For Presentation at the
Asia-North-American Waste Management Conference
Los Angeles, California
December 9-11, 1998

Solid Waste Management in American Samoa

Mr. George M. Savage
CalRecovery, Inc.
725C Alfred Nobel Drive
Hercules, CA 94547-1806
Tel: 510-724-0220
Fax; 510-724-1774
E-mail: GSavage@calrecovery.com

Mr. Michael Dworsky
American Samoa Power Authority
PO Box PPB
Pago Pago, American Samoa 96799
Tel: 684-633-5200
Fax: 684-633-5451
E-mail: MikeD@satala.aspower.com

ABSTRACT

The Territory of American Samoa (population of about 55,000) in the South Pacific is in the process of improving its solid waste management system on Tutuila Island. Currently, American Samoa is implementing a new collection system and is expanding its landfill. The design of both of these systems was prepared based on the local conditions and on modern solid waste management practices. Substantial data acquisition preceded the design efforts for the collection system and for the landfill expansion in order to provide a firm foundation for the designs. A waste characterization study was conducted to support the entire solid waste management plan for Tutuila. A recent and comprehensive process was conducted to procure collection services for the island, including the development of performance specifications and of extensive reporting requirements to aid in the management of wastes. The design of the landfill extension included sub-surface investigations and other studies in order to develop a landfill facility that would protect the island's delicate environment and that would be affordable. Education and training in solid waste management was also seen as an important element and, consequently, has been used during the planning process and implementation of both the new collection system and the landfill expansion.

INTRODUCTION

American Samoa comprises a group of seven islands in the South Pacific Ocean, lying at approximately longitude 170° west and latitude 14° south. The main and largest island, Tutuila, has an area of 137 km^2. The majority of the population (about 55,000) live on the main island. The island is located in the tropical zone and on average receives about 315 cm of rain per year; the average temperature is about 29°C.

The government of the island consists of an executive branch headed by the Governor, legislative branch, and judicial branch. The island is a territory of the United States. The solid waste management (SWM) system was formerly administered by the government through the Public Works Department. In 1994, the responsibility for

SWM was shifted to the American Samoa Power Authority (ASPA) by Executive Order. The Power Authority also is responsible for the provision of electric power, potable water, and wastewater treatment.

The island consists of about 70 villages, with populations ranging from several hundreds to several thousands. The island has a long and narrow profile with a mountainous ridge separating longitudinally the northwest side of the island from the southeast side, except for access by a few roads with steep grades. The villages on the northwest side of the island are thus remote from the more populous southeast. These conditions represent challenges in terms of waste collection. Substantial residential and commercial development has been occurring recently on the central, southwest area (i.e., on the Tufuna/Leone plain), also representing challenges in terms of providing solid waste collection to new residences. Roads leading to the villages are paved; however, access within the villages and fringe residential areas is in many cases limited to dirt roads.

The only significant industry on the island consists of two tuna canneries.

EXISTING SOLID WASTE MANAGEMENT SYSTEM

The existing solid waste management system on the island is composed of the collection system and a single land disposal facility. ASPA manages the solid waste collection contract and operates the land disposal facility. Additionally, ASPA conducts public education through public service announcements and other vehicles of communication. Recycling is limited to aluminum cans and to returnable glass beer bottles. Aluminum cans are recovered and recycled by local importers through collection programs incorporated into their beverage delivery systems or recovered by scavengers from wastes delivered to the land disposal site.

The collection of wastes from the villages was up until recently provided solely by a private contractor. The contractor serviced residential, commercial, and institutional generators. The collection frequency was about twice weekly for residences and once to six times per week for businesses and institutions, depending on their needs. The prevailing method of storage and setout of solid wastes among the villages has been uncovered 55-gallon steel drums. The drums are shared among the residences. Commercial businesses use drums or 4 yd^3 steel bins for storage of waste. The drums are serviced by rear loader packer trucks or flatbed trucks, with the containers being manually lifted and emptied (i.e., manual loading). The bins are serviced by front loaders. The canneries use open-top roll-off containers to store and haul their wastes. They haul their own waste to the disposal site.

In addition to drums shared by residences, ASPA has initiated several waste collection stations. These stations are in effect small transfer stations. Stationed at these locations are 4 yd^3 bins in which generators can place their wastes.

Recently, ASPA took over the collection of wastes from the collection stations and some of the schools in an effort to improve the overall operation of the collection system and to gain some experience with solid waste collection. ASPA purchased front loaders for this purpose.

WASTE CHARACTERISTICS

The quantities and composition of the island's solid waste stream were estimated from a waste characterization study conducted in 1996. The daily rate of disposed waste in 1996 was estimated to be about 50 TPD. The rate is likely higher today since the collection coverage and convenience of collection service to generators have been increased due to the improvements in the waste collection system. The composition of the waste in 1996 included about 49% paper and 13% plastics, as shown in Figure 1. The composition of the waste stream reflects the packaging that attends the importation of goods onto the island.

Notes: 1) 1996 waste characterization
2) arithmetic averages of the major category of generators

Figure 1. Composition of Solid Waste in American Samoa (weight %)

COLLECTION SYSTEM

In recent years, solid waste collection on the island has been provided by a local waste hauler. Recently, ASPA desired to improve the collection system. The desired improvements included:

- expansion of collection coverage (including improving the convenience of collection to residences and businesses);
- standardization of collection day, frequency, and container type;
- reduction of litter;
- optimization of the cost of collection;
- better accounting and monitoring of collection performance and of cost; and
- better customer service.

Expansion of collection coverage was deemed necessary to accommodate increases in population and to control illegal dumping of waste. Standardization of collection services was desired to facilitate cost-efficient service and convenience to the generators. Littering was a problem caused by lack of collection service to some generators and by dogs scavenging from the uncovered drums. Better performance was desired from the collection service provider, both in terms of customer service and in terms of financial recordkeeping and reporting.

In late 1997 and early 1998, ASPA solicited proposals for collection services for residential and commercial solid waste. A comprehensive request for proposals was prepared including, but not limited to, a scope of services, performance requirements, financial recordkeeping and reporting requirements, invoicing requirements, draft service agreement, and proposal evaluation criteria.

A field study of the number and location of waste storage containers was performed to support an analysis of the design and cost of the existing collection system and of potential improvements to it. Adjustments to the field observations and collected data were made to account for increases in need for collection service and containers. The analysis identified that conversion of some of the residential service from small containers to bin service would serve to facilitate and increase collection coverage and to optimize the overall cost of collection. Thus, small container and bin routes and locations were designed to provide a practical level of collection coverage and convenience while maintaining collection costs at an affordable level based on conditions on the island. These requirements were incorporated into the scope of services defined in the collection request for proposals.

Proposals were sought for a small container collection service along four routes and for bin collection service along three routes. To control litter, reduce worker stress and injuries, improve the aesthetics of the waste storage, and increase customer convenience, the requirements for the small container collection service included a switch to 64-gallon HDPE containers with hinged lids and wheels, and the capability of the successful contractor to load the containers semi-automatically using lifters mounted on the vehicles (i.e., semi-automatic loading). Also, collection frequency would be standardized at twice weekly.

The requirements for the provision of bin service also included twice weekly service because the economic analysis indicated that this frequency optimized the cost of bin collection. In those cases where more frequent service had been required in the past, additional bins would be set out under the new system in order to accommodate the decrease in collection frequency.

Several proposals were received from local businesses, including the incumbent collection contractor. After a thorough technical and financial evaluation, a service agreement was signed. The new agreement commenced on August 1, 1998.

• LANDFILL EXPANSION

As mentioned earlier, the main island has one land disposal site. The site is located in an old volcanic crater. Early disposal consisted of dumping wastes over the edge of the crater. Over time, the incoming wastes were pushed by bulldozer further into the crater, thus forming a half dome with an approximately flat top with a steep face (i.e., the southern slope) of wastes opposite the edge of the crater. The depth of the waste is about 25 m. Prior to improving the land disposal site, the average slope of the steep face of wastes was on the order of 45°, with some sections being nearly vertical. The top edge of steep slope was about 250 m in length and overgrown with vegetation in a number of locations. The southern slope, because of its steepness, was determined to represent a risk of landslide.

Land available at the foot of the southern slope was available for expansion of the disposal site. The land represents the bottom of the crater, and consists of an approximately flat area of 400 m by 60 m.

Prior to implementing the most recent improvements, the operation of the land disposal facility had been improved gradually. Most importantly, the operation had been converted from open dumping with little control to one that used frequent covering of the wastes. However, no landfill cell construction was practiced. Commencing in 1997, a comprehensive design and operational plan was prepared for improving the current operations and for closing the existing area of the land disposal facility, and for opening an adjacent modern landfill. Important aspects of the planning and design process were that modern landfill practices be incorporated into the new design and that the design also be affordable.

The recommended improvements to the current operations included the initiation of proper methods of waste compaction, landfill cell construction, daily covering of waste with soil, and proper grading of the site to control run-off and run-on. Landfill equipment operators and supervisory personnel were instructed during this same time period in the practices of modern landfill design and operation, with the intent that the training would be transferred to the operations in the expansion area when that operation commenced. The features of the overall expansion of the land disposal facility included controlled access to the facility, weighing of delivered wastes, construction of landfill cells, use of daily cover, control of drainage, provision for an erosion control system, and stabilization of the steep, southern slope. In order to minimize leachate, a key design principle of the landfill formation was to specify that exposure of wastes to water should be minimized and that wastes awaiting landfilling should never be exposed to accumulated water.

The geology of the island, including the land disposal site, is volcanic in origin. Thus, the soils are permeable. Groundwater protection consequently depends upon control of pollutants and natural attenuation, e.g., dilution, adsorption, and absorption.

Several field studies were conducted in order to characterize the geological and hydrological conditions at the land disposal site and the surrounding area. An array of excavations were dug in the expansion area to determine the subsurface conditions. One purpose of the subsurface investigations was to determine if locally available, low permeability soils would be available by chance. The key findings were that little soil of low permeability was available on the site and that liquid would permeate through the soil into the groundwater lens located some 50 m below the site.

A separate field investigation was conducted to determine the potential of leachate from the landfill contaminating the local groundwater and sea water. Samples of leachate, groundwater, and sea water were collected, analyzed, and compared for this purpose. Leachate samples were collected from several locations around the perimeter of the disposal site. These samples represent leachate generated under anaerobic conditions. Additionally, to judge the characteristics of leachate generated under aerobic conditions, a 400 liter lysimeter was set up with representative solid waste delivered to the disposal site and monitored for several months. The results of the analyses are shown in Table 1. A review of the data indicate that no obvious link exists between the concentrations of key analytes in the leachate samples and their corresponding concentrations in the surrounding groundwater or sea water samples. Concentrations of analytes in the leachate are typical of those that would be expected from wastes that are predominantly domestic in origin. Therefore, the conclusions are that the potential of contamination of groundwater or sea water from leachate is insignificant and therefore that the expense of a bottom liner was not warranted.

Based on the analysis of the leachate, the results of the field investigations, and the need to secure cover soil for closing the old disposal area and for daily cover, the floor of the expansion area has been designed as an excavation (of about 50 m in width and 400 m in length) consisting of a sloping bottom excavated from east to west. The availability of excavated soil has virtually eliminated the need and expense of purchasing cover material from offsite. The excavation is to proceed ahead of the advance of the landfilling operation such that 50 m of distance will always be between the wastes in the cells and the far end of the excavation. The sloping of the floor of the excavation and the 50 m of separation are intended to assure that wastes are never sitting in ponded water. Additionally, as mentioned above, drainage and erosion control systems are included in the landfill design to divert potential run-on as much as possible from coming into contact with the wastes. Run-off and run-on are diverted from landfill and from the bottom of the excavation to the far western end of the site to an old cinder pit where the accumulated liquid is allowed to percolate into the soil. In the future, groundwater quality monitoring

Table 1. Summary of Leachate and Water Analyses

		LEACHATE (1997)				GROUNDWATER (1997, except as noted)								SEAWATER (1997)		LYSIMETER (1997)	
		Leachate Sample #				Nearest Groundwater Monitoring Wells (b)				ASEPA							
Parameter	Units	1/Toe	2/Toe	3/Top	ASEPA Top[a]	2 1989	3 1989	4 1989	6 1989	Fagatele Bay Spg (diss)[a]	Fagatele Bay Spring	SE Cove	SW Cove	Larson Bay Seawater	Fagatele Bay Seawater	Lys-13 (S#Lys1)	Lys-48 (S#Lys2)
pH		7.9	7.3	7.46	nr	7.6	7.5	7.7	7.3	nr	7.89	9.08	8.7	8.05	8.54	5.81	7.06
COD	mg/l	623	412	202	nr					nr	<10	10	<10	250	250	7260	3400
EC	umhos/cm	4340	3620	1470	nr					nr	320	840	850	26000	3400000	4110	1750
Ca	mg/l	44	110	117	72	diss 33	32	27	7.3	34	34	35	40	440	420	296	160
Na	mg/l	520	520	76.3	1700	diss 21	23	59	13	24	23	130	97	10000	9400	227	200
Mg	mg/l	31	52	48.2	55	diss 12	11	20	6.3	9.9	11	21	20	1500	1400	87.2	57
NH4	mgN/l	201	100	77.2	nr					nr	<0.2	<0.2	<0.2	<0.2	<0.2	154	142
TKN	mgN/l	315	176	85.3	nr				1.1	nr	<0.5	<0.5	<0.5	<0.5	<0.5	240	160
Total P	mgP/l	1.12	4.06	0.92	nr	0.1	0.1	0.04	0.04	nr	<0.06	0.03	0.02	<0.01	<0.01	10.6	0.7
As	ug/l	<500 *	<500 *	15.4	nr	<1	<1	<1	<1	nr	<5	<5	<5	<5	<5	22	9
Ba	ug/l	87	360	188	87	<100	<100	<100	<100	<2	<50	<50	<50	<50	<50	461	310
Cd	ug/l	<1000 *	<5 *	<5 *	19	<1	<1	<1	<1	<2	<5	<5	<5	<5	<5	<5	<5
Cr	ug/l	<50 *	140	32	73	2	3	2	2	<5	6	<5	<5	<5	<5	38.5	5
Cu	ug/l	<100 *	300	128	420	3	<12	2	3	<10	<50	<50	<50	<50	<50	15.8	<50
Hg	ug/l	0.67	1.4	<0.2 *	nr	<0.1	0.1	<0.1	<0.1	nr	<0.8	<0.8	<0.8	<0.8	<0.8	<0.54	<0.8
Mn	ug/l	260	1200	1160	400	<10	<10	<10	<10	<1	<20	<20	<20	<20	<20	7240	7100
Ni	ug/l	<100 *	160	<30 *	<100 *					<10	<50	<50	<50	<50	<50	55.8	<50
Pb	ug/l	<100 *	110	75.2	<100 *	2	<3	2	<1	<10	<5	<5	<5	<17	<18	<25	<5
Zn	ug/l	190	610	2420	390	<10	10	<10	<10	<3	<50	<50	<50	<50	<50	467	400
Fe	mg/l	nr	nr	nr	8500	<10	30	10	10	8	0.052	<.05	<.05	<.05	<.05	nr	100
Nitrate-N	mg/l	nr	nr	nr	nr	nr	nr	nr	nr	nr	<0.2	2	0.3	<0.2	<0.2	nr	<0.2
Nitrite-N	mg/l	nr	nr	nr	nr	nr	nr	nr	nr	nr	<0.2	<0.2	<0.2	<0.2	<0.2	nr	<0.2
K	mg/l	160	170	37	nr	diss 8.4	9.6	18	4.9	nr	4.7	12	12	520	520	225	200
Lab/(Source)		AC	AC	AC	(EPA)	(USGS)	(USGS)	(USGS)	(USGS)	(EPA)	McC	McC	McC	McC	McC	AC	McC

a: Reported as dissolved concentrations.

b: For metals, all values are total concentrations except in the cases of concentrations for Ca, Na, Mg, and K among Samples 2,3,4,and 6, which are reported as dissolved (diss) concentrations.

* = [ ] less than value listed.

nr = not reported.

wells will be installed at specified locations around the landfill for the purpose of monitoring potential impacts of the new landfill operation.

As the excavation of the expansion area commenced, the flattening and stabilization of the southern slope was also commenced as part of the expansion plan. The steep face was contoured to a finished slope of 1:2 (vertical:horizontal). The process involved pushing wastes with a bulldozer from the top edge of the slope down to the area of the expansion in gradual stages from east to west until the desired slope was achieved.

No landfill gas control has been recommended for the site at this time for several reasons. The reasons include the fact that the surrounding subsurface soils and cover materials are highly permeable. Thus, the gas is free to vent and the risk of accumulation of explosive levels of landfill gas is considered very low. Landfill gas monitoring is included in the overall plan.

The landfill expansion was officially opened for operation on September 8, 1998.

CONCLUSIONS

The management of solid waste in American Samoa has been improved substantially through an orderly process of planning and implementation. Both the waste collection system and the disposal system have been improved to reflect modern waste management practices, while at the same time taking into account the availability of local resources and the ability of the island to finance the improvements. In addition to proper methods of planning and design, a key component in the successful implementation of the improvements has been the training of local staff to properly manage and operate the systems.