Final Restoration Plan for Rose Atoll National Wildlife Refuge

(Including Environmental Assessment)

Prepared by:

U.S. Fish and Wildlife Service
Divisions of Environmental Contaminants,
Refuges, and Ecological Services

and

The Department of Marine and Wildlife Resources,
The Government of American Samoa

May 2001

TABLE OF CONTENTS

Page

Page

Executive Summary

In October 1993 the *Jin Shiang Fa*, a Taiwanese fishing vessel, ran hard aground on the western reef of Rose Atoll National Wildlife Refuge (NWR). The vessel broke up before a salvage tug could reach the atoll, resulting in the release of over 100,000 gallons of diesel and lube oil across the reef. The spill killed a large area of the primary reef building organisms, crustose coralline algae, near the wreck site. Invasive species of cyanobacteria and articulated coralline algae immediately began colonizing those areas of the reef injured by the spill. Data collected in the years following the spill indicates that iron released into the water from corroding metal wreckage is stimulating the growth of the invasive 'weedy' species, thereby preventing resources injured by oil from returning to baseline conditions. These 'weedy' species have spread to areas of the atoll that initially were unaffected by the incident, overgrowing and killing the crustose coralline algae below. Other documented spill-related injuries included the death of numerous giant clams, sea cucumbers and sea urchins. Studies also showed that the composition of the local fish community was altered by the incident.

Since the oil spill, conditions on the reef have continued to deteriorate and there is an increasing likelihood that the very structure of the atoll will become seriously weakened in those areas where the invasive species have replaced the reef building crustose coralline algae. The Natural Resource Trustees (Department of the Interior represented by the U.S. Fish and Wildlife Service and the Government of American Samoa) have serious concerns that if the reef is weakened further by the lack of a healthy reef building community, it may be breached, resulting in a significant change in water circulation patterns across the atoll, and the eventual destruction of Rose and Sand Islands. If these islands are destroyed, it would mean the loss of the most important resting and nesting habitat for federally protected seabirds and the federally listed green sea turtle in the American Samoa archipelago.

The goal of the Natural Resource Trustees' (Trustees) Restoration Plan is to stop the ongoing, spill-related injuries to the atoll, thereby permitting the natural resources of the atoll to return to their baseline conditions. The large area of crustose coralline algae initially killed by the oil spill has failed to return to baseline levels due to the spread of invasive 'weedy' species. Various marine invertebrates injured by the oil also have failed to return to baseline levels following the spill. Furthermore, the area of crustose coralline algae injured has expanded due the spread of the invasive species. Emergency restoration actions taken in July-August 1999 and April 2000 indicate that removal of metal debris will arrest the spread and dominance of the invasive 'weedy' species. The Trustees have concluded that the only way to halt the ongoing injury, caused by the *Jin Shiang Fa* oil spill, is to remove the remaining metal debris. The removal of metal debris also is considered a prerequisite to implementing any other restoration alternative.

The Restoration Plan for Rose Atoll NWR consists of removing the remaining metal debris and monitoring the recovery of the injured reef community. Because of differences in metal debris removal techniques, the restoration activities will be divided into three separate operations. The vast majority of the metal debris on the reef flat has recently been removed by hand and the remaining removal will not require the use of underwater equipment. Larger debris on the reef slope must be cut into smaller pieces by divers and transported to the surface before being loaded onto a vessel for transport to an approved offshore dumpsite. The removal of the remaining lagoon debris also will require divers, who will transport the debris to a smaller work vessel stationed within the lagoon and then to the offshore dumpsite. Monitoring will begin after restoration activities are complete, and will be conducted biennially for the following ten years. The Natural Resource Trustees have estimated the total cost of this restoration to be $1,277,400.

Public comments were sought on the Draft Restoration Plan for Rose Atoll NWR. No public comments were received by the Trustees. By approving this Final Restoration Plan (including Environmental Assessment), Trustees select the proposed restoration project described as the preferred alternative and make a Finding of No Significant Impact.

NEPA Compliance

The restoration of natural resources under OPA must comply with National Environmental Policy Act (NEPA) regulations (40 CFR 1500 et seq.). The Trustees used information gathered during several years of assessing injury at Rose Atoll to determine whether an Environmental Impact Statement (EIS) would be required prior to the selection of the final restoration alternative. The Draft Restoration Plan served as an Environmental Assessment by describing: 1) the need for the proposed restoration action, 2) the environmental setting, and 3) the restoration alternatives along with their potential environmental consequences. The Trustees have received no new information from the public or otherwise, do not believe that the proposed restoration alternative will significantly adversely affect the quality of the environment and, therefore, have determined that preparation of an Environmental Impact Statement is not required.

The Need for Restoration Actions

Data collected at Rose Atoll NWR in the years following the 1993 *Jin Shiang Fa* oil spill indicate that conditions on the reef are deteriorating. The oil spill killed a large area of crustose coralline algae, which was quickly colonized by invasive opportunistic species (U.S. Fish and Wildlife Service [USFWS] 1997). These invasive species continue to dominate in the spill zone and have spread to other areas of the atoll, overgrowing and killing otherwise healthy portions of the reef. The Trustee's preliminary field data indicate that the bloom of these invasive species is being artificially maintained by elevated iron levels in the water coming from the corroding vessel debris (Maragos 1999). These data also suggest that the reef area injured by the oil spill will not return to baseline conditions until these invasive species are brought back to baseline levels.

There is an increasing likelihood that the structure of the atoll may become seriously weakened in those areas where invasive species have replaced the reef building crustose coralline algae for several years. If an area becomes so weak it is breached, a significant change in water circulation patterns across the atoll likely would occur leading to the eventual destruction of Rose and Sand Islands. If these islands are destroyed, it would mean the loss of the most important nesting and roosting habitat for federally protected seabirds and the federally listed green sea turtle in the American Samoa archipelago. The preferred restoration alternative proposed in this plan will prevent additional injury to the reef community by returning the invasive species to baseline levels and allowing reef organisms to return to baseline conditions.

Public Participation

The Trustees considered public review of the Draft Restoration Plan for Rose Atoll NWR to be an integral part of the restoration planning process. Current and complete information was made available about the nature and extent of the natural resource injuries identified and the restoration alternatives evaluated. Public comment was sought on the assessment of natural resource injuries and the restoration project being proposed to restore injured natural resources or replace lost resource services.

A Notice of Intent to Conduct Restoration Planning was published in the Samoa Post on February 24, 2000. A public notice regarding the opportunity to comment on the draft plan was placed in the Samoa Post on April 16, 2000. Public comments were accepted over a period of 30 days until May 15, 2000. The draft plan was made available to the public as part of the publicly-available Administrative Record or by delivery in hardcopy form by request. Public review of the Draft Restoration Plan for Rose Atoll NWR was consistent with all federal and state laws and regulations that apply to the Natural Resource Damage Assessment Process, including Section 1006 of the Oil Pollution Act (OPA), the OPA regulations, the National Environmental Policy Act, as amended (42 USC 4371 *et seq.*) and its implementing regulations (40 CFR Parts 1500-1508).

The Trustees received no written comments on the draft plan. Additional information on the status of emergency restoration actions and resulting impacts on the reef community was provided by Dr. James Maragos, USFWS (2000) and incorporated into this document. The Trustees, therefore, determined that the Draft Restoration Plan for Rose Atoll NWR could be adopted as a final plan without modifications to the proposed project. The Trustee resolution to adopt the proposed restoration project is provided in Appendix C. A Finding of No Significant Impact determination was made by each of the Trustee agencies. Copies of this determination are provided in Appendix D.

Rose Atoll is located on the far eastern edge of the Samoan Archipelago (Figure 1). The shape of the atoll is square, with the four "corners" facing roughly north, south, east, and west. The lagoon is almost entirely enclosed by the reef, except for a narrow opening on the northwest side (Figure 2). Prior to the *Jin Shiang Fa* oil spill, the atoll was considered to be one of the least disturbed coral atolls in the world (UNEP/IUCN 1988). The unique coral reef ecosystem at Rose Atoll is dominated by crustose coralline algae rather than hermatypic corals more commonly found in the Samoan Archipelago (Mayor 1921, Green 1996). Dominant coral genera at Rose Atoll include *Favia, Acropora, Porites, Montipora, Astreopora, Montastrea* and *Pocillopora*. Two species, *Favia speciosa* and *Astreopora myriopththalma*, are much more abundant at Rose Atoll than elsewhere in Samoa (Maragos 1994). In contrast, four genera (*Pavona, Galaxea, Leptastrea*, and *Platygyra*) are less abundant at Rose Atoll than they are on the other islands in the archipelago (Maragos 1994).

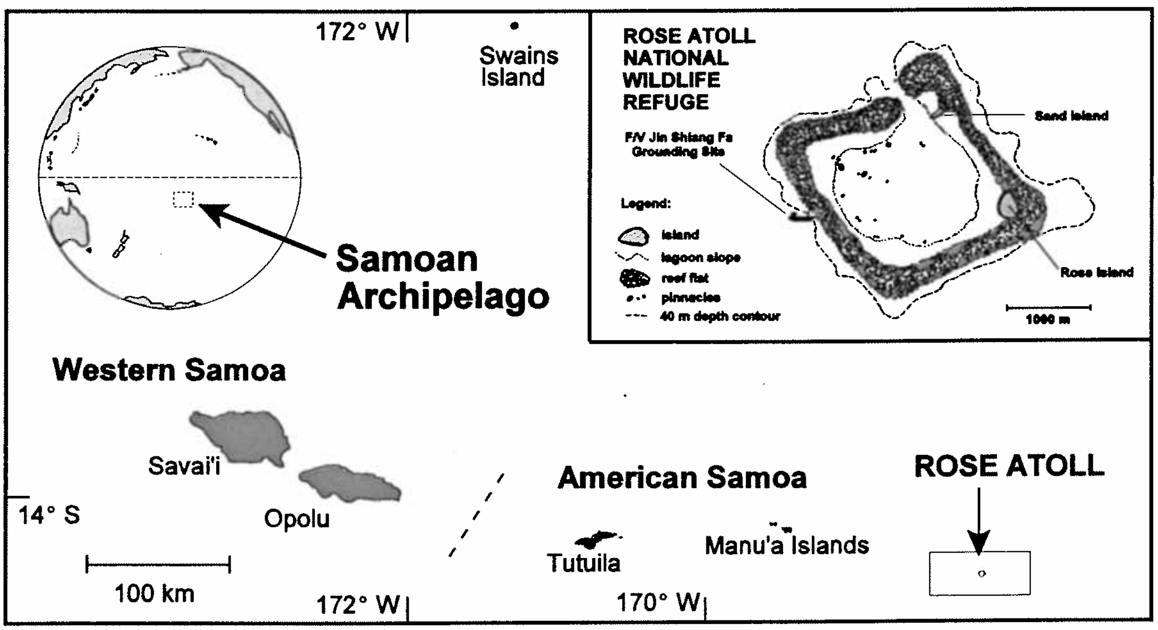

Figure 1. Map of Samoan Archipelago showing the location of Rose Atoll National Wildlife Refuge (modified from USFWS 1997).

Although a "coral" atoll dominated by crustose coralline algae is not unique in the central Pacific Ocean, Rose Atoll is an excellent example of this type of reef. Rose Atoll was designated as a National Wildlife Refuge in 1974 "for the conservation, management, and protection of its unique and valuable fish and wildlife resources" (Greenwalt 1974). Soon after, a Presidential Proclamation recognized that "the submerged lands surrounding Rose Atoll are necessary for the protection of the atoll's marine life, including the green sea and hawksbill turtles" (Ford 1975). This remote refuge is jointly administered by the U.S. Fish and Wildlife Service (USFWS) and the Department of Marine and Wildlife Resources (DMWR) of the American Samoa Government.

The fish community at Rose Atoll also is distinctly different from those that occur elsewhere in the Samoan Archipelago (Green 1996). Fish density is very high and species richness is moderately high at Rose Atoll, although fish biomass is low because of the dominance of small, planktivorous species (Green 1996). The fish assemblages at Rose Atoll also differ from the rest of the archipelago by having a much lower diversity of herbivorous species (especially parrotfishes and damselfishes), and a high density of planktivorous and carnivorous species (primarily damselfishes, unicornfishes, and snappers) (Wass 1981a, Green 1996, unpubl. data). Giant clam (*Tridacna maxima*) densities at Rose Atoll are much higher than elsewhere in the Samoan Archipelago, where populations have been severely reduced by over-harvesting (Green and Craig 1996). Clam density is highest on the atoll at the base of the lagoon pinnacles (Wass 1981b, Radtke 1985, Green and Craig 1996).

Rose Atoll supports two emergent islets, the largest of which (Rose Island, 5.2 ha [12.8 acres]) is heavily vegetated with *Pisonia* trees and beach heliotrope shrubs (*Tournefortia argentea*) (USFWS 1996a,b). Rose Island is an important nesting site for 12 species of federally protected seabirds. Approximately 97% of the total seabird population of American Samoa resides on the atoll (Amerson *et al.* 1982, Rodgers *et al.* 1993, USFWS 1996a,b). Five species of federally protected migratory shorebirds and one species of forest bird use the terrestrial habitat, shoreline, and exposed reef for feeding, resting, and roosting (USFWS 1996a,b). The second island (Sand Island) is smaller (2.6 ha) and unvegetated. Both islands are uninhabited and are important nesting sites for the threatened green sea turtle (*Chelonia mydas*) (Rodgers *et al.* 1993). Satellite tags attached to nesting green turtles at Rose Atoll have shown that these turtles migrate between American Samoa and other Pacific island nations including Fiji and French Polynesia (Balazs *et al.* 1994). In addition to the migratory breeding population of turtles that use the atoll during the nesting season (from August to February), there also appears to be a small, resident population of juveniles living on the atoll (G. Balazs, pers. comm.). Endangered hawksbill turtles (*Eretmochelys imbricata*) also have been seen in the lagoon (USFWS 1996a). It is not known if they nest on the islands.

The coral reefs at Rose Atoll can be divided into seven habitat zones, which vary in terms of their physical and biological characteristics (Figure 2). The **outer reef slope** is located on the seaward side of the atoll, and consists of an irregular and often steep slope down to a depth of approximately 50 meters (m). In some locations, a shallow reef terrace (< 10 m deep) is located on the upper slope, before the reef plunges down almost vertically into very deep water. Spur and groove formations occur on the shallow reef terrace in some locations. The **reef flat** is a hard, consolidated substratum that is exposed during spring tides. The seaward edge of the reef flat, just before the reef starts to slope down into deeper water, is called the **reef margin**. The lagoon is almost entirely enclosed by the reef flat, except for a narrow channel on the northwest side. The inner edge of the reef flat slopes down to a shallow shelf (1-3 m deep) that surrounds the lagoon called the **lagoon terrace**. Most of this shelf (50-75%) is covered with coral rubble and a few scattered colonies of *Acropora*; the rest is dotted with small patch reefs whose tops are uncovered at low tide. The inner edge of the lagoon terrace slopes steeply down the **lagoon**

slope to the **lagoon floor** (> 15 m deep). The lagoon has an undulating sandy floor with a few isolated *Acropora* patches around its perimeter and numerous flat-topped, vertical **patch reefs** that extend up to the surface and pinnacles submerged below the surface. Wave exposure is low in the lagoon and high on the outer reef slope and reef flat.

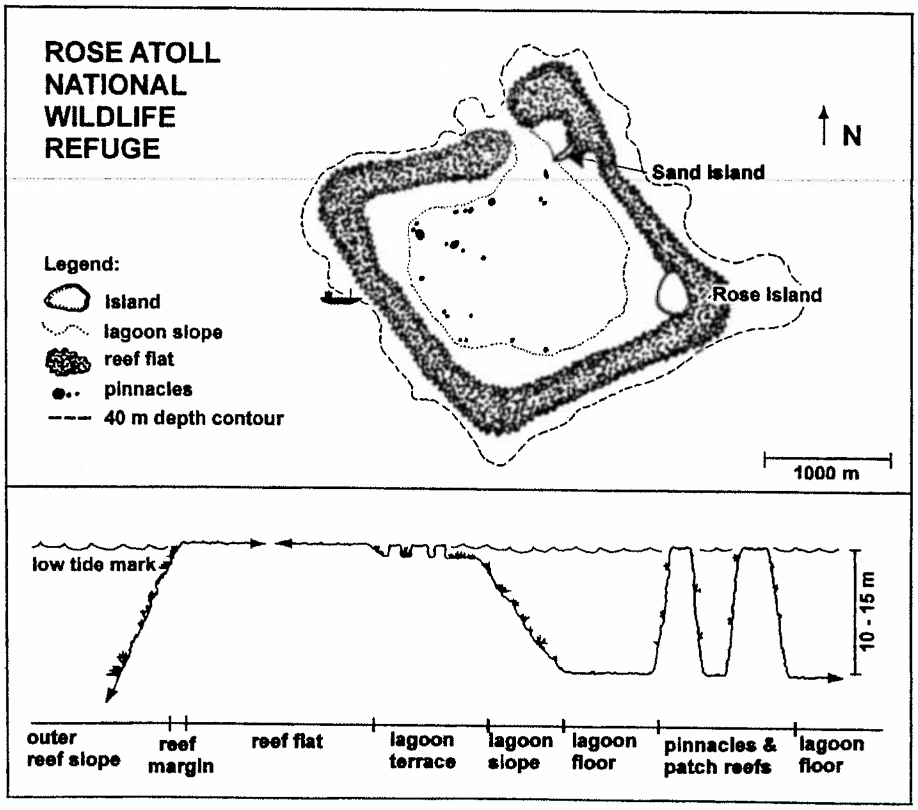

Figure 2. Map of Rose Atoll National Wildlife Refuge (modified from Green and Craig 1996) showing the location of the grounded vessel. A profile of the reef appears below the map and shows the seven habitat zones found on the atoll.

2.1 Oil Release

At approximately 4:00 am on October 14, 1993, the Taiwanese longline fishing vessel *Jin Shiang Fa* ran hard aground on the seaward edge of the southwest arm of Rose Atoll NWR. The ship had just refueled in Pago Pago Harbor on Tutuila Island less than 24 hrs earlier and was in transit to an unspecified fishing area in the Pacific (USFWS 1996a). Initial observations of the wreckage suggest that the vessel was traveling parallel to the southwest arm when it struck the reef. The vessel collided with the upper portion of the outer reef slope and skipped across the tops of two large spurs (depth 3-4 m) before coming to rest on the tops of two others. The orientation of the grounded vessel was nearly parallel to the reef margin, with the ship's hull keeled over toward its port side and its bow pointed in a north-northwesterly direction (Molina 1994).

At the time of the grounding, the 37 m vessel was carrying approximately 100,000 gallons of diesel fuel and 500 gallons of lube oil. All of these contaminants were discharged into the marine environment at the wreck site where prevailing currents carried the bulk of the material across the reef flat and into the lagoon. The rate at which the contaminants were released into the marine environment could not be accurately determined, although the discharge appeared to be continuous for approximately six weeks after the initial grounding. Based on observations during over-flights and site visits, the majority of the oil likely was discharged within the first few days after the grounding, with lesser amounts discharged up until the time of salvage operation six weeks later (Barclay 1993, Molina 1994, USFWS 1996b).

Due to the heavy wave action at the atoll, it is likely that a significant portion of the fuel oil moving over the surf zone was forced downward into the water column and trapped in the reef structure. Entrapped oil was documented extending at least 190 m southeast and 440 m northwest of the spill site. Molina (1994) observed that oil remained on the reef flat for at least three weeks after the spill in the form of sunken oily debris and oil entrapped in the reef matrix, coral rubble, and associated sediments. Oil persisted in the sediment at the grounding site for at least 22 months after the spill (D. Palawski, USFWS, unpubl. data). Diesel fuel also was detected in sediment samples taken from the lagoon terrace and lagoon slope, indicating that reef organisms were exposed to petroleum hydrocarbons for an extended period of time.

2.2 Response Actions

Initial response actions included: 1) estimating the amount of fuel discharged; 2) limited documentation of marine life mortalities; and 3) an initial attempt at salvaging the vessel. No fuel or lube oil was removed or recovered from either the vessel or the reef. The vessel grounded in an area of high wave energy and broke up before a salvage tug could reach the atoll (Barclay 1993). When salvage operations began on November 27, 1993, the stern of the vessel (approximately 250 tons) was nearly submerged on the shallow reef slope with only a small amount of rigging above water. The bow section (76 tons), wheelhouse (5 tons), shelter deck (2 tons) and miscellaneous pieces of the ship (38 tons) were scattered over the reef flat, covering an area of approximately 9,000 m^2. Ship debris was also spread over an estimated 175,000 m^2 of reef flat and lagoon terrace, although the majority was concentrated in a 100-m wide band adjacent to the wreck (Barclay 1993).

Salvage operations removed most of the larger pieces of wreckage and debris from the reef flat. These operations included pulling the bow, wheelhouse, shelter deck, and miscellaneous pieces of ship wreckage off the reef flat into deeper water (600 to1,000 m). The mass of the stern (approximately 160 tons) prevented its removal from the shallow reef slope (Barclay 1993). In the months following the salvage operation, high wave energy broke the stern into smaller pieces. Recent surveys revealed that much of the wreckage is still present on the reef flat and reef slope (J. Maragos 2000).

2.3 Emergency Restoration

Funding for emergency restoration actions was provided by the USFWS, Pacific Islands Ecoregion, Refuges Division. Emergency restoration actions in July and August 1999 succeeded in the removal of 75 tons (about 99%) of the metallic debris from the reef flats, as well as approximately 2 tons of debris from the lagoon. Additional emergency restoration actions in April 2000 resulted in the removal of 30 tons of metallic debris and several tons of line and nets from the reef slope (Maragos 2000). The debris was transported to a U.S. Environmental Protection Agency-designated ocean disposal site located approximately 6 km north of the atoll. Approximately 40 tons of large metallic debris remain on the reef slope and 10 tons of non-metallic debris remain in the lagoon. Another 2 tons of metallic debris have washed up on the reef flat from the reef slope between August 1999 and April 2000. Removal of the remaining debris is expected to allow complete recovery of the atoll reef ecosystem.

2.4 Involvement of the Responsible Party

The owner of the F/V *Jin Shiang Fa* is Jin Ho Ocean Enterprise Co., Ltd., a Taiwanese business incorporated in 1985. Under the U.S. Oil Pollution Act and associated Natural Resource Damage Assessment regulations, this company was designated as the responsible party for the spill that injured the natural resources at Rose Atoll NWR. According to the law offices of LeGros, Buchanan and Paul, which represented the insurance interests of the responsible party, the company's sole source of income was the sale of fish from the vessel, and the vessel was the company's only asset. The company and the vessel had Protection and Indemnity insurance coverage through Shipowners' Mutual Protection and Indemnity Association (Luxembourg). Under the policy, the insurance company was only obligated to reimburse costs paid by the insured. The insurance company claims to have paid in excess of 1.1 million dollars for the salvage operation. The insurance company has also asserted that it has exceeded the vessel's limitation of liability, and has refused to pay for any further expenses. The United States determined not to file an action to recover its response costs. Given these circumstances, there has been no participation by the responsible party in the assessment process.

Injury Determination — Chapter 3

3.1 Pre-Assessment Screen

Data was collected for a pre-assessment screen (PAS) in the weeks following the ship grounding. That data showed that oil sheens and oily debris were spread across the reef and lagoon and oil was entrapped within coral rubble and sediments. Additionally, biologists documented an extensive area where oil killed the reef-building pink crustose coralline algae (*Hydrolithon* or *Porolithon* spp.) as well as hundreds of marine snails, boring sea urchins (*Echinometra* spp.) and giant clams (*Tridacna maxima*). Opportunistic blue-green algae (the cyanobacteria *Lyngbya* and *Oscillatoria* spp.), which often invade a tropical reef after an oil spill, were also first noted at this time (USFWS 1996a).

A review of the evidence gathered during the PAS process allowed the Trustees to determine that:

- The Oil Pollution Act applies to the spill;
- Natural resources under the jurisdiction of the Trustees were injured by the spill;
- Response actions did not adequately address injuries to trust natural resources; and
- Feasible restoration actions exist to address injuries to trust natural resources.

On the basis of the above determinations, the Trustees began planning for restoration with the initiation of a natural resource damage assessment.

3.2 Natural Resource Damage Assessment

An ongoing natural resource damage assessment has confirmed that the reef ecosystem suffered substantial and extensive oil-related injuries (USFWS 1997). These injuries are summarized below.

3.2.1 Reef-building Corals

Prior to the spill, the living matrix that formed Rose Atoll NWR was composed primarily of crustose coralline algae. Observations during and after the oil spill indicated that the coralline algal community was severely impacted and significantly altered by the petroleum released during the grounding. The following oil-related injuries and changes were documented:

- A massive die-off of crustose coralline algae, extending approximately 1000 m along the reef flat and reef margin, occurred on the southwest arm of the atoll where the vessel grounded. Dead or injured coral also were documented along the outer reef slope and terrace, and the slope, floor and pinnacles of the lagoon (Maragos 1994, USFWS 1997).

- The large scale die-off of the crustose coralline algae was accompanied by a bloom of opportunistic invasive "weedy" species (cyanobacteria and the articulated coralline algae [*Jania* spp.]), which were previously uncommon on the atoll. Within a year, these 'weedy' species had spread across the atoll's entire southwest arm and had begun to invade adjacent areas of the lagoon as well as portions of the northwest arm (USFWS 1997).

- By 1995, data showed that sampling stations previously dominated by crustose coralline algae were now almost entirely (up to 90%) covered by the opportunistic invasive 'weedy' species (USFWS 1997).

3.2.2 Sea Urchins

- Early observations indicated that many boring sea urchins were killed by the oil spill, mostly along the outer reef flat (USFWS 1997).

- Surveys in 1993 revealed that boring sea urchins were extirpated from a zone 90 m north and 60 m south of the spill site. Surveys conducted in 1995 and 1996 revealed that sea urchin densities had declined along the atoll's entire southwest arm (USFWS 1997).

3.2.3 Sea Cucumbers

- The abundance of sea cucumbers (*Holothuria* spp.) was reduced in the vicinity of the grounding site immediately following the spill (USFWS 1997).

- Surveys in 1995 and 1996 revealed that the southwest arm of the atoll had the lowest density of sea cucumbers.

3.2.4 Giant Clams

- Initial surveys showed that a large number (>200) of giant clams died in the immediate vicinity of the spill. Dead clams were recorded along the reef flat and lagoon terrace up to a distance of 400 m from the grounding site (USFWS 1997).

- Surveys conducted six months after the spill revealed that clams on the lagoon terrace and pinnacles adjacent to the wreck site were covered with a thick growth of cyanobacteria.

These clams appeared physiologically stressed, as evidenced by abnormally heavy mucus production (USFWS 1997).

- Clam mortality remained elevated at the spill sited in 1994 and 1995, indicating that oil-related effects were still apparent 12 to 18 months after the spill (USFWS 1997).

3.2.5 Fishes

- The cyanobacteria bloom produced by the oil spill altered the fish community in the vicinity of the grounding site. Herbivorous species, such as surgeonfish (*Acanthurus triostegus*) and parrotfish (*Scarus frontalis*), increased in abundance, while those species associated with a healthy reef ecosystem such as butterflyfish (*Chaetodon* spp.) and damselfish (*Chromis acares*) decreased in abundance (USFWS 1997).

- Alterations in the fish community were still evident two years after the spill, and appeared to be maintained by the on-going cyanobacteria bloom and altered physical habitat (USFWS 1997) .

3.3 Recent Field Surveys and Natural Recovery

Recent field studies revealed that the reef ecosystem remains severely altered both intertidally on the reef flats and subtidally along the ocean and lagoon-facing reef slopes (Burgett 1998, J. Maragos 2000.) Limited natural recovery has occurred in areas where restoration activities have been implemented (J. Maragos 2000). The following oil-related injuries were still apparent five to seven years after the spill:

- During 1997 surveys, cyanobacteria and articulated coralline algae dominated more than 800 m of the reef flat. Much of the normally abundant crustose coralline algae remains dead within this area, and shows no signs of recovery. By 1999, over 700 m of reef was still covered by the cyanobacteria and articulated coralline algae immediately prior to the emergency restoration. Upon completion of the emergency restoration, the area covered by these species declined to approximately 400 m due to natural recovery in the areas where the metal was removed.

- The area of proliferating invasive species and dead crustose coralline algae has **expanded** into additional areas and now includes portions of the atoll's northwest arm and lagoon.

- In 1997, several pinnacles within the lagoon were largely devoid of any living coral colonies and were dominated by large mats of cyanobacteria. Several pinnacles continue to be devoid of any living coral colonies as of April 2000.

- The sea urchin population continued to be reduced within 1000 m of the grounding site as of 1997.

- Sea cucumbers remain absent near the grounding site.

Detailed investigations of fish and giant clam populations were not conducted in 1998 due to time and funding constraints. Photoquadrat surveys of corals and clams were completed in 1999 at seven lagoon sites, but the data have not been analyzed. However, since neither the crustose coralline, sea urchin, or sea cucumber populations have recovered, and cyanobacteria and articulated coralline algae still dominate much of the reef area injured by the oil spill, there is no reason to assume the fish or giant clam populations have recovered from the effects of the oil.

In mid-1999, the zone of opportunistic invasive species still dominated most of the reef flats along the southwest arm of the atoll, but there were some signs that the area of coverage had shrunk in size as a result of the removal of some of the metal debris in that area. Nevertheless the 'weedy' species still dominate the reef flat near the grounding site (J. Maragos, 2000). The Trustees believe the data clearly shows that natural recovery will not occur for many years, if at all, thereby necessitating the continuation of active restoration efforts.

3.4 Conclusions

The pristine nature of Rose Atoll NWR was seriously impacted in October 1993 when the Taiwanese fishing vessel *Jin Shiang Fa* ran aground on the southwestern side of the atoll and spilled over 100,000 gallons of fuel and lube oil. Initial documented injuries due to the oil release included a massive die-off of crustose coralline algae, giant clams, boring sea urchins and other invertebrates in the vicinity of the spill site. Areas along the reef flat and reef slope where the coralline algae died were quickly colonized by opportunistic invasive species (primarily cyanobacteria and the articulated coralline algae). Conditions on the atoll over eight years after the spill either show little improvement or have deteriorated. The crustose coralline algae have only shown limited recovery in areas where restoration activities have occurred and the 'weedy' invasive bloom has expanded into other areas of the reef and lagoon. Sea urchins and sea cucumber numbers near the spill zone remain depressed. Although giant clams appear to be slowly recolonizing the impacted area, clams within the lagoon continue to show signs of physiologic stress.

The die-off of crustose coralline algae is of particular concern for the future management of Rose Atoll NWR, since this algae is the primary reef-building plant on the atoll. In the absence of a healthy crustose coralline algal community, reef growth may fail to keep pace with storm erosion or rising sea levels. The structure of the reef also may become weakened in areas where crustose coralline algae are absent. Either scenario could lead to unpredictable changes in the water circulation patterns across the atoll, or possibly result in a breach of the southwest arm of the atoll. Such an event would produce catastrophic changes in the lagoon's protected ecosystem, and would threaten critical nesting habitat for federally protected seabirds and sea turtles.

The bloom and expansion of opportunistic invasive species at the spill site is also of major concern. Although such blooms are common after an oil spill in the marine environment (Bellamy *et al.* 1967, Houghton *et al.* 1991, Jackson *et al.* 1989), they are usually ephemeral, lasting only several months to a year (Bellamy *et al.* 1967, Keller and Jackson 1993). The bloom at Rose Atoll is now in its sixth year, it has expanded, and it is most persistent in areas containing high levels of dissolved iron associated with metal debris. Iron has been shown to be a limiting nutrient for algae in oceanic environments (Martin and Fitzwater 1988), and it seems likely that the algal bloom at Rose Atoll is being maintained or enhanced by the presence of this element above baseline levels. Emergency restoration activities begun in 1999 corroborate these data and evidence.

The Trustees injury assessment data indicates that immediate action is necessary to address conditions that are preventing the resources injured by the oil spill from returning to their baseline condition. The remaining metal debris must be removed before the reef will be able to fully recover from the adverse effects of the *Jin Shiang Fa* oil spill. The Trustees data also suggests that without intervention, this once pristine atoll will not only continue to degrade, but could undergo a catastrophic change if crustose coralline algae populations do not return to their pre-spill abundance and distribution. It is therefore necessary to complete restoration actions at Rose Atoll as soon as possible.

In accordance with the OPA regulations (CFR Section 990.54), the Trustees have developed and evaluated three primary restoration alternatives. Compensatory restoration alternatives were not evaluated, nor are any being considered at this time. In addition, the Trustees have carefully considered, but are not evaluating further, a *No Action Alternative*. The Trustees believe the data collected on the oil spill injured natural resources at Rose Atoll during the past several years clearly show that these resources are not returning to their pre-spill conditions via natural recovery. Thus, the Trustees believe active primary restoration actions must be taken.

In selecting the preferred restoration alternative for the injuries at Rose Atoll NWR, the Trustees followed the guidance criteria provided by the NOAA OPA NRDA regulations and considered the following questions/criteria:

- The likelihood of success - will the alternative return the reef to its pre-spill conditions?
- Will the alternative prevent future injury or cause collateral injury?
- Will the alternative benefit multiple injured natural resources?
- Will the alternative cause a public health or safety problem?
- Can the Trustees establish meaningful performance criteria to evaluate the progress/success of the alternative?
- What are the projected costs and are they reasonable in relation to the expected benefits?

4.1 Removal of Metal Debris (preferred alternative)

Removing the remaining metal debris is the single most important action that can be taken to return the oil-injured natural resources at Rose Atoll to their pre-spill conditions. Evidence from the Trustees' studies suggest that the injury and death of corals, fish, giant clams, sea cucumbers, sea urchins, and crustose coralline algae and the proliferation of invasive cyanobacteria and articulated coralline algae, began with, and was directly related to, the *Jin Shiang Fa* oil spill. In addition, studies indicate that the persistent, invasive cyanobacteria and articulated coralline algal bloom is being artificially maintained and enhanced by elevated iron levels in the water, the result of corrosion from the remaining metal debris.

Limited recovery of the reef flat has begun in areas where emergency restoration removed metal debris in July-August 1999 and April 2000 (Maragos 2000). However, the Trustees believe that significant recovery of the entire reef community injured by the oil spill will not occur until the remaining metal debris is removed. Once restoration activities are complete, the Trustees anticipate that natural recovery processes will return the atoll to its pre-spill conditions without additional intervention. No other potential restoration alternative is considered viable without the removal of the remaining metal debris.

4.1.1 Project Description

Future restoration actions have been separated into distinct reef flat, reef slope and lagoon components, as each has a different project strategy and equipment requirement. Removal of metal debris from the reef flat and lagoon is conducted from the lagoon side of the reef, while the removal of debris from the reef slope is approached from the seaward side.

Removal of reef flat and lagoon debris requires the use of a small work vessel capable of traversing the 3 m deep channel into the lagoon. Larger debris may be cut into a manageable size using acetylene cutting torches (or Caricable ®). The reef flat debris is then moved to the edge of the lagoon, loaded onto a skiff, and transferred to the work vessel's hold using a combination of booms, davits, winches and cargo nets. Lagoon debris is stockpiled to or cut into a manageable size by divers before being lifted to the surface and onto the work vessel using a combination of nets, cables, lift bags, and hoists.

The removal of metal debris from the ocean-facing reef slope is more difficult due to the constant, heavy wave action in this area. An unanchored work vessel must be stationed just outside the surf zone to support divers. Divers will gather and stockpile small debris, section larger debris using underwater cutting torches (if possible), place cargo netting around piles or pieces, and then attach cables and air lift bags. The debris then is lifted off the bottom and moved offshore, or dragged down the reef slope away from the surf zone, where it can be hoisted off the bottom. A tugboat likely will be needed to move or drag the largest items (*i.e.*, the engine block and drive train assembly) which cannot be cut.

Debris must be deposited into the ocean at a sufficient depth (>500 m) to prevent future storms and large waves from carrying the material back onto the reef slope. Therefore, debris will be transported 3 nautical miles north of the atoll and deposited at an open ocean disposal site already authorized by the Environmental Protection Agency. The depth and distance of this site from the atoll is sufficient to eliminate any further interference with the zone of living coral, and will permit the atoll's reef to return to baseline conditions.

4.1.2 Likelihood of Success

The Trustees believe that once the metal debris is removed, and iron levels in the water are reduced, the likelihood of continuing injury to the Rose Atoll reef ecosystem from the *Jin Shiang Fa* oil spill will be significantly reduced. Although there is limited direct evidence to explain exactly what factors are promoting the bacteria and articulated coralline algal bloom at Rose Atoll, marine chemists and ecologists contacted by the Trustees agreed that the additional iron present in the ecosystem may be the primary causative factor. Thus, removal of the metal debris and thereby the additional iron, appears to be the most viable restoration option available to return this atoll to its pre-spill conditions. This explanation is bolstered by two on-site observations. First, in a previously un-impacted area of the reef where an iron rebar stake was placed by scientists studying the effects of the spill, a swath of cyanobacteria grew on the down current side of the stake. Second, preliminary observational data recorded following recent emergency restoration activities involving removal of much of the metal debris on the reef flat, indicated an obvious reduction in the amount of cyanobacteria in the area cleared and active re-colonization of the reef flat surfaces by reef-building pink coralline algae (Maragos 2000).

4.1.3 Benefits to Multiple Resources

The Trustees expect that the actions of the preferred restoration alternative will benefit multiple components of the impacted reef community at Rose Atoll. Marine scientists suggest that one of the reasons the crustose coralline algae, sea urchins, sea cucumbers and other marine invertebrates, and marine fish impacted by the oil spill have not returned to pre-spill levels is because the cyanobacteria and articulated coralline algal mats may be acting as a physical barrier on the reef substrate. Specifically, these invasive species may be preventing marine invertebrates from fully accessing protective cover or foraging habitat. Returning the cyanobacteria and articulated coralline algal community to its pre-spill conditions is expected to allow the injured invertebrate populations to fully re-colonize Rose Atoll and return to their pre-spill levels.

4.1.4 Likelihood of Preventing Further Injury and Avoiding Collateral Injury

Restoration activities have the potential to disturb or injure reef organisms in areas where restoration activities are being conducted. The Trustees will minimize this potential injury by having the Trustees' Project Manager on site during restoration activities.

4.1.5 Effects on Public Health and Safety

Since the atoll is closed to all public access, restoration operations will have no impact on either public health or safety.

4.1.6 Performance Criteria

Performance criteria will be used to determine whether restoration objectives are met and whether the injured marine resources have recovered to near pre-spill conditions. The Trustees have selected performance criteria to evaluate the success of restoration efforts at Rose Atoll. One measure of success will be the return of crustose coralline algae, cyanobacteria, and articulated coralline algae to very near their baseline percent cover levels. Data collected from reference sites at Rose Atoll show that crustose coralline algae typically cover from 50 to 80 percent of the reef substrate (J. Burgett, USFWS, unpubl. data), while opportunistic species like cyanobacteria are usually absent or rare. Restoration will be considered satisfactory when greater than 80% of the monitoring sites in the impacted area return to un-impacted reference site levels.

Oil-caused injury also was apparent in several marine invertebrate species including: corals, boring sea urchins, sea cucumbers and giant clams. The populations of these species will continue to be monitored at previously established sampling locations. Recovery will be considered successful when the density of these species at impacted sampling locations reaches more than 80% of the mean density found at un-impacted sampling locations.

Data from the reef community will be evaluated in detail on an annual basis for ten years following the restoration actions. In the event that the performance criteria reviews provide little sign of significant improvement at the atoll, the Trustees will consider proposing modifications to the plan or reconsidering some of the presently rejected restoration alternatives.

4.1.7 Monitoring Reef Recovery and Return to Baseline Conditions

Reef flat communities often take years to recover following an oiling event (Cubit and Conner 1993, Suchanek 1993, USFWS 1997). For example, coral reefs killed by response actions at Pago Pago Harbor are expected to take approximately ten years to fully recover (NOAA 1999). The types of long term injuries documented to corals following oil spills include death, reduced growth, and reduced reproduction (Loya and Rinkevich 1980, Jackson *et al.* 1989).

Based on this information, it is likely that the reef at Rose Atoll also will take many years to fully recover. Long term monitoring is therefore necessary to determine whether additional restoration actions will be necessary to return the reef community to its baseline condition. Sampling locations established during the injury assessment phase of this incident, as well as additional monitoring sites recently established in the lagoon and on the ocean reef slopes, will be monitored in the field biennially to determine changes in the percent cover of crustose coralline algae, other benthic algae, corals, and abundance of other marine invertebrates and fishes. These data will allow Trustees to accurately assess reef recovery and evaluate the effectiveness of the selected restoration alternative. Monitoring studies will begin following the completion of restoration activities and will be conducted annually for ten years.

Newly available imagery from the IKONOS 1 satellite may provide a cost-effective means of monitoring the return of the coralline algae community to the reef flat in the years between field monitoring surveys. Previous satellite images revealed that portions of the reef flat covered with invasive algae appeared darkly colored compared to areas covered with a healthy crustose coralline community. However, there is little information available on using satellite imagery to monitor the recovery of a remote coralline algal reef. Thus, the Trustees expect this technique will require significant field monitoring to ensure that the interpretation of the satellite images is providing accurate data on recovery.

4.1.8 Expected Costs

The cost to implement the preferred restoration alternative and monitor recovery (including the emergency restoration phase of the project) is expected to be $1,181,375 (Appendix A). The Trustees believe these costs are reasonable considering the amount of metal debris involved (estimated to be 145 tons), the challenging work conditions (constant high energy wave action), and the atoll's extremely remote location (nearly 2,500 miles SSW of Honolulu, HI). The Trustees estimated total cost ($631,978) for removing the metal debris is roughly half the cost of the response actions, which insurers reported at over $1,100,000 (USFWS 1997). The estimated costs are also considerably less than the $2,000,000 estimate provided by Mobile Diving Salvage Unit of the U.S. Navy, for removal of the remaining debris (letter to Secretary Berry from Admiral Archie Clemens dated January 25, 1999). Finally, the estimated project costs are less than the costs estimated by a private salvage firm for removing individual vessels grounded in Pago Pago Harbor ($232,053 - $696,159 per vessel; NOAA 1999), a much more easily accessible, less challenging work environment.

The expected costs for monitoring ($549,397) are also reasonable considering the remoteness of Rose Atoll NWR, its open ocean exposure, and the uncertainty faced by the Trustees. In addition, the Trustees are attempting to reduce monitoring costs by using ground verified satellite imagery on alternate years to monitor recovery. The satellite imagery provides a considerable cost savings compared with annual on site visits. Compilation of an Administrative Record for the restoration actions is estimated at $8,000.

Although the Trustees are making every effort to conduct the most cost effective restoration program, there remains a considerable amount of uncertainty. This uncertainty includes not only the challenging work conditions and remoteness of the site, but the uncertainty regarding how quickly the reef killing algae will persist after the iron is removed. Since these many uncertainties make it likely that mid-course corrections will be necessary in the proposed restoration effort, 10 percent of the remaining total cost ($88,025) has been added to the budget as a contingency for uncertainty. This project contingency is expected to allow the Federal and American Samoan Trustees to make the logistical and administrative adjustments necessary to achieve a fully successful restoration effort. Total estimated costs of emergency restoration, future restoration activities, restoration monitoring, administrative record keeping, and project contingency amount to $1,277,400.

4.2 Manual Removal of Invasive Species / Transplantation of Crustose Coralline Algae (rejected alternative)

Manual removal of invasive algae would entail using knives or similar tools to scrape off the 'weedy' algae adhering to the reef substrate, and would be a prerequisite to the transplantation of crustose coralline fragments. Attempting to transplant crustose coralline fragments without first removing the 'weedy' species likely would result in the cyanobacteria and articulated coralline algae over-growing and killing the transplants. In addition, cementing coralline transplants to the reef substrate requires that the surface be relatively clean and free of growth such as cyanobacteria.

This project would, at least in the short term, reduce the amount of cyanobacteria and articulated coralline algae on the reef and potentially promote the return of the crustose coralline algae to areas injured by the oil spill. However, for the reasons described below, the Trustees have concluded that this restoration alternative is not the most practical and appropriate option for Rose Atoll at this time:

- This approach would likely have little or no long-lasting effect if water iron levels remain elevated. Before either project could be initiated, iron concentrations in the water would need to be lowered to pre-spill levels to inhibit the return of the cyanobacteria and articulated coralline algae and promote the growth of the crustose corallines. This project could therefore only be attempted after all metal debris had been removed.

- The very widespread occurrence of the cyanobacteria and articulated coralline algae following six years of growth, combined with the rough open ocean conditions at Rose Atoll would make the manual removal of the algae a very difficult and costly task.

- At present, the area of the reef covered by the invasive species is too large to be the focus of a transplant operation. Without some certainty that the 'weedy' invasives will not again proliferate, transplanted corals likely would be rapidly overgrown.

4.3 Reintroduction of Marine Invertebrates (rejected alternative)

Injury studies demonstrated that a significant number of boring sea urchins, sea cucumbers, and giant clams were killed by the spill. Restoration efforts for these species could include the reintroduction of individuals of each species into impacted areas. These reintroduced individuals could be either raised in aquaria at a facility specifically constructed for the purpose, or they could be collected from areas on the atoll unaffected by the oil spill and translocated to impacted areas.

This direct facilitated recolonization effort likely would enhance the recovery of specific marine invertebrate populations affected by the oil spill. However, this alternative was rejected at the present time for the following reasons:

- Releasing propagated or collected marine invertebrates into areas where invasive species are still abundant likely would reduce their chances of survival as the cyanobacteria mats may act as a physical barrier to settling juveniles and prevent them from accessing the reef substrate for cover or foraging habitat. Also, field observational data suggest that the presence of the cyanobacteria appears to be causing a stress reaction in giant clams. Thus, this project could only proceed after these mats are removed.

- Sea urchins and sea cucumbers can have very high fecundity and they are relatively mobile. Therefore, the Trustees are hopeful that they will naturally recolonize impacted areas once the mats of invasive algae are eliminated. The Trustees are less certain about the recovery rates of the giant clam. However, at present we do not have the technical and logistical expertise to artificially propagate this species and have decided our best option is to monitor recovery after the invasive species are significantly reduced. If any of the impacted marine invertebrate populations fail to grow back towards baseline levels following the significant reduction in the cyanobacteria mats, the Trustees may reconsider the option of artificially propagating and releasing larvae of the still impacted species.

4.4 Restoration Summary

The Trustees have selected the removal of the remaining metal debris as the preferred restoration alternative. This action will remove the source of iron believed to be maintaining the bloom of invasive species that began following the *Jin Shiang Fa* oil spill. The removal of the proliferating invasive species should, in turn, facilitate the recolonization of the crustose coralline algae, as well as benefit populations of marine invertebrates injured by the oil spill. While each of the rejected restoration alternatives could potentially provide additional benefits to affected species, we believe that the natural recolonization of impacted areas may make such efforts largely unnecessary once the metal debris is removed. A summary of project costs is presented in the following table, while detailed cost for different phases of the restoration is presented in Appendix A.

Summary of Total Costs for Restoration of Rose Atoll National Wildlife Refuge	
Project Element	**Total Cost**
Emergency Restoration	$309,128
Future Restoration Activities	$322,850
Restoration Monitoring	$549,397
Administrative Record	$8,000
Project Contingency (10%)	$88,025
Total Project Costs	**$1,277,400**

4.5 Project Management

The U.S. Fish and Wildlife Service (Service) will serve as the Lead Administrative Trustee. These duties will include: responsibility for programmatic oversight, review, and management; financial management and cost documentation; public notification; and outreach. The American Samoa Department of Marine and Wildlife Resources is co-trustee for the refuge, and will offer assistance to the Service and the contractor as necessary.

In accordance with OPA regulations (CFR Section 990.45), an Administrative Record (Record) was established by the Trustees. The Record will provide the public with a repository of documents relied upon by the Trustees in making determinations regarding injuries to the atoll and the selected restoration alternative. In addition, the Record may facilitate administrative and judicial review of the Trustees' actions and determinations. The Record will be available for public review at the following locations during normal business hours:

U.S. Fish and Wildlife Service
Pacific Islands Ecoregion
300 Ala Moana Blvd., Rm 3-122
P.O. Box 50088
Honolulu, HI 96850

American Samoa Government
Department of Marine and Water Resources
P.O. Box 3730
Pago Pago, American Samoa 96799

References

Amerson, A.B., W.A. Whistler, and T.D. Schwaner. 1982. Wildlife and wildlife habitat of American Samoa. II. Accounts of flora and fauna. U.S. Dept. of the Interior, Fish and Wildlife Service Report. 151 pp.

Balazs, G., P. Craig, B. Winton, and R. Miya. 1994. Satellite telemetry of green turtles nesting at French Frigate Shoals, Hawaii and Rose Atoll, American Samoa. Proc. 14th Annual Symp. on Sea Turtle Biology and Conservation. 4 pp.

Barclay, S. 1993. Trip Report: Rose Atoll, November 28 - December 9, 1993. Administrative Report, U.S. Fish and Wildlife Service, Honolulu, Hawaii. 13 pp.

Bellamy, D.J., P.H. Clarke, D.M. John, D. Jones, and A. Whittlick. 1967. Effects of pollution from the Torrey Canyon on littoral and sublittoral ecosystems. Nature 216:1170-1172.

Burgett, J. 1998. Memorandum to Don Palawski. Update on conditions of Rose Atoll, August 1998. U.S. Fish and Wildlife Service, Honolulu, Hawaii.

Cubit, J. and J.L. Connor. 1993. Effects of the 1986 Bahia las Minas oil spill on reef flat communities. Proceedings of the 1993 Oil Spill Conference. Pages 329-334.

Ford, G.R. 1975. Needs of the United States Territories of Guam, American Samoa, and the Virgin Islands, a proclamation by the President of the United States of America. February 1, 1975. 2 pp.

Green, A.L. 1996. Status of the coral reefs of the Samoan Archipelago. Department of Marine and Wildlife Resources, Biological Report Series, Pago Pago, American Samoa. 125 pp.

Green, A.L. and P. Craig. 1996. Rose Atoll: a refuge for giant clams in American Samoa? Department of Marine and Wildlife Resources, Biological Report Series, Pago Pago, American Samoa. 55 pp.

Greenwalt, L.A. 1974. Notice of Establishment, Rose Atoll National Wildlife Refuge, American Samoa. Federal Register 39(71), Thursday, April 11, 1974. 16 pp.

Houghton, J.P., D.C. Lees, W.B. Driskell, and A.J. Mearns. 1991. Impacts of the *Exxon Valdez* spill and subsequent cleanup on intertidal biota--1 year later. *In* Proc. of the 1991 Oil Spill Conference. American Petroleum Institute, Washington, D.C., pp. 467-475.

Jackson, J.B.C., J.D. Cubit, B.D. Keller, V. Batista, K. Burns, H.M. Caffery, R.L. Caldwell, S.D. Garrity, C.D. Getter, C. Gonzalez, H.M. Guzman, K.W. Kaufmann, A.H. Knap, S.C. Levings, M.J. Marshall, R.Steger, R.C. Thompson, and E. Weil. 1989. Ecological effects of a major oil spill on Panamanian coastal marine communities. Science 243:37-44.

Keller, B.D. and J.B.C. Jackson, eds. 1993. Long-term assessment of the oil spill at Bahia Las Minas, Panama. Synthesis Report, Volume II: Technical Report. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Regional Office, New Orleans. 1017 pp.

Loya, Y. and B. Rinkevich. 1980. Effects of oil pollution on coral reef communities. Marine Ecology Progress Series 1:77-80.

Maragos, J.E. 1994. Review Draft: Reef and coral observations on the impact of the grounding of the longliner *Jin Shiang Fa* at Rose Atoll, American Samoa. Program on Environment, East-West Center, Honolulu, Hawaii, 21 pp. + 4 tbs. + 1 fig.

Maragos, J.E. 1999. Observations of the reefs, corals, and giant clams at Rose Atoll during initial operations to remove ship debris from the reef flats and lagoon (May-Aug. 1999). U.S. Fish and Wildlife Service Report, Honolulu, Hawaii, in preparation.

Maragos, J.E. 2000. Rose Atoll National Wildlife Refuge Clean-up Project, FY 1999-2000. U.S. Fish and Wildlife Service Report, Honolulu, Hawaii. 2 pp.

Martin, J.H. and S.E. Fitzwater. 1988. Iron deficiency limits phytoplankton growth in the northeast Pacific subarctic. Nature 331:341-343

Mayor, A. 1921. Rose Atoll, American Samoa. Proc. Amer. Philos. Soc. 60:62-70.

Molina, M. 1994. Trip report: Rose Atoll National Wildlife Refuge, American Samoa: October 31 to November 8, 1993. Administrative Report, U.S. Fish and Wildlife Service, Honolulu, Hawaii. 13 pp. + appendices.

National Oceanic and Atmospheric Administration. 1999. Emergency Restoration Plan and Environmental Assessment. Pago Pago Harbor, American Samoa. 92 pp.

Radtke, R. 1985. Population dynamics of the giant clam, *Tridacna maxima*, at Rose Atoll. Hawaii Institute of Marine Biology, University of Hawaii. 24 pp.

Rodgers, K.A., I.A.W. McAllan, C. Cantrell, and B.J. Ponwith. 1993. Rose Atoll: an annotated bibliography. Technical Reports of the Australian Museum 9:1-37.

Suchanek, T.H. 1993. Oil impacts on marine invertebrate populations and communities. Amer. Zool. 33:510-523.

UNEP/IUCN. 1988. Coral reefs of the World Volume 3: Central and Western Pacific. UNEP Regional Seas Directories and Bibliographies. IUCN, Gland, Switzerland and Cambridge, U.K./UNEP, Nairobi, Kenya. xlix + 329 pp., 30 maps.

U.S. Fish and Wildlife Service. 1996a. Pre-assessment screen for physical injuries caused by the F/V *Jin Shiang Fa* grounding at Rose Atoll National Wildlife Refuge, American Samoa. Report prepared by the U.S. Fish and Wildlife Service, Pacific Islands Office, Honolulu, Hawaii.

U. S. Fish and Wildlife Service. 1996b. Pre-assessment screen for spill-related injuries caused by the F/V *Jin Shiang Fa* oil spill at Rose Atoll National Wildlife Refuge, American Samoa. Report prepared by the U.S. Fish and Wildlife Service, Pacific Islands Office, Honolulu, Hawaii.

U.S. Fish and Wildlife Service. 1997. The impact of a ship grounding and associated fuel spill at Rose Atoll National Wildlife Refuge, American Samoa. Report prepared by the U.S. Fish and Wildlife Service, Pacific Islands Office, Honolulu, Hawaii.

Wass, R. 1981a. The fishes of Rose Atoll. Department of Marine and Wildlife Resources, Biological Report Series, Pago Pago, American Samoa. 10 pp.

Wass, R. 1981b. The *Tridacna* clams of Rose Atoll. Department of Marine and Wildlife Resources, Biological Report Series, Pago Pago, American Samoa. 9 pp.

Appendix A: Restoration and Monitoring Costs

Restoration and Monitoring Costs

Emergency Restoration[1]

Initial reef flat cleanup (project completed - 75 tons)

Project vessel	15 days @ $2,000/day	$30,000
Project skiff	15 days @ $400/day	$6,000
Project equipment (cutting torches, ropes and cables)		$4,750
Project personnel (6)	15 days @ $300/day (x6)	$27,000
FWS personnel (2)	17 days @ $600/day (x2)	$20,400
FWS airfare	$1,000 (x2)	$2,000
FWS lodging and per diem	2 days @ $200/day (x2)	$800
DMWR personnel (2)	15 days @ $300/day (x2)	$9,000
FWS/DMWR support vessel	15 days @ $2,000/day	$30,000
Food and fuel		$3,000
Project Development and Field Oversight and Management (10%)		$13,295
Total estimated cost of initial reef flat cleanup:		**$146,245**

Reef slope cleanup of small pieces (project completed - 30 tons)

Project vessel	15 days @ $2,000/day	$30,000
Project skiff	15 days @ $400/day	$6,000
Project equipment (cutting torches, cables, air compressors, air tanks)		$15,375
Project personnel		
Divers (3)	15 days @ $600/day (x3)	$27,000
Deck hands (2)	15 days @ $150/day (x2)	$4,500
FWS personnel (2)	17 days @ $600/day (x2)	$20,400
FWS airfare	$1,000 (x2)	$2,000
FWS lodging and per diem	2 days @ $200/day (x2)	$800
DMWR personnel (2)	15 days @ $300/day (x2)	$9,000
FWS/DMWR support vessel	15 days @ $2,000/day	$30,000
Food and fuel		$3,000
Project Development and Field Oversight and Management (10%)		$14,808
Total estimated cost of reef slope cleanup, small pieces:		**$162,883**

Future Restoration Actions

[1] Using funding provided through the U.S. Fish and Wildlife Service's National Wildlife Refuge cleanup fund, a contractor removed much of the metal debris from the reef flat and removed some the debris from the reef slope and lagoon areas.

Reef slope cleanup of large pieces (40 tons)

Project vessel (tugboat)	10 days @ $2,200/day	$22,000
Project skiff	10 days @ $400/day	$4,000
Project equipment (shackles, cables, air compressors, lift bags)		$3,000
Project personnel		
Divers (3)	10 days @ $600/day (x3)	$18,000
Deck hands	10 days @ $150/day (x2)	$3,000
Reef workers	5 days @ $150/day (x2)	$1,500
FWS personnel (2)	14 days @ $600/day (x2)	$16,800
FWS airfare	$1,000 (x2)	$2,000
FWS lodging and per diem	2 days @ $200/day (x2)	$800
DMWR personnel (2)	10 days @ $300/day (x2)	$6,000
FWS/DMWR support vessel	10 days @ $2,000/day	$20,000
Food and fuel		$2,000
Project Development and Field Oversight and Management (10%)		$9,910
Total estimated cost of reef slope cleanup, large pieces:		**$109, 010**

Final Reef Flat Cleanup (2 tons)

Project vessel	10 days @ $2,200/day	$22,000
Project skiff	10 days @ $400/day	$4,000
Project equipment (raft, chain hoist, cutting torches, davits)		$5,000
Project personnel (6)	10 days @ $300/day (x6)	$18,000
FWS personnel (2)	14 days @ $600/day (x2)	$16,800
FWS airfare	$1,000 (x2)	$2,000
FWS lodging and per diem	2 days @ 200/day (x2)	$400
DMWR personnel (2)	10 days @ $300/day (x2)	$6,000
FWS/DMWR support vessel	10 days @ $2,000/day	$20,000
Food and fuel		$2,000
Project Development and Field Oversight and Management (10%)		$9,620
Total estimated cost of final reef flat cleanup:		**$105,820**

Lagoon Cleanup (10 tons)

Project vessel	10 days @ $2,200/day	$22,000
Project skiff	10 days @ $400/day	$4,000
Project equipment (cargo nets, cables, air compressors, air tanks, davits)		$5,500
Project personnel		
Divers (6)	10 days @ $600/day (x6)	$36,000
Deck hands (3)	10 days @ $150/day (x3)	$4,500
FWS personnel (2)	12 days @ $600/day (x2)	$14,400
FWS airfare	$1,000 (x2)	$2,000

FWS lodging and per diem	2 days @ $200/day (x2)	$800
DMWR personnel (2)	10 days @ $300/day (x2)	$6,000
Food and fuel		$3,000
Project Development and Field Oversight and Management (10%)		$9,820
Total estimated cost of lagoon cleanup:		**$108,020**

Restoration Monitoring (6 biennial trips over 10 years; costs adjusted for inflation using a 3% per year inflation rate)

Personnel

FWS/DMWR support vessel	7 days @ $2,000/day (x6 trips)	$97,877
FWS personnel (4)	9 days @ $600/day (x4 personnel) (x6 trips)	$151,008
FWS airfare	$1,000 (x4 personnel) (x6 trips)	$27,965
FWS lodging and per diem	2 days @ $200/day (x4 personnel) (x6 trips)	$11,185
DMWR personnel (2)	7 days @ $300/day (x2 personnel) (x6 trips)	$29,362

Field equipment, maintenance, and supplies

Small boat and motor		$20,000
Diving gear		$8,000
Gear maintenance	5 years @ $500/year	$3,495
Underwater photography gear		$3,000
Laptop computer and printer		$2,500
Scientific supplies	5 years @ $500/year	$3,495
Chemical Analysis of Water Samples for Iron	6 years @ $7,000/year	$4,200
Remote sensing	6 years @ $8,000/year	$55,928
Annual report printing, graphics, and web site maintenance	$9,000 (x10)	$90,000
Project Development and Field Oversight and Management (10%)		$41,382
Total cost of monitoring:		**$549,397**

Administrative Record Costs	**$8,000**
Project Contingency (10%)	$88,025
Total Cost of Restoration:	**$1,277,400**

Appendix B: Index to Administrative Record

Administrative Record

The Administrative Record for the Rose Atoll National Wildlife Refuge Natural Resource Damage Assessment and Restoration contains documents that were considered or relied upon by the Trustees during the assessment of injuries caused by the October, 1993 oil spill, including during the restoration planning and selection process. This Administrative Record does not contain copies of published reference documents that are readily available through a public or university library.

4/11/74 U.S. Fish and Wildlife Service. 1974. Notice of Establishment, Rose Atoll National Wildlife Refuge, American Samoa. Federal Register 39(71):16, Thursday, April 11, 1974.

2/01/75 Ford, G.R. A proclamation by the President of the United States. Retains submerged lands adjacent to Rose Atoll National Wildlife Refuge from transfer to the Government of American Samoa, and establishes joint administrative jurisdiction by Department of Commerce and Department of the Interior. 2 pp.

1993 Rodgers, K.A., I.A.W. McAllan, C. Cantrell, and B.J. Ponwith. 1993. Rose Atoll: an annotated bibliography. Technical Reports of the Australian Museum, Number 9, ISSN 1031-8062. 37 pp.

3/18/93 U.S. Fish and Wildlife Service. Memorandum of Understanding between the Fish and Wildlife Service, U.S. Department of the Interior and the American Samoa Government. Establishes coordination for management of Rose Atoll National Wildlife Refuge. U.S. Fish and Wildlife Service, Region 1, Portland, Oregon. 7 pp. + attachment.

12/4/93 Barclay, S. 1993. Trip Report: Rose Atoll, November 28 - December 9, 1993. Administrative Report, U.S. Fish and Wildlife Service, Pacific/Remote Islands National Wildlife Refuge Complex, Honolulu, Hawaii. 13 pp.

4/94 Maragos, J.E. 1994. Reef and coral observations on the impact of the grounding of the longliner *Jin Shiang Fa* at Rose Atoll, American Samoa (Review Draft). University of Hawaii, Program on Environment, East-West Center, Honolulu, Hawaii. 21 pp. + 4 tbs. + 1 fig.

7/7/94 U.S. Fish and Wildlife Service. Letter from Brooks Harper, Field Supervisor, to Capt. Curtis C. Martin, Commander, Fourteenth Coast Guard District, describing preliminary assessments of petroleum discharge effects upon Rose Atoll natural resources and indicating support of USCG pursuit of civil penalties against responsible parties.

9/14/94 Molina, M. 1994. Trip report: Rose Atoll National Wildlife Refuge, American Samoa: October 31 to November 8, 1993. Administrative Report, U.S. Fish and Wildlife Service, Pacific Islands Field Office, Honolulu, Hawaii. 13 pp. + appendices.

11/94 Green, A., P. Craig, and F. Tuilagi. 1994. Distribution and abundance of giant clams at Rose Atoll (American Samoa), with notes on the effects of the longliner grounding on clam populations (Draft). Department of Marine and Wildlife Resources, Pago Pago, American Samoa. 11 pp. +3 tbls. + 7 fig.

1995 Molina, M. 1995. Trip report: Rose Atoll National Wildlife Refuge, American Samoa: March 23 to 30, 1994. Administrative Report, U.S. Fish and Wildlife Service, Pacific Islands Field Office, Honolulu, Hawaii. 13 pp. + appendices.

4/12/95 Flint, E. and P. Craig. 1995. Preliminary survey of the algal infestation at Rose Atoll National Wildlife Refuge associated with the F/V *Jin Shiang Fa* oil spill. Administrative Report, U.S. Fish and Wildlife Service, Pacific/Remote Islands National Wildlife Refuge Complex, Honolulu, Hawaii. 5 pp.

6/28/95 U.S. Department of the Interior. Letter from Robin Kohn Glazer, Assistant Field Solicitor, to Marc Warner, Esq., Law Offices of LeGros, Buchanan and Paul, regarding natural resources assessment boat trip planned from August 4-18, 1995. Office of the Solicitor, San Francisco, California. 2 pp.

7/25/95 Law Offices of LeGros, Buchanan and Paul. Letter from Marc E. Warner to Robin Kohn Glazer, Assistant Field Solicitor, acknowledging receipt of natural resource assessment boat trip planning letter, and further describing the insurance and indemnity status of the F/V *Jin Shiang Fa* corporate owners. Seattle, Washington. 3 pp.

1996 Green A.L. 1996. Status of the coral reefs of the Samoan Archipelago. Department of Marine and Wildlife Resources, Biological Report Series, Pago Pago, American Samoa. 125 pp.

1996 Molina, M. 1996. Chronology of major events related to the grounding of the *Jin Shiang Fa* at Rose Atoll National Wildlife Refuge, American Samoa. Report to Assistant Field Supervisor. Ecological Services, Pacific Islands Ecoregion, Honolulu, Hawaii.

4/96 U.S. Fish and Wildlife Service. 1996. Preassessment screen for spill-related injuries caused by the F/V *Jin Shiang Fa* oil spill at Rose Atoll National Wildlife Refuge, American Samoa. Pacific Islands Field Office, Honolulu, Hawaii. 14 pp.

4/96 U.S. Fish and Wildlife Service. 1996. Preassessment screen for physical injuries caused by the F/V *Jin Shiang Fa* oil spill at Rose Atoll National Wildlife Refuge, American Samoa. Pacific Islands Field Office, Honolulu, Hawaii. 13 pp.

4/96 Green. A.L. and P. Craig. 1996. Rose Atoll: a refuge for giant clams in American Samoa? Department of Marine and Wildlife Resources, Biological Report Series, Pago Pago, American Samoa. 55 pp.

9/97 U.S. Fish and Wildlife Service. 1997. The impact of a ship grounding and associated fuel spill at Rose Atoll National Wildlife Refuge, American Samoa. U.S. Fish and Wildlife Service Report, Pacific Islands Ecoregion, Honolulu, Hawaii. 60 pp.

4/3/98 U.S. Fish and Wildlife Service, Pacific Islands Ecoregion. Letter from Robert P. Smith, Pacific Islands Manager, to Admiral Clemens, Commander in Chief, U.S. Pacific Fleet, requesting Navy diver support to survey wreckage at Rose Atoll from July 15-37, 1998. Pacific Islands Ecoregion, Honolulu, Hawaii. 1 p.

6/9/98 Department of the Navy. Letter from Rear Admiral J.L. Taylor, Deputy Chief of Staff for Fleet Maintenance, to Robert P. Smith, Pacific Islands Manager, agreeing to provide Navy divers to survey wreckage at Rose Atoll. U.S. Pacific Fleet, Pearl Harbor, Hawaii. 1 p.

9/98 Burgett, J. 1998. Memorandum to Don Palawski. Update on conditions of Rose Atoll, August 1998. U.S. Fish and Wildlife Service, Pacific Islands Ecoregion, Honolulu, Hawaii. 1 p.

1999 Maragos, J.E. 1999. Rose Atoll National Wildlife Refuge Clean-up Project FY 1999 (Draft). U.S. Fish and Wildlife Service, Pacific/Remote Islands National Wildlife Refuge Complex, Honolulu, Hawaii. 1 p.

1999 Maragos, J.E. 1999. Observations of the reefs, corals, and giant clams at Rose Atoll during initial operations to remove ship debris from the reef flats and lagoon (May-Aug. 1999). U.S. Fish and Wildlife Service Report, Pacific/Remote Islands National Wildlife Refuge Complex, Honolulu, Hawaii, in preparation.

6/22/99 U.S. Fish and Wildlife Service. Draft briefing statement - Status of coral reef restoration at Rose Atoll National Wildlife Refuge, American Samoa. Prepared for Regional Director, Region 1. 3 pp.

11/30/99 U.S. Department of the Interior. Memorandum from Willie R. Taylor, Director, Office of Environmental Policy and Compliance, to Director, Office of Insular Affairs, and Regional Director, Fish and Wildlife Service, Region 1, describing appropriate designation of the Authorized Official for Rose Atoll Natural Resource Damage Assessment and Restoration activities associated with the F/V *Jin Shiang Fa*, Rose Atoll, American Samoa. 2 pp.

2000 Maragos, J.E. 2000. Rose Atoll National Wildlife Refuge Clean-up Project, FY 1999-2000. U.S. Fish and Wildlife Service, Pacific/Remote Islands National Wildlife Refuge Complex, Honolulu, Hawaii. 2 pp.

1/13/00 U.S. Department of the Interior. Memorandum From Willie R. Taylor, Director, Office of Environmental Policy and Compliance, to Anne Badgley, Regional Director, U.S. Fish and Wildlife Service, Region 1, regarding designation of Authorized Official for natural resource damage assessment and restoration activities associated with the F/V *Jin Shiang Fa* oil spill, Rose Atoll, American Samoa.

2/24/00 The Samoa Post. 2000. Notice of Intent to Conduct Restoration Planning pursuant to 15 C.F.R. Section 990.44 for the Oil Spill at Rose Atoll, American Samoa in October, 1993. Thursday, February 24, 2000

4/16/00 The Samoa Post. 2000. Notice of Opportunity for Public Review and Comment Regarding Restoration Plan and Environmental Assessment fo October, 1993 Oil Spill at Rose Atoll, American Samoa.

4/20/00 Samoa Post. 2000. Notice of Opportunity for Public Review and Comment Regarding Restoration Plan and Environmental Assessment fo October, 1993 Oil Spill at Rose Atoll, American Samoa.

4/00 U.S. Fish and Wildlife Service and Department of Marine and Wildlife Resources, Government of America Samoa. 2000. Draft restoration plan for Rose Atoll National Wildlife Refuge (Including Environmental Assessment). U.S. Fish and Wildlife Service, Pacific Islands Ecoregion, Honolulu, Hawaii. 26 pp.

5/01 U.S. Fish and Wildlife Service and Department of Marine and Wildlife Resources, Government of America Samoa. 2001. Final restoration plan for Rose Atoll National Wildlife Refuge (Including Environmental Assessment). U.S. Fish and Wildlife Service, Pacific Islands Ecoregion, Honolulu, Hawaii.

Appendix C: Trustee Adoption of Restoration Plan

ADOPTION RESOLUTION

The undersigned, as authorized officials of their respective federal and Government of American Samoa natural resource trustee agencies, hereby approve and adopt the Final Restoration Plan for Rose Atoll, National Wildlife Refuge (Including Environmental Assessment) and select the restoration project described as the Preferred Alternative contained therein.

United States of America
Department of the Interior

By:
Name: Anne Badgley
Title: Regional Director, Region 1
U.S. Fish and Wildlife Service

Government of American Samoa
Department of Marine and Wildlife Resources

By: ______________________
Name: Ray Tulafono
Title: Director
Department of Marine and Wildlife Resources

Date: ______________________

Approved as to Form:

Charles McKinley
Assistant Field Solicitor
Office of the Solicitor

ADOPTION RESOLUTION

The undersigned, as authorized officials of their respective federal and Government of American Samoa natural resource trustee agencies, hereby approve and adopt the *"Final Restoration Plan for Rose Atoll, National Wildlife Refuge (Including Environmental Assessment)"* and select the restoration project described as the Preferred Alternative contained therein.

Government of American Samoa

By:
Name: Togipa Tausaga
Title: Director
American Samoa Environmental Protection Agency

Date: 8/24/07

ADOPTION RESOLUTION

The undersigned, as authorized officials of their respective federal and Government of American Samoa natural resource trustee agencies, hereby approve and adopt the Final Restoration Plan for Rose Atoll, National Wildlife Refuge (Including Environmental Assessment) and select the restoration project described as the Preferred Alternative contained therein.

United States of America
Department of the Interior

By: ______________________________
Name: Anne Badgley
Title: Regional Director, Region 1
U.S. Fish and Wildlife Service

Government of American Samoa
Department of Marine and Wildlife Resources

By: ______________________________
Name: Ray Tulafono
Title: Director
Department of Marine and Wildlife Resources

Date: ______________________________

Approved as to Form: ______________________________
Charles McKinley
Assistant Field Solicitor
Office of the Solicitor

Appendix D: Finding of No Significant Impact

Finding of No Significant Impact

Having reviewed this environmental assessment relative to the proposed emergency restoration action at Rose Atoll, NWR, American Samoa, I have determined that there will be no significant impacts from the proposed actions. Accordingly, preparation of an Environmental Impact Statement on these issues is not required by Section 102 (2)(c) of the National Environmental Policy Act or its implementing regulations.

United States of America
Department of the Interior

By: Anne Badgley (signature)
Name: Anne Badgley
Title: Regional Director, Region 1
U.S. Fish and Wildlife Service

Government of American Samoa
Department of Marine and Wildlife Resources

By: ______________________________
Name: Ray Tulafono
Title: Director
Department of Marine and Wildlife Resources

Date: ______________________________

Finding of No Significant Impact

Having reviewed this environmental assessment relative to the proposed emergency restoration action at Rose Atoll, NWR, American Samoa, I have determined that there will be no significant impacts from the proposed actions. Accordingly, preparation of an Environmental Impact Statement on these issues is not required by Section 102 (2)(c) of the National Environmental Policy Act or its implementing regulations.

United States of America
Department of the Interior

By: ____________________________
Name: Anne Badgley
Title: Regional Director, Region 1
U.S. Fish and Wildlife Service

Government of American Samoa
Department of Marine and Wildlife Resources

By: ____________________________
Name: Ray Tulafono
Title: Director
Department of Marine and Wildlife Resources

Date: ________________________