and field notes were taken by PPC representatives for each watershed. Significant issues were also documented on available topographic maps of the Territory that are based upon 1989 aerial photography.

Geographical Information System for American Samoa

A geographical information system (GIS) was developed by Pedersen Planning Consultants to facilitate future reference to selected types of information. This planning tool resource should facilitate future resource planning and management activities. The GIS for American Samoa was developed through the use of ArcView software, version 3.0, which is manufactured and distributed by Environmental Systems Research Institute, Inc. in Redlands, California.

In the development of the GIS for American Samoa, some available digital information was provided by the American Samoa Department of Commerce, the American Samoa Power Authority, and the U.S. Geological Survey. A considerable amount of hardcopy information was also scanned via a high-quality scanner that was available at the University of Wyoming in Laramie, Wyoming. Some other information, e.g., point data, was manually digitized by PPC. Digital files were subsequently organized by Pedersen Planning Consultants to develop the actual geographical information system.

It is important for users of the Watershed Protection Plan to recognize that the illustrations provided in this report reveal only a portion of information that is readily available through the GIS. Users of the Plan are strongly encouraged to use the GIS for American Samoa when reviewing data, conclusions and recommendations in the Plan. The level of detail available in the GIS and the opportunity to correlate various combinations of information, e.g., soils and anticipated growth, enables GIS users to gain a greater understanding of watershed issues and/or share the information with other personnel.

RECOMMENDED STRATEGY FOR PLAN IMPLEMENTATION

Establishment of a Territorial Watershed Resource Management Board

Many of the federal programs of the U.S. Government that are related to resource management now encourage local resource management in the context of *watersheds*. This policy is a move away from past programs that focused primarily upon the preservation of endangered species or unique natural resources. It is widely recognized throughout most of the world that the conservation of natural resources is largely dependent upon the balance of ecological relationships within the watershed where natural resources are located. This is particularly true in the tropical environment of American Samoa.

The implementation of the various resource management programs that are associated with watershed conservation requires a cooperative partnership between several agencies in American Samoa, as well as several federal U.S. Government agencies.

Several federal agencies of the U.S. Government already provide technical assistance and/or grant funds that represent an important contribution to the implementation of various resource management programs in American Samoa. At the same time, several resource management agencies in American Samoa establish and carry out local programs to pursue various resource conservation strategies and, in some cases, related regulatory programs.

In order to formalize a more cooperative resource management effort, it is recommended that a Territorial Watershed Resource Management Board be established. This Board would consist of one representative from each of the following agencies of the American Samoa Government:

- American Samoa Environmental Protection Agency
- American Samoa Department of Commerce, Coastal Zone Management Program
- American Samoa Power Authority

- American Samoa Department of Marine and Wildlife Resources
- American Samoa Department of Public Works
- American Samoa Community College, Land Grant Program
- American Samoa Department of Agriculture
- Office of Samoan Affairs

Ex-officio members of the Watershed Resource Management Board would also include representatives of the following federal agencies:

- U.S. Department of Agriculture, Natural Resources Conservation Service
- U.S. Department of Interior, National Park Service

The Watershed Resource Management Board should meet monthly or quarterly, or as frequently as desired. During regular meetings, the Board would discuss work progress and schedules related to the implementation of specific watershed improvement projects and ongoing monitoring tasks that are identified in the Watershed Protection Plan, as well as other cooperative resource management opportunities not reflected in the Plan. It is envisioned that representatives of participating agencies would also share findings from agency surveys, consultant reports, and other evaluations that would help increase the understanding of information gained from ongoing resource management programs of individual agencies.

Establishment of a Lead Agency

The Watershed Protection Board needs a lead agency that will assume responsibility for the overall management and daily implementation of the inter-agency, resource management program. Since many of the resource management issues relate to water quality, it is logical that the program should initially be managed by ASEPA.

The designation of ASEPA as the lead agency for watershed protection would not supercede the authorities already given to various ASG agencies. Rather, it would act as the catalyst for cooperative, watershed improvement programs that are made on an inter-agency basis. In addition, ASEPA would also help ensure that the progress and information gained from both independent and cooperative resource management programs are shared by all participating agencies which are represented on the Watershed Protection Board.

The lead agency will be responsible for assigning a full-time program manager who will be assigned to coordinate the implementation of the Watershed Protection Plan and the activities of the Territorial Watershed Resource Management Board. The program manager will need to be a strong individual who is willing to listen and constructively respond to the concerns of participating ASG and federal agencies and traditional village leaders, as well as take constructive, aggressive steps to support their decisions.

It is also important that the selected program manager is highly motivated and committed to making the program a successful effort. Knowledge of the Samoan language and culture, as well as the environment of American Samoa, is essential.

The use of a designated consultant firm should also be considered to provide occasional technical assistance to the lead agency, program manager, and the overall Watershed Resource Management Board. The selected firm would provide technical assistance related to specific watershed improvement projects, and possibly help make periodic evaluations of program success. Any firm selected for this work should have considerable experience associated with the environment of American Samoa, as well as some knowledge of *faaSamoa*. The firm should also be willing to supplement its resources with the capabilities of other consultants, if necessary.

Participation of Traditional Leaders and Residents in Resource Management Solutions

The implementation of the Watershed Protection Plan can only be accomplished via a cooperative inter-agency effort that is linked to traditional village leaders and residents. Despite significant changes in land tenure, a significant proportion of lands in the Territory remain as "communally-owned" lands. Many village councils also remain active in the management of village affairs, lifestyle, and village improvement projects. Traditional leaders and village residents in American Samoa are keenly aware of many resource management issues, as well as the specific environmental conditions in their respective watersheds.

Desired modifications in the way people live and use natural resources typically require community motivation. More motivation for desirable changes can be expected when people affected can become involved in resource management decisions and gain some greater understanding and appreciation for the purpose and benefits of recommended changes in lifestyle, land use, and the use of other natural resources. It is their commitment that is essential to long-term change.

Despite many ongoing cultural changes, the village remains the heart of *faaSamoa.*. It is this social unit that binds the families who live in Territory. It is interesting to note that some of the more recent immigrants to American Samoa, e.g., Tongans, are already building small communities within villages such as Nuuuli and Tafuna in order to organize themselves into their own "village units" away from their native islands.

Through the establishment of a constructive working relationship, the American Samoa Government is confirming to its traditional leaders that their wisdom and experience has relevance to addressing long-term management issues. Further, ASEPA and participating resource management agencies on the Watershed Resource Management Board will be sending the message that they stand ready to assist the villages rather than only telling them what to do, or not to do.

Through the sharing of information between villages and participating agencies, this process will help participating agencies better determine program and project priorities. Village leaders, in turn, will gradually begin to recognize that increased village participation and commitment to resource management will yield benefits that will help improve village sanitation, the quality of drinking water, flood control, surface water quality and coral communities, fishing opportunities, recreation, and general lifestyle.

Village leaders will be requested by the core management group to identify one representative that can be the primary point-of-contact for a given village. It is important that this person is respected and trusted by the village council. Ideally, the point-of-contact will also be a member of the village council.

Watersheds 36 - 41

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American Samoa Watershed Protection Plan
VOLUME 3 - LIST OF WATERSHEDS

Watersheds in this Volume Listed by Watershed Number

Watersheds Listed Alphabetically (Watershed/Volume-Number)

OFU SAUTE
Watershed 36

GEOGRAPHY

The Ofu Saute watershed generally represents the south and west sides of Ofu Island. The watershed comprises about 1.78 square miles of land area (Figure 36-1).

The inland boundaries of the watershed include Tumu Mountain and the mountain ridges known as Tia Ridge, Mako Ridge, and Leolo Ridge. Sunuitao Peak, which is located on the east end of Ofu, defines the east boundary of the watershed.

Along the south and west coasts of Ofu, the watershed extends between Feia Point, the northwest tip of Ofu, and Asagatai Point. Asaga Strait separates the Islands of Ofu and Olosega on the east side of Ofu. There are no embayments along the south and west coasts of Ofu.

RESOURCES OF THE WATERSHED

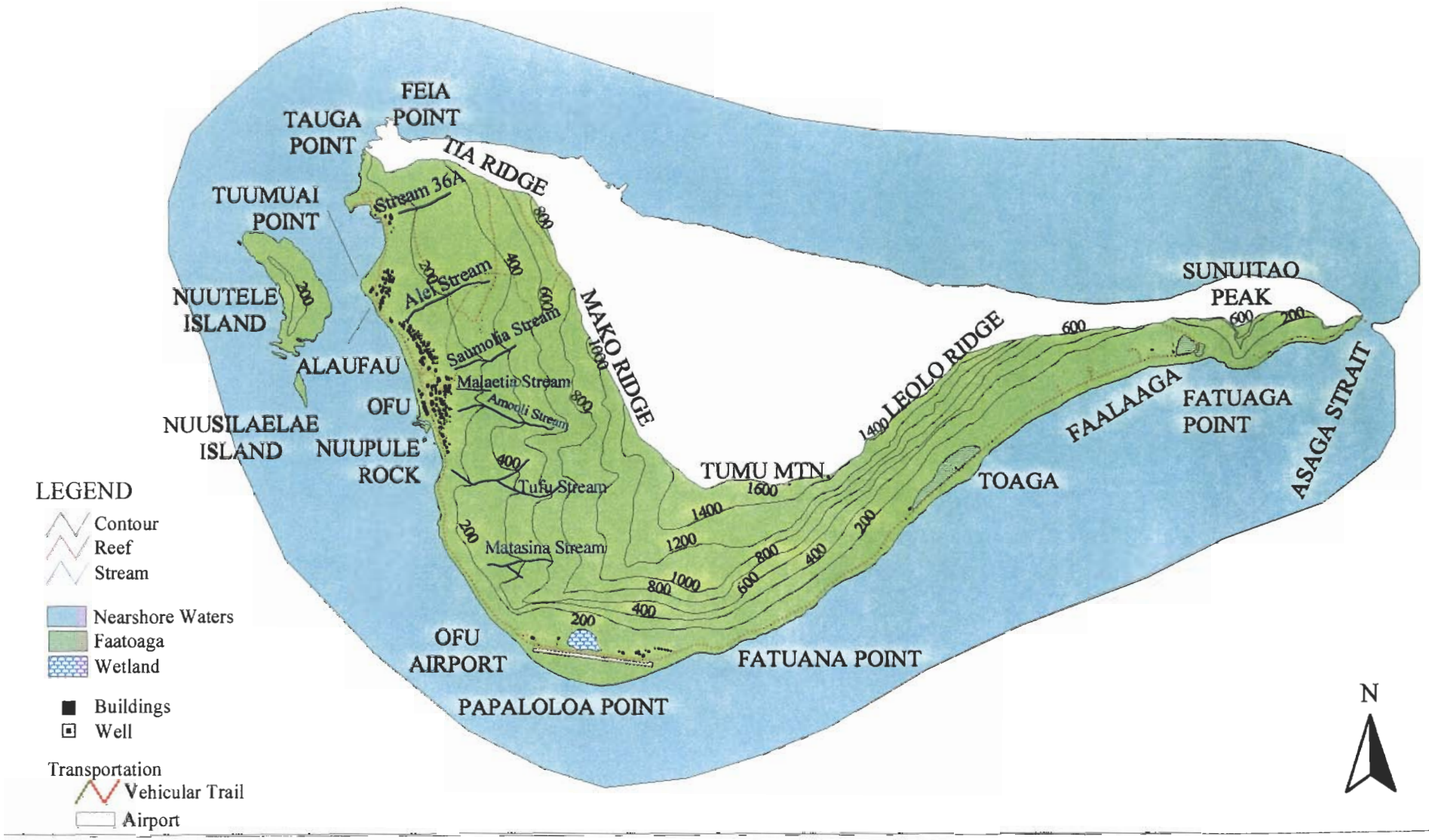
Soils

The U.S. Soil Conservation Service (National Resource Conservation Service) published a Soil Survey of American Samoa in 1984. Selected information derived from this survey provides some useful information for future watershed planning and management (Figure 36-2). Eight soil classifications were identified by the U.S. Soil Conservation Service for lands within the Ofu Saute watershed (Table 36-1).

TABLE 36-1
SELECTED SOIL CHARACTERISTICS
OFU SAUTE WATERSHED

SCS Soil Unit	Name	Typical Slope (Percent)	Flood	Runoff	Erosion	Soil Depth To:		Land Use Suitability	
						High Water (Feet)	Bed Rock (Inches)	Soil Based WW Treatment	Subsistence Ag Potential
2	Aua very stony silty clay loam	30-60	None	Rapid	Severe	<6	<60	Severe Slope	Poor
4	Fagasa family-Lithic Hapludolls-Rock outcrop assoc	70-130	None	Very Rapid	Very Severe	>6	20-40	Severe Slope Depth	Poor
6	Insak mucky sandy loam	0-2	Freq	Ponded to Slow	Slight	0.5-2.0	20-40	Severe Flooding depth to Rock Ponding	Poor for dry land crops
11	Ngedebus mucky sand	0-2	Occ	Very slow	Slight	>3.5	>60	Severe flood Wetness Poor Filter	Moderate
14	Ofu silty clay	15-40	None	Med	Mod	>6.0	>60	Severe Slope	Good
15	Ofu silty clay	40-70	None	Med	Mod	>6.0	>60	Severe Slope	Poor
27	Rock outcrop-Hydrandepts-Dystrandepts assoc	70-130	N/A	N/A	N/A	N/A	N/A	N/A	Poor
35	Urban Land-Ngedebus complex	0-5	Occ.	Slow	Slight	>3.5	>60	Severe Flood Wet Pool Filter	Poor

Source: U.S. Soil Conservation Service, 1984



American Samoa Geographical Information System

0.5 0 0.5 1 1.5 2 2.5

Miles

Scale: 1:30,000

Prepared by: Pedersen Planning Consultants Tel: 307-327-5434

Ofu Saute Watershed Existing Conditions

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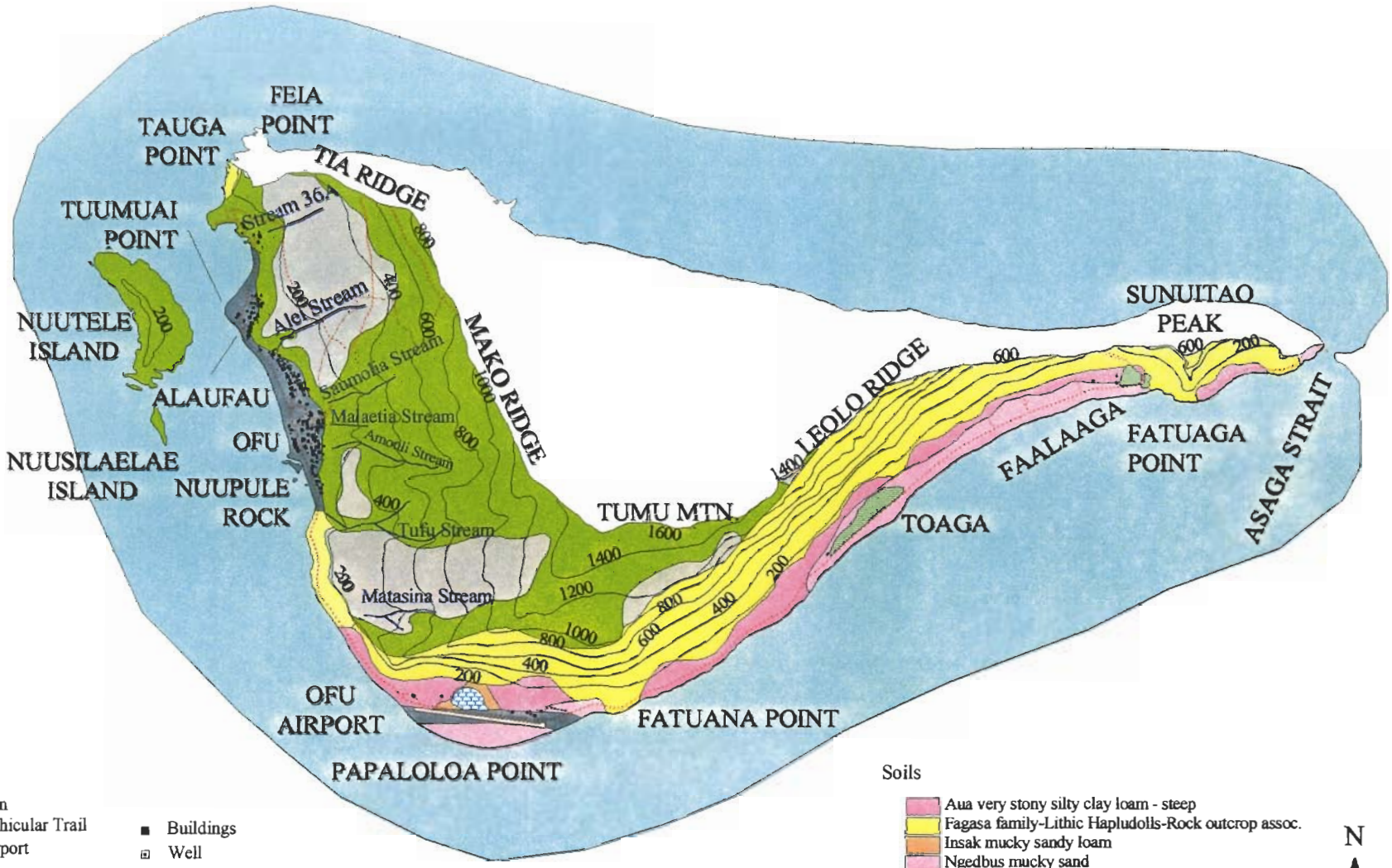
Figure 36-1



American Samoa Geographical Information System

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Miles

Scale: 1:30,000

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Ofu Saute Watershed Management Issues

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Figure 36-2

Urban Land-Ngedebus Complex

Urban land-Ngedebus complex soils (SCS mapping unit #35) is found in two areas of Ofu:

- north of Papaloloa Point in the vicinity of Ofu Airport; and,
- the inhabited village areas of Ofu and Alaufau villages.

These soils generally comprise coral fragments, sand, cinders and other material that have been graded or filled to support residential, commercial and public facilities in the village area.

The Ngedebus soil extends to a depth of 60 inches or more. The surface layer, which extends about 4 inches below ground elevation, typically contains light, brownish-gray and brown sand. The underlying material is characterized by pale brown and light yellow, brown sand.

The permeability of Ngedebus soil ranges between six and 20 inches per hour. Surface drainage on this soil is generally slow, and the hazard of potential soil erosion is slight. In some places, the soil is subject to occasional, brief periods of flooding during prolonged, heavy rainfall or during high tide (U.S. Soil Conservation Service, 1984).

These soils are generally suitable to support residential and commercial development in areas that are protected from flooding. However, this soil is poorly suited in unprotected areas (U.S. Soil Conservation Service, 1984).

Where moderate to higher housing densities occur, the U. S. Natural Resources Conservation Service recommends the use of community sewage systems prevent the potential contamination of groundwater and surface water supplies. Housing densities in Alaufau and Ofu range between five to seven units per acre.

Rock Outcrop-Hydrandepts-Dystrandepts Association, Very Steep

Along the west shoreline of Ofu, soils known as rock outcrop-hydrandepts-dystrandepts association (SCS mapping unit 27) are situated between Tufu Stream and Matasina Stream. These soils generally extend between the shoreline and the 200-foot contour (Figure 36-2). As the name implies, rock outcrop-hydrandepts-dystrandepts association represents a combination of rock outcrop, Hydrandepts, and Dystrandepts.

Exposed areas of bedrock represent Rock outcrop. The rock outcrop is on very steep and nearly vertical side slopes. This soil type contains little or no soil material. Where present, the soil is usually gravelly and ranges from sandy loam to silty clay loam.

Hydrandepts are located at higher elevations on very steep side slopes. Hydrandepts formed in volcanic ash under heavy rainfall. This soil is well drained and frequently represents a silty clay loam. Hydrandepts is typically shallow, or sometimes moderately deep to bedrock.

Dystrandepts are found at lower elevations on very steep side slopes. Dystrandepts, which is formed in volcanic ash, is well drained and are usually shallow or moderately deep to bedrock. The soil contains a stony surface layer and typically represents a clay loam or silty clay loam.

These soils are unsuitable for both subsistence agriculture and septic tank applications because of steep slopes and the lack of an adequate soil layer for soil-based wastewater treatment.

Ngedebus Mucky Sand

Four areas of the Island of Ofu contain Ngedebus mucky sand (SCS mapping unit #11):

- along the shore at Papaloloa Point;
- west of Fatuana Point and northeast of Ofu Airport;
- the Toaga area along the southeast coast of Ofu; and,

- in the vicinity of Asagatai Point on the east tip of Ofu.

Ngedebus mucky sand is a deep, somewhat excessively drained soil. This soil is derived from coral and sea shells.

The surface layer is typically black mucky sand that is approximately 12 inches thick. In some areas, the surface layer comprises loamy sand. The substratum is gray to very pale brown sand that extends to a depth of 60 inches or more.

The permeability of Ngedebus mucky sand is rapid. The potential hazard of water erosion is slight; potential runoff is very slow. Very brief periods of flooding can occur on these soils.

Ngedebus mucky sand is moderately suited to the production of subsistence crops such as taro, bananas, breadfruit and coconuts. However, agricultural uses are constrained by the retention of adequate moisture and low soil fertility.

Its suitability for septic tank installations and effluent drainfields is poor. Rapid permeability and the limited depth to the water table do not enable effective soil-based treatment.

Aua Very Stony Silty Clay Loam (30 to 60 percent slopes)

From northwest of Papaloloa Point to the west side of Sunuitao Peak, the steeper slopes of the lower watershed contain Aua very stony silty clay loam soils (SCS mapping unit #2). These steeper slopes are generally located downslope of the 200-foot contour (Figure 36-2).

The Aua soils range between seven to 60 inches in depth. The permeability of these soils (between 2 and 6 inches per hour) is moderately rapid. For watershed management purposes, it is important to note that these Aua soils have a high potential for runoff and erosion.

This Aua soil is not recommended for agricultural production because of the stoniness of the soil, the high erosion potential, and hazards associated with subsistence crop cultivation on steeper slopes. However, when cultivation in these soils is necessary, the use of a mulch or ground cover is recommended to reduce soil erosion in cultivated areas.

The U.S. Soil Conservation Service estimates that this soil can annually sustain up to 5 tons per acre of erosion without impacting crop productivity (U.S. Soil Conservation Service, 1984). While the erosive characteristics of this soil generally may not significantly impact subsistence crop productivity, the erosive quality of the soil can be a significant contributor to sedimentation in downslope streams and the nearshore waters.

The general characteristics of these Aua soils are also undesirable for individual wastewater disposal systems (U.S. Soil Conservation Service, 1984). The soils contain a significant amount of larger stones that hamper installation and provide inadequate soil treatment.

Insak Mucky Sandy Loam

Vaoto Marsh is situated on the north side of Ofu Airport. The Marsh and adjoining land areas to the east and west contain Insak mucky sandy loam (SCS mapping unit 6).

Insak mucky sandy loam is a moderately deep and very poorly drained soil that is typically found in coastal depressions. The soil is formed in coral sand and organic matter.

The surface layer, which is typically a black mucky sandy loam, is approximately 11 inches thick. In some areas, however, the surface layer contains a mucky loamy sand. Very dark, gray-mucky loam comprises a second layer of about six inches. White and light gray sand, approximately 9 inches thick, lies over coral that is found about 26 inches below ground elevation. The depth to bedrock ranges from 20 to 40 inches.

Soil permeability ranges between six and 20 inches per hour. The hazard of potential water erosion is considered slight; potential runoff is ponded to slow.

The depth of the water table is 10 to 20 inches below ground elevation. Areas that are unprotected are frequently flooded.

The soil is suitable for the production of wetland taro. and other water tolerant plants.

Insak mucky sandy loam is unsuitable for septic tank and effluent drainfield applications. Potential flooding and the limited depth to the water table do not promote effective soil-based treatment.

Fagasa Family-Lithic Hapludolls-Rock Outcrop Association

Steeper upland slopes along the south slopes of Tumu Mountain and Leolo Ridge, as well as the upland slopes of Sunuitao Peak, contain well-drained soils known as the Fagasa Family-Lithic Hapludolls-Rock outcrop association (SCS mapping unit 4).

The Fagasa Family soils contain a surface layer of dark, brown silty clay that is about 12 inches thick. A dark brown subsoil is approximately five inches thick. The substratum, which is characterized by a dark-brown, sandy clay loam, extends to a depth of 31 inches. The depth to bedrock ranges between 20 to 60 inches or more.

The Lithic Hapludolls soils are shallow, well-drained soils that are derived from igneous rock. The surface layer is highly variable, but U.S. Soil Conservation Service soil scientists have observed the surface layer to contain about five inches of dark brown, cobbly silty clay. The subsurface layer, which is about four inches thick, is a dark brown, very cobbly, silty clay. The substratum represents a clay loam, approximately six inches thick, over weathered bedrock.

The soil permeability of the Fagasa Family and Lithic Hapludolls soils are both between two and six inches per hour. Since the Fagasa Family-Lithic Hapludolls soils typically occur on very steep slopes, potential runoff can be very rapid. The potential for water erosion is very severe (U.S. Soil Conservation Service, 1984).

The cultivation of subsistence crops on these soils is not considered desirable. However, when cultivation in these soils is necessary, care should be exercised to minimize the amount of exposed soil in cultivated areas.

When heavier rainfall events occur, significant erosion of these soils can be expected from undeveloped upslope areas of the watershed. Natural runoff from steeper slopes in the watershed carries water, sediments, and organic debris to downslope drainage courses and streams. Such erosion can readily influence downstream water quality.

Fagasa Family and Lithic Hapludolls soils are unsuitable for septic tank and effluent drainfield applications. Steeper slopes and the limited depth to bedrock do not afford effective soil-based treatment of wastewater.

Ofu Silty Clay (40 to 70 percent slopes)

A portion of the steeper, upland slopes of Tumu Mountain and Mako Ridge are characterized by Ofu silty clay (SCS mapping unit 15). This soil is a deep, well drained soil formed in volcanic ash and residuum that is derived from basic igneous rock.

The surface layer, which is about 10 inches thick, is typically dark reddish-brown, silty clay. In some locations, the surface layer represents a stony silty clay. The subsoil contains about nine inches of dark reddish brown silty clay loam; reddish brown silty clay loam extends another 18 inches. The

substratum of reddish-brown, silty clay loam extends to a depth of 60 inches or more. The depth to weathered bedrock ranges from 40 to 60 inches or more.

Ofu silty clay soils have a soil permeability that ranges between two and six inches per hour. The potential hazard of water erosion is severe; the potential occurrence of runoff is medium to rapid.

These soils generally support woodlands, but not commercial timber harvests. Steeper slopes, as well as potential water erosion and runoff hazards, make these soils unsuitable for subsistence agricultural production.

The use of these soils for septic tank and effluent drainfield applications is also unsuitable. Steeper slopes where these soil occur do not promote effective soil-based treatment of wastewater effluent.

Ofu Silty Clay (15 to 40 percent slopes)

Ofu silty clay on 15 to 40 percent slopes (SCS mapping unit 14) is found on a portion of the slopes of Leolo Ridge, the steeper southwest slopes of Tumu Mountain, and the northwest slopes of Mako Ridge. This Ofu silty clay soil is a deep, well drained soil that is formed in volcanic ash and residuum derived from basic igneous rock.

The surface layer is typically a reddish-brown silty clay that is approximately 16 inches thick. A dark brown, silty clay loam characterizes the upper 29 inches of the subsoil; the lower 15 inches of the subsoil contains a dark brown silty clay. A substratum of dark brown silty clay, or silty clay loam, is found in some areas at depths of 30 to 60 inches or more.

The permeability of Ofu silty clay ranges between two and six inches per hour. The potential hazard of water erosion is moderate; potential runoff is considered to be medium (U.S. Soil Conservation Service, 1984).

Ofu silty clay is well-suited for subsistence crop production. Typical crops produced from these soils include coconuts, breadfruit, bananas and taro.

These soils are poorly suited for septic tanks and related effluent drainfields. Steeper slopes do not enable effective soil-based treatment of wastewater.

Streams

Stream Locations

There are seven streams in the Ofu Saute watershed. These drainages are all located along the west slopes of Tumu Mountain and Mako Ridge.

North of Alaufau, an unnamed stream (Stream 36A) originates at about the 315-foot elevation on the south side of Tia Ridge. This stream discharges north of the ASPA office, which is located generally east of the Ofu Harbor boat launching ramp. This stream drains the south slopes of Tia Ridge and the northwest slopes of Mako Ridge.

Alei Stream begins at approximately 325-feet above mean sea level along the southwest slopes of Mako Ridge. The stream passes through the north side of Ofu Village before discharging along the shoreline into the nearshore waters.

The headwaters of Saumolia Stream are located at about the 450-foot contour along the southwest slopes of Mako Ridge. The stream drains a portion of these slopes and discharges upland of Ofu Village near the 37-foot elevation.

Malaetia Stream also drains the southwest slopes of Mako Ridge. The stream originates near the 255-foot elevation. Malaetia Stream also discharges upslope of Ofu Village near the 45-foot contour. However, a small, man-made channel on the north side of Vaeao Store carries stormwater runoff from the center of the village to the shoreline. This channel primarily transports flows that are carried by Malaetia Stream.

Amouli Stream generally parallels Malaetia stream. This stream course begins considerably higher at about 545 feet above mean sea level. However, it also discharges upslope of Ofu Village at about the 70-foot elevation.

South of Ofu Village, Tufu Stream and one tributary carry surface runoff from the west slopes of Tumu Mountain. The main stem of the stream begins at about the 680-foot contour. Its point of discharge is upslope of the primary shoreline roadway at approximately 60 feet above mean sea level.

Along the southwest slopes of Tumu Mountain, Matasina Stream originates near the 600-foot elevation. This stream also discharges upslope of the primary shoreline roadway at approximately 270 feet above mean sea level.

Stream Flows Within the Watershed

In May, 1996, Chief Tafao reported that the four streams in Ofu Village (Alei, Saumolia, Malaetia, and Amouli) provided only intermittent flows. Otherwise, no other streamflow data was discovered for the seven streams in the watershed.

Surface Water Quality

Streams

The four streams that flow in the vicinity of Ofu Village also generate significant turbidity in the nearshore waters during and following heavier rainfall periods (Tafao, 1996).

Nearshore Waters

Observations by marine ecologists in October, 1979 reported good underwater visibility in the strait between Ofu and Nuupele Rock. However, refuse and silt accumulated in the nearshore boat channel (Aecos and Aquatic Farms, 1980).

During the same period, marine biologists also documented excellent underwater visibility in a nearshore depression that extended northwest from Papaloloa Point. Reduced water quality was evident closer to Papaloloa Point. It was also observed that longshore currents in this area flowed to the northwest.

Wetlands

On the north side of Ofu Airport, there is small coastal marsh known as Vaoto Marsh. The marsh contains approximately four acres of land that is backed by steep coastal cliffs. Available topographic maps of this area suggest that this marsh was somewhat larger prior to the construction of Ofu Airport.

Whistler reported in 1976 that vegetation in Vaoto Marsh primary consisted of mangrove, water chestnut, and willow primrose. He also noted that the marsh was reverting back to a natural condition because of an apparent neglect of cultivation.

During a May, 1996 survey of the watershed, it was learned that stormwater flows, which drain into the marsh, are normally detained within the margin of the marsh (Vaovasa, 1996).

Marine Resources

Coral Communities

The Island of Ofu is encircled by a fringing reef. Available topographic maps indicate that this reef ranges between 300 and 1,00 feet seaward of the shoreline.

Various private consultants have made field investigations of the fringing reef that adjoins the watershed since the late 1970's. In a cumulative sense, available survey information suggests that:

- Corals in this watershed have not been significantly reduced by recent storms or crown-of-thorns starfish infestations as coral communities around Tutuila Island.
- A number of rare corals inhabit the fringing reef along the south coast of Ofu.

1978-1979

On the reef flat seaward of Alaufau, marine life was almost non-existent to Nuutele Islet. Coral cover was less than 5 percent on rubble located north of Tuumuai Point.

The construction of Ofu Harbor was completed around 1975. After only four years, corals rapidly colonized harbor structures. The revetment within the inner harbor was characterized by a coral coverage near 50 percent between depths of 5 and 15 feet.

Seaward of Ofu Village, live coral was absent from a narrow boat channel that paralleled Ofu Beach. There was about five percent live coral cover on the reef flat near Nuutele Islet.

South of Nuupule Rock, coral coverage was only five percent on the inner reef flat. Limited coral coverage was noted on the outer reef flat.

Small amounts of coral were observed on the relatively flat outer reef platform that was seaward of Papaloloa Point.

In the vicinity of Asaga Strait, live coral was sparse near the shoreline. Offshore, coral coverage increased to about 15 percent. Near the middle of Agasa Strait, coral coverage ranged from 40 to almost 100 percent at a depth of 6 feet.

1992

Field investigations were made by Maragos, Hunter, and Meier in 1992 along the reef front that is seaward of Ofu Village.

These marine ecologists noted that the reefs seaward of Ofu Village are partially protected by offshore islands, Nuutele and Nuusilaelae. The nearshore waters in this area *".....support among the best developed reef slope coral communities in American Samoa. Furthermore, the reef flats along Ofu's south coast to the east of Vaoto Lodge and the airfield are among the best developed in the territory. The rare blue coral Heliopora coerulea and several other corals form spectacular microatolls on the reef flats and reef moats. The National Park Service has designated a national park for this reef region, and the Territory of American Samoa designated the reef segments between the airfield and the National Park area as a territorial park. This latter reef area was intensively surveyed in September 1992"* (Maragos, Hunter, and Meier, 1992).

1995

A recent 1996 study of various coral reefs throughout the Samoan Archipelago included the performance of five transects along the reef front that is located on the seaward side of Nuupule Rock. The study focused primarily upon the quantification of coral communities, the abundance and diversity of reef fish, and selected habitat characteristics.

Coral cover of less than 20 percent was observed. Fish species richness ranged between 100 to 149 species. present. Fish density was observed to be between 5,000 and 9,999 individuals per ha. Fish biomass was documented between 500 to 999 kilograms per ha.

Green also noted that the coral reefs of the Manua Islands were severely damaged by Hurricane Tusi in 1987, but escaped significant damage from Hurricane Ofa in February, 1990 and Hurricane Val in December, 1991. In addition, the reefs in Manua were also influenced by infestations by the crown-of-thorns starfish and a recent coral bleaching event. From her review of past studies, Green concluded that the reef fronts of the Manua Islands tended to be in better condition that those on Tutuila.

Wildlife Resources

In the 1980 Coral Reef Inventory, Nuutele Islet was identified as a major breeding place for five of the six species of seabirds that are known to nest on the Island of Ofu. These birds included:

- brown boobies;
- blue-grey noddies;
- brown noddies;
- white terns; and,
- red-footed boobies.

Three larger caves underneath Nuutele Islet, as well as trees on the Islet may also provide roosting sites for fruit and sheath tailed bats (Aecos and Aquatic Farms, 1980).

Aecos and Aquatic Farms also noted that flying fox roosts are found on the sea cliffs along the south coast of Ofu. It was also reported that the common brown noddy nests on the southern cliffs above Toaga.

More recently, a 1986 Survey of the Forest Birds of American Samoa also documented a considerable number of forest birds in various areas of the Island of Ofu (Engbring and Ramsey, 1989). These habitats generally included rain forest, secondary vegetation, mixed vegetation, and plantation lands. Specific locations of these habitats were not identified. However, several brown noddies were observed landing on the rocky west cliffs of Nuutele Islet. White-rumped swiftlets were also observed in this area.

In August, 1997, Brook counted 211 fruit bats that were exiting from a ridge behind the Vaota Lodge near Ofu Airport (Utzurrum, 1998).

Shoreline Protection

The fringing reef of the Ofu Saute watershed affords some natural protection to the shoreline of the watershed. In addition, some man-made shore protection facilities have been developed at various shoreline locations:

- Ofu Harbor;
- South of Tuumuai Point;
- South of Nuupule Rock;
- the east and west ends of the Ofu Airport runway.

North of Alaufau, shoreline protection facilities include revetments associated with Ofu Harbor. Construction of the original harbor was completed in 1975. However, severe harbor damages that were sustained by Hurricanes Val and Ofa required significant repairs to protective revetments, a breakwater, and adjoining shoreline revetments in the mid-1990's.

Other shoreline protection facilities include marginal shore protection. These facilities generally include coral and basalt walls, as well as the placement of larger, basalt boulders.

In March, 1994, Sea Engineering, Inc. and Belt Collins Hawaii published a shoreline inventory report that outlined, in part, ongoing shoreline erosion conditions and related shore protection needs for American Samoa. Sea Engineering, Inc. and Belt Collins Hawaii noted the following conditions in the Ofu Saute watershed that were determined to be "critical", or "potentially critical" conditions.

Tuumuai Point

In the vicinity of Tuumuai Point, there is a public dispensary that is operated by the American Samoa Government. The hospital immediately inland of Tuumuai Point is the only structure that is located seaward of the primary shoreline roadway. Critical erosion was documented to be occurring along the southern 100 feet of the beach at Tuumuai Point where waves reach a 3-foot rock wall that supports the foundation of the dispensary.

North of Nuupule Rock

Several homes are built seaward of the primary shoreline roadway and threatened with erosion. Some shore protection measures have been constructed or placed on the shoreline such as filled 50 gallon drums, a loose coral wall, and large 6-foot coral boulders at the mean lower water line. A sand beach is present, but the homes were observed to be less than 50 feet from the top of the wave swash, and only 3 to 4 feet above mean high water.

South of Ofu Village

South of Ofu Village there is a shoreline reach, between Tufu Stream and Matasina Stream that extends about 2,500 feet. The shoreline dirt trail closely parallels the shoreline and ranges between the 11 and 33-foot elevation. At two locations, a scarp is cut into the backshore and has damaged the shoreline trail. "*At the north end, a concrete retaining structure has been built and filled in. In the middle of the reach, the damage has been repaired with coral and basalt gravel and rocks"* (Sea Engineering, Inc. and Belt Collins Hawaii, 1994).

Papaloa Point

Along a 150-foot length west of the Ofu Airport runway, large basalt boulders have been placed alongside the shoreline trail to provide some shoreline protection. The airport runway is located on the flat backshore approximately 8 feet above MSL (mean sea level). The runway is set back over 400 feet in the middle, and 50 to 100 feet at each end. A scarp is cut into the backshore of the shoreline reach that is adjacent to the west end of the runway. The scarp, which is located within 5 feet of the west end of the runway, indicates past storm erosion.

Groundwater and Surface Water Supplies

Groundwater Supply and Quality

Ofu Village has a satellite water system that is operated and maintained by the American Samoa Power Authority (ASPA). This system includes, in part, two groundwater wells (ASPA wells 201 and 202). This water system serves Ofu Village and the Ofu Airport area (Figure 36-3).

Good groundwater quality is provided by these groundwater sources. The groundwater supply is regularly chlorinated at well 202 via the regular application of a batched solution of liquid bleach and water. Existing chloride levels are low (ASPA, 1995).

Surface Water Supply and Quality

There is no village water system in the Ofu Saute watershed (ASPA, 1995).

USE OF THE WATERSHED

Resident Population

Between 1980 and 1990, the resident population of Ofu Village increased from 345 to 353 residents. Such growth represented an average annual growth rate of about 2.3 percent. Development activity between 1990 and 1995 increased resident population to about 433 persons.

Population trends reflected in the 1990 Census statistics suggest that considerable in-migration has occurred in this community between 1980 and 1990. The proportion of residents who were born outside of American Samoa during the 1980-1984 period was about 15 percent. Between 1985 and 1990, the proportion increased to 53 percent. In 1990, the proportion declined sharply to 13 percent. The more recent downward swing of migration within Ofu suggests that a significant return of American Samoans, who were born outside of American Samoa, occurred during the 1985-1989 period.

Land Uses

Residential

The 1990 Census documented 59 units in the Ofu village Census area. Roughly 81 percent of the homes were owner-occupied; approximately two percent were rental units. Seventeen percent were vacant or used as vacation homes by their owners.

ASG Building Division records indicate that building permits were issued for three new single family structures from 1990 through 1994. Consequently, the 1995 housing stock included about 62 homes.

Agriculture

Piggeries

There were five piggeries in Ofu Village in May, 1996. Each piggery contained between six and 20 pigs (Tafao, 1996).

Subsistence Agricultural Crops

Faatoaga were scattered throughout various parts of the watershed.

Smaller plantations were observed on the east side of Ofu in the Toaga and Faalaaga areas. These areas were generally located on the north side of the primary shoreline roadway.

Along the upper slopes of the Matasina Stream drainage, an upslope plantation was observed on the south side of Matasina Stream. Plantations were also documented behind Ofu Village.

Commercial

There are about 17 commercial enterprises that operate on the Island of Ofu. These include the Amerika Samoa Bank, eight village grocery and retail stores, one bakery, two gasoline distributors, a construction contractor, two commercial agricultural product distributors, and two restaurants.

Vaoto Lodge, which is located on the northeast side of Ofu Airport, includes five guest cottages. The cottages can provide overnight accommodations for up to 20 persons.

Industrial

There are no industrial operations on the Island of Ofu.

Public Facilities

Public facilities in Ofu Village include a Post Office, a local public health dispensary, and Ofu Harbor.

The ASG Department of Education offers one early childhood education program in Ofu. In September, 1994, this program had a student enrollment of 17. Elementary school-aged children attend Olosega Elementary in the nearby village of Olosega. High school students attend Manua High School on Tau Island.

Use of the Nearshore Waters

Nearshore Fishing

One local resident indicated that 10 to 15 persons per day use the nearshore waters near the Ofu Airport for fishing (Vaovasa, 1996).

In Ofu Village, Chief Tafao reported that five to six persons per day typically use the nearshore waters for fishing purposes. Another 20 persons use the nearshore waters for swimming and general water recreation.

RESOURCE MANAGEMENT ISSUES

Future Land Uses to the Year 2015

Residential

Potential expansion area for future residential housing is located in four areas of Ofu:

- At least 112 single family homes could be built on moderate slopes that are *mauga* of Alaufau and northwest of Alei Stream.
- Between Samouli and Malaetia Streams, there is about one acre of shoreline property that remains undeveloped. About six single family units could be constructed there.
- Between Matasia and Tufu Streams, about 15 single family homes could be constructed *mauga* of the shoreline roadway between 200 and 275 feet above mean sea level.
- Along Ofu Island's southern coastline, between Papaloloa Point and Fatuaga Point, an existing faatoaga area could provide space area for about 66 new homes at a density between three and four units per acre.

While significant potential expansion area exists, only a gradual in-migration of more middle-aged American Samoans will generate some demand for new residential construction. However, this in-migration will continue to be offset with the out-migration of Manua's youth who attend high school and/or college off-island, but choose to not return.

The anticipated establishment of a U.S. National Park area along Ofu Island's southern coast will begin to bring a small wave of *palagi* visitors beginning in the year 2000. These visitors will undoubtedly be impressed with the beauty and resources Ofu and Olosega and will convey their conclusions to local chiefs and other Samoans in Tutuila and the continental United States.

These reactions will prompt greater interest among American Samoans, particularly those living on Tutuila. More American Samoans residing on Tutuila will begin to take more frequent weekend visits to Ofu and Olosega. Increased interest can be expected for the gradual development of a sizable number of vacation homes on the moderate slopes mauga of Alaufau. An unimproved dirt trail already provides vehicular access to this area.

Similarly, the inland *faatoaga* behind the proposed National Park shoreline area also provides a likely destination for future new residents of Ofu. The existing shoreline roadway provides good access to the Ofu Airport, other parts of Ofu Village, and the Island of Olosega.

Excellent views, the proximity to air transportation, and convenient access to Ofu Village will provide all the "ingredients" necessary to attract more new residential construction by American Samoans who are returning to seek an early retirement, help aging extended family members, or desire a more relaxed lifestyle. During the 1996-2015 period, about 30 new housing units are expected to be constructed by these future residents. These homes will be scattered throughout each of the four potential residential expansion areas; roughly 80 percent of the housing will be developed *mauga* of Alaufau or behind the proposed National Park shoreline area.

A second source of new residential construction will be derived from some "second-home" development by a smaller number of more affluent American Samoan families between 2006 and 2015. Such development will result from increased crowding on Tutuila that will prompt a greater number of off-island recreational visits by local residents. More affluent families will be those who will be able to invest in a second home and are able to spend a greater amount of time away from Tutuila. Prime candidates are those persons who are already involved in professional services such as lawyers, consultants, accountants, and sales representatives who are not dependent upon the maintenance of an office space in the Pago Pago Harbor area. Cellular telephones, personal computers, modems, and other telecommunication opportunities will only enhance potential investment opportunities to other professionals in the community.

During the next 20 years, ASPA believes that these potential development opportunities and constraints will generate the following sequence and volume of residential construction.

1996-2000	Two new single family homes between Samouli and Malaetia Streams between shoreline and 25-foot elevation.
	One new single family home between Matasia and Tufu Streams between 200 and 275 feet above mean sea level.
2001-2005	One new single family home between Samouli and Malaetia Streams between shoreline and 25-foot elevation.
	Two new single family homes between Matasia and Tufu Streams between 200 and 275 feet above mean sea level.
2006-2010	Six single family homes *mauga* of Alaufau and northwest of Alei Stream between 175 and 450-foot elevation.
	Six single family homes along the southern coastline of Ofu between Papaloloa and Fatuaga Point (between shoreline and 25-foot elevation).
2011-2015	Six single family homes *mauga* of Alaufau and northwest of Alei Stream between 175 and 450-foot elevation.
	Six single family homes along the southern coastline of Ofu between Papaloloa and Fatuaga Point (between shoreline and 25-foot elevation).

The cumulative effect of this prospective residential growth is that the housing stock would increase to roughly 92 housing units in the year 2015. During the same period, it is believed that the average household size will have gradually decreased to approximately 5.97 persons per household. Consequently, the anticipated 2015 population will include about 549 persons.

Commercial

Informal discussions with the Honorable Tufele Lia, former Lt. Governor of American Samoa and present Manua District Governor, suggest that the American Samoa Government may eventually encourage the establishment of an increased number of commercial agricultural producers. District Governor Lia believes that expanded harbor facilities, an improved shoreline roadway, and the availability of vacant, developable lands that are suitable for agriculture, and the need for cash employment opportunities will drive ASG's future commitment to increased commercial agricultural production.

Increased commercial agricultural production may result in the development of some limited warehousing near existing harbor facilities. It is expected that a privately-owned warehouse will be built between 2001 and 2006 and will employ four persons.

The gradual influx of returning American Samoans and some additional part-time residents on the Island of Ofu will generate a limited increase in commercial retail establishments within Ofu Village. Future commercial expansion will include a new video store and an amusement center between the year 2001 and 2005. Two additional retail stores will begin operation during the 2006-2010 period. All commercial facilities will most likely be constructed on the one acre of vacant shoreline property in Ofu Village that is situated between Samouli and Malaetia Streams.

Hotel and Visitor Accommodations

The establishment of a National Park along the southern coast of Ofu Island will encourage a greater number of visitors to the Island, as well as an increased demand for overnight accommodations. It is believed that the demand for overnight accommodations will be limited, but sizable enough to support the gradual development and operation of two bed and breakfast facilities between 2001 and 2005. One additional bed and breakfast facility will begin operation between 2006 and 2010; one additional bed and breakfast will be established between 2011 and 2015.

Industrial

Despite modest increases in future resident population, no additional light industrial operations or facilities are anticipated during the next 20 years. The lack of developable land that would be suitable for industrial activities, as well as the lack of a nearby consumer market, represent the primary constraints to future industrial development in this community.

Public Facilities

Despite modest increases in the future population of Ofu, no facility expansions are anticipated for these facilities.

Population characteristics for Ofu in 1990 suggest that approximately seven percent of the village population is three and four years of age, 26 percent is elementary school age (ages 5 through 13), and about eight percent is high school age (14-18).

Application of these assumptions to anticipated future population suggests that Ofu will contribute the following estimated student enrollments to facilities within and outside the community in the year 2015:

- early childhood education 38 students
- elementary school 143 students
- high school 44 students

Impact of Future Population Growth Upon Water Consumption and Waste Generation

Future population growth and changes in land use in the Ofu Saute watershed will increase the volume of future wastewater and solid wastes that are generated by local residents. Wastewater generation in Ofu Village, for example, is expected to rise from about 30,293 gallons per day (gpd) to 44,449 gpd in the year 2015.

The consumption of potable water will also increase with a growing population. The American Samoa Power Authority (ASPA) estimates that the average day demand for water in Ofu was about 43,275 gallons in 1995. By the year 2015, ASPA anticipates that the average demand will increase to roughly 63,499 gpd.

Flood Potential

A flood insurance study of American Samoa and related flood insurance rate maps were published by the U.S. Federal Emergency Management Agency (FEMA) in 1991. The study evaluated selected geographical locations throughout the Territory. Hydrologic and hydraulic analyses that were presented in the study were made by the U.S. Army Corps of Engineers, Pacific Ocean Division. No detailed study was made of the Island of Ofu.

Inland Flood Potential

Potential flooding can be expected in Vaoto Marsh via a 100-year storm event. However, no potential flood elevations were calculated by Federal Emergency Management Agency (FEMA) for these areas.

The remaining areas of the Ofu Saute watershed have been designated by FEMA as "zone x". This designation indicates that the areas are outside of the 100-year floodplain (Federal Emergency Management Agency, 1991). In essence, FEMA is suggesting that the flood hazard potential in these areas is limited.

Coastal Flood Hazard

The flood insurance rate map for the shoreline of the Ofu Saute watershed indicates that there is a coastal flood hazard through much of the nearshore waters and adjoining shoreline. However, no potential coastal flood elevations were determined by FEMA for the shoreline of the watershed.

Stormwater Runoff/Sedimentation and the Relationship to Surface Water Quality

Intermittent stream discharges on the west side of Ofu occasionally generate turbid fresh-water into the nearshore waters. The primary source of these turbid waters is derived from more erosive soils on steeper, undeveloped slopes of Tumu Mountain and Mako Ridge. Fortunately, only one stream in Ofu Village discharges into the nearshore waters at the shoreline.

Ofu Village residents use a considerable amount of coral fill around homes and village stores. This practice is very desirable as it helps filter urban runoff that could otherwise flow into man-made channels within the village.

The detention of turbid stormwater runoff on the west side of Ofu is desirable, but not practical. There are few, if any, areas that are sizeable enough and in close proximity to existing drainages.

However, anticipated residential development is expected to occur on moderate slopes upslope of Alaufau. Should this development be realized, the installation of individual drywells for each residence or the development of a community stormwater detention facility should be required to reduce potential stormwater discharges into the nearshore waters.

Nearshore Water Quality and the Marine Environment

Turbidity and Sedimentation

The concern for continued turbidity and sedimentation in the nearshore waters of the watershed is important. Coral communities are significantly dependent upon the availability of light and related photosynthesis, and occasional periods of significant turbidity and sedimentation do not promote long-term coral nutrition, growth, reproduction, and depth distribution (Richmond, 1993).

When corals fertilize, they are free-swimming. Consequently, they need a good location to settle and make a good attachment. With significant soil deposition, sediments can physically interfere with the recruitment of coral larvae (Richmond, 1993; Dashbach, 1996).

Coral communities are an important component of the overall ecology of the nearshore waters that adjoin the Ofu Saute watershed. They provide shelter to fish, invertebrates, and other marine organisms. Some of these resources represent a supplemental food source for residents of the watershed and other areas of Ofu Island.

Nutrient Inputs

Some nutrient contribution is also occurring through the continued use of septic tanks, cesspools, or other soil-based, wastewater treatment systems in the watershed. In addition, some of the piggeries in Ofu may also discharge nutrient-enriched wastewater into local streams and man-made channels. These sources of nutrients are also accompanied by some bacterial contamination.

While the total volume of wastewater generation from the watershed is limited, the discharges are concentrated in the inhabited village area where housing densities are between five and seven housing units per acre. Local soils are generally inadequate to provide effective treatment.

The long-term input of turbid and nutrient-enriched waters into the nearshore waters represents an important concern. These inputs are potentially detrimental to the quality because they can adversely change the composition of the nearshore marine environment. However, the degree of impact upon water quality is also highly dependent upon currents and water exchange within the nearshore environment.

As the population of the watershed grows, nutrient and bacterial inputs will only increase. Aside from these resource management considerations, the future use of the nearshore waters for fishing, swimming and general recreation will eventually represent a more significant public health concern unless practical steps are made to reduce potential nearshore water contamination.

The limited population of Ofu will likely continue to make this system expansion unfeasible. In the absence of this reality, village areas in the Ofu Saute watershed that are unsuitable for soil-based, wastewater treatment should be more specifically identified. As recommended in the ASPA Utilities Master Plan, this identification process should be based upon a more detailed sanitation survey of more densely inhabited areas such as Ofu and Alaufau. This survey would evaluate existing wastewater treatment practices, soil characteristics, the location and density of land uses, the distance to surface water supplies and the nearshore waters, topography, and other related factors. Using the conclusions and recommendations associated with this evaluation, ASPA and other participating Project Notification and Review System (PNRS) agencies will be better able to:

- require the use of septic tanks and leachfields that provide a sufficient amount of additional soil-based treatment;
- provide greater technical assistance to building permit applicants; and, if necessary,
- deny building applications in land areas that are unsuitable for soil-based treatment systems.

Long-Term Monitoring

The future monitoring of the nearshore waters is necessary and should be combined with water quality monitoring of the nearshore waters that adjoin Ofu Village. Turbidity and sedimentation are the primary stresses to the coral communities in the nearshore waters. However, future levels bacterial contamination and nutrient inputs should also be documented to help ensure future public safety and evaluate potential stresses to the fringing coral reef communities.

In addition, the ASG Department of Marine and Wildlife Resources should monitor the coral communities along the reef front that is seaward side of Nuupule Rock at least once every three years. Long-term monitoring of this site should also include an evaluation of the impact of sedimentation and turbidity that already influence the nearshore marine environment.

Groundwater and Surface Water Supplies

As stated earlier, Ofu Village is already connected to the ASPA water system. To facilitate the long-term conservation of these resources, it is also recommended that a 100-foot buffer or setback should be established around each surface supply, i.e., stream or spring catchment, in the watershed. In essence, the establishment of piggeries, new structural development, or other land uses would not be permitted within the 100-foot radius to prevent potential contamination of the surface supplies.

MANAGEMENT NEEDS AND RECOMMENDATIONS

The primary focus of future resource management in the Ofu Saute watershed will be to:

- detain urban runoff through the use of drywells in conjunction with the development of any new residential structures upslope of Alaufau;
- perform detailed sanitation survey of the inhabited Ofu Village area; and,
- conserve coral communities.

Representatives of participating public agencies should make periodic visits to the watershed to observe, document, and monitor selected resource conditions, determine potential methods of correcting a potential hazard or undesirable conditions, share potential solutions with designated residents of Ofu Village, and encourage the participation of traditional leaders and village residents in the implementation of resource management solutions.

The scope of issues that should be addressed by each agency in the field is summarized in Table 36-2. The general focus of recommended technical assistance is also identified. The experience and insights of agency representatives will determine the specific methodology to be used in the field.

TABLE 36-2
RECOMMENDED FOCUS OF FUTURE TECHNICAL ASSISTANCE
OFU SAUTE WATERSHED

Participating Public Agency	Resource Management Issue	Focus of Technical Assistance
ASEPA	Facilitate a coordinated resource management effort within the watershed.	1. Coordinate overall watershed management activities. 2. Hold periodic meetings with participating ASG and federal agencies to discuss, prioritize, and schedule resource management activities. 3. Coordinate program efforts with local traditional leaders and/or designated residents of the watershed. 4. Make annual assessment of resource management program.
ASPA/ASEPA	Perform a detailed evaluation of community sanitation problems associated with the use of soil-based treatment systems.	1. Survey inhabited village areas in Ofu Village. 2. Evaluate existing treatment practices, soil characteristics, location and density of land uses, the distance to water supplies and nearshore waters, topography, and other factors. 3. Require use of septic tanks and leachfields that provide sufficient amounts of additional soil-based treatment; or, deny building applications in areas unsuitable for soil-based treatment.
ASEPA	Conserve surface water supplies	1. Revise American Samoa GIS to delineate 100-foot buffers around each surface supply. 2. Restrict land uses within designated buffers.
ASCZM/DOC	Detain stormwater runoff in future residential and commercial areas.	In the event that residential development takes place upslope of Alaufau, require the use of onsite drywells for all new residential structures, or the development of a community stormwater detention facility.
ASDOC	Monitor changes in population and land use	Annually map type and location of land uses in village and estimate resident population.
ASCC Land Grant Program	Reduce sedimentation from agricultural activities	1. Determine locations where upslope agricultural activities may be generating some sedimentation. 2. Encourage soil conservation methods with resident growers of subsistence crops.
ASG Dept. of Marine and Wildlife Resources	Sustain healthy marine communities in nearshore waters	Monitor changes in coral coverage, fish habitat, diversity and other characteristics (used by Green) approximately every three years. Monitor reef front site seaward of Nuupule Rock.

Source: Pedersen Planning Consultants, 1998

OFU MATU
Watershed 37

GEOGRAPHY

The Ofu Matu watershed comprises the northeast side of the Island of Ofu. The watershed comprises about 1.06 square miles of land area (Figure 37-1).

The inland boundaries of the watershed include Tumu Mountain and the mountain ridges known as Tia Ridge, Mako Ridge, and Leolo Ridge. Sunuitao Peak, which is located on the east end of Ofu, defines the east boundary of the watershed.

Along the north coast of Ofu, the watershed extends between Feia Point, the northwest tip of Ofu, and Asagatai Point. Asaga Strait separates the Islands of Ofu and Olosega on the east side of Ofu. There are no embayments along the north coast of Ofu.

Agaputuputu, Tafe, Ulafala, and Vaimuulua Streams comprise the four streams in the watershed.

Only a few homes are located on the east side of the watershed in the vicinity of Asagatai Point. Otherwise, the watershed is uninhabited.

RESOURCES OF THE WATERSHED

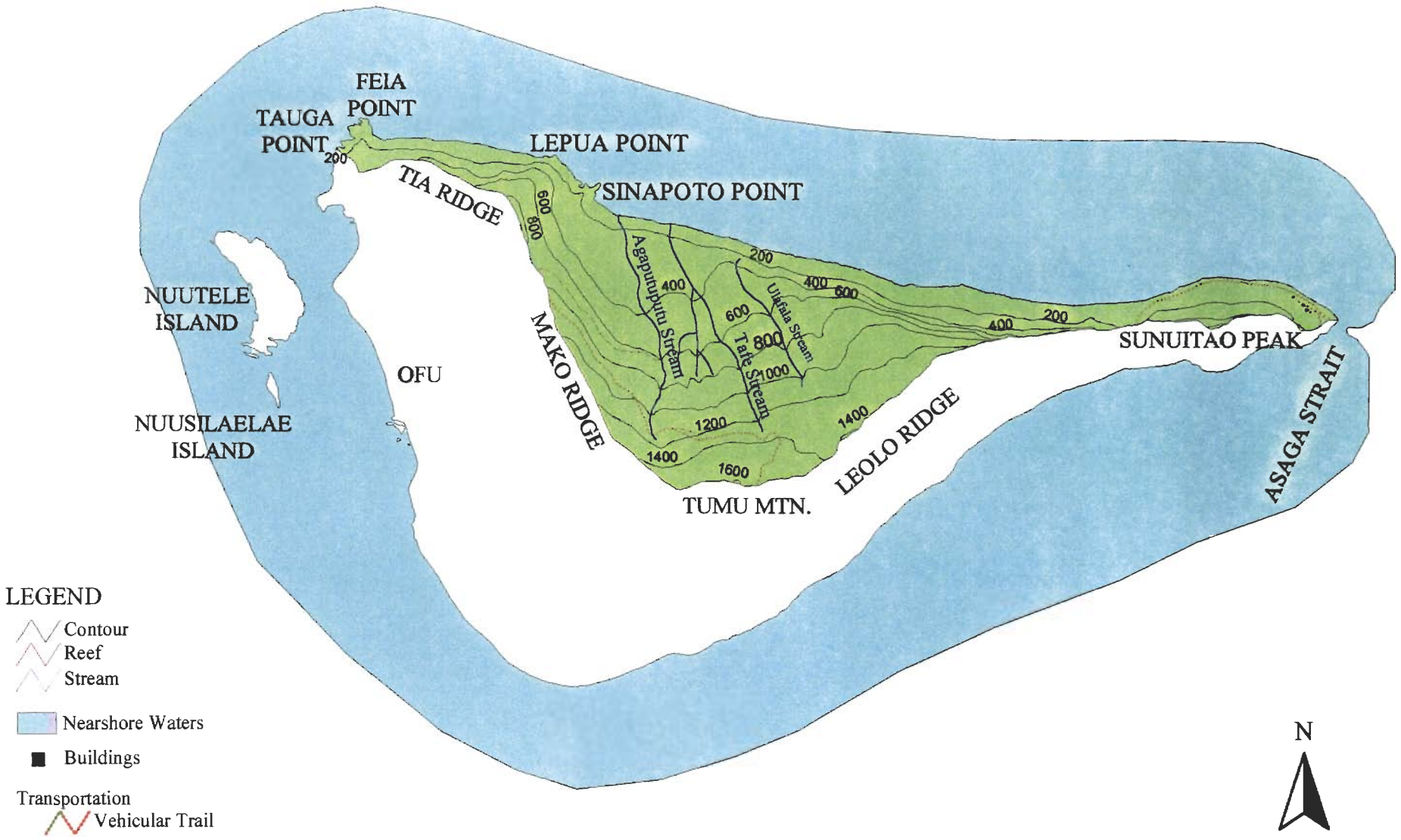
Soils

The U.S. Soil Conservation Service (National Resource Conservation Service) published a Soil Survey of American Samoa in 1984. Selected information derived from this survey provides some useful information for future watershed planning and management (Figure 37-2) . Five soil classifications were identified by the U.S. Soil Conservation Service for lands within the Ofu Matu watershed (Table 37-1)

TABLE 37-1
SELECTED SOIL CHARACTERISTICS0
OFU MATU WATERSHED

SCS Soil Unit	Name	Typical Slope (Percent)	Flood	Runoff	Erosion	Soil Depth To:		Land Use Suitability	
						High Water (Feet)	Bed Rock (Inches)	Soil Based WW Treatment	Subsistence Ag Potential
2	Aua very stony silty clay loam	30-60	None	Rapid	Severe	<6	<60	Severe Slope	Poor
4	Fagasa family-Lithic Hapludolls-Rock Outcrop Assoc	70-130	None	Very Rapid	Very Severe	>6	20-40	Severe Slope Depth	Poor
11	Ngedebus mucky sand	0-2	Occa-sional	Very slow	Slight	>3.5	>60	Severe flood Wetness Poor Filter	Moderate
14	Ofu silty clay	15-40	None	Med	Mod	>6.0	>60	Severe Slope	Good
15	Ofu silty clay	40-70	None	Med	Mod	>6.0	>60	Severe Slope	Poor

Source: U.S. Soil Conservation Service, 1984



American Samoa Geographical Information System

0.5 0 0.5 1 1.5 2 2.5

Miles

Scale: 1:30,000

Prepared by: Pedersen Planning Consultants Tel: 307-327-5434

Ofu Matu Watershed Existing Conditions

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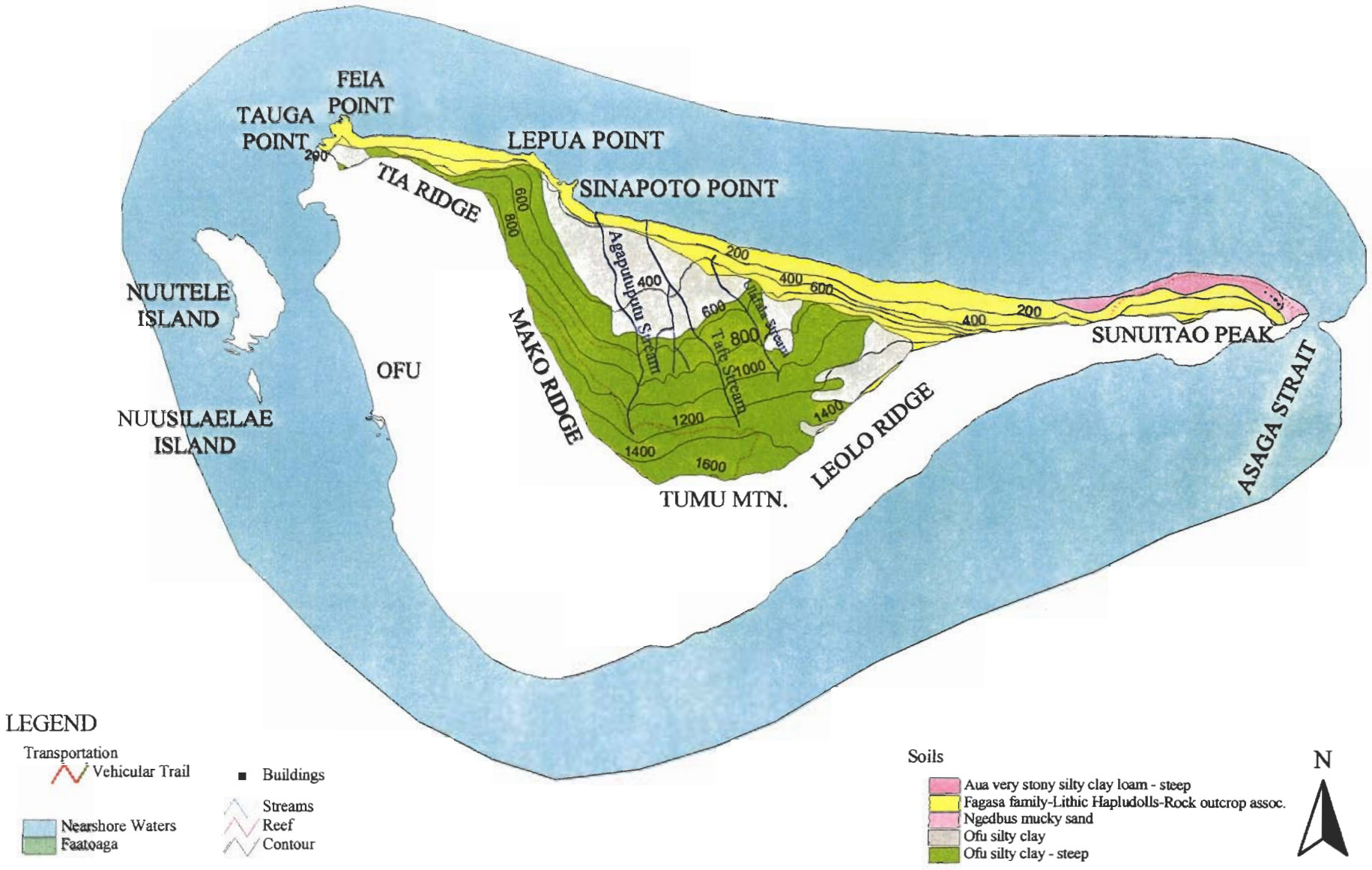
Figure 37-1



American Samoa Geographical Information System

0.5 0 0.5 1 1.5 2 2.5

Miles

Scale: 1:30,000

Prepared by: Pedersen Planning Consultants Tel: 307-327-5434

Ofu Matu Watershed Management Issues

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Figure 37-2

On the north side of Sunuitao Peak, steeper slopes of the lower watershed contain Aua very stony silty clay loam soils (SCS mapping unit 2). Two or three dwelling units are located in this area.

The Aua soils range between seven to 60 inches in depth. The permeability of these soils (between 2 and 6 inches per hour) is moderately rapid. For watershed management purposes, it is important to note that these Aua soils have a high potential for runoff and erosion.

This Aua soil is not recommended for agricultural production because of the stoniness of the soil, the high erosion potential, and hazards associated with subsistence crop cultivation on steeper slopes. However, when cultivation in these soils is necessary, the use of a mulch or ground cover is recommended to reduce soil erosion in cultivated areas.

The U.S. Soil Conservation Service estimates that this soil can annually sustain up to 5 tons per acre of erosion without impacting crop productivity (U.S. Soil Conservation Service, 1984). While the erosive characteristics of this soil generally may not significantly impact subsistence crop productivity, the erosive quality of the soil can be a significant contributor to sedimentation in downslope streams and the nearshore waters.

The general characteristics of these Aua soils are also undesirable for individual wastewater disposal systems (U.S. Soil Conservation Service, 1984). These soils contain a significant amount of larger stones that hamper installation and provide inadequate soil treatment.

Fagasa Family-Lithic Hapludolls-Rock Outcrop Association

Steeper, lower slopes along the north side of Tia Ridge, Tumu Mountain and Leolo Ridge, as well as the upland slopes of Sunuitao Peak, contain well-drained soils known as the Fagasa Family-Lithic Hapludolls-Rock outcrop association (SCS mapping unit 4).

The Fagasa Family soils contain a surface layer of dark, brown silty clay that is about 12 inches thick. A dark brown subsoil is approximately five inches thick. The substratum, which is characterized by a dark-brown, sandy clay loam, extends to a depth of 31 inches. The depth to bedrock ranges between 20 to 60 inches or more.

The Lithic Hapludolls are shallow, well-drained soils that are derived from igneous rock. The surface layer is highly variable, but U.S. Soil Conservation Service soil scientists have observed the surface layer to contain about five inches of dark brown, cobbly silty clay. The subsurface layer, which is about four inches thick, is a dark brown, very cobbly, silty clay. The substratum represents a clay loam, approximately six inches thick, over weathered bedrock.

The soil permeability of the Fagasa Family and Lithic Hapludolls soils is both between two and six inches per hour. Since the Fagasa Family-Lithic Hapludolls soil typically occurs on very steep slopes, potential runoff can be very rapid. The potential for water erosion is very severe (U.S. Soil Conservation Service, 1984).

The cultivation of subsistence crops on these soils is not considered desirable. However, when cultivation in these soils is necessary, care should be exercised to minimize the amount of exposed soil in cultivated areas.

When heavier rainfall events occur, significant erosion of these soils can be expected from undeveloped upslope areas of the watershed. Natural runoff from steeper slopes in the watershed carries water, sediments, and organic debris to downslope drainage courses and streams. Such erosion can readily influence downstream water quality.

Fagasa Family and Lithic Hapludolls soils are unsuitable for septic tank and effluent drainfield applications. Steeper slopes and the limited depth to bedrock do not afford effective soil-based treatment of wastewater.

Ngedebus Mucky Sand

A small area of Ngedebus mucky sand (SCS mapping unit 11) is located on the east tip of Ofu in the vicinity of Asagatai Point (Figure 37-2).

Ngedebus mucky sand is a deep, somewhat excessively drained soil. This soil is derived from coral and seashells.

The surface layer is typically black mucky sand that is approximately 12 inches thick. In some areas, the surface layer comprises loamy sand. The substratum is gray to very pale brown sand that extends to a depth of 60 inches or more.

The permeability of Ngedebus mucky sand is rapid. The potential hazard of water erosion is slight; potential runoff is very slow. Very brief periods of flooding can occur on these soils.

Ngedebus mucky sand is moderately suited to the production of subsistence crops such as taro, bananas, breadfruit and coconuts. However, agricultural uses are constrained by the retention of adequate moisture and low soil fertility.

Its suitability for septic tank installations and effluent drainfields is poor. Rapid permeability and the limited depth to the water table do not enable effective soil-based treatment.

Ofu Silty Clay (15 to 40 percent slopes)

Ofu silty clay on 15 to 40 percent slopes (SCS mapping unit 14) is found on a portion of the upland slopes of Leolo Ridge, the steeper north slopes of Tumu Mountain, and the northeast slopes of Mako Ridge. This Ofu silty clay soil is a deep, well-drained soil that is formed in volcanic ash and residuum derived from basic igneous rock.

The surface layer is typically a reddish-brown silty clay that is approximately 16 inches thick. A dark brown, silty clay loam characterizes the upper 29 inches of the subsoil; the lower 15 inches of the subsoil contains a dark brown silty clay. A substratum of dark brown silty clay, or silty clay loam, is found in some areas at depths of 30 to 60 inches or more.

The permeability of Ofu silty clay ranges between two and six inches per hour. The potential hazard of water erosion is moderate; potential runoff is considered to be medium (U.S. Soil Conservation Service, 1984).

Ofu silty clay is well suited for subsistence crop production. Typical crops produced from these soils include coconuts, breadfruit, bananas and taro.

These soils are poorly suited for septic tanks and related effluent drainfields. Steeper slopes do not enable effective soil-based treatment of wastewater.

Ofu Silty Clay (40 to 70 percent slopes)

A portion of the steeper, upland slopes of Tumu Mountain and Mako Ridge are characterized by Ofu silty clay (SCS mapping unit 15). This soil is a deep, well-drained soil formed in volcanic ash and residuum that is derived from basic igneous rock.

The surface layer, which is about 10 inches thick, is typically dark reddish-brown, silty clay. In some locations, the surface layer represents a stony silty clay. The subsoil contains about nine inches of

dark reddish brown silty clay loam; reddish brown silty clay loam extends another 18 inches. The substratum of reddish-brown, silty clay loam extends to a depth of 60 inches or more. The depth to weathered bedrock ranges from 40 to 60 inches or more.

Ofu silty clay soils have a soil permeability that ranges between two and six inches per hour. The potential hazard of water erosion is severe; the potential occurrence of runoff is medium to rapid.

These soils generally support woodlands, but not commercial timber harvests. Steeper slopes, as well as potential water erosion and runoff hazards, make these soils unsuitable for subsistence agricultural production.

The use of these soils for septic tank and effluent drainfield applications is also unsuitable. Steeper slopes where these soil occur do not promote effective soil-based treatment of wastewater effluent.

Streams

Stream Locations

There are four streams that drain the north slopes of Tumu Mountain and the east slopes of Mako Ridge.

Agaputuputu Stream originates on the north slopes of Tumu Mountain at about the 1,130-foot contour. A steep, well-defined drainage course transports surface flows to a shoreline discharge east of Sinapoto Point. The defined stream course ends at about the 200-foot contour and discharges into the nearshore waters via a direct fall during higher stream flows. During lower stream flow periods, surface runoff continues to drain down the steep, lower slopes of the drainage before discharging into the nearshore waters.

Tafe Stream begins near the 1,300-foot elevation on the north slopes of Tumu Mountain. The main stem of the Stream and two upland tributaries carry surface runoff to the nearshore waters. Available topographic maps indicate a point of discharge near the 235-foot elevation. Similar to Agaputuputu Stream, higher stream flows may discharge to the nearshore waters as a fall while lower flows probably drain down the steep, lower slopes of the drainage.

The headwaters of Ulafala Stream are located at approximately 1,075 feet above mean sea level. This stream drains a portion of the north slopes of Tumu Mountain. The single stream stem discharges surface runoff to a point near the 400-foot contour where higher stream flows discharge as a fall; lower flows likely drain down the steeper, lower slopes of the drainage prior to its shoreline discharge.

Vaimuulua is a fourth stream on the north side of the Tumu Mountain. This stream is depicted on available USGS topographic maps, but not reflected on 1:200 scale topographic maps for the Territory. This stream likely originates near the 900-foot contour. At the 550-foot elevation, Vaimuulua Stream, higher stream flows discharge as a fall. Lower stream flows drain down the steep, lower slopes of the drainage before discharging into the nearshore waters.

Stream Flows Within the Watershed

There are no stream flow records that are available for the four streams in the Ofu Matu watershed. During the May, 1996 survey of the watershed, no stream discharges to the nearshore waters were evident. The streams of the watershed probably flow intermittently throughout the year.

Surface Water Quality

Streams

There is no water quality data for the streams in the watershed. However, significant erosion was documented along Mako Ridge and the vehicular trail in May, 1996. Visual observations from this area indicated that the west and central parts of the watershed contained several areas of exposed soils on steeper, upland slopes. Consequently, even though the watershed is heavily vegetated, local streams in the watershed likely transport a considerable amount of sediment and turbid water to the nearshore waters.

Nearshore Waters

No surface water quality data is available for the nearshore waters that adjoin the Ofu Matu watershed. Limited access to most of the watershed in May, 1996 did not enable an inspection of the points of discharge for the four streams that discharge into the nearshore waters.

Wetlands

No significant wetlands are located in the Ofu Matu watershed.

Marine Resources

Coral Communities

A fringing reef is located along most of the north coast of Ofu.

Various private consultants have made field investigations of the fringing reef since the late 1970's. In a cumulative sense, the available survey information suggests:

- Corals in this watershed have not been significantly reduced by recent storms or crown-of-thorns starfish infestations as coral communities around Tutuila Island.
- A number of rare corals inhabit the fringing reef along the south coast of Ofu.
- Corals in this watershed have not been impacted as dramatically by recent storms or crown-of-thorns starfish infestations as coral communities around Tutuila Island.
- A number of rare corals inhabit the fringing reef, although coverage is variable.

1978-1979

In the vicinity of Asaga Strait, live coral was sparse near the shoreline. Offshore, coral coverage increased to about 15 percent. Near the middle of Agasa Strait, coral coverage ranged from 40 to almost 100 percent at a depth of 6 feet.

1995

A recent 1996 study of various coral reefs throughout the Samoan Archipelago included the performance of five transects along the reef front on the northwest side of Asaga Strait. The study focused primarily upon the quantification of coral communities, the abundance and diversity of reef fish, and selected habitat characteristics.

Coral cover along the reef front ranged between 20 and 39 percent. Fish species richness included more than 150 species. Fish density was also considered to be "high," or greater than 10,000 individuals per ha. Fish biomass represented between 500 to 999 kilograms per ha.

Green also noted that the coral reefs of the Manua Islands were severely damaged by Hurricane Tusi in 1987, but escaped significant damage from Hurricane Ofa in February, 1990 and Hurricane Val in December, 1991. In addition, the reefs in Manua were also influenced by infestations by the crown-of-thorns starfish and a recent coral bleaching event. From her review of past studies, Green concluded that the reef fronts of the Manua Islands tended to be in better condition that those on Tutuila. The reef front at Asaga Strait represented one of the best coral reefs in the Samoa archipelago.

In this context, Green also expressed concern for proposed road construction along the east end of the Ofu Matu watershed. In May, 1996, this project was under construction by McConnell-Dowell. The road project was completed in late 1996.

Wildlife Resources

Historical data suggests that the common brown noddy may nest along the north coast of Ofu between Tauga Point and Sinapoto Point. In addition, a potential nesting area for the white-rumped swiftlets is located between Lepua Point and Sinapoto Point. The sheath-tailed roosts in caves in the vicinity of Sinapoto Point (Aecos and Aquatic Farms, 1980).

A 1986 Survey of the Forest Birds of American Samoa also documented a considerable number of forest birds in various areas of the Island of Ofu (Engbring and Ramsey, 1989). These habitats generally included rain forest, secondary vegetation, mixed vegetation, and plantation lands. The specific locations of these habitats on each island were not identified.

Shoreline Protection

Man-made shoreline protection facilities are located only along the shoreline northwest of Asaga Strait. Roughly 3,000 feet of shoreline revetment are located between the west side of Asaga Strait and the northwest slopes of Sunuitao Peak. The revetment affords some storm wave protection to the bridge that connects the Island of Ofu and Olosega, as well as two nearby residences.

Significant repairs to this rock revetment were completed in late 1996. These repairs were prompted by damage generated by Hurricane Val in December, 1991 which washed out the access road on both sides of the bridge.

The fringing reef and rugged basaltic shoreline provides natural protection to the remaining portions of the north coast of Ofu.

Groundwater and Surface Water Supplies

No groundwater wells or surface water systems are known to be developed in the Ofu Matu watershed. The two households on the east side of the watershed obtain drinking water via individual roof catchment and/or connection to ASPA's satellite village water system in Olosega.

USE OF THE WATERSHED

Resident Population

Two homes are located on the east side of the Ofu Matu watershed. The homes may house up to 10 residents. Otherwise, the remainder of the watershed is uninhabited.

Land Uses

In addition to limited residential use on the east side of the watershed, some *faatoaga* were located on the upper slopes of Tumu Mountain in May, 1996. No other land uses were documented.

Use of the Nearshore Waters

Shoreline access to the north coast of Ofu is limited to the northeast part of the watershed between Mafafa and Asaga Strait. No fishing and general water recreation is known to take place along the nearshore waters of the watershed. The repaired revetment northwest of Asaga Strait may, however, may encourage some future limited shoreline fishing from the revetment.

RESOURCE MANAGEMENT ISSUES

Future Land Uses to the Year 2015

With limited vehicular access, no new land uses are expected to occur in this watershed during the 1996-2015 period.

Impact of Future Population Growth Upon Water Consumption and Wastewater Generation

Since no increase in resident population is expected, there will be no impact upon future water consumption and wastewater generation.

Flood Potential

A flood insurance study of American Samoa and related flood insurance rate maps were published by the U.S. Federal Emergency Management Agency (FEMA) in 1991. The study evaluated selected geographical locations throughout the Territory. Hydrologic and hydraulic analyses that were presented in the study were made by the U.S. Army Corps of Engineers, Pacific Ocean Division. No detailed study was made of the Island of Ofu.

Inland Flood Potential

The entire Ofu Matu watershed has been designated by the Federal Emergency Management Agency (FEMA) as "zone x". This designation indicates that the areas are outside of the 100-year floodplain (Federal Emergency Management Agency, 1991). In essence, FEMA is suggesting that the flood hazard potential in these areas is limited.

Coastal Flood Hazard

The flood insurance rate map for the shoreline of the Ofu Matu watershed indicates that there is a coastal flood hazard through much of the nearshore waters and adjoining shoreline. However, no potential coastal flood elevations were determined by FEMA for the shoreline of the watershed.

Stormwater Runoff/Sedimentation and the Relationship to Surface Water Quality

The four streams in the Ofu Matu watershed likely transport a considerable amount of turbid water and sediments to the nearshore waters that adjoin the watershed. These discharges are derived almost exclusively from the natural erosion of more erosive soils on steeper slopes of the watershed. However, some erosion from upland *faatoaga* and vehicular trails in the watershed also takes place.

The detention of a portion of future stormwater flows would be desirable. However, this is not feasible because of the remote nature of the central watershed.

No extensive use is made of the upland vehicular trails except by those persons who maintain and harvest crops from upland *faatoaga*. Consequently, there is no need to restrict vehicular travel along these trails.

In a broader context, it is recommended that future land uses in the watershed be limited to agricultural production and watershed conservation. Future agricultural production should be limited to upland areas where Ofu silty clay on 15 to 40 percent slopes (SCS mapping unit 14) is present. These soils have good potential for subsistence crop production. At the same time, the soils pose a moderate potential for water erosion and soil runoff. Consequently, the ASG Land Grant representatives should provide technical assistance to plantation operators to ensure that appropriate land conservation practices are applied to future agricultural production.

Nearshore Water Quality and the Marine Environment

Turbidity and Sedimentation

The concern for continued turbidity and sedimentation in the nearshore waters of the watershed is important. Coral communities are significantly dependent upon the availability of light and related photosynthesis, and occasional periods of significant turbidity and sedimentation do not promote long-term coral nutrition, growth, reproduction, and depth distribution (Richmond, 1993).

When corals fertilize, they are free-swimming. Consequently, they need a good location to settle and make a good attachment. With significant soil deposition, sediments can physically interfere with the recruitment of coral larvae (Richmond, 1993; Dashbach, 1996).

Coral communities are an important component of the overall ecology of the nearshore waters that adjoin the Ofu Matu watershed. They provide shelter to fish, invertebrates, and other marine organisms.

Long-Term Monitoring

The long-term monitoring of the reef front northwest of Asaga Strait is recommended. However, these investigations should be supplemented with a reef front seaward of the central watershed. The monitoring of the central watershed site will enable the ASG to better understand the ecological impacts associated with turbid water and sediment discharges from a relatively, undisturbed watershed.

Groundwater and Surface Water Supplies

The several residents who live on the east side of the watershed rely upon groundwater supplies in Olosega and/or surface water supplies derived individual roof catchment systems. Consequently, there are no significant management issues associated with these resources.

MANAGEMENT NEEDS AND RECOMMENDATIONS

The primary focus of future resource management in the watershed will be to:

- encourage appropriate agricultural practices in upland *faatoaga* areas;

- limit agricultural production to selected areas with soils more conducive to agricultural production and less prone to erosion;
- restrict land uses other than agriculture that would significantly increase the discharge of turbid waters and sediments into local streams;
- monitor future changes in land use; and,
- monitor the condition of coral reefs seaward of the central watershed.

Representatives of participating public agencies should make periodic visits to the watershed to observe, document, and monitor selected resource conditions, determine potential methods of correcting a potential hazard or undesirable conditions, share potential solutions with a designated resident of Ofu, and encourage the village's implementation of resource management solutions.

The scope of issues that should be addressed by each agency in the field is summarized in Table 37-2. The general focus of recommended technical assistance is also identified. The experience and insights of agency representatives will determine the specific methodology to be used in the field.

TABLE 37-2
RECOMMENDED FOCUS OF FUTURE TECHNICAL ASSISTANCE
OFU MATU WATERSHED

Participating Public Agency	Resource Management Issue	Focus of Technical Assistance
ASEPA	Facilitate a coordinated resource management effort within the watershed.	1. Coordinate overall watershed management activities. 2. Hold periodic meetings with participating ASG and federal agencies to discuss, prioritize, and schedule resource management activities. 3. Coordinate program efforts with local traditional leaders and/or designated resident of the watershed. 4. Make annual assessment of resource management program.
ASDOC	Restrict land uses other than agriculture that would generate significant discharges of turbid water and sediment into local streams.	1. Require a PNRS review for any structural development in the watershed. 2. Limit future structural development to those supporting agricultural production. 3. Provide specific design and construction criteria in conjunction with the approval of any future structures.
ASDOC	Monitor changes in population and land use	Annually map type and location of land uses in village and estimate resident population.
ASCC Land Grant Program	Reduce erosion and sedimentation from upslope agricultural production	1. Encourage soil conservation methods with resident growers of subsistence crops. 2. Encourage upslope agricultural production only on Ofu silty clay soils on 15 to 40 percent slopes (SCS unit 14).
ASG Dept. of Marine/Wildlife Resources	Sustain healthy marine communities in nearshore waters	Monitor changes in coral coverage, fish habitat, diversity and other characteristics (used by Green) approximately every three years. Monitor reef front seaward of central watershed, as well as northwest of Asaga Strait.

Source: Pedersen Planning Consultants, 1998

OLOSEGA SISIFO
Watershed 38

GEOGRAPHY

The Olosega Sisifo watershed is located on the west side of the Island of Olosega. The watershed comprises about 0.8 square miles of land area (Figure 38-1).

The east and west sides of Olosega are divided by Piumafua Mountain, near the center of the Island, which rises approximately 2,095 feet above mean sea level. Alei Ridge extends north of the Piumafua Mountain peak to Leaumasili Point. Mataala Ridge extends southeast to Maga Point, which represents the southern tip of Olosega.

Along the west shoreline of Olosega, the Olosega Sisifo watershed is located between Leaumasili Point and Maga Point. No embayments are situated along the west shoreline of the watershed.

RESOURCES OF THE WATERSHED

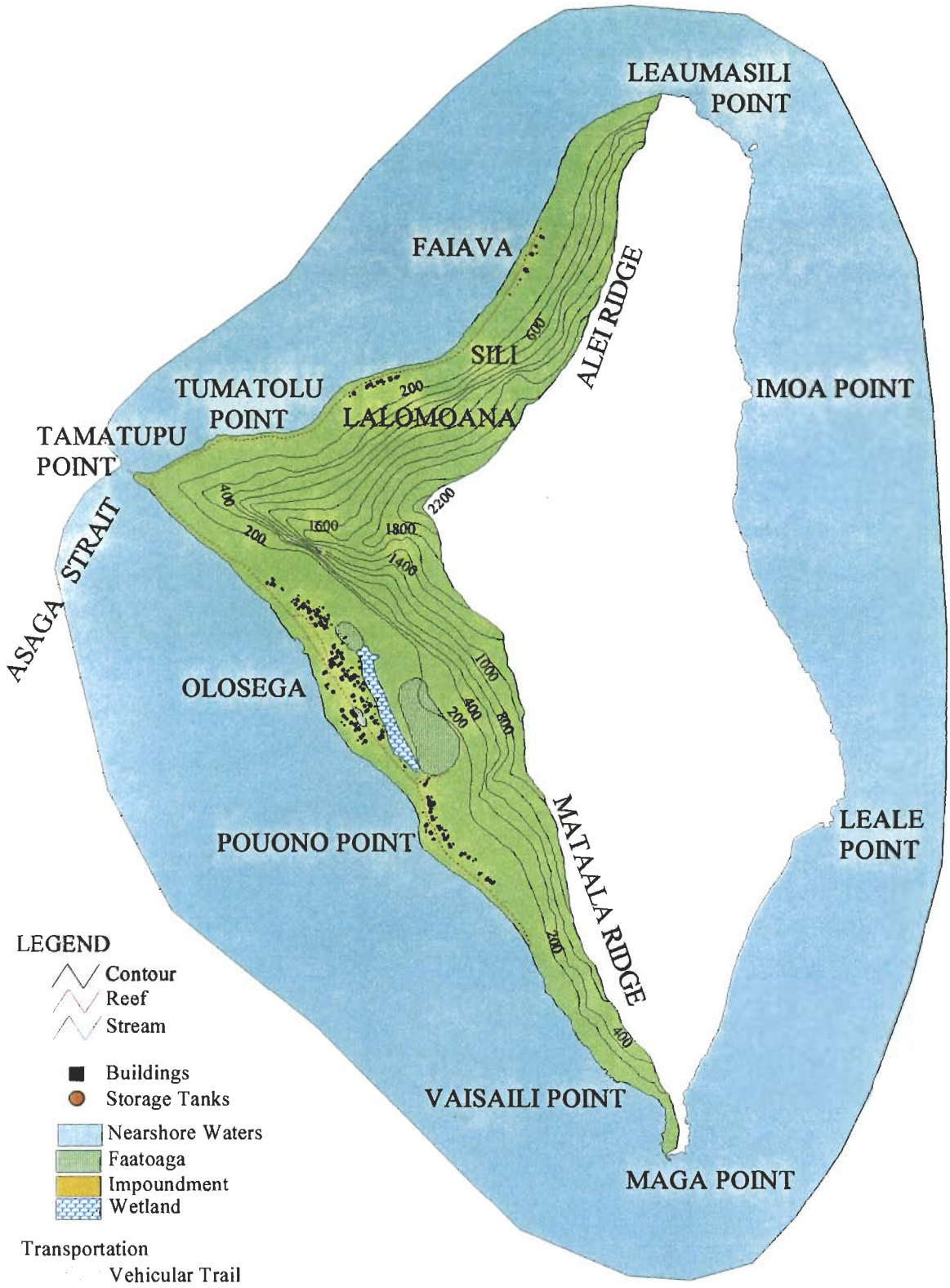
Soils

The U.S. Soil Conservation Service (National Resource Conservation Service) published a Soil Survey of American Samoa in 1984. Selected information derived from this survey provides some useful information for future watershed planning and management (Figure 38-2). Seven soil classifications were identified by the U.S. Soil Conservation Service for lands within the Olosega Sisifo watershed (Table 38-1).

TABLE 38-1
SELECTED SOIL CHARACTERISTICS
OLOSEGA SISIFO WATERSHED

SCS Soil Unit	Name	Typical Slope (Percent)	Flood	Runoff	Erosion	Soil Depth To:		Land Use Suitability	
						High Water (Feet)	Bed Rock (Inches)	Soil Based WW Treatment	Subsistence Ag Potential
2	Aua very stony silty clay loam	30-60	None	Rapid	Severe	<6	<60	Severe Slope	Poor
4	Fagasa family-Lithic Hapludolls-Rock outcrop assoc	70-130	None	Very Rapid	Very Severe	>6	20-40	Severe Slope Depth	Poor
6	Insak mucky sandy loam	0-2	Fre-quent	Ponded to Slow	Slight	0.5-2.0	20-40	Severe Flooding Depth to Rock Ponding	N/A
12	Ngedebus Variant extremely cobbly sand	0-5	Occ	Very Slow	Slight	>6.0	>60	Severe Flood Poor Filter Large Stones	Poor
14	Ofu silty clay	15-40	None	Med	Mod	>6.0	>60	Severe Slope	Good
15	Ofu silty clay	40-70	None	Med	Mod	>6.0	>60	Severe Slope	Poor
35	Urban land-Ngedebus complex	0-5	Occ	Slow	Slight	>3.5	.60	Severe Flood Wet Poor Filter	Poor

Source: U.S. Soil Conservation Service, 1984



American Samoa Geographical Information System

0.25 0 0.25 0.5 0.75 1 1.25

Miles

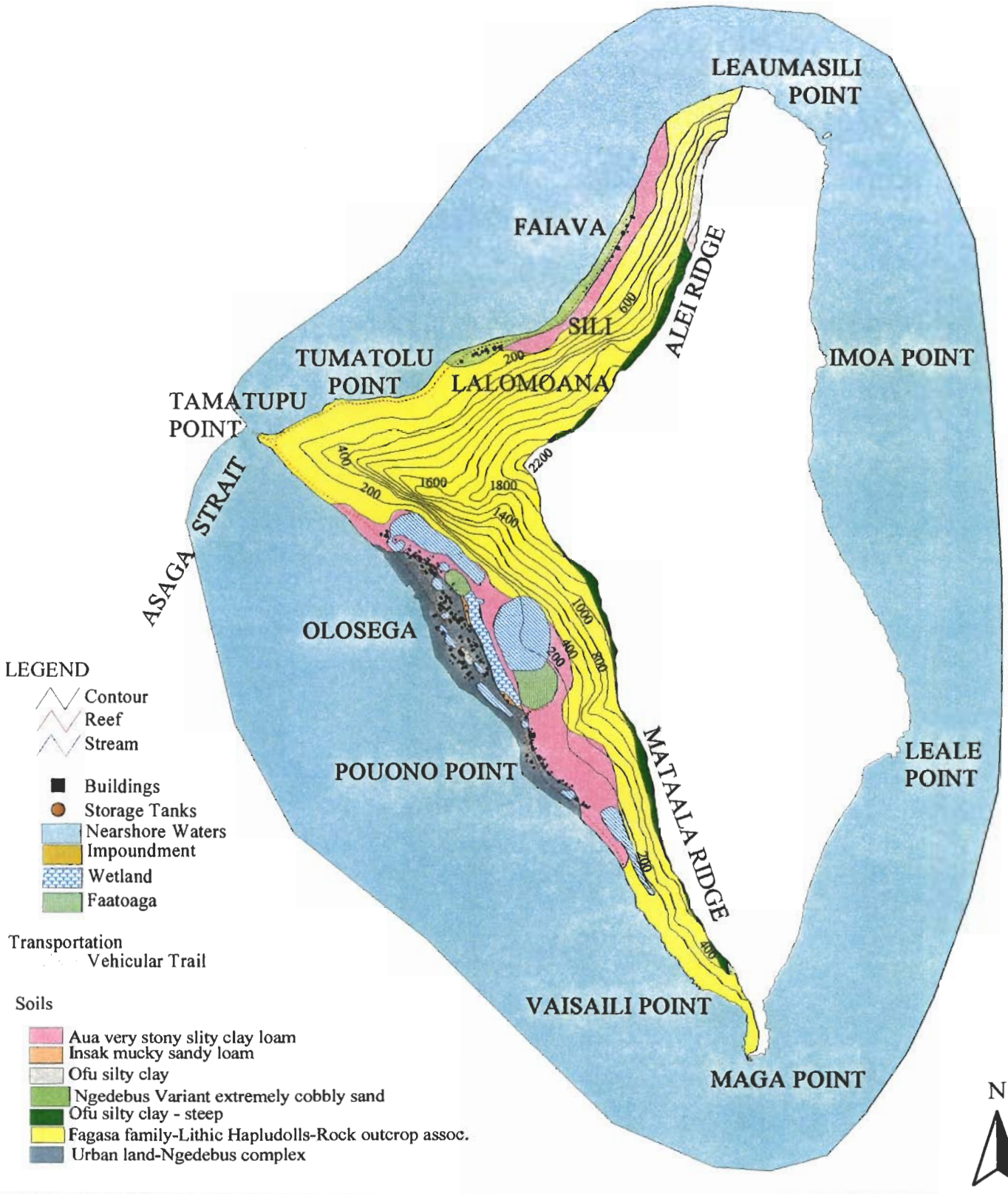
Scale: 1:24,000

Prepared by: Pedersen Planning Consultants Tel: 307-327-5434

Olosega Sisifo Watershed
Existing Conditions

Figure 38-1

38



American Samoa Geographical Information System

0.25 0 0.25 0.5 0.75 1 1.25

Miles

Scale: 1:24,000

Prepared by: Pedersen Planning Consultants Tel: 307-327-5434

Olosega Sisifo Watershed Management Issues 38

Figure 38-2

< FIGURE 38-2 >

Urban Land-Ngedebus Complex

Most of the inhabited village area in Olosega contains Urban land-Ngedebus complex soils (SCS mapping unit 35).

These soils generally comprise coral fragments, sand, cinders and other material that have been graded or filled to support residential, commercial and public facilities in the village area.

The Ngedebus soil extends to a depth of 60 inches or more. The surface layer, which extends about 4 inches below ground elevation, typically contains light, brownish-gray and brown sand. The underlying material is characterized by pale brown and light yellow, brown sand.

The permeability of Ngedebus soil ranges between six and 20 inches per hour. Surface drainage on this soil is generally slow, and the hazard of potential soil erosion is slight. In some places, the soil is subject to occasional, brief periods of flooding during prolonged, heavy rainfall or during high tide (U.S. Soil Conservation Service, 1984).

These soils are generally suitable to support residential and commercial development in areas that are protected from flooding. However, this soil is poorly suited in unprotected areas (U.S. Soil Conservation Service, 1984).

Where moderate to higher housing densities occur, the U. S. Natural Resources Conservation Service recommends the use of community sewage systems prevent the potential contamination of groundwater and surface water supplies. Housing densities in Olosega range between two to six units per acre.

Ngedebus Variant Extremely Cobbly Sand

Ngedebus variant extremely cobbly sand soils (SCS mapping unit 12) extends along the northwest coast of the Olosega Sisifo watershed between Lalomoana and Faiava areas. This soil is found in most of the existing and former residential areas along the shoreline.

Ngedebus variant extremely cobbly sand soils is a deep, excessively drained soil that is derived from coral and seashells. These soils commonly comprise narrow sandy beaches less than 50-feet wide.

A representative surface layer is usually black extremely cobbly sand that is about 15 inches thick. The surface layer has a high content of organic matter; however, in some areas, the surface layer comprises extremely stony sand. Pale brown extremely cobbly sand defines the substratum to a depth of 60 inches or more (U.S. Soil Conservation Service, 1984).

The permeability of this soil ranges between six and 20 inches per hour. The potential hazard of water erosion is slight; potential soil runoff is very slow. This soil is occasionally subjected to brief periods of flooding.

Ngedebus Variant extremely cobbly sand soils has a poor potential for subsistence agricultural production. Coconut production can only be supported in scattered areas. Subsistence production is hampered by a higher content of coral fragments throughout the soil.

Rapid permeability characteristics of this soil make this soil unsuitable for septic tank and effluent drainfield applications. Rapid permeability of the soil does not afford effective soil-based treatment of wastewater.

Insak Mucky Sandy Loam

The coastal marsh that lies inland of the central village area of Olosega contains Insak mucky sandy loam (SCS mapping unit 6). This soil, which is formed in coral sand and organic matter, a moderately deep and very poorly drained soil that is typically found in coastal depressions.

The surface layer, which is typically a black mucky sandy loam, is approximately 11 inches thick. In some areas, however, the surface layer contains a mucky loamy sand. Very dark, gray-mucky loam comprises a second layer of about six inches. White and light gray sand, approximately 9 inches thick, lies over coral that is found about 26 inches below ground elevation. The depth to bedrock ranges from 20 to 40 inches.

Soil permeability ranges between six and 20 inches per hour. The hazard of potential water erosion is considered slight; potential runoff is ponded to slow.

The depth of the water table is 10 to 20 inches below ground elevation. Areas that are unprotected are frequently flooded.

The soil is suitable for the production of wetland taro and other water tolerant plants.

Insak mucky sandy loam is unsuitable for septic tank and effluent drainfield applications. Potential flooding and the limited depth to the water table do not promote effective soil-based treatment.

Aua Very Stony Silty Clay Loam (30 to 60 percent slopes)

Steeper slopes of the lower watershed include Aua very stony silty clay loam soils (SCS mapping unit 2). These soils are generally located immediately upslope of the inhabited village area of Olosega and below the 400-foot contour. Upland portions of the inhabited village area on the northwest and southeast ends of Olosega Village also include these Aua soils. Along the northwest coast of the watershed, these soils are found immediately upslope of Lalomoana, Sili, and Faiava.

The Aua soils range between seven to 60 inches in depth. The permeability of these soils (between 2 and 6 inches per hour) is moderately rapid. For watershed management purposes, it is important to note that these Aua soils have a high potential for runoff and erosion.

This Aua soil is not recommended for agricultural production because of the stoniness of the soil, the high erosion potential, and hazards associated with subsistence crop cultivation on steeper slopes. However, when cultivation in these soils is necessary, the use of a mulch or ground cover is recommended to reduce soil erosion in cultivated areas.

The U.S. Soil Conservation Service estimates that this soil can annually sustain up to 5 tons per acre of erosion without impacting crop productivity (U.S. Soil Conservation Service, 1984). While the erosive characteristics of this soil generally may not significantly impact subsistence crop productivity, the erosive quality of the soil can be a significant contributor to sedimentation in downslope streams and the nearshore waters.

The general characteristics of these Aua soils are also undesirable for individual wastewater disposal systems (U.S. Soil Conservation Service, 1984). These soils contain a significant amount of larger stones that hamper installation and provide inadequate soil treatment.

Fagasa Family-Lithic Hapludolls-Rock Outcrop Association

Most of the steeper upland slopes along the west slopes of Puimafua Mountain, Mataala Ridge, and Alei Ridge, as well as the upland slopes of Sunuitao Peak, contain well-drained soils known as the Fagasa family-Lithic Hapludolls-Rock outcrop association (SCS mapping unit 4).

The Fagasa Family soils contain a surface layer of dark, brown silty clay that is about 12 inches thick. A dark brown subsoil is approximately five inches thick. The substratum, which is characterized by a dark-brown, sandy clay loam, extends to a depth of 31 inches. The depth to bedrock ranges between 20 to 60 inches or more.

The Lithic Hapludolls are shallow, well-drained soils that are derived from igneous rock. The surface layer is highly variable, but U.S. Soil Conservation Service soil scientists have observed the surface layer to contain about five inches of dark brown, cobbly silty clay. The subsurface layer, which is about four inches thick, is a dark brown, very cobbly, silty clay. The substratum represents a clay loam, approximately six inches thick, over weathered bedrock.

The soil permeability of the Fagasa Family and Lithic Hapludolls soils are both between two and six inches per hour. Since the Fagasa Family-Lithic Hapludolls soil typically occurs on very steep slopes, potential runoff can be very rapid. The potential for water erosion is very severe (U.S. Soil Conservation Service, 1984).

The cultivation of subsistence crops on these soils is not considered desirable because of the stoniness of the soil and high erosion potential. When cultivation in these soils is necessary, care should be exercised to minimize the amount of exposed soil in cultivated areas. The U.S. Soil Conservation Service estimates that this soil can annually sustain up to 5 tons per acre of erosion without impacting crop productivity (U.S. Soil Conservation Service, 1984). While the erosive characteristics of this soil generally may not significantly impact subsistence crop productivity, the erosive quality of the soil can be a significant contributor to sedimentation in downslope streams and the nearshore waters.

When heavier rainfall events occur, significant erosion of these soils can be expected from undeveloped upslope areas of the watershed. Natural runoff from steeper slopes in the watershed carries water, sediments, and organic debris to downslope drainage courses and streams. Such erosion can readily influence downstream water quality.

Fagasa Family and Lithic Hapludolls soils are unsuitable for septic tank and effluent drainfield applications. Steeper slopes and the limited depth to bedrock do not afford effective soil-based treatment of wastewater.

Ofu Silty Clay (40 to 70 percent slopes)

Smaller areas of Ofu silty clay (SCS mapping unit 15) along the ridge of Puimafua Mountain, Mataala Ridge, and Alei Ridge. This soil is a deep, well-drained soil formed in volcanic ash and residuum that is derived from basic igneous rock.

The surface layer, which is about 10 inches thick, is typically dark reddish-brown, silty clay. In some locations, the surface layer represents a stony silty clay. The subsoil contains about nine inches of dark reddish brown silty clay loam; reddish brown silty clay loam extends another 18 inches. The substratum of reddish-brown, silty clay loam extends to a depth of 60 inches or more. The depth to weathered bedrock ranges from 40 to 60 inches or more.

Ofu silty clay soils have a soil permeability that ranges between two and six inches per hour. The potential hazard of water erosion is severe; the potential occurrence of runoff is medium to rapid.

These soils generally support woodlands, but not commercial timber harvests. Steeper slopes, as well as potential water erosion and runoff hazards, make these soils unsuitable for subsistence agricultural production.

The use of these soils for septic tank and effluent drainfield applications is also unsuitable. Steeper slopes where these soil occur do not promote effective soil-based treatment of wastewater effluent.

Ofu Silty Clay (15 to 40 percent slopes)

The upper north part of Alei Ridge is characterized by Ofu silty clay on 15 to 40 percent slopes (SCS mapping unit 14). This Ofu silty clay soil is a deep, well-drained soil that is formed in volcanic ash and residuum derived from basic igneous rock.

The surface layer is typically a reddish-brown silty clay that is approximately 16 inches thick. A dark brown, silty clay loam characterizes the upper 29 inches of the subsoil; the lower 15 inches of the subsoil contains a dark brown silty clay. A substratum of dark brown silty clay, or silty clay loam, is found in some areas at depths of 30 to 60 inches or more.

The permeability of Ofu silty clay ranges between two and six inches per hour. The potential hazard of water erosion is moderate; potential runoff is considered to be medium (U.S. Soil Conservation Service, 1984).

Ofu silty clay is well suited for subsistence crop production. Typical crops produced from these soils include coconuts, breadfruit, bananas and taro.

These soils are poorly suited for septic tanks and related effluent drainfields. Steeper slopes do not enable effective soil-based treatment of wastewater.

Streams

There are no defined streams in the Olosega Sisifo watershed. Surface runoff occurs along the steeper slopes of Piumafua Mountain, Mataala Ridge, and Alei Ridge. This runoff, which occurs via sheet flow, drains into the coastal marsh near the center of Olosega, as well as a small coastal depression on the north side of the village church.

Along the northwest coast, surface runoff drains directly into the nearshore waters. Lower flows may, in some areas, percolate along sandy beach areas or smaller, basaltic rock depressions. One full-time resident in the Lalomoana area reported that a cut in the steep, basaltic wall behind the residential area sometimes discharges surface runoff from upland slopes during heavier rainfall periods (Tau, 1996).

Surface Water Quality

Streams

Since there are no streams, there is no surface water quality data for these water bodies.

Nearshore Waters

There is no surface water quality available for the nearshore waters that adjoin the Olosega Sisifo watershed.

Wetlands

Near the center of Olosega Village, approximately six acres of wetland are located in narrow depression that is situated immediately inland of the inhabited village area. This area was, at one time, a coastal marsh (Whistler, 1976).

In 1976, Whistler observed that this area was covered with taro cultivation and weeds associated with taro. Secondarily, this wetland contained some typical marsh plants such as the willow primrose, red mangrove, and water chestnut.

In May, 1996, it was evident that the wetland was used extensively for agriculture. *Faatoaga* were located on the northwest and southeast ends of this wetland area. The central portion of the wetland was characterized primarily by grass. No taro production was documented.

A buried culvert along the shoreline of Olosega Village was also observed in May, 1996. This culvert was seaward of the southeast end of the wetland. Despite this blockage, this culvert may still permit some discharge of overflows within the wetland. It is recommended that traditional leaders and the village *aumaga* of Olosega Village be encouraged to clear this culvert to enhance its intended function.

Marine Resources

Coral Communities

A continuous fringing reef characterizes the nearshore waters that adjoin the Olosega Sisifo watershed. Man-made *ava* have been cut the reefs seaward of Olosega and Sili to provide boat access to deeper coastal waters.

Indenting the margin of the irregular reef front off Olosega Village are small channels. At depths of 65 to 85 feet offshore the bottom is rocky and large limestone blocks form valleys and ridges.

Various private consultants have made field investigations of the fringing reef since the late 1970's. In a cumulative sense, the available survey information suggests:

- Coral communities seaward of Olosega were in considerably better condition compared to coral reefs that front the Island of Tutuila.
- The fringing reefs that front Sili and Olosega are considered to be some of the better coral reefs in the Samoa archipelago.

1978-1979

Seaward of Faiava, the middle reef flat contained approximately 20 percent live coral coverage.

The inner reef platform seaward of Sili was characterized with less than five percent coral cover. However, along the steep reef front, coral coverage ranges between 50 and 70 percent.

In the vicinity of Asaga Strait, coral cover was generally low on the reef flat north of the bridge that connects the Islands of Olosega and Ofu. South of the Strait, coral cover was up to 15 percent in shallow parts of the reef flat.

Southeast of Tamatupu Point, coral was almost absent on the inner reef flat. However, coral coverage increased to up to 10 percent on the middle reef that was located about 300 feet from shore.

North of Pouono Point, about five percent coral coverage was documented in the *ava* seaward of Olosega Village. On the middle reef flat, which began about 150 feet from the shoreline, live coral coverage was approximately 20 percent. *"An additional 15 percent of the bottom was covered by dead, standing coral heads"* (Aecos and Aquatic Farms, 1980). The outer reef was characterized by only five percent coral cover.

1988

A survey of Olosega was made by Itano and Buckley in 1988. Survey notes from this survey were briefly summarized in the 1992 American Samoa Coastal Resources Inventory Report.

Seaward Lalomoana, Itano and Buckley noted coral coverage along the reef front ranged between 50 and 100 percent.

The coral reef front between South Agasa Strait and Pouono Point varied between low and 50 percent cover.

South of Pouono Point to Vaisaili Point, a 100 meter stretch along the reef front was characterized by 50 percent coral cover. Between Vaisaili Point and Maga Point, maximum coral coverage was between 40 and 50 percent.

1991

Field investigations were also made by Maragos, Hunter, and Meier in 1991 in the nearshore waters of the watershed. The 1991-1992 American Samoa Coastal Resources Inventory

Report that the coral reefs between Lalomoana Village and Faiava Village, as well as Tamatupu Point to Vaisaili Point, contain *"high natural productivity and pristine value"* and are *"coastal marine areas recommended for special protection"* (Maragos, Hunter, and Meier, 1992).

Two sites are also considered to be *"sites of high natural productivity and pristine value"* and are *"coastal marine areas recommended for special protection."* The Sili fringing reef, from, is the first site. The second site is the Olosega fringing reef and beach, from Tamatupu Point to Vaisaili Point.

1995

A recent 1996 study of various coral reefs throughout the Samoan Archipelago included marine surveys along reef front between Lalomoana and Sili, as well as the reef front at Olosega. The study focused primarily upon the quantification of coral communities, the abundance and diversity of reef fish, and selected habitat characteristics.

Marine surveys at both locations yielded similar results. Coral cover was greater that 40 percent. Fish specie richness was greater than 150 species at each site. Fish density was greater than 10,000 individuals per ha at Lalomoana-Sili and Olosega. Fish biomass ranged between 500 and 999 kilograms per ha.

Green also noted that the coral reefs of the Manua Islands were severely damaged by Hurricane Tusi in 1987, but escaped significant damage from Hurricane Ofa in February 1990 and Hurricane Val in December 1991. In addition, the reefs in Manua were also influenced by infestations by the crown-of-thorns starfish and a recent coral bleaching event. From her review of past studies, Green concluded that the reef fronts of the Manua Islands tended to be in better condition that those on Tutuila.

Green also mentioned that the reef fronts at Lalomoana-Sili and Olosega were among the best surveyed in the Samoan archipelago.

Wildlife Resources

Forest Birds

A 1986 Survey of the Forest Birds of American Samoa also documented about 12 forest birds in various areas of Olosega (Engbring and Ramsey, 1989). This survey, which was made on the Islands of Tutuila, Ofu, Olosega, and Tau, recorded the number of birds observed during 8-minute counts in July 1986 (Table 38-2).

Bats

Steep rock and almost vertical rock faces characterize the rocky cliffs above Olosega and Sili. These areas represent roosting sites for the fruit bat in both Olosega and Sili. Small numbers of sheath-tailed bats may also roost in a cave located on the cliff above Sili Village (Aecos and Aquatic Farms, 1980). A limited survey of the fruit bat population of Olosega was made by Brooke, Solek and Utzurrum in August 1997. Data obtained from this survey indicated that the fruit bat was very uncommon (Utzurrum, 1998).

Other Birds

The common brown noddy has also been reported to nests in trees along the northwest coast of Olosega, as well as along the sea cliff upslope of Olosega Village (Aecos and Aquatic Farms, 1980).

Historically, the Australian gray duck has also been observed in the wetland area that is inland of the inhabited village area of Olosega (Aecos and Aquatic Farms, 1980). Little potential habit for this duck was documented on the Island of Olosega during a 1986 survey (Engbring and Ramsey, 1989).

TABLE 38-2
FOREST BIRD SURVEY RESULTS
NATIVE FOREST AND NON-FOREST BIRDS
JULY, 1986

Species	Tutuila	Ofu	Olosega	Tau	Total
Tahiti Petrel	0	-	-	1	1
White-tailed Tropicbird	154	11	27	234	426
Red-footed Booby	22	-	-	-	22
Great Frigatebird	1	-	-	-	1
Reef Heron	1	0	0	0	1
Red Junglefowl	527	17	0	26	570
Banded Rail	163	22	16	75	276
Spotless Crake	-	-	-	1	1
Purple Swamphen	10	4	0	15	29
Blue-gray Noddy	1	0	0	0	1
Brown Noddy	65	1	0	359	425
Black Noddy	0	11	0	5	16
White Tern	331	88	17	60	496
Many-colored Fruit Dove	10	0	0	2	12
Purple-capped Fruit Dove	3,107	104	33	1,176	4,420
Pacific Pigeon	207	15	8	282	512
Blue-crowned Lory	-	65	79	533	677
Common Barn Owl	2	0	0	0	2
White-rumped Swiftlet	441	348	13	284	1,086
Collared Kingfisher	136	43	14	95	288
Red-vented Bulbul	95	-	-	-	95
Fiji Shrikebill	-	1	9	93	103
Wattled Honeyeater	3,748	875	457	2,779	7,859
Cardinal Honeyeater	621	-	-	-	621
Polynesian Starling	296	41	3	146	486
Samoan Starling	1,647	253	91	929	2,920
Total Birds Recorded	**11,585**	**1,899**	**767**	**7,095**	**21,346**

Notes: A dash (-) indicates the species is not resident on the island surveyed.

Source: Engbring and Ramsey, 1989

Seabirds

Nesting and roosting seabirds, including the brown booby, the brown noddy, and the blue-gray noddy, use the rocky peninsula at Maga Point and the adjacent coastal cliffs. Red-footed boobies and masked boobies have also been observed in this area (Engbring and Ramsey, 1989).

"Maga Point is steep and inaccessible, and seabirds have found a refuge here because of its isolation. The area should be designated as a seabird sanctuary" (Engbring and Ramsey, 1989). It is believed that this recommendation remains appropriate. There is no demand for land uses on the east side of Olosega or access to the nearshore waters. Consequently, the establishment of a seabird sanctuary could probably be made without significantly impacting recreational activities or other land uses in the vicinity of Maga Point.

It is recommended that the ASG Department of Marine and Wildlife Resources should discuss the proposed wildlife sanctuary with selected traditional leaders from all villages on the Island of Olosega. If traditional leaders believe that the designation of a wildlife sanctuary would not conflict with other land uses and recreational activities along the south tip of Olosega, the ASG Department of Marine and Wildlife Resources should prepare legislation for review and adoption by the *Fono*.

The ASG Department of Marine and Wildlife Resources should prepare legislation for review and adoption by the *Fono*.

Shoreline Protection

The shoreline of the Olosega Sisifo watershed varies considerably. Basalt boulders, basalt cobbles, and coral rubble characterize much of the shoreline along the northwest coast. However, a coral and basalt cobble beach is located along the shoreline that fronts Lalomoana. Narrow basalt boulders and coarse sand are found on the shoreline immediately southeast of Agasa Strait and Tamatupu Point. In contrast, the shoreline of Olosega Village contains a considerable amount of sandy beach that is interspersed with areas of basalt outcrops and boulders.

The fringing reef of that surrounds much of Olosega affords some natural protection from storm waves by its dissipation of nearshore wave energy. Otherwise, there are few shoreline protection structures that have been constructed in the watershed. One rock wall provides some marginal protection to one home in Lalomoana. In addition, some basalt rocks have been placed southeast of Tamatupu Point to stabilize a backshore scarp.

In March 1994, Sea Engineering, Inc. and Belt Collins Hawaii published a shoreline inventory report that outlined, in part, ongoing shoreline erosion conditions and related shore protection needs for American Samoa. Sea Engineering, Inc. and Belt Collins Hawaii noted the following conditions in the Olosega Sisifo watershed that were determined to be "critical" or "potentially critical" conditions.

Tumatolu Point

The shoreline fronting Tumatolu Point included a utility pole that defined the location of the former road shoulder along the northwest coast. Despite the extensive damage to the shoreline road along the northwest coast, FEMA recommended that the residential areas along the coast should not be rebuilt.

Southeast of Tamatupu Point

The shoreline northwest of Olosega Village is potentially vulnerable to a backshore erosion scarp. The scarp was within five feet of the primary shoreline access road.

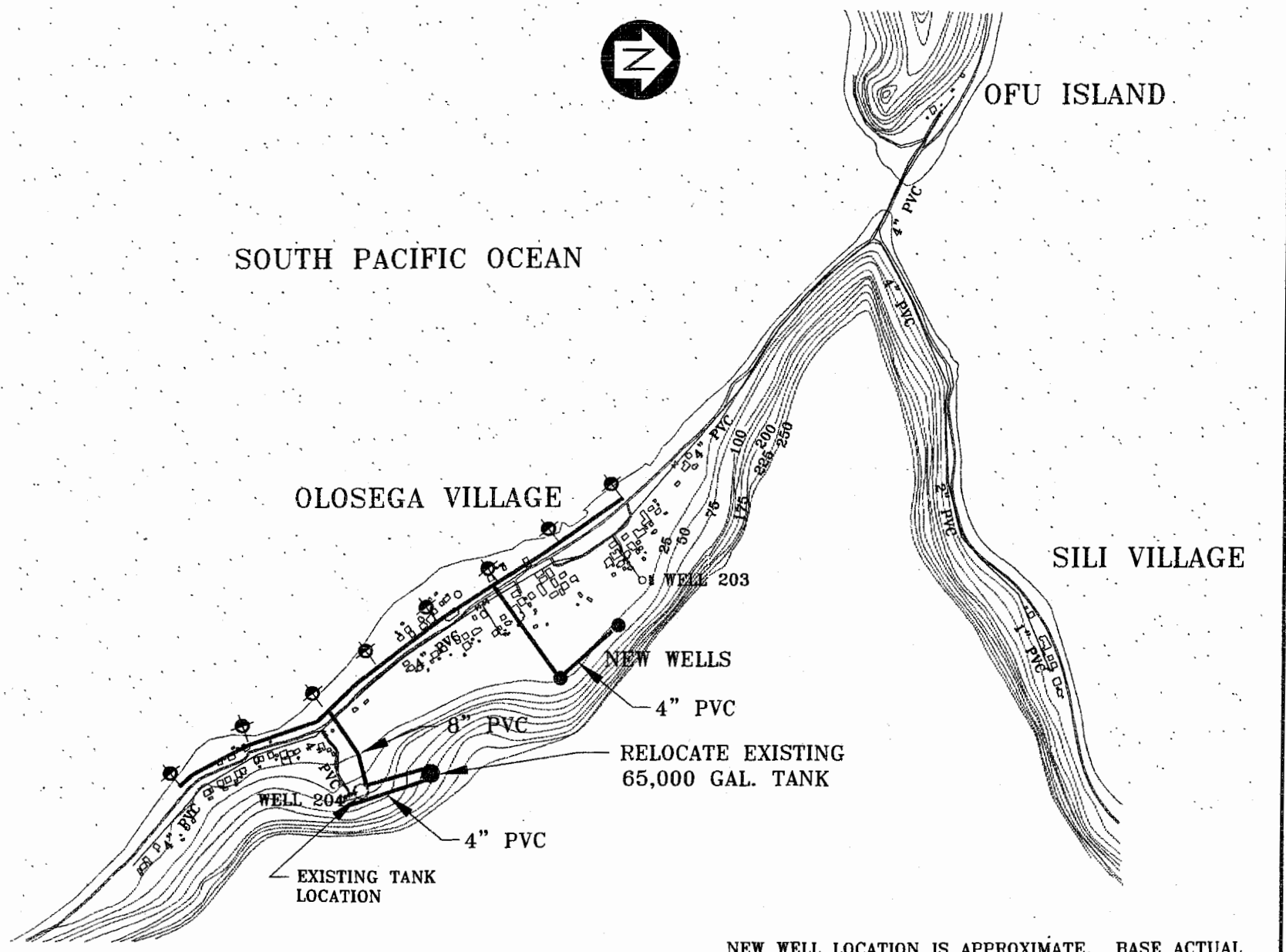
During the May, 1996 survey, a considerable amount of shoreline erosion in front of Olosega Village. Such erosion was evident between the north end of the Village and the *malae* that fronts the house of the village *faifeau*. Local residents recall the presence of many coconut trees along this portion of the shoreline and indicate that a growing volume of sand is being lost from the sandy beach (Malae, 1996; Tausaga, 1996).

Groundwater and Surface Water Supplies

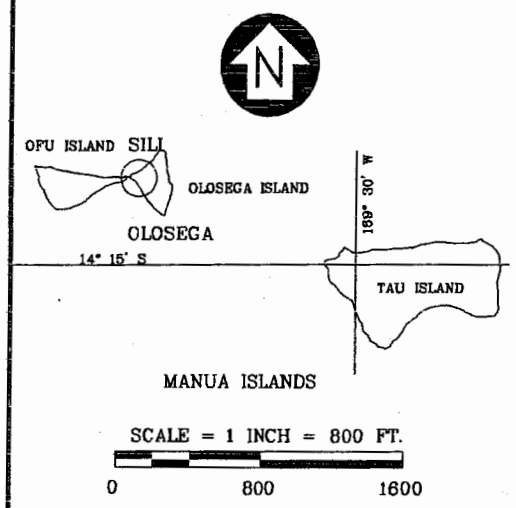
Groundwater Supply and Quality

A satellite water system of the American Samoa Power Authority is located in Olosega Village. This system serves the Island of Olosega, Lalomoana and Sili (Figure 38-3).

The ASPA water system includes two groundwater wells (ASPA wells 203 and 204). Well 203 was out of service in 1995 because of pump and motor damage.



NEW WELL LOCATION IS APPROXIMATE. BASE ACTUAL LOCATION OF DRILLING ON SITE AND GEOLOGICAL DATA



LEGEND

EXISTING

- 4" PVC — WATER MAIN, SIZE & TYPE
- ROADS
- 25 — CONTOURS
- STREAMS

PLANNED

- 6" PVC — WATER MAIN, SIZE & TYPE
- 6" FIRE HYDRANT

AMERICAN SAMOA
POWER AUTHORITY
P.O BOX PPB, PAGO PAGO, AMERICAN SAMOA

PLANNING CRITERIA

1995 POPULATION (ESTIMATED): 271	2015 POPULATION (FORECASTED): 334
1995 AVERAGE DAY DEMAND: 19,145 GAL.	2015 AVERAGE DAY DEMAND: 37,050 GAL.

CONSTRUCTION COST (1995 USD): $395,000

FIGURE 38-3
OLOSEGA AND SILI VILLAGES
PLANNED WATER SYSTEM IMPROVEMENTS

Both groundwater wells are characterized by elevated chloride levels. This water quality characteristic may reflect that the wells were drilled to deep (ASPA, 1995).

Residents of Olosega do not use water from the ASPA system for drinking purposes.

Surface Water Supply and Quality

A *vaipuna,* or spring, south of Olosega provides a surface water supply for Olosega residents. Local spring apparently provides a good source of potable water to the village (Hart, 1996). There is a spring box and a storage tank on the slopes of Mataala Ridge.

Available water quality from FY 1994 suggests that the village water system is chlorinated. Water quality indicated no coliform contamination, as well as some nominal levels of chlorine.

Proposed Water System Improvements

The draft ASPA Utilities Master Plan proposes the following improvements to its satellite water system in Olosega:

- completion of a leak detection survy of Olosega and Sili, and the related repair of all system leaks.
- renovation of well 203 and the restoration of its operation with chlorination.
- development of one or two groundwater wells north of Olosega Village at the base of Piumafua Mountain.
- development of a village spring as a water source for the ASPA system if the development of groundwater wells is not successful.
- development of new water storage tank northwest of the existing tank site at the 150-foot elevation.
- installation of a 4-inch PVC pipe extension to well 204 transmission main to new tank location.
- construction of an 8-inch discharge line to system distribution and the installation of PVC fire protection main along the primary shoreline road.
- installation of tank level telemetry for all groundwater wells.
- installation of 10 fire hydrants in Olosega Village.

USE OF THE WATERSHED

Resident Population

Between 1980 and 1990, the resident population of Olosega Village declined from 211 to 201 residents. This represents an average annual decline in population of about 4.7 percent. Development activity between 1990 and 1995 increased resident population to about 259 persons.

There were 13 persons living in the Lalomoana area in May, 1996. This population resided in two households.

Land Uses

Residential

Olosega

The 1990 Census documented 47 housing units in Olosega. Eighty-three percent of the housing stock was owner-occupied; two percent were rental units. Approximately 15 percent were vacant or used by owners as a vacation home.

ASG Building Division records indicate that six building permits were issued for new residential structures from 1990 through 1994. Consequently, the 1995 housing stock includes approximately 53 homes.

Sili

The 1990 Census documented 10 housing units in the Sili village Census area. Forty percent of the units were owner-occupied; none were rental units. Sixty percent were believed to be vacant or used by owners for vacation homes.

The existing housing stock has now reduced to about two housing units which are uninhabited. The Sili village Census area sustained serious damage from Hurricane Val which destroyed or seriously damaged several homes in the village. The ASG Building Division records indicate that no building permits have been issued for any new residential structures in the Village since the occurrence of Hurricane Val.

Agriculture

Piggeries

Historically, Olosega Village contained one large piggery that was located between the steep rock cliffs and the wetland that lie inland of the inhabited village area. This piggery extended all along the back side of Olosega Village to the present solid waste dump on the south end of the Village.

In 1996, about 35 families lived in Olosega. Almost every household had one piggery that housed three to four pigs (Malae, 1996).

Faatoaga

Various plantations are located in the watershed. Within Olosega Village, the primary agricultural production area is the wetland area inland of the inhabited village area.

Commercial

In 1995, five grocery stores and one retail store were operated in the Village.

Don and Ilaisa's Guest Fale is situated near the northwest end of Olosega Village. This facility includes four guest rooms that can accommodate between eight and 16 persons.

Industrial

There are no industrial operations on the Island of Olosega.

Public Facilities

The ASG Department of Education offers an early childhood education programs in Olosega. In September, 1994, this program had a student enrollment of five children.

Elementary school-aged children attend Olosega Elementary in Olosega Village. High school students attend Manua High School on Tau Island.

Use of the Nearshore Waters

Nearshore Fishing and General Water Recreation

The nearshore waters are primarily used on Saturdays. Thirty to forty persons use the nearshore waters that front Olosega Village or fishing on Saturdays. An additional 10 or more persons use the nearshore waters for swimming and general water recreation (Malae, 1996).

RESOURCE MANAGEMENT ISSUES

Future Land Uses to the Year 2015

Residential

Olosega Village

While available lands could accommodate a sizable residential expansion, the location of the Elementary School within the village is perhaps the most significant attraction to incoming families with younger children. In this regard, it is interesting to note that school enrollment at the public elementary school has increased over 40 percent since 1993 (Tuata, 1994). This may be a factor in future residential growth if proposed plans are made by ASG to encourage greater commercial agricultural opportunities in Ofu and Olosega. Potential cash employment opportunities might encourage a few more younger families to remain in the community rather than relocating to Tutuila.

Future residential growth in Olosega Village is expected to be driven primarily by a small, but growing number of returning American Samoans from the continental United States who are seeking an earlier retirement and have no school-aged children living with them. For these newcomers, lifestyle and the attractiveness of a potential housesite probably represents the more important concerns. From this perspective, the *taufusi* behind the main village area may somewhat discourage future residential expansion because the *taufusi* may generate some vector problems under various weather conditions.

The prospects and constraints to future population growth suggest that residential expansion in Olosega Village will not exceed 20 units between 1996 and 2015. Future residential expansion will probably occur on moderate slopes at the northwest and southeast ends of the village.

During the next 20 years, ASPA believes that these potential development opportunities and constraints will generate the following sequence and volume of residential construction.

1996-2000	Five new single family homes within the northwest end of the village between the shoreline and 25-foot elevation.
2001-2005	Two new single family homes between 25 and 100-foot elevation. Three new single family homes within the northwest end of the village between the shoreline and the 25-foot elevation.
2006-2010	Five new single family homes between 25 and 100-foot elevation.
2011-2015	Five new single family homes between 25 and 100-foot elevation.

The cumulative effect of this prospective residential growth is that the housing stock will increase to roughly 73 housing units in the year 2015. During the same period, it is believed that the average household size will have gradually decreased to approximately 4.17 persons per household. The anticipated 2015 village population will include about 304 persons.

Sili

The moderate slopes immediately *mauga* of Faiava and Sili could provide ample space for, at least, 15 housing units. However, this community is subject to potential storm wave damage, has no schools, or commercial facilities.

Nevertheless, it is expected that some extended families will return to either rebuild former houses or new homes. Such expansion will include two additional single family homes between 2001 and 2005 and two additional single family units between 2006 and 2010. This

growth will primarily be prompted by the construction of a paved roadway to Sili. Appropriations have already been approved by ASG for this project.

The cumulative effect of this prospective residential growth is that the housing stock will increase to roughly six housing units in the year 2015. During the same period, it is believed that the average household size will have gradually decreased to approximately 4.97 persons per household. It is expected that the 2015 village population will include about 30 persons.

Commercial

Informal discussions with the Honorable Tufele Lia, former Lt. Governor of American Samoa and present Manua District Governor, suggest that the American Samoa Government may eventually encourage the establishment of an increased number of commercial agricultural producers. District Governor Lia believes that expanded harbor facilities, an improved shoreline roadway, the availability of vacant, developable lands that are suitable for agriculture, and the need for cash employment opportunities will drive ASG's future commitment to increased commercial agricultural production.

Significant agricultural lands are located on the north side of Olosega. However, there is presently no convenient vehicular access to these lands. The proposed road to Sili will clearly enhance this commercial agricultural opportunity. The proximity of potential agricultural lands will encourage the formation of three new commercial agricultural enterprises in Olosega Village.

Otherwise, it is expected that two additional retail stores will be developed in the community between the year 2001 to 2005. These stores will be established to respond to new demands for more household amenities, e.g., video store.

The establishment of a National Park along the southern coast of nearby Ofu Island will encourage a greater number of visitors to the Island, as well as an increased demand for overnight accommodations. It is believed that the demand for overnight accommodations will be limited, but sizable enough to support the gradual development and operation of one new bed and breakfast facility between 2001 and 2005 and a second bed and breakfast operation during the 2006-2010 period.

The construction of no new commercial facilities in Sili is anticipated during the 1996-2015 period. The size of the residential community is not sufficient to economically support a feasible operation. Local residents will make use of commercial facilities in Olosega Village.

Industrial

Despite modest increases in future resident population, no additional light industrial operations or facilities are anticipated during the next 20 years. The lack of developable land that would be suitable for industrial activities, as well as the lack of nearby consumer market, represent the primary constraints to future industrial development in this community.

Public Facilities

Population characteristics for Olosega in 1990 suggest that approximately eight percent of the village population is three and four years of age, 20 percent is of elementary school age (ages 5 through 13), and about seven percent is high school age (14-18).

Application of population characteristics to anticipated future population suggests that Olosega will contribute the following estimated student enrollments to facilities within and outside the community in the year 2015:

- early childhood education 24 students
- elementary school 61 students
- high school 21 students

Population characteristics for Sili in 1990 suggest that approximately 13 percent of the village population is three and four years of age, eight percent are elementary school age (ages 5 through 13), and no students are of high school age (14-18).

Application of these assumptions to anticipated future population suggests that Sili will contribute the following estimated student enrollments to facilities within and outside the community in the year 2015:

- early childhood education 4 students
- elementary school 2 students
- high school 0 students

Impact of Future Population Growth Upon Water Consumption and Waste Generation

Future population growth and changes in land use in the Olosega Sisifo watershed will increase the volume of future wastewater and solid wastes that are generated by local residents. Wastewater generation in Olosega Village, for example, is expected to rise from about 11,833 gallons per day (gpd) to 24,145 gpd in the year 2015.

The consumption of potable water will also increase with a growing population. The American Samoa Power Authority (ASPA) estimates that the average day demand for water in Olosega was about 16,904 gallons in 1995. By the year 2015, ASPA anticipates that the average demand will increase to roughly 34,493 gpd.

Wastewater generation in Sili Village (including Lalomoana) is expected to rise from about 1,569 gallons per day (gpd) in 1995 to 1,790 gpd in the year 2015.

The American Samoa Power Authority (ASPA) estimates that the average day demand for water in Sili (including Lalomoana) was about 2,241 gallons in 1995. By the year 2015, ASPA anticipates that the average demand will increase to roughly 2,557 gpd.

Flood Potential

A flood insurance study of American Samoa and related flood insurance rate maps were published by the U.S. Federal Emergency Management Agency (FEMA) in 1991. The study evaluated selected geographical locations throughout the Territory. Hydrologic and hydraulic analyses that were presented in the study were made by the U.S. Army Corps of Engineers, Pacific Ocean Division. No detailed study was made of the Island of Olosega.

Inland Flood Potential

The entire Ofu Sisifo watershed has been designated by FEMA as “zone x”. This designation indicates that the areas are outside of the 100-year floodplain (Federal Emergency Management Agency, 1991). In essence, FEMA is suggesting that the flood hazard potential in these areas is limited.

Coastal Flood Hazard

The flood insurance rate map for the shoreline of the Ofu Saute watershed indicates that there is a coastal flood hazard through much of the nearshore waters and adjoining shoreline. However, no potential coastal flood elevations were determined by FEMA for the shoreline of the watershed.

Stormwater Runoff/Sedimentation and the Relationship to Surface Water Quality

Stormwater runoff and sedimentation is not an important issue on the Island of Aunuu unless steeper slopes upslope of Olosega Village are developed for residential purposes, or expanded considerably for agricultural use.

As stated earlier, no streams discharge turbid stormwater runoff into the nearshore waters. Sheet flow generated during occasional heavier rainfall periods drain into the wetland that is inland of the inhabited village area in Olosega. High Chief Malae reported that flooding does not occur in Olosega. Detention of the stormwater runoff in the wetland permits the filtering of sediments and turbid waters before their recharge into Olosega's basal aquifer. The future conservation of the wetland is important to ensure that this important wetland function continues. In its absence, Olosega Village can become flooded and groundwater supplies can become contaminated. Further, potential opportunities for groundwater recharge opportunities are considerably diminished.

It is recommended that be taken to ensure the conservation of Olosega's wetland area. No land uses other than subsistence and commercial crop production should be permitted in the Marsh. However, the land area within the wetland should not be filled to accommodate agricultural activities. In addition, no structural uses other than small buildings, e.g., sheds, that support the maintenance of *faatoaga*, should be authorized in the wetland. A community education program should accompany any land use restrictions associated with the future use of the wetland.

Olosega Village residents use a considerable amount of coral fill around homes and village stores. This long-time village practice is very desirable. Unlike paved concrete or other impermeable surfaces, the use of coral fill helps filter urban runoff.

Anticipated residential development is expected to eventually occur on moderate slopes upslope of Olosega Village. Should this development be realized, the installation of individual drywells for each residence should be required. A second option would be to require the development of a community stormwater detention facility to reduce potential stormwater discharges, potential downslope flooding, and potential discharges into the nearshore waters.

Nearshore Water Quality and the Marine Environment

Turbidity and Sedimentation

The concern for continued turbidity and sedimentation in the nearshore waters of the watershed is important. Coral communities are significantly dependent upon the availability of light and related photosynthesis, and occasional periods of significant turbidity and sedimentation do not promote long-term coral nutrition, growth, reproduction, and depth distribution (Richmond, 1993).

When corals fertilize, they are free-swimming. Consequently, they need a good location to settle and make a good attachment. With significant soil deposition, sediments can physically interfere with the recruitment of coral larvae (Richmond, 1993; Dashbach, 1996).

Coral communities are an important component of the overall ecology of the nearshore waters that adjoin the Ofu Saute watershed. They provide shelter to fish, invertebrates, and other marine organisms. Some of these resources represent a supplemental food source for residents of the watershed and other areas in West Tutuila.

In Olosega, discharges of turbid waters and sediments are not expected to impact future nearshore water quality and the marine environment. The lack of streams and the availability of Olosega's wetland area enables the detention of stormwater runoff.

Long-Term Monitoring

Surveys of coral communities have been performed along the reef fronts in the vicinity of Sili and Olosega. Continued monitoring of the Sili sites is not believed to be necessary since there is little potential for the discharge of turbid stormwater, sediments, and nutrients into the nearshore waters along the northwest coast.

Similarly, Olosega Village is not influenced by turbid stormwater runoff from local streams or sheet runoff. There are no streams in the Village. The Olosega wetland and other depressions detain most of the sheet flow from upland slopes.

At the same time, nutrient inputs from cesspools, septic tanks, and piggeries may be generating significant nutrient inputs into the nearshore waters that front Olosega Village. Consequently, the marine survey site used by Green should be monitored approximately once every three years.

Groundwater and Surface Water Supplies

Conservation of Groundwater Supplies

As stated earlier, Ofu Village is already connected to the ASPA water system. However, Olosega presently uses spring water for its drinking water supply.

To facilitate the long-term conservation of these resources, it is recommended that a 100-foot buffer or setback should be established around each groundwater and surface supply, i.e., groundwater well or spring catchment, in the watershed. In essence, the establishment of piggeries, new structural development, or other land uses would not be permitted within the 100-foot radius to prevent potential contamination of the surface supplies.

Nutrient Inputs

Some nutrient contribution is also occurring through the continued use of septic tanks, cesspools, or other soil-based, wastewater treatment systems in the watershed. In addition, some of the piggeries in Olosega may also discharge nutrient-enriched wastewater into the Olosega wetland or other natural depressions. These sources of nutrients are also accompanied by some bacterial contamination.

While the total volume of wastewater generation from the watershed is limited, the discharges are concentrated in the inhabited village area where housing densities are between two and four housing units per acre. Local soils are generally inadequate to provide effective treatment. For this reason, the nearshore waters in front of Olosega Village should be monitored for nutrient and bacterial contamination on a quarterly basis.

The long-term input of turbid and nutrient-enriched waters into the wetland and other depressions in Olosega represents an important concern. These inputs are potentially detrimental to groundwater quality if they cannot be effectively treated by the wetland and the underlying substrata. In addition, nutrient inputs may also adversely change the composition of the nearshore marine environment.

As the population of the watershed grows, nutrient and bacterial inputs will only increase. Village areas in the Olosega Sisifo watershed that are unsuitable for soil-based, wastewater treatment should be more specifically identified. As recommended in the ASPA Utilities Master Plan, this identification process should be based upon a more detailed sanitation survey of more densely inhabited areas of Olosega Village. This survey would evaluate existing wastewater treatment practices, soil characteristics, the location and density of land uses, the distance to surface water supplies and the nearshore waters, topography, and other related factors. Using the conclusions and recommendations associated with this evaluation, ASPA and other participating Project Notification and Review System (PNRS) agencies will be better able to:

- require the use of septic tanks and leachfields that provide a sufficient amount of additional soil-based treatment; and,
- provide greater technical assistance to building permit applicants.

MANAGEMENT NEEDS AND RECOMMENDATIONS

The primary focus of future resource management in the Olosega Sisifo watershed will be to:

- conserve the wetland in Olosega;
- perform a detailed sanitation survey of the inhabited Ofu Village area;
- monitor nearshore water quality;
- conserve and monitor coral communities; and
- detain urban runoff through the use of drywells in conjunction with the development of any new future residential development upslope of Olosega Village.

Representatives of participating public agencies should make periodic visits to the watershed to observe, document, and monitor selected resource conditions, determine potential methods of correcting a potential hazard or undesirable conditions, share potential solutions with designated residents of Olosega Village and Lalomoana, and encourage the participation of traditional leaders and village residents in the implementation of resource management solutions.

The scope of issues that should be addressed by each agency in the field is summarized in Table 38-3. The general focus of recommended technical assistance is also identified. The experience and insights of agency representatives will determine the specific methodology to be used in the field.

TABLE 38-3
RECOMMENDED FOCUS OF FUTURE TECHNICAL ASSISTANCE
OLOSEGA SISIFO WATERSHED

Participating Public Agency	Resource Management Issue	Focus of Technical Assistance
ASEPA	Facilitate a coordinated resource management effort within the watershed.	1. Coordinate overall watershed management activities. 2. Hold periodic meetings with participating ASG and federal agencies to discuss, prioritize, and schedule resource management activities. 3. Coordinate program efforts with local traditional leaders and/or designated resident of the watershed. 4. Make annual assessment of resource management program.
ASPA/ASEPA	Perform a detailed evaluation of community sanitation problems associated with the use of soil-based treatment systems.	1. Survey inhabited village areas in Olosega Village. 2. Evaluate existing treatment practices, soil characteristics, location and density of land uses, the distance to water supplies and nearshore waters, topography, and other factors. 3. Require use of septic tanks and leachfields that provide sufficient amounts of additional soil-based treatment; or, deny building applications in areas unsuitable for soil-based treatment.
ASEPA	Monitor water quality of nearshore waters.	Measure changes in and total/fecal bacteria and nutrients on a quarterly basis.
ASEPA	Conserve surface water supplies	1. Revise American Samoa GIS to delineate 100-foot buffers around each groundwater and surface supply in Olosega Village. 2. Restrict land uses within designated buffers.
ASCZM/DOC	Detain stormwater runoff in future residential and commercial areas.	In the event that residential development takes place upslope of Olosega, require the use of onsite drywells for all new residential structures, or the development of a community stormwater detention facility.
ASDOC	Monitor changes in population and land use	Annually map type and location of land uses in village and estimate resident population.
ASG Dept. of Marine/Wildlife Resources	Sustain healthy marine communities in nearshore waters	Monitor changes in coral coverage, fish habitat, diversity and other characteristics (used by Green) along the reef front of Olosega approximately every three years.

Source: Pedersen Planning Consultants, 1998