# CORL Watershed Pollution Study American Samoa
## Funded by the National Fish and Wildlife Foundation

### Project Title:
## Coral Reef Pollution Reduction in American Samoa
## Project # (2006-0090-024)

### Summery:

The Coalition of Reef Lovers (CORL) American Samoa Branch has completed its study titled "Coral Reef Pollution Reduction in American Samoa". A community based project to identify the pollution sources and to create awareness and action. The goal of this project is to help solve the local problems that are causing loss of coral reef habitats. The study areas for this project are four villages (Auto, Afulei, Amaua, and Alofau) in the Eastern district of Tutuila, the main Island of American Samoa.

The results of the testing show that the major source of Ammonias, Nitrites, and Nitrates comes from piggeries and inadequate septic systems along the streams and shorelines. The testing for Phosphate showed a wide concentration range from one day to the next. The base line level being between .51ppm (parts per million which is equal to mg/l) and .95ppm in water samples before the stream entered inhabited areas of the villages to an average of 2-4ppm before they emptied into the ocean. The main source for the reactive phosphates was investigated and found to be from high phosphate detergents that were being sold in the Territory. As a result of this project the American Samoa government has banned the importation of all soaps and detergents with a phosphate level greater than 11%.

The Water quality monitoring, and point discharge identification and mapping, provided adequate information to conduct Stress Stream Analysis (SSA) on just about all the streams in the study area. The use of SSA and mapping provided an easy way to inform the community about the condition of the village's water supply and watershed, while reviling problem areas that need addressing by the community. The watershed investigation conducted in the villages show that many houses discharge their Grey water (waste water from sinks, showers, bathtubs and washers that does not contain fecal waste

material) directly into the streams or drainage ditches that empty into the streams. This method of waste water disposal and use of the high phosphate soaps and detergents is most likely the cause of many of the macro algae blooms occurring around the Island of Tutuila at this time. Because this study involved only in-situ measurements and no laboratory study a direct link between nutrients and algae growth could not be established, however many nutrient and algae studies have been conducted and their results do show that algae blooms do occur with elevated nutrient levels on the coral reefs and near shore habitats.

The Marine debris accumulation results showed that much of the marine debris along the shore was being transported there by the nearby streams. Plastics made up a large percentage of the shoreline debris found in the study area.

## Introduction:

The four villages in this study (Amaua, Auto, Afulei, and Alofau) have coastal areas containing coral reef flats and coral fringe reefs, Alofau the largest village in the study also has a lagoon (an uncommon feature in American Samoa) and Turtle grass bed areas. All four villages are located on the island of Tutuila in the United States Territory of American Samoa. American Samoa contains the only US Indo Pacific Coral reef Habitats, with a large amount of species diversity found no where else in the U.S. or its territories.

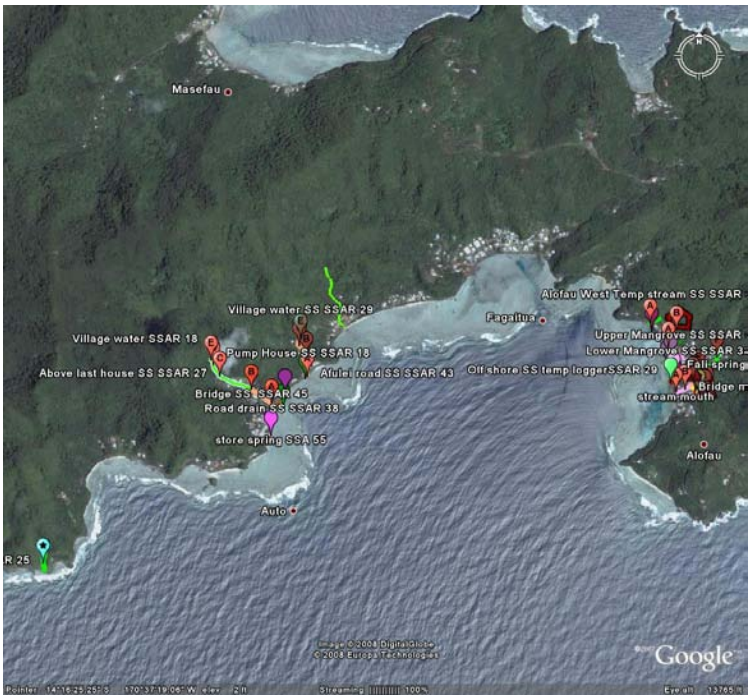



Photo: Study area on Eastern side of Tutuila

This project's short term outcome is to create a community based project under CORL's guidance that will; locate and identify the sources of pollution entering the community's watersheds and causing algae blooms upon the coral reefs and turtle grass beds, make the community aware of the problems that are destroying their near shore habitats, instigate action to correct those problems can be addressed by the community, and to help the community's to locate financial help where the cost of correcting a problem is beyond their abilities. The long term outcome will be the reduction of the stressors degrading the coral reef habitats and the eventual restoration of coral reef, mangrove and turtle grass habitats in the project areas. Urgent action is needed to try to correct the sources of pollution as the algae blooms in Alofau are smothering the Turtle grass beds and encroaching upon the Lagoon and reef flat areas. Algae blooms in Amaua and Auto at this time are still seasonal occurring mainly during the hotter times of the year. These villages all have community fisheries management programs Alofau, Amaua, and Auto participate in the American Samoa's Department of Marine and Wildlife Resources (DMWR) Community Fisheries Management Program (CFMP). While the DMWR provides support to the communities involved in its CFMP and is starting a community fish monitoring program it doesn't plan on doing any water quality work in the next 4 years. The American Samoa Environmental Protection Agency (ASEPA) is doing some water quality monitoring in several streams in American Samoa, but not within the villages in this study. ASEPA is not able to conduct the extensive testing needed to track down the problems at this time. The AS Land Grant program at the AS Community College (ASCC) has been studying one creek within the Alofau watershed but its goal is just to determine the amounts of nutrients and types of fresh water algae, it is not trying to track down any of the nutrient sources. The Land grant study at this time shows a high level of Phosphate in the one stream being studied but no correlation to any source. Both the ASEPA and Land Grant program welcome this project and support the activities planned. CORL has formed partnerships with ASCC, DMWR, ASRC&D, and ASEPA. While three of the communities involved in the study have management plans that were created with the help of the DMWR that state the reduction of land based pollution is important, not one village has the means to carryout this objective. The reduction of Land Based Pollution is also one of the Local Action Strategies (LAS) designated by The AS Governors Coral Reef Action Group (CRAG), which is the local Coral Reef Initiative group. While CORL doesn't have any formal partnership with the CRAG governing body (Non-governmental organizations are not allowed to actively participate in CRAG at this time.) it does work with all the members of the CRAG.

The current rate of habitat degradation occurring requires immediate attention to

determine and eliminate the source of nutrients. The Turtle grass beds being destroyed by the algal blooms are feeding areas for green sea turtles and the lagoon and reef flats are frequently visited by feeding Hawksbill turtles which are critically endangered, all four villages have all reported Sea turtle nesting sites in the past.

**Project's primary objectives:**

1.) Conduct water testing and set up monitoring sites in watershed and coastal areas of the 4 villages in the project.

2.) Conduct awareness workshops in each village

3.) Compile results from testing for Stressed Stream Analysis and create a watershed and pollutant GIS source map using GPS and water analysis data.

4.) Conduct a survey of each village to determine the number of households with inadequate sewage disposal facilities, and to identify other possible pollution sources.

5.) Conduct Community awareness workshops, Clean ups of the streams, beaches and coastal areas of solid waste.

6.) Data analysis and final results report to ASCC Marine Dept, NFWF, CRAG, ASEPA, DMWR. Create a web page on the project and results.

7.) Create 4-6 5minuite pollution awareness videos and 1 project video 30min to be shown on local TV and made into DVD format for distribution

## Methods:

Stressed Stream Analysis (SSA) has been used for community planning and watershed ecosystem management for several decades now. Because it's a simple and reliable method it and its results can be easily understood by the average community member. When SSA is combined with GIS (Google Earth included) an easy to understand map can be created that will provide much information for village planning and future development. This project will demonstrate to other communities facing similar problems how to investigate where the pollution originates and how to compile the scientific data, along with the Survey data into a result that is both informative for their planning and functional as a tool for pollution reduction. SSA can also be an important tool in Watershed planning and development in rural communities where the hiring of professionals is not feasible.

Water quality monitoring for Ammonia Nitrogen Fresh (F) and Salt water (S), (Both fresh and salt water noted as (FS)) Chemical Oxygen Demand (COD) (F), Nitrite (FS), Nitrate (FS), Phosphate (FS), was conducted using a HACH Colorimeter. Dissolved Oxygen, pH and Oxygen Reduction Potential was measured using YSI 85 and Pinpoint

monitors. Testing for waterborne pathogens was also conducted using HACH bacterial testing methods. Water testing was conducted on the streams, springs, and at points selected in the communities marine areas. Temperature loggers were placed at several sample sites and rain gauges were installed in each village to record rainfall events. GPS point location was used to pinpoint the location of test sights and any possible nutrient source within the study areas.

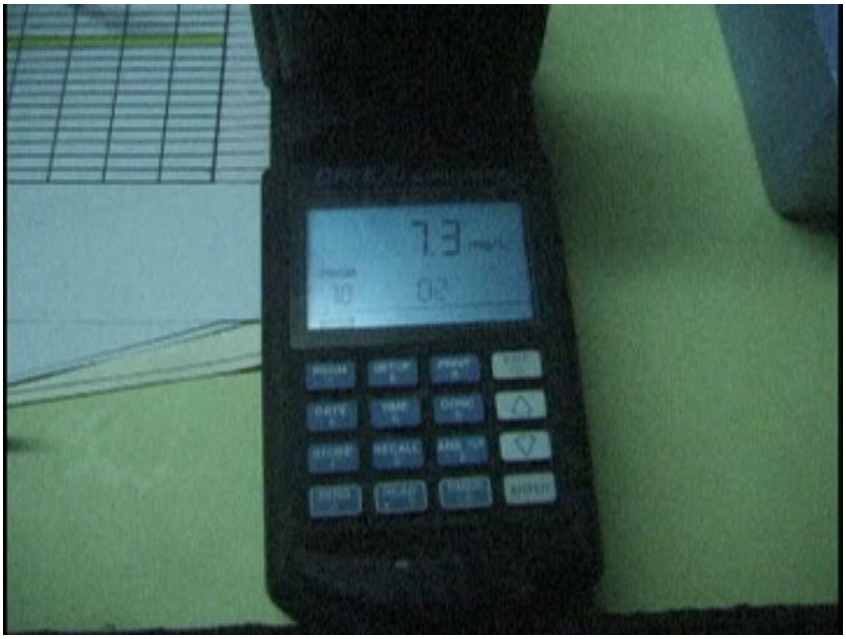



Photo: HACH Colorimeter

While the water testing and investigation of the watershed for nutrient sources was conducted to provide valuable information that would indicate the pollution sources, further investigation was needed to pinpoint the exact source when possible. To help with this investigation work Community water usage surveys were conducted to gather information regarding the household sewage and waste water disposal facilities. Because the village community structure in American Samoa is a semi-closed one when outsiders are involved, the survey was conducted by community members under the direct supervision of CORL Staff. It was also emphasized that the survey was to help the households correct any sewage disposal problems that may exist, and not to penalize them if their disposal system is inadequate. The results from the water testing, SSA, GIS mapping, and village surveys were analyzed and the problem areas identified were prioritized according to health and environmental impacts. The Village and CORL along with the US NCRS and American Samoa Resource Conservation and Development

council are now working with each other and the local government to address and correct the problems discovered.

The Awareness and Community involvement is the key to correcting the problems that exist and preventing them from reoccurring in the future. Visible involvement by the community leaders is very important. The community will react positively seeing Chiefs, Mayors, Titled men, youth group members, and CORL personnel working together to clean up and correct the problems that are destroying their coral reefs and near-shore areas. The video productions to be broadcast on TV will also help other villages to take similar action to clean up and correct their village's problems. After the clean ups the workers were invited to a Barbecue (food in American Samoa is a big crowd attracter) and the village leaders when possible gave a short talk. Each village completed 2-4 clean ups, workshops were sometimes added to the cleanups to tackle special problems within the communities such as Piggery waste and the occurrence of waterborne diseases.

The methodology used in this project will help others working with Polynesian communities to create a better working relationship with the community and therefore will increase their acceptance and chances of their projects success.

**Project Phases:**

The project was broken down into 3 phases; some objectives such as water quality monitoring were conducted during more than 1 phase. The projects objectives of Phase 1 included;

- **1.) Conduct a total of 9 workshops (2 per village) on Awareness, Action, and project results and village planning**
- **2.) Map streams, test water quality, and identify possible pollution sources in the four study villages**
- **3) Collect water samples from village streams and shoreline springs 1 to 2 times a week**.
- **4.) Conduct analysis of water samples using at least 8 parameters**.
- **5.) Carryout Data collection and input for stressed stream analysis of each stream.**
- **Set up water quality monitoring stations.**

**Phase 1 Accomplishments;**

**Workshops:** A total of 9 workshops were conducted and CORL arranged 3 introductory project meetings (project awareness) and attended 2 Village Council Meeting for Amaua / Auto and Afulei villages.

**Mapping of streams, test water quality, and identify possible pollution sources:** Alofau's two permanent streams "East" and "Mangrove" were mapped out to the upper most accessible points and all visible pollution sources identified. The Temporary stream

on the west side of the village only flows during heavy rain storms and is very limited in distance. There is one drainage ditch in the center of the village that also only flows during heavy rain storms. Both of these temporary waterways were investigated and findings mapped s best as possible

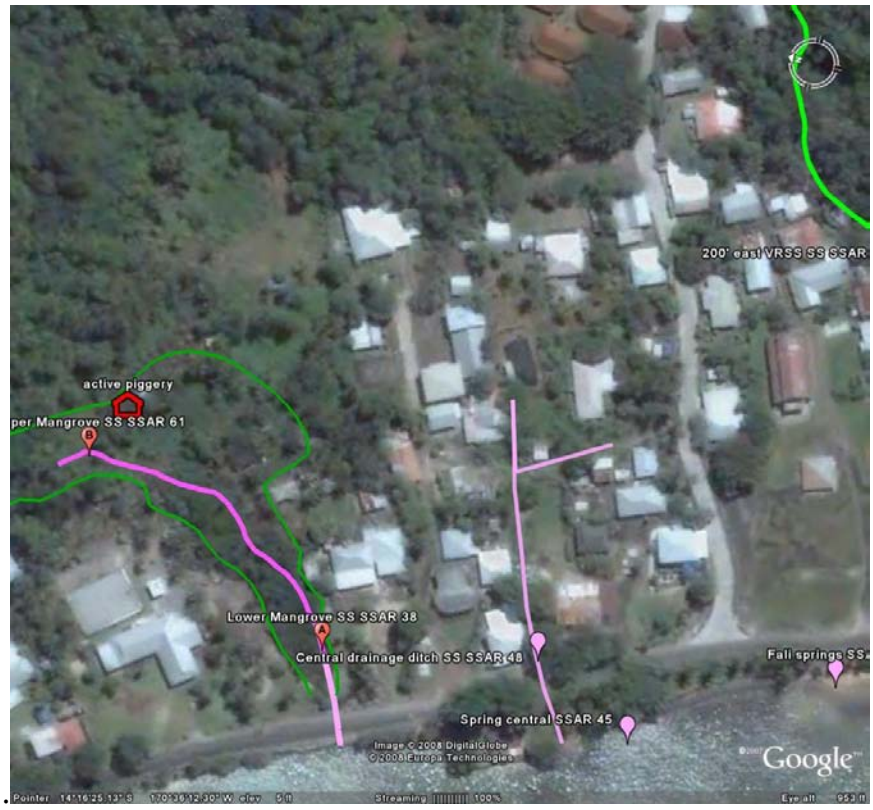



Photo of Alofau's Mangrove area and central drain.

Amaua's stream has been mapped from the ocean to an area above the houses at the base of the mountain. All known possible pollution sources have been identified and the village Mayor has been informed as to the findings. Afulei's Stream has been also mapped out from the ocean to the mountain and all possible pollution sources identified and brought to the attention of the village mayor and landowner. The majority of the nutrient pollution in this stream comes from washing clothes and cooking equipment in the stream or the banks where the water flows back into the stream. Auto's stream has been mapped out from the ocean to the old pump area for the village water supply all possible sources of pollution have been identified and brought to the attention of the village mayor. At the old pump area the stream emerges from a steep mountain gully where any further exploration would be both very difficult and dangerous. This stream has the best water quality of all, and most water samples taken have reviled low nutrient levels throughout the study. It was only after the village water was knocked out by a

flood that the phosphate levels increased due to villagers washing clothes and cooking utensils in the stream. Visa's stream flows directly off the mountain and its upper reaches are not accessible. Visa's stream has no man made pollution sources. Feral pigs and fruit bat roost and the high Phosphorus levels that are associated with tropical volcanic soils are its only natural sources of nutrient Phosphate pollution.

In the process of mapping out the streams it was discovered that a large amount of the houses in the Alofau area discharged their grey water (waste water from washing and bathing) directly into the stream or a drainage ditch that emptied into the stream. Two drains containing sewage from non-functioning septic systems were discovered, and two active piggeries were found to be in non-compliance with local laws regarding the drainage and disposal of piggery waste. The dumping of trash and debris into the stream was also an on-going problem. The heaviest Ammonia and Nitrate nutrient loads were determined by water testing to be from the piggeries but high amounts of phosphates and nitrites were detected coming from the grey water discharge pipes. The pollution sources in Amaua's stream were basically the same as Alofau's but the levels of nutrients were lower due to its lower population. The Stream in Afulei showed low amounts of Nitrates and Ammonias but the Phosphate levels varied greatly.

Photo: Afulei washing area in upper village.

It was reviled that the residents at the houses on the upper reaches of this stream were quite poor and routinely washed their clothes, cooking equipment and bathed in the stream or along it where a stream water discharge pipe (from a small dam placed above the village) emptied out, the water from this pipe would then flow back into the stream. Auto's Stream has no piggeries and maintained the best water quality of all those except Visa in the study area.

**Water sample collection:** Water samples were taken from near shore areas, shoreline springs, and streams from the ocean to above the last dwellings on the mountain sides Over 32 sample sets were collected, each set contained water samples from 8 to 32 sampling stations. Samples were collected 1 to 2 times a week and analyzed for over 8 water quality parameters. The set goal was to take a maximum of one full set and one partial set each week, heavy rains and threat of flash floods prevented the gathering of samples on a few occasions. The total number of samples collected was 582, 253 from Alofau's 15 monitoring stations, 84 from Amaua's 4 monitoring stations, 89 from Afulei's 6 monitoring stations, 120 from Auto's 7 monitoring stations and 36 from Visa's 1 monitoring station and other village water supplies used for a water quality baseline. The large number of samples per location was needed in order to get a good idea of the condition of the streams and the nutrient levels being added by the village residents.
Shoreline spring samples were only obtainable at very low tides during full and new moons. Lower mangrove stream samples were also dependent upon the tides.

Photo Francis Lieato takes a water sample.

**Conduct analysis of water samples using 8 parameters:** All water samples collected were analyzed for over 8 water quality parameters:

1.) Temperature

2.) Dissolved Oxygen

3.) pH

4.) Oxidation Reduction Potential

5.) Ammonia

6.) Nitrite

7.) Nitrate

8.) Reactive Phosphate

9.) Total Phosphate

10.) Pathogenic Bacteria

11.) Turbidity

Additional test conducted on some but not all water samples were:

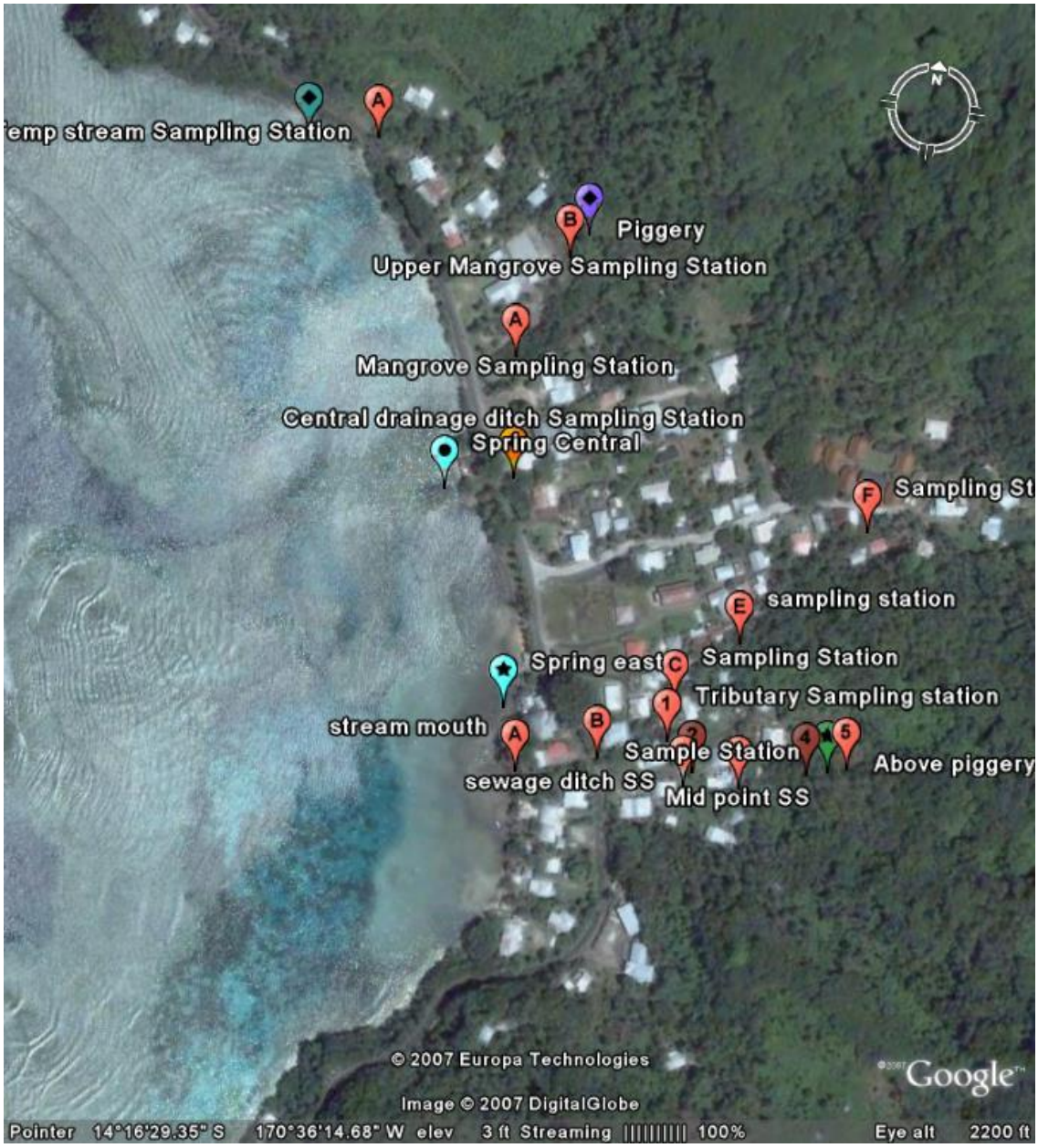
1.) Chemical Oxygen Demand

2.) Total Bacteria
3.) Coliform bacteria
4.) Active chlorine

1 additional test for surfactants should have been used in testing:
The testing of Surfactant (soaps and detergents) levels would provide information on the amounts of soap and detergent levels in the streams.

**Carry out data collection and input for stressed stream analysis:** (This objective was conducted throughout phase 1 and 2). The collection of water quality data was carried out throughout phase 1 and 2 and averages were calculated for each sampling station. The total number of samples collected from the water quality sampling stations was 582 each one of these was tested for those parameters listed in phase 1 objective 4 above. The results were entered after analysis of each sample set. (The village SSA map objective in phase 3 visually shows the results from the SSA and was distributed during the results and planning workshops along with the final reports and recommendations for village action on the problems discovered.)
The SSA results for each village were presented to the Villages, DMWR, NFWF, and Village Mayors. Links are provided to the final reports in Phase 3 Accomplishments.

**Set up Water quality monitoring stations:** The numbers of monitoring stations and villages where they are located are; Alofau 15, Amaua 4, Afulei 6, Auto 7, and Visa 1. Village water samples from Nu'uuli were also analyzed as the source is from the mountain far above any inhabitants or plantations and provided a good source for determining a baseline on water quality. Additional samples were taken at three additional sites to help get a better scope of baseline water quality data.




Picture: Alofau's Water Sampling Stations.

## Phase 2 and 3 Objectives and Accomplishments

**Phase 2 Objectives;**

- **Conduct at least two cleanups of streams, beaches, and coral reefs per village.**
- **Collect Data on amounts of trash and debris collected from each area and number of volunteer hours contributed; record data by village**
- **Create four five minute videos**

**Accomplishments:**

**Cleanups and data collection:**

A total of 11 shoreline and stream cleanups were completed, 4 in Auto, 3 in Alofau, 2 in Amaua and 2 in Afulei Village. The total number of trash bags collected were 327, total participants numbered 143 with volunteer hours totaling 784. Shoreline Marine Accumulation rates were recorded for three of the villages (Auto, Amaua, and Alofau) to determine how fast the debris is accumulating. Trash transect were conducted using a 25 meter run and a 1 meter square grid measurements of shoreline debris were taken at fixed points along the line (0-1m , 5-6m 10-11m, 15-16m, 20-21m), all debris within each grid was counted and recorded. The main goal of this study is to gain a better idea as to how often cleanup activities are needed so the Mayor's can plan events ahead of time in order to obtain more help from the community. The cleanup activities have been ongoing even though they were listed as Phase 2 activities, to date a total of 6 cleanups have been completed. In Phase 2 of the project there will be at least 3 to 4 cleanups conducted. During each cleanup activity the collected debris was identified, categorized, counted and recorded. This data will be analyzed to judge the effectiveness of the Trash transect method we have been using in the 3rd project phase.

The Marine Debris Shore line cleanup and monitoring results showed that pieces of glass, plastics and Styrofoam containers made up the largest percentage of shoreline marine debris followed by aluminum beverage cans. Because glass pieces were; persistent, seldom removed during cleanups and small they were removed from the tally counts and the totals were adjusted.

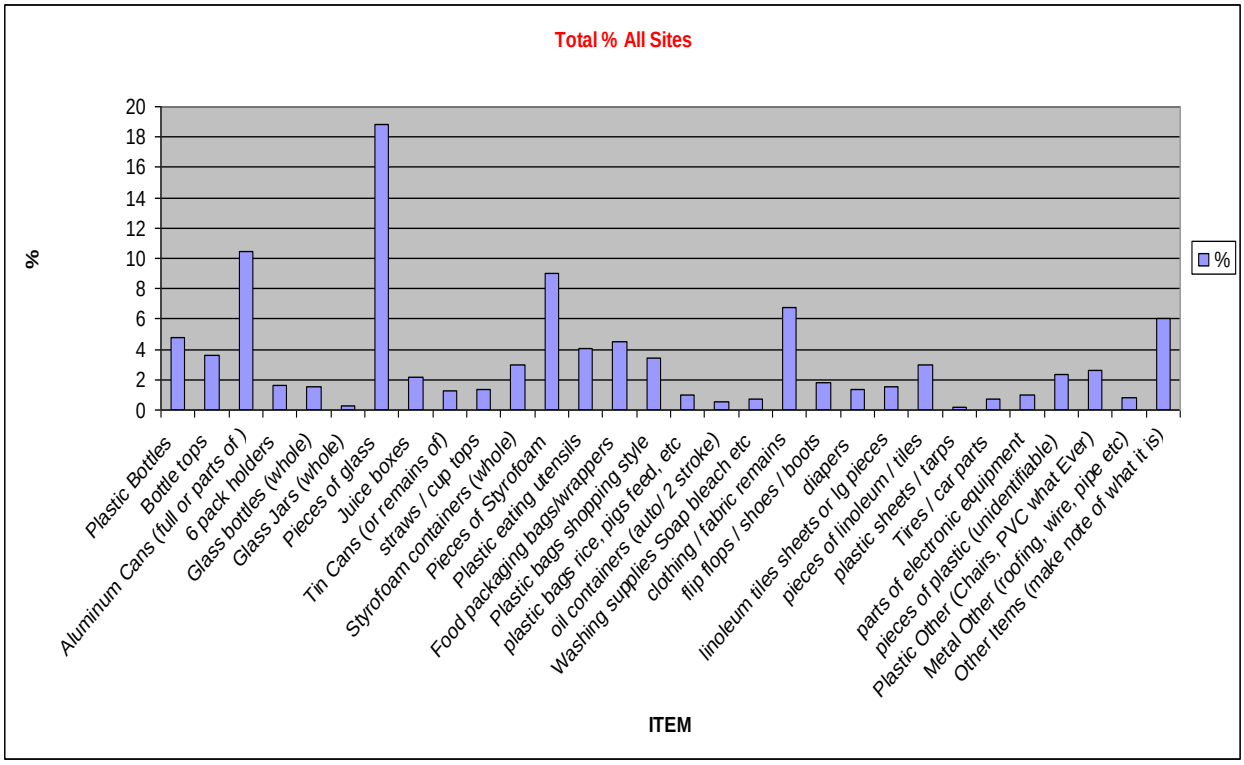



Table A: Marine Debris Composition from Cleanup data total.

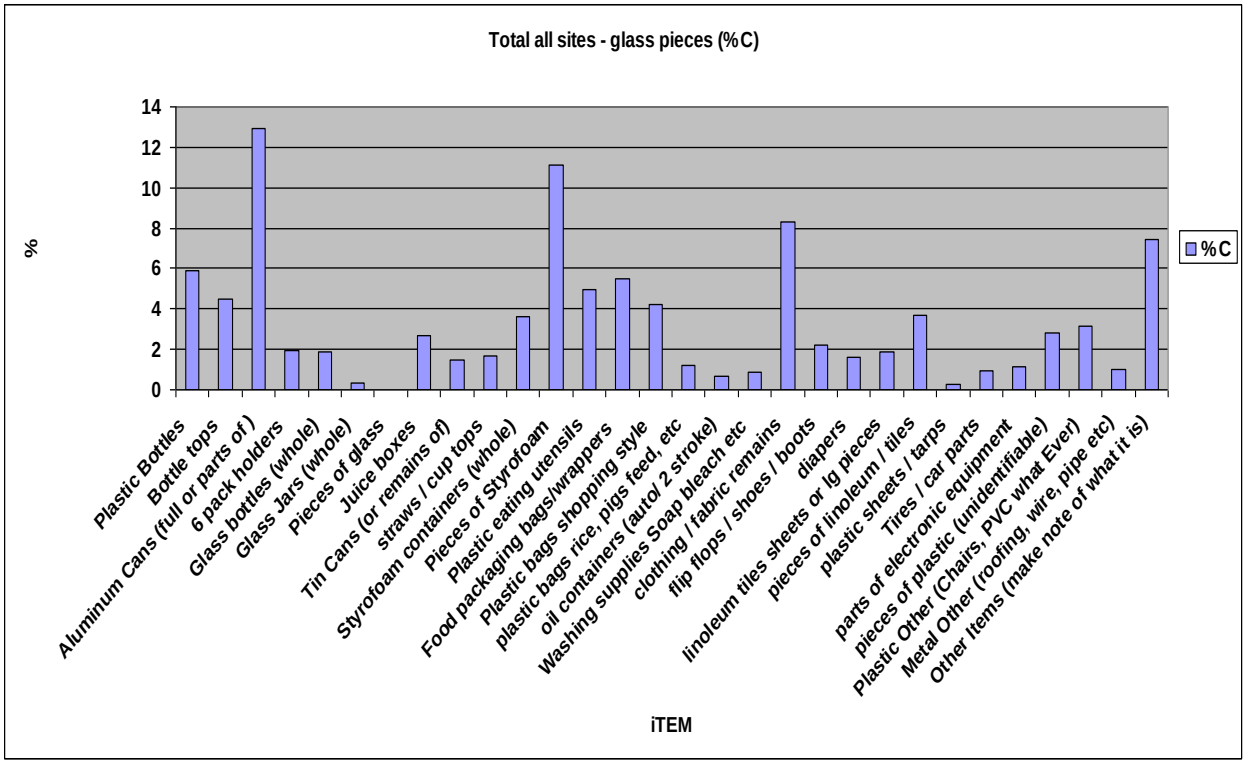



Table B: Adjusted Marine Debris Composition from cleanup data (Glass pieces excluded).

Photo: Nico and Ritchie run a high tide debris Transect.

**Awareness Videos:**

Five Coral Reef Awareness videos were created and distributed to local TV stations. These videos were; American Samoa's Coral reefs 10 minutes, Nutrient Pollution 5 minutes, Destructive fishing 5 minutes, Marine Debris 5 minutes, and a Under water cleanup video 5 minutes.

These and other Coral Reef Awareness videos will be made available at www.corl.org in the future.

**Phase 3 Objectives;**

- **1) Conduct Results workshops to provide study results to Village Council, Mayors, and community members.**
- **2) Compile a project report and create a paper for peer review**
- **3) Create one 30 minute video on project and results**
- **4) Submit final report to NFWF**

**Phase 3 Accomplishments:**

**Workshops local Results dissemination**: The final village results workshops were conducted on November 17th and 18th of 2007.

Five final reports were completed one on each village and one that combined Auto, Amaua and Afulei villages because their Village Council is composed of Chiefs from all three villages with many related agia (families). [Links to reports: AAA results, Auto, Amaua, Afulei, and Alofau.

**Project videos:** One 30 minute project video has been completed and is available through CORL's website. An additional 1.5 hour video will be produced in the near future that will provide a detailed project design description along with a very complete materials and methods section. This future project DVD video will provide valuable information to anyone desiring to undertake a similar project in the future.

**Reports:** The final project report was sent to the NFWF in March of 2008 [link to final NFWF reports]. A paper for peer review will be completed after CORL completes SSA work on at least three more villages in 2009.

## Discussion:

The results of the testing show that the major source of Ammonias, Nitrites, and Nitrates comes from piggeries and inadequate septic systems along the streams and shorelines. The testing for Phosphate showed a wide concentration range from one day to the next. The base line level being between .51ppm (parts per million which is equal to mg/l) and .95ppm in water samples before the stream entered inhabited areas of the villages to an average of 2-4ppm before they emptied into the ocean. The stream mapping and pollution source investigation show that many houses discharge their waste water from sinks and washers (This water is called grey water as it does not contain fecal waste material) directly into the streams or drainage ditches that empty into the streams. When we looked at them as a possible source of phosphates, we were at first not sure, as Phosphates were eliminated from most soaps and detergents made and sold in the USA back in the late 1970's.

Photo: Soap Suds in Alofau's Eastern Stream from Grey water discharges.

After investigating it was concluded that the source was indeed the grey water pipes along with washing and bathing directly in the streams. Further investigating reviled that the local stores were replacing the soaps and detergents made in the USA with cheaper foreign soaps which contained up to 80% Phosphates. One water sample taken in Auto (after their village water line was broken) showed a reactive phosphate level of 318mg/l, that's about 623 times the normal amount found in their stream. Where did it come from? The answer was 100' upstream from where the sample was taken; a family was doing their washing in the stream using a foreign bar soap.

Photo: Afulei Stream

The level of phosphates in a stream that empties into a coastal coral reef habitat is very important as Phosphate is the main nutrient that causes algae growth. Excessive nutrient levels in the nutrient poor habitats like coral reefs increases the growth of algae so much it can choke out other plants and overgrow coral colonies killing them. The rate of algal growth is proportional to the supply or input of phosphorus (Phosphates). Since one pound of phosphorus (Phosphate is a chemical form of the element Phosphorus) can grow 700 pounds of algae the amount of damage caused by excessive phosphorus inputs from the foreign soaps and detergents can be very large. Many Samoans have noticed an increase in the non-edible green hair like algae and asked what could be causing it. It was their questions and what CORL members were seeing happing to Alofau's lagoon that led to the undertaking of this study.

Photo: Filamentous Algae growth in a fresh water stream.

CORL has been working in Alofau for several years doing cleanups and restoring their coral reef area. During our work we noticed a change in the quality of water in the near shore area, and the growth of a thick algae bed spreading across the bottom overgrowing a turtle grass bed where the green sea turtles usually feed. This overgrowth can be seen in the photos provided. Photo 1 shows the area in 2003, photo 2 in 2005 and photo 3 in early 2007. These photos show the turtle grass bed (photo1) and its overgrowth (photo 2) by cyanobacter (an algae like bacteria), and then further overgrowth by turf alga in photo 3. None of the original turtle grass bed survives today and the Green Sea turtles don't seem to like eating the turf alga that replaced it. The unwanted turf alga growth has also been spreading toward the corals in the lagoon and has smothered some coral colonies resulting in their death (photo 4). The turf alga also acts as a fine sediment trap creating a very soft sediment bottom under the algae where a hard sand bottom once was, this also destroys the areas shell fishery.

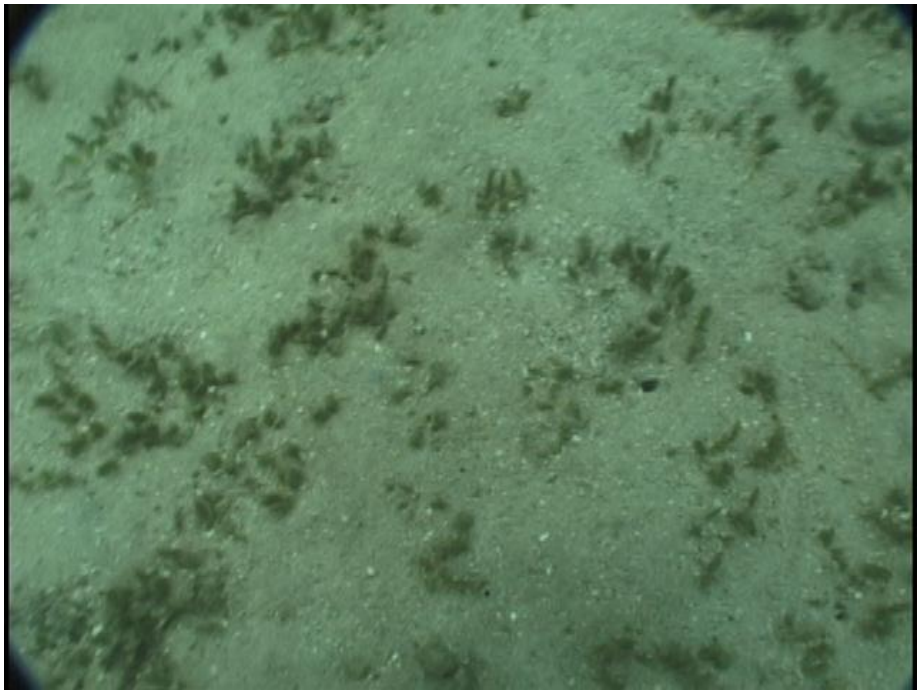


Photo: 2003 turtle grass bed Alofau lagoon

Photo: 2005 former turtle grass area Alofau lagoon

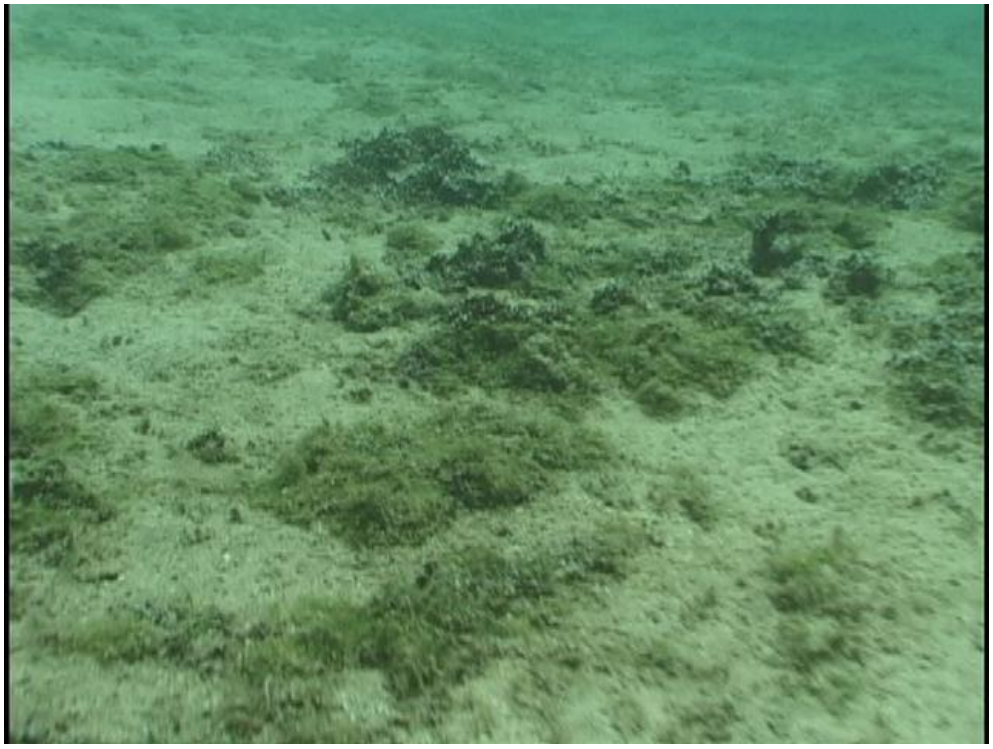


Photo: 2007 Turf algae covering former Turtle grass area Alofau Lagoon

Photo: 2007 Algae encroaching on living corals

What needs to be done? The reduction of waste water entering our waterways from Grey Water sources (sinks, showers, and washers) will take time and money as will the

redesigning and relocation of the piggeries so they create less pollution. The quickest action and least expensive to undertake that will decrease American Samoa's nutrient pollution problem is the immediate banning of all high phosphate soaps and detergents from importation into the Territory.

The Governor of American Samoa Togiola T.A. Tulafono on the 21st of August 2007 added a clause to the Executive Order NO. 010-2007. [Link to Executive Order NO. 010-2007. (http://www.coralreef.gov/meeting18/climateeo_samoa_2007.pdf.)] that stated "in order to combat the destruction of coral reefs by increased algae blooms, the importation of all high phosphorous (greater than 11%) detergents will be banned beginning October 1, 2007.

This measure alone when enforced will greatly reduce the phosphate nutrient pollution problem and reduce the damage being done to streams and coastal areas including the coral reef areas of American Samoa.

## Conclusion:

This project and its outputs helped to inform the village communities and Territory of American Samoa about the nutrient pollution problem and resulted in a Territory action to reduce the amount of phosphorus entering the watersheds from detergents and soaps. Additional projects to correct other nutrient sources in the village of Alofau are being undertaken by the NRCS, ASRC&D, at this time and CORL will continue to assist with the abatement projects as they develop.

The use of Stressed Stream Analysis proved to be a very effective method to show the community where the problem areas within the villages are. The mapping of the streams and investigation work can be duplicated by the villagers without much capital investment. The cost of the water testing equipment along with access to laboratory use and supplies may be beyond the financial abilities of many smaller rural communities. Adequate lab skills to perform the water testing required can be easily transferred using hands on education. Seeing that the laboratory and testing equipment are the major cost of conducting SSA and will pose an obstacle to many rural communities further investigation is needed to find less costly alternatives. The use of aquarium water quality testing kits (both fresh and Salt water) may provide a workable alternative and will be investigated in the future.

The Marine debris cleanup and accumulation results showed that much of the marine debris along the shore was being transported there by the nearby streams. Plastics made up a large percentage of the shoreline debris found in the study area.

## Acknowledgements:

The CORL Board of Directors and I would like to thank all the volunteers who have offered their time in researching SSA, collecting samples, mapping streams, doing cleanups and helping with the surveys. We would also like to give a very big Thank You to the Mayors of the villages for all they have done, The USDA NRCS, Sea Grant, American Samoa Community College Marine biology department, and the American Samoan governmental departments and divisions (DMWR, ASEPA, ASPA's solid waste), along with the Governors Coral Reef Advisory Group. We would also like to thank the following Companies for their support; Industrial Gasses, Sepp's Paints, Tool Shop, Jamil's Auto Service and Towing, Blue Sky communications, Mr. Lava Lava, Tradewinds Hotel, Ace Hardware, and Scanlan services.

Also, this project would not have been possible without the funding from The National Fish and Wildlife Foundation and the support from The National Resources Conservation Service, we all owe them our thanks for the help they provided.