2002- Oahu- FEIS-
Waimanalo Gulch Landfill H

Appendix H

Final Supplemental Environmental Impact Statement (FEIS)

WAIMANALO GULCH SANITARY LANDFILL EXPANSION

Waimanalo Gulch, Oahu, Hawaii
TMK: 9-2-03:072 and 073

Appendix H - Alternatives Analysis for Disposal of Municipal Refuse, Pacific Waste Consulting Group

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Alternatives Analysis for Disposal of Municipal Refuse

December 2002

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1 EXECUTIVE SUMMARY

This Appendix details analysis of alternative sites and technologies that could be used rather than the Expansion of the Waimanalo Gulch Landfill and is part of the *Waimanalo Gulch Sanitary Landfill Expansion Final EIS.*

This analysis reviews the alternatives for replacing the Landfill within a five–year period. As such, the alternative technologies and sites must be able to be placed into operation within five years to be considered an acceptable alternative. Given that the alternative must be in use prior to the end of the five–year period, one of the key determining factors is whether all of the permitting, design, and construction activities can be accomplished within the five-year period. The more desirable alternatives are those with the least time between selection of the alternative and the opening of the new facility.

The "Project" for EIS purposes is

> *to evaluate the impacts of landfilling at the Waimanalo Gulch Landfill for five years starting when the landfill receives the expansion permit.*

The alternatives are other landfill sites and new technologies that could reduce or eliminate the need for a landfill. Technologies that could reduce the need for a landfill are included since use of two or more of them together was considered to potentially eliminate the need for a landfill. The "No Action" alternative is also included.

Alternative Sites

The following potential landfill sites were evaluated as alternatives:

a. The 42 sites included in the draft EIS for the 15 year landfill expansion (the Expansion EIS);

b. Makakilo Gulch (the closed Palailai Landfill);

c. The site identified in reports provided by private parties to assist the C&C in preparation of the Expansion EIS (these sites are the Ameron Kapaa Quarry Site and the Central Oahu site that has been the subject of state legislation in the last two sessions); and

d. The exporting of the waste to one or more sites located outside of the island of Oahu. The export sites are the West Hawaii Landfill in the County of Hawaii and the Altamont Landfill located in California.

The evaluation of the sites was accomplished in the following steps

- Application of the Federal landfill exclusion criteria. These criteria related to siting in areas that are within an airport restriction area and in floodplains, wetlands, fault areas seismic impact zones, and unstable areas. Federal regulations preclude or severely limit siting in areas that violate the exclusion criteria.

- Evaluation of landfill capacity to identify the sites with the greatest life. Using two or more smaller sites is less desirable than one larger site as it impacts more areas, is more costly due to lack of economies of scale, and is more complex and time consuming to permit. The beneficial aspect of using two sites is to potentially reduce the cost of transportation to the sites (they might be more proximate to the locations that waste is generated).

The sites, in order of the capacity estimate, are listed in **Table ES-1.**

Table ES-1 - Potential Landfill Site

Site	TMK	Years
Kaloi	9-2-2, 3, 4	37
Ohikilolo	8-3-1:13	24
Makaiwa	9-2-3	23
Waimanalo South	4-1	21
Nanakuli	8-7-9:1 & 3 and	20
Ameron Quarry	4-2-015-001	18
Makakilo Quarry	9-2-003-082	16
Waimanalo North	4-1-8:13	15
Maili	8-7-10:3	14
Waimanalo Gulch Expansion	9-2-3:72 & 73	14
Bellows	4-1-15	11
Kahe	3-1-42:por 6	11
Makua	8-1-1 and 8-2-1	11
Punaluu	5-3	11
Waikane	4-8	11
Kunia B	9-4-3:por 19	11
Waianae Expansion	8-50-3/;1, 29-32	10

Alternative Technologies

The following alternative technologies to reduce or eliminate the need for a landfill were evaluated:

- All of the technologies included in the Expansion EIS (plasma arc processing, transformation of waste into a construction material using pressure and a chemical binder, metal recycling, and gypsum (wall board) recycling. The ability of these technologies to eliminate the need for a landfill ranges from potentially complete elimination of disposal need to minor diversion from disposal.

- Additional recycling programs. These programs are not expected to eliminate the need for a landfill, but will reduce the amount of material for which disposal is needed. In general, they can be implemented in one to two years.

- Expansion of the H-POWER incinerator by adding a third boiler. This alternative will reduce the material for disposal. It should be in operation before the five years elapses.

The following programs are suggested for the C&C to pursue as they have demonstrated long–term cost–effectiveness.

- The third boiler at H-POWER
- Wood recovery at the landfill
- Metal recovery at the landfill
- Gypsum recovery at the landfill
- Enhanced enforcement of landfill bans
- Aggressive implementation of the bottle bill (while this is a state responsibility, the C&C should actively participate in the process)
- Consideration of establishment of user fees for residential refuse collection to encourage recycling.

The information about the technologies was taken from several reports the C&C had commissioned to review the alternatives over the last several years. These reports have evaluated plasma systems (those most often suggested as replacement for the landfill and H-POWER) and came to the following conclusions.

- None of the three processes (two plasma systems and a waste compression system) has a plant that has been operating on MSW, so all three fail the primary evaluation criteria.

- The tests indicate the Hawaii Medical Vitrification facility would have produced a negative 3,366 kWh per ton of refuse derived fuel (from H-POWER) if the Syngas had been burned in an efficient combined cycle generating system (the HMV facility uses less efficient engine generators). By comparison, H-POWER produced a positive 712 kWh per ton of RDF in 2001. Both energy values exclude the energy required to prepare the RDF from municipal solid waste.

- If the processing capacity at HMV were increased to the four tons per day design capacity, and if the electric energy input remained the same, the HMV plant would still have produced less electric energy than it consumed (a negative 299.2 kWh per ton of RDF).

- The disposal of MSW using conventional waste-to-energy technology, such as H-POWER, is well established. The oldest WTE plant has been operating continuously since the 1970's. By contrast, disposal of MSW using plasma technology is just beginning. There are no continuously operating MSW plasma facilities in the United States and only two operating in the rest of the world. These two facilities have an average throughput of less than 100 tons per day and the oldest facility has been operating since 1999.

- The lack of operating history is an inherent problem with new technologies. Previous experience with WTEs shows that the nature of MSW, particularly its heterogeneity, presents a set of problems that are solved only through operating experience.

- It is not unusual for the financing process for a new technology to take several years.

- There is risk associated with the disposal MSW if the project is delayed, operates below design capacity, or does not work at all. To illustrate the risk for the project proponent, assume that a 15-year contract is awarded for a plant to dispose of 150 TPD of MSW for a tipping fee of $75 per ton. In the worst case scenario, the plant does not work, so that the proponent must repay its loan and is responsible for disposing of 150 TPD of waste at a price that may exceed the tipping fee for the next

15 years. For the proponent of a new technology, this additional risk may limit or eliminate the interest in responding to the RFP.

- If the city does not accept a portion of the disposal risk, the proponent's risk could increase beyond the original investment. Whether the risk is limited to a specific dollar amount or is unlimited will have a bearing on the proponent's ability to obtain financing for the project. Although this "disposal" risk is common in the MSW facilities with which we are familiar, it is a key consideration with a new technology. In Hawaii with its limited access to alternative means of disposal, it will have a clear bearing on the proponent's interest in the Project.

The "No Action" Alternative

This alternative would have landfilling at the Waimanalo Gulch Landfill cease with no alternative site or technology available. That condition will result in the shutdown of the H-POWER incinerator as there will be no disposal location for ash produced. Shutting down H-POWER will also stop disposal of most of the solid waste that is generated in the C&C. Taken together these actions will result in a health and safety catastrophe.

2 INTRODUCTION

This section discusses the basis for the alternatives analysis.

2.1 Purpose and Scope of the Analysis

This Appendix provides the details of the analysis of alternatives to the Expansion of the Waimanalo Gulch Landfill for a five-year period. The Appendix will be part of the *Waimanalo Gulch Sanitary Landfill Expansion Revised Supplemental EIS.*

> The Project for the purposes of this revised supplemental EIS is continued operation of the Waimanalo Gulch Landfill for a five-year period subsequent to approval of all permits.

The Office of the Mayor in Honolulu issued the following statement on May 12, 2002 [1] (quoted in part):

> "Managing Director Ben Lee released the following statement today:
>
> > 'By expanding H-Power and developing a cutting edge recycling technology park we believe we can dramatically reduce the need for landfill space on this island. Therefore, instead of extending the life of the Waimanalo Gulch landfill by 15 years, the Mayor has instructed us to reduce the extension to only five years. But, phasing out the Waimanalo Gulch landfill can only happen with Council support..."

Later the City Council approved the purchase of land for a technology park.

This analysis reviews the alternatives for replacing the Waimanalo Gulch Landfill within the five year period. As such, the alternative technologies and sites must be able to be placed into operation within five years to be considered an acceptable alternative. The more desirable alternatives are those with the least time between selection of the alternative and the opening of the new facility. Given that the alternative must be in use prior to the end of the five year period, one of the key determining factors is whether all of the permitting, design, and construction activities can be accomplished within the five-year period.

2.1.1 Sources of Data

Information contained in this analysis is from the City and County of Honolulu (C&C), Department of Environmental Services (ENV), and from research performed for ENV to investigate waste collection and diversion programs on Oahu. In particular, information from the following studies are used to establish the existing composition of solid waste on Oahu, and the potential for use of alternative technologies to reduce or eliminate continued dependence on sanitary landfills:

> <u>Waste Composition Study, Oahu Municipal Refuse Disposal Alternatives Study, May 1999</u> (Appendix A).

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[1] News Release, Public Communications Division, Department of Customer Services, City & County of Honolulu, 523 - 4385

New Systems Research for Refuse Disposal, Oahu Municipal Refuse Disposal Alternatives Study, April 2000 , Department of Public Works, August 1977; (Appendix B)

Inventory Study of Potential Sanitary and Demolition Landfill Sites, City and County of Honolulu, Department of Public Works, August 1977: (Appendix C)

Supplement to Inventory of Potential Sanitary and Demolition Landfill Sites on the Island of Oahu, City and County of Honolulu, Department of Public Works, November 1979; (Appendix D) and,

Solid Waste Integrated Management Plan, City and County of Honolulu, Department of Public Works, 1995, Chapter 10 (Appendix E).

2.2 Alternatives Evaluated

The "Project" for EIS purposes is to evaluate the impacts of landfilling at the Waimanalo Gulch Landfill for five years starting upon approval of the permits. The alternatives to the Project comprise other landfill sites and new technologies that could reduce or eliminate the need for a landfill. Technologies that could reduce the need for a landfill are included since use of two or more of them together is considered to potentially eliminate the need for a landfill. The "No Action" alternative is also included.

In general the site selection, permitting, design and construction time is expected to require at least four years. Some may require more than five years.

1. Alternative Sites to be evaluated are the following:

   a. The 42 sites included in the draft EIS for the 15-year landfill expansion (the Expansion EIS);

   b. Makakilo Gulch (the closed Palailai Landfill);

   c. The site identified in reports provided by private parties to assist the City in preparation of the Expansion EIS (these sites are the Ameron Kapaa Quarry Site) and the Central Oahu site has been the subject of state legislation in the last two sessions; and

   d. The exporting of the waste to one or more sites located outside of the island of Oahu. The export sites are the West Hawaii landfill in the County of Hawaii and the Altamont Landfill located in California

2. Alternative Technologies to be evaluated are the following:

   a. All of the technologies included in the Expansion EIS (plasma arc processing, HYDROMEX (transformation of waste into a construction material using pressure and a chemical binder), metal recycling, and gypsum (wall board) recycling. The ability of these technologies to affect the need for a landfill ranges from potentially complete elimination of disposal need to minor diversion from disposal.

   b. Additional recycling programs. These programs are not expected to eliminate the need for a landfill, but will reduce the amount of material for which disposal is needed. In general, they can be implemented in one to two years.

c. Expansion of the H-POWER incinerator by adding a third boiler. This alternative will reduce the material for disposal. It should be in operation before the five years elapses. It will require more landfill capacity to dispose of ash under present regulations.

3. The "No Action" Alternative. This alternative would have landfilling at the Waimanalo Gulch Landfill cease with no alternative site or technology available. That condition will result in the shutdown of the H-POWER facility as there will be no disposal location for ash produced. Shutting down H-POWER will also stop disposal of most of the solid waste that is generated on Oahu. Taken together these actions will result in a health and safety catastrophe.

2.3 The Waste Management Setting

There are three primary components involved in the management of solid waste: collection, diversion, and disposal.

2.3.1 Waste Collection

The C&C of Honolulu is divided into seven collection districts (the Honolulu District is informally divided into East Honolulu and West Honolulu). These districts are: Honolulu (East and West Honolulu); Ewa; Koolaupoko; Koolauloa; Wahiawa; Waialua; and Waianae **(Figure 2-1)**.

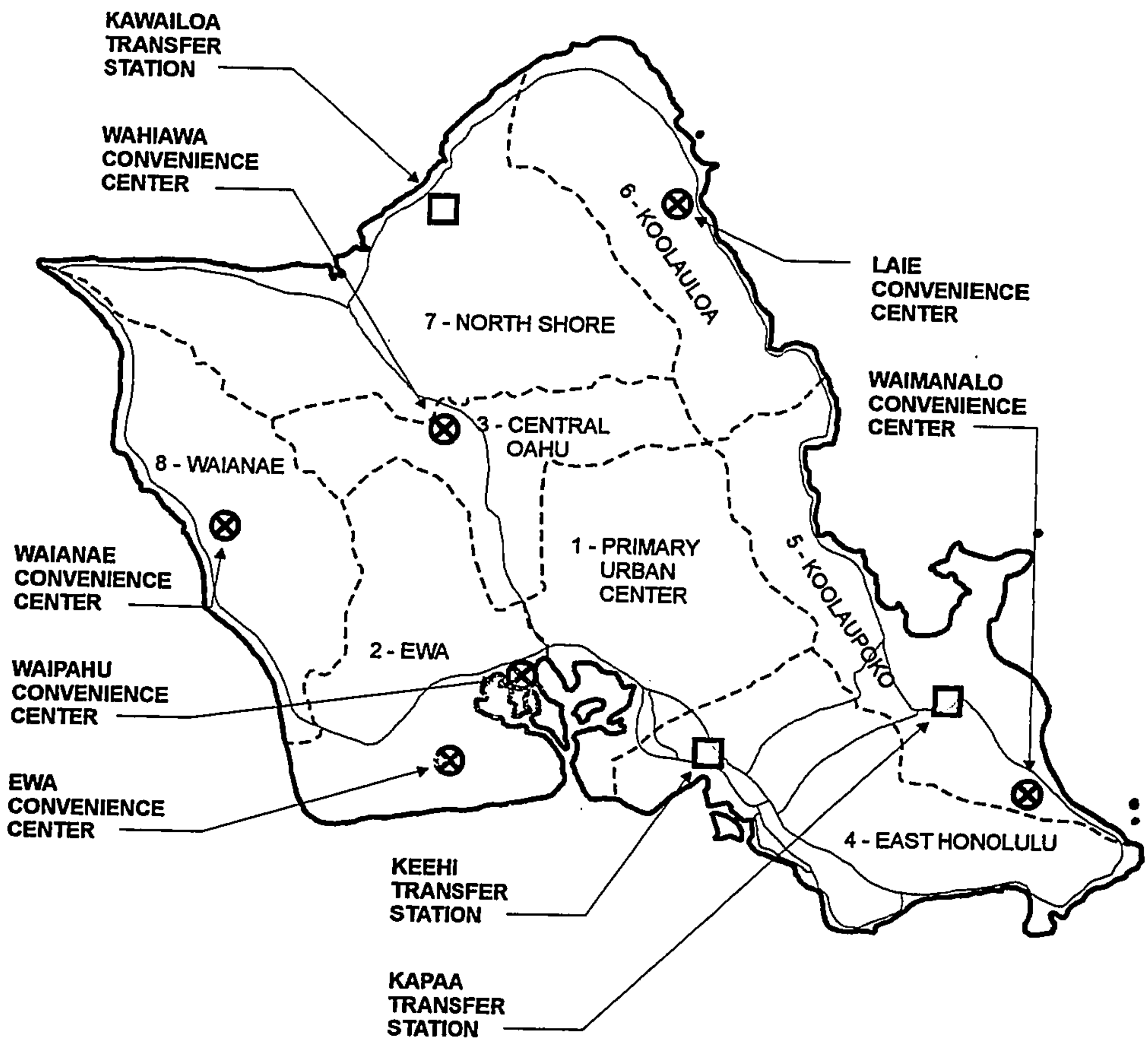
Waste from the collection districts is sent either to one of three transfer stations or directly to the disposal site, depending on distance from the route to the disposal point. The three transfer stations are located at Keehi, Kapaa, and Kawailoa, and are owned and operated by the City.

Residential waste from single-family dwellings is collected by the ENV Refuse Division. The Refuse Division also collects some multi-family units, and small business commercial waste. Private haulers collect most of the waste from apartment buildings and commercial facilities. The City also offers curbside collection of bulky items.

Depending on the route either automated or manual trucks are used for residential waste collection. In districts with automated collection services, green waste is collected separately twice per month. All automated service areas have additional on-call green waste collection services for excess material. In areas with manual collection, green waste is collected with the rubbish. Residential waste is collected twice per week.

The City also operates a system of six convenience centers where residents can drop off their waste. Depending on the type of material, waste from convenience centers is recycled, combusted, or disposed of in a landfill. These centers are at the following locations **(Figure 2-1)**:

- Waimanalo Refuse Convenience Center - located on Hihimanu Street near the Waimanalo Wastewater Treatment Plant.
- Ewa Refuse Convenience Center - located on Geiger Road next to the Honouliuli Wastewater Treatment Plant.
- Waipahu Refuse Convenience Center - located on Waipahu Depot Road south of Farrington Highway.
- Laie Refuse Convenience Center - located north of Laie, on Kamehameha Highway next to the City Refuse Division Laie Collection Base Yard.



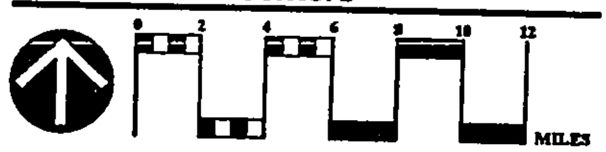
LEGEND

- - - - - - - Collection District

□ Transfer Station

⊗ Convenience Center

FIGURE 2-1
Location of Collection Districts, Waste Transfer Stations and Convenience Centers



Alternatives Analysis for Disposal of Municipal Solid Waste (MSW)
Dept. Of Environmental Services (ENV) • C & C Honolulu
Waste Management of Hawaii, Inc.

R.M. TOWILL CORPORATION

* Source: C & C Honolulu, ENV 2000

- Waianae Refuse Convenience Center - located off of Plantation Road and Hoopuhi Road north of the Waianae Intermediate School.

- Wahiawa Refuse Convenience Center - located on Wilikina Drive near the intersection with Kamananui Road.

2.3.2 Diversion

Waste diversion involves recovery and recycling efforts that reduce the amount of waste requiring disposal. Existing waste diversion programs in the C&C include the following:

- Community recycling drop-off containers located at various schools and commercial facilities, such as grocery stores and supermarkets around the island. Materials collected include cardboard, paper, plastic, bottles, aluminum cans, and glass bottles.

- Green waste processing is done at two locations, the same under private operation. Both operations produce both mulch and compost. The finished product is marketed in retail stores and in wholesale bulk.

- A statewide advance disposal fee for glass provides an incentive for glass recycling. A fee of 1.5 cents is collected for each glass container entering the state. The processor is paid eight cents per pound for the recycled glass.

- The Partnership for the Environment is a City-supported organization comprised of representatives from companies that have extensive commercial recycling activities. The Partnership acts as an information resource for expanding commercial recycling on Oahu.

- The City requires recycling of glass containers from bars and restaurants. It also requires office buildings greater than 20,000 square feet in size to recycle office paper, newspaper, and cardboard.

- Restaurants and other facilities that generate food waste are required to recycle that material.

- The City has a program to recycle materials from its offices.

- There are two private operations that offer residential curbside collection by subscription.

- While not City-sponsored, there are commercial programs to recycle construction and demolition waste, tires, and appliances.

- Diversion in form of landfill bans.

In addition to the above, the City has contracted for a sludge drying facility which is intended to process sewage sludge into a marketable product. Dewatered sewage sludge is currently sent to the Waimanalo Gulch Sanitary Landfill for disposal. The proposed project will convert this waste into an organic fertilizer which can be used in various applications. The project is planned for startup in 2004. We have assumed this material will cease disposal at the landfill.

2.3.3 Disposal

Disposal is the last component of the waste management system. The C&C owns two disposal facilities (which are operated by contractors), and a third is privately owned and operated. The City facilities are the Waimanalo Gulch Sanitary Landfill and H-POWER. PVT Land Company operates a private construction and demolition landfill facility.

H-POWER is a waste-to-energy plant that processes about 2,000 tons of waste per day (approximately 582,000 tons of waste in 2001) and generates electricity (approximately 282,043 MW hours in 2001). The average disposal at H-Power has been 607,000 tons per year, in excess of the plant's 600,000 ton capacity. Ferrous metals are reclaimed prior to incineration of waste, and non-ferrous metals are reclaimed from the ash following incineration.

The Waimanalo Gulch Sanitary Landfill accepts MSW and the ash and residue from H-POWER. MSW comes mostly from commercial waste haulers and private self-haulers. Some of the convenience center waste is also taken to the Waimanalo Gulch Landfill.

The PVT Landfill accepts only inert construction and demolition materials. It is not permitted to accept MSW and could not accept most of the material sent to the Waimanalo Gulch Landfill.

2.4 Amount of Disposal

The total amount of material sent for disposal in 2001 is indicated in several tables in this section. **Table 2-1**, *Total Disposal by Source*, shows the tonnage of material from Refuse Division collections, other C&C agencies, collections, private garbage haulers, and others that haul their own garbage.

Some of the tonnage estimates do not agree in different tables due to adjustments in the measuring systems. The difference in the total tonnage is less than 0.75 percent so is deemed to be insignificant.

Table 2-1, Total Disposal by Source

Customer	Tons
Waimanalo Gulch Landfill	
C&C Refuse Division	110,796
C&C Other Agencies	51,150
Waste Haulers	339,082
Other Customers	2,255
Individuals	2,953
Total Waimanalo Gulch Landfill	506,237
H-POWER	
C&C Refuse Division	279,318
C&C Other Agencies	1,458
Waste Haulers	266,422
Other Customers	28,264
Individuals	6,974
Total H-POWER	582,436
Total Disposal	**1,088,673**

Table 2-2, Disposal by Customer Type and Facility, shows the amount of waste disposed by the different types of customers at H-POWER and Waimanalo Gulch Landfill.

Table 2-2, Disposal by Customer Type and Facility

Customer Type	H–POWER	Waimanalo Gulch Landfill	Total
Residential	264,522	93,514	358,036
Convenience Center	1,086	20,235	21,321
Commercial	309,855	202,207	512,062
Haulers	266,422	183,561	449,983
Other C&C	1,458	16,391	17,849
Other Private Parties	28,264	2,255	30,519
H–POWER Ash		84,421	84,421
H–POWER Residue		78,512	78,512
Sludge		34,759	34,759
C&C Sources		33,090	33,090
Other Sources		1,670	1,670
Other		605	7,579
Total	871,607	514,253	1,096,690

Table 2-3, Disposal by Facility for Each Month, shows the tons of disposal and percentage of disposal for H-POWER and Waimanalo Gulch Landfill for each month of 2001. The disposal at Waimanalo Gulch Landfill reached a peak in March when H-POWER was down for scheduled maintenance.

Table 2-3, Disposal by Facility for Each Month

Month	Tons			Percentage of Annual		
	Waimanalo Gulch	H–POWER	Total	Waimanalo Gulch	H–POWER	Total
Jan	34,164	56,392	90,557	7%	10%	8%
Feb	36,850	48,915	85,765	7%	8%	8%
Mar	63,302	17,876	81,178	13%	3%	7%
Apr	43,917	43,657	87,574	9%	7%	8%
May	39,242	56,735	95,977	8%	10%	9%
Jun	35,229	60,212	95,441	7%	10%	9%
Jul	40,569	55,751	96,320	8%	10%	9%
Aug	46,781	48,436	95,217	9%	8%	9%
Sep	34,022	51,826	85,848	7%	9%	8%
Oct	44,403	50,639	95,042	9%	9%	9%
Nov	43,506	43,481	86,987	9%	7%	8%
Dec	44,252	48,515	92,767	9%	8%	9%
Annual	506,237	582,436	1,088,673			

This document is focused on analyzing alternatives for use of the Waimanalo Gulch Landfill. As such, the focus of the document is that material which is accepted at the landfill. The next section discusses the composition of Oahu's waste stream and the material accepted at the Waimanalo Gulch Landfill.

2.5 Composition of the Waste

Information about the overall waste stream on Oahu is included because that is the waste stream that must be accepted when H-POWER is shut down (usually for two to three weeks per year). The information about the composition of the waste disposed at Waimanalo Gulch Landfill is discussed in greater detail as that is the material most often accept at the landfill. The alternative technology or site will need be able (either technically capable or permitted) to accept this material most of the time and the waste described by the overall composition for a short time. This data is taken from the report prepared for the C&C in 1999 that analyzed the composition of the waste stream.[2]

The composition of the waste is based on the 1999 composition data and the latest full year of disposal data (2001) available at the time this report was prepared. There have been changes to the waste management system that are expected to affect the accuracy of these estimates. The primary change is the expansion of the green waste (garden trimmings, grass, leaves, and branches) collection program that would remove material from the disposal stream to the recycled stream.

For all the composition data the estimates of precision were calculated at a 90 percent confidence interval. As an example of how the data can be used, newspaper is estimated to be 3.7 percent of the total waste. The ± 0.3 percent indicated is the precision of the estimate. That means that the report authors were 90 percent certain that the true amount of newspaper in the waste is between 3.4 (3.7 minus 0.3) and 4.0 (3.7 plus 0.3) percent.

2.5.1 Overall Waste Composition

The composition of the overall waste stream is indicated in **Table 2-4**, *Overall Waste Composition*. These composition values were taken before two additional city recycling programs (the expanded green waste program and the expanded drop off program) were in operation. As a result, the composition of the waste stream today differs from that measured in 1999. The 1999 values are the best that is available at this time in the City so are used for this analysis.

The total tons indicated in **Table 2-4**, 898,997 tons of (MSW) is only the rubbish that is disposed of. It does not include the sludge, H–POWER ash or H–POWER residue that are disposed in the Waimanalo Gulch Landfill.

[2]Oahu Municipal Refuse Disposal Alternatives Study, Waste Composition Study, May 1999, R. M. Towill Corp., Cascadia Consulting Group, Solid waste Associates.

Table 2-4: Overall Waste Composition

	Composition		Estimated Tons	
Calculated at 90% confidence	Mean	+/-	Mean	+/-
Paper	26.2%		235,737	
Newspaper	3.7%	0.3%	33,126	2,690
Cardboard	6.7%	0.7%	60,354	6,495
High Grade	1.6%	0.4%	14,492	3,850
Low Grade	9.0%	0.7%	80,542	6,004
Compostable	3.9%	0.6%	35,005	5,330
Other Paper	1.4%	0.2%	12,218	2,204
Plastics	7.7%		69,009	
PET #1 Bottles	0.4%	0.0%	3,699	430
HDPE #2 Bottles	0.4%	0.0%	4,042	340
Other Bottles	0.1%	0.0%	1,042	236
Other Rigid Plastic	2.4%	0.2%	21,270	1,959
Film Plastic	3.6%	0.4%	32,732	3,599
Mixed Plastic/Other Materials	0.7%	0.1%	6,224	1,329
Metal	6.5%		58,816	
Aluminum Cans	0.5%	0.0%	4,317	436
Tin Cans	0.9%	0.1%	8,179	887
Ferrous	2.2%	0.5%	19,482	4,423
NonFerrous	0.4%	0.2%	3,496	1,763
Mixed Metals/Other Materials	2.6%	0.6%	23,341	5,671
Glass	1.9%		17,004	0
Glass Containers	1.6%	0.2%	14,286	1,503
Other Glass	0.3%	0.1%	2,718	1,237
Other Inorganics	5.2%		46,675	
Gypsum Wallboard	1.4%	0.5%	13,029	4,796
Asphalt Roofing	0.3%	0.3%	2,918	2,607
Asphalt Paving	0.3%	0.3%	2,873	3,066
Concrete	0.6%	0.4%	5,440	3,494
Sand/Soil/Dirt	0.9%	0.5%	8,156	4,099
Ceramic Products	0.2%	0.2%	2,203	1,911
Misc Inorganics	1.3%	0.6%	12,057	5,437
Other Wastes	3.1%		27,783	
Hazardous/Chemicals	0.3%	0.1%	3,082	1,103
Furniture/Mattresses	1.9%	0.6%	17,382	5,051
Brown Goods (appliances)	0.8%	0.5%	7,319	4,377
Yard Waste	17.9%		160,931	
Yard Waste	17.9%	1.7%	160,931	14,863
Wood	12.0%		108,238	
Untreated Lumber	1.8%	0.5%	15,761	4,593
Untreated Plywood	0.9%	0.4%	8,226	3,491
Pallets/Crates	4.8%	2.1%	43,002	18,670
Treated Wood	3.9%	0.9%	35,191	7,666
Stumps	0.7%	0.3%	6,058	2,947
Other Organics	19.4%		174,805	
Food	12.0%	1.1%	108,254	9,952
Textiles	1.7%	0.3%	15,718	2,847
Carpet	1.9%	0.8%	17,342	6,905
Tires	0.1%	0.1%	1,171	1,226
Misc Organics	3.6%	0.5%	32,320	4,232
Total Tonnage			898,997	

2.5.2 Residential Waste Composition

In 2001, a total of 358,036 tons residential waste was disposed in the C&C (this total excludes sludge and H-POWER ash and residue and construction and demolition waste that was disposed at the PVT landfill). As shown in **Figure 2-2,** the most prevalent materials in the overall waste stream are paper, other organics (which includes food, carpeting, and textiles), and yard waste. The paper, other organics, and yard waste categories account for well over half (63.5%) of the overall waste stream. The percentages may not add to 100 because of rounding.

Table 2-5, *Residential Waste Composition,* identifies the detailed composition of the overall residential waste stream.

2.5.3 Commercial Waste Composition

In 2001, the commercial waste stream comprised a total of 512,062 tons of waste. The overall commercial composition results, by weight, for each of the disposal categories are indicated in **Table 2-6.** As shown in **Figure 2-3,** paper, yard waste, and other organics (primarily food) accounted for 61.4% of the waste in the residential sub-stream. Totals may not add to 100% because of rounding.

2.5.4 Convenience Center Waste Composition

Convenience Center waste is dropped off by residents and hauled by the Refuse Division. In 2001, waste from the convenience centers was a total of 27,176 tons.

Overall commercial composition results, by weight, are shown in **Table 2-7.** Paper, other organics (including food, carpeting, and textiles), and wood categories accounted for 41.6% of the overall commercial waste as shown in **Figure 2-4.** The percentages may not add up to 100 because of rounding.

2.6 Waimanalo Gulch Landfill Waste

In 2001, a total of 514,253 tons of waste (including ash, residues, and sludge) was deposited at the Waimanalo Gulch Landfill. Combustible waste is sent to H-POWER. Non-combustible waste are sent to recyclers or to the Waimanalo Gulch Landfill. The sources and types of waste disposed at the Waimanalo Gulch Landfill are shown in **Table 2-8,** *Waste Disposed in the Waimanalo Gulch Landfill.*

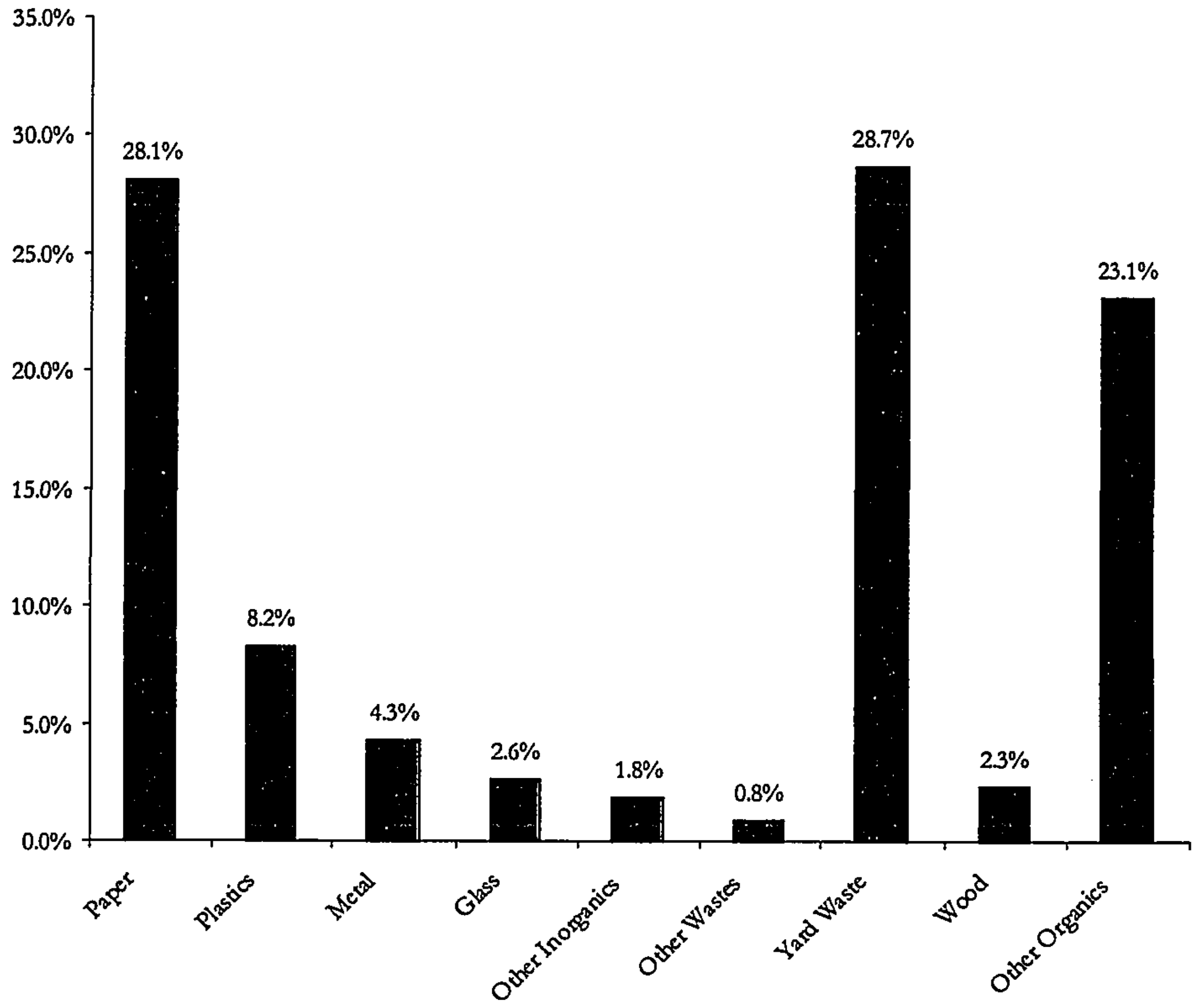


FIGURE 2-2
Residential
Waste Composition

Alternatives Analysis for Disposal of Municipal Solid Waste (MSW)

Dept. Of Environmental Services (ENV) • C & C Honolulu
Waste Management of Hawaii, Inc.

R.M. TOWILL CORPORATION

* Source: C & C Honolulu, ENV 2000

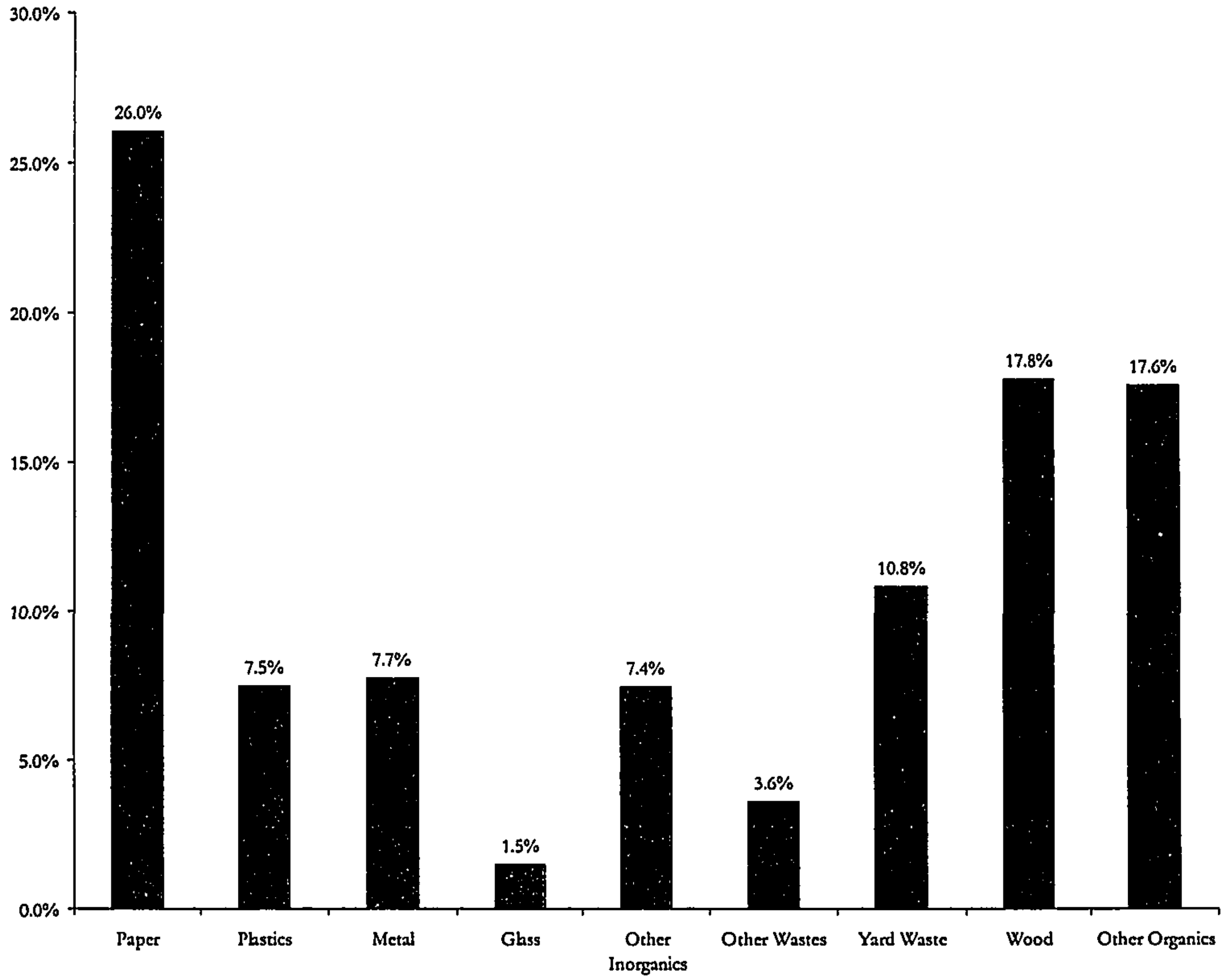


FIGURE 2-3
Commercial
Waste Composition

Alternatives Analysis for Disposal of Municipal Solid Waste (MSW)

Dept. Of Environmental Services (ENV) • C & C Honolulu
Waste Management of Hawaii, Inc.

R.M. TOWILL CORPORATION

* Source: C & C Honolulu, ENV 2000

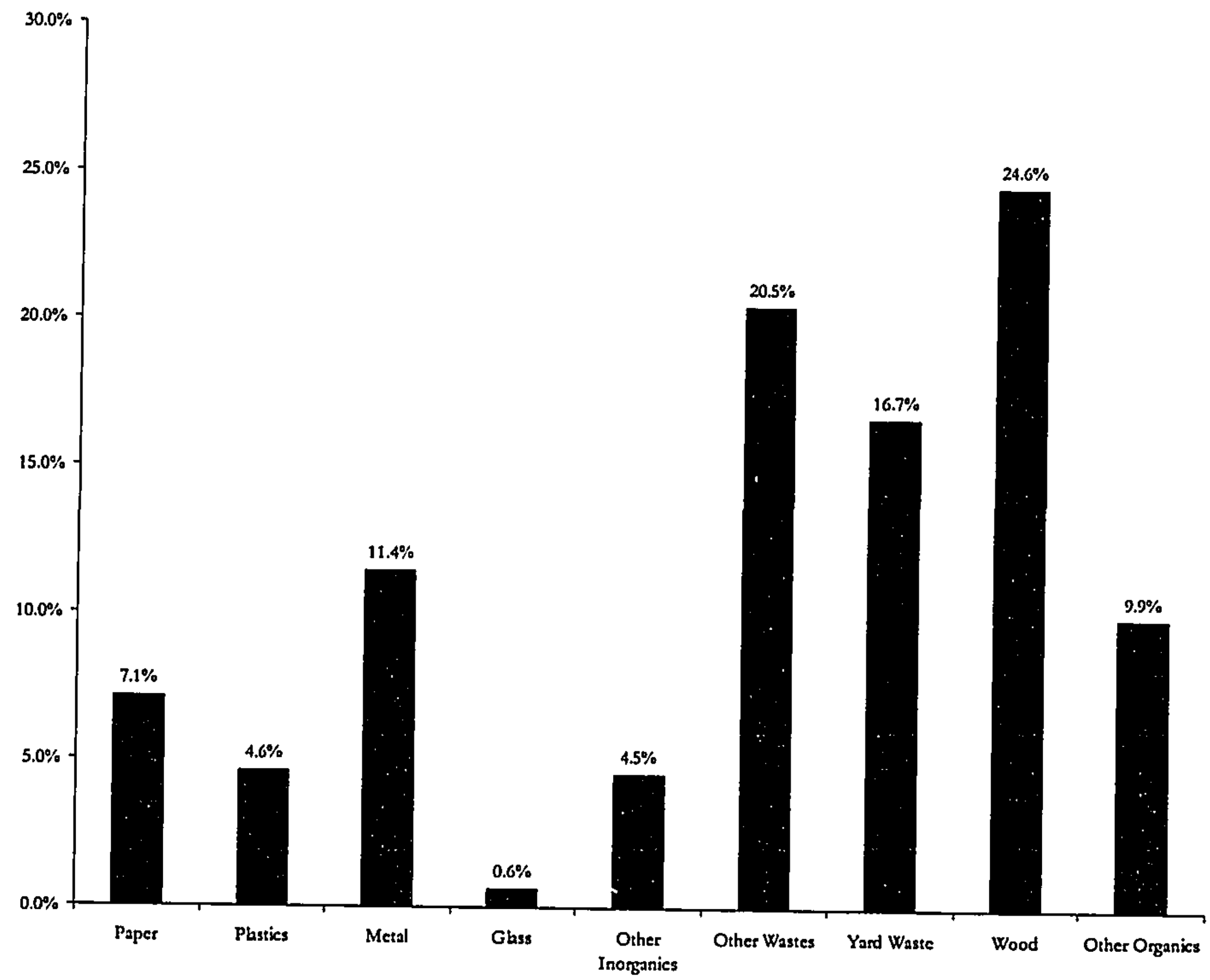


FIGURE 2-4
Convenience Center
Waste Composition

Alternatives Analysis for Disposal of
Municipal Solid Waste (MSW)
Dept. Of Environmental Services (ENV) • C & C Honolulu
Waste Management of Hawaii, Inc.

R.M. TOWILL CORPORATION

* Source: C & C Honolulu, ENV 2000

Table 2-5, Residential Waste Composition

	Composition		Estimated Tons	
Calculated at 90% confidence interval	Mean	+/-	Mean	+/-
Paper	28.1%		100,698	
Newspaper	6.5%	0.5%	23,386	1,786
Cardboard	4.6%	0.4%	16,565	1,454
High Grade	1.1%	0.2%	4,007	820
Low Grade	11.4%	0.6%	40,718	2,053
Compostable	3.2%	0.2%	11,321	775
Other Paper	1.3%	0.2%	4,701	682
Plastics	8.2%		29,426	
PET #1 Bottles	0.5%	0.0%	1,767	142
HDPE #2 Bottles	0.7%	0.0%	2,445	163
Other Bottles	0.2%	0.0%	572	122
Other Rigid Plastic	2.4%	0.2%	8,525	579
Film Plastic	3.8%	0.2%	13,714	639
Mixed Plastic/Other Materials	0.7%	0.2%	2,404	656
Metal	4.3%		15,446	
Aluminum Cans	0.6%	0.1%	2,078	195
Tin Cans	1.2%	0.1%	4,304	331
Ferrous	0.7%	0.2%	2,661	739
NonFerrous	0.3%	0.1%	1,025	211
Mixed Metals/Other Materials	1.5%	0.3%	5,378	1,045
Glass	2.6%		9,370	0
Glass Containers	2.4%	0.2%	8,415	766
Other Glass	0.3%	0.2%	955	596
Other Inorganics	1.8%		6,593	
Gypsum Wallboard	0.2%	0.2%	809	849
Asphalt Roofing	0.1%	0.1%	382	207
Asphalt Paving	0.0%	0.0%	71	101
Concrete	0.2%	0.1%	561	311
Sand/Soil/Dirt	0.5%	0.2%	1,661	645
Ceramic Products	0.1%	0.1%	319	299
Misc Inorganics	0.8%	0.3%	2,789	917
Other Wastes	0.8%		2,980	
Hazardous/Chemicals	0.4%	0.2%	1,346	614
Furniture/Mattresses	0.1%	0.1%	342	247
Brown Goods (appliances)	0.4%	0.2%	1,292	693
Yard Waste	28.7%		102,638	
Yard Waste	28.7%	1.9%	102,638	6,885
Wood	2.3%		8,211	
Untreated Lumber	0.5%	0.1%	1,965	506
Untreated Plywood	0.1%	0.1%	275	213
Pallets/Crates	0.0%	0.0%	58	67
Treated Wood	1.0%	0.2%	3,585	860
Stumps	0.6%	0.3%	2,327	1,211
Other Organics	23.1%		82,674	
Food	15.4%	1.0%	55,168	3,434
Textiles	2.2%	0.3%	7,741	1,119
Carpet	0.9%	0.2%	3,223	833
Tires	0.0%	0.1%	174	204
Misc Organics	4.6%	0.4%	16,368	1,605
TOTAL TONNAGE			358,036	

Table 2-6 Commercial Waste Composition

	Composition		Estimated Tons	
Calculated at 90% confidence interval	Mean	+/-	Mean	+/-
Paper	26.0%		133,377	
Newspaper	2.0%	0.4%	10,043	2,015
Cardboard	8.3%	1.2%	42,659	6,207
High Grade	2.0%	0.7%	10,319	3,688
Low Grade	7.8%	1.1%	39,785	5,547
Compostable	4.6%	1.0%	23,404	5,167
Other Paper	1.4%	0.4%	7,166	2,041
Plastics	7.5%		38,363	
PET #1 Bottles	0.4%	0.1%	1,929	398
HDPE #2 Bottles	0.3%	0.1%	1,629	295
Other Bottles	0.1%	0.0%	476	200
Other Rigid Plastic	2.3%	0.4%	11,979	1,813
Film Plastic	3.7%	0.7%	18,851	3,472
Mixed Plastic/Other Materials	0.7%	0.2%	3,498	1,134
Metal	7.7%		39,631	
Aluminum Cans	0.4%	0.1%	2,204	384
Tin Cans	0.8%	0.2%	3,869	809
Ferrous	3.0%	0.8%	15,320	4,246
NonFerrous	0.5%	0.3%	2,344	1,714
Mixed Metals/Other Materials	3.1%	1.1%	15,895	5,437
Glass	1.5%		7,596	0
s Glass Containers	1.2%	0.2%	5,932	1,280
Other Glass	0.3%	0.2%	1,664	1,070
Other Inorganics	7.4%		38,142	
Gypsum Wallboard	2.3%	0.9%	11,628	4,621
Asphalt Roofing	0.4%	0.5%	2,196	2,527
Asphalt Paving	0.5%	0.6%	2,746	3,001
Concrete	0.9%	0.7%	4,680	3,405
Sand/Soil/Dirt	1.2%	0.8%	6,277	3,963
Ceramic Products	0.3%	0.4%	1,735	1,842
Misc Inorganics	1.7%	1.0%	8,879	5,246
Other Wastes	3.6%		18,425	
Hazardous/Chemicals	0.3%	0.2%	1,710	909
Furniture/Mattresses	2.2%	0.9%	11,274	4,778
Brown Goods (appliances)	1.1%	0.8%	5,440	4,226
Yard Waste	10.8%		55,494	
Yard Waste	10.8%	2.5%	55,494	12,955
Wood	17.8%		91,062	
Untreated Lumber	2.5%	0.9%	12,614	4,460
Untreated Plywood	1.4%	0.7%	7,319	3,391
Pallets/Crates	8.1%	3.6%	41,720	18,281
Treated Wood	5.2%	1.4%	26,752	7,381
Stumps	0.5%	0.5%	2,657	2,575
Other Organics	17.6%		89,972	
Food	10.4%	1.8%	53,092	9,183
Textiles	1.4%	0.5%	7,423	2,565
Carpet	2.5%	1.3%	12,959	6,681
Tires	0.1%	0.2%	706	1,159
Misc Organics	3.1%	0.8%	15,792	3,846
Total Tonnage			512,062	

Table 2-7 Overview of Convenience Center Waste Composition

Calculated at 90% confidence interval	Composition Mean	Composition +/-	Estimated Tons Mean	Estimated Tons +/-
Paper	7.1%		1,940	
Newspaper	0.8%	0.4%	226	119
Cardboard	2.6%	0.7%	701	185
High Grade	0.3%	0.3%	71	77
Low Grade	1.8%	0.5%	480	143
Compostable	0.5%	0.4%	140	96
Other Paper	1.2%	0.9%	322	254
Plastics	4.6%		1,250	
PET #1 Bottles	0.1%	0.0%	18	10
HDPE #2 Bottles	0.0%	0.0%	12	6
Other Bottles	0.0%	0.0%	3	2
Other Rigid Plastic	2.7%	1.0%	722	285
Film Plastic	0.7%	0.2%	197	61
Mixed Plastic/Other Materials	1.1%	0.5%	298	138
Metal	11.4%		3,110	
Aluminum Cans	0.2%	0.1%	52	30
Tin Cans	0.2%	0.1%	59	38
Ferrous	4.3%	1.7%	1,155	462
NonFerrous	0.4%	0.2%	101	62
Mixed Metals/Other Materials	6.4%	1.9%	1,743	518
Glass	0.6%		168	0
Glass Containers	0.3%	0.2%	80	50
Other Glass	0.3%	0.2%	87	52
Other Inorganics	4.5%		1,233	
Gypsum Wallboard	1.2%	0.8%	339	223
Asphalt Roofing	1.0%	1.1%	279	288
Asphalt Paving	0.0%	0.0%	0	0
Concrete	0.4%	0.6%	108	156
Sand/Soil/Dirt	0.5%	0.6%	128	170
Ceramic Products	0.4%	0.6%	112	160
Misc Inorganics	1.0%	1.0%	266	260
Other Wastes	20.5%		5,561	
Hazardous/Chemicals	0.1%	0.1%	31	29
Furniture/Mattresses	18.6%	4.3%	5,061	1,175
Brown Goods (appliances)	1.7%	1.0%	469	262
Yard Waste	16.7%		4,541	
Yard Waste	16.7%	4.2%	4,541	1,138
Wood	24.6%		6,678	
Untreated Lumber	3.3%	1.1%	895	308
Untreated Plywood	1.6%	1.3%	444	360
Pallets/Crates	1.2%	1.1%	314	289
Treated Wood	14.8%	3.8%	4,026	1,030
Stumps	3.7%	2.1%	999	579
Other Organics	9.9%		2,696	
Food	2.3%	0.9%	612	237
Textiles	2.2%	0.9%	592	249
Carpet	3.3%	2.3%	906	637
Tires	0.9%	0.9%	258	231
Misc Organics	1.2%	0.9%	329	251
Total Tonnage			27,176	

Table 2-8, Sources of Waste Disposed in the Waimanalo Gulch Landfill

Customer Type	Annual Tons
Residential	93,514
Convenience Center	20,235
Commercial	202,207
Haulers	183,561
Other C&C	16,391
Other Private Parties	2,255
H-POWER Ash	84,421
H-POWER Residue	78,512
Sludge	34,759
C&C Sources	33,090
Other Sources	1,670
Other	605
Total	**514,253**

The total amount of material that an alternate technology or site will need to accept excludes the sludge from the C&C. That material is to be processed at a sludge drying facility now being permitted at the Sand Island Wastewater Treatment Plant. The total amount of waste that needs to be accepted is 481,173 tons per year (based on the disposal in 2001). It can be disposed/ processed at more than one site and/or with more than one technology.

Composition estimates for the overall waste stream is shown in **Table 2-9,** *Waimanalo Gulch Landfill Waste Composition.* **Figure 2-5** shows the wood, the other wastes (primarily furniture/mattresses), and the yard waste categories accounted for 37.2% of the waste. The percentages may not add to 100 because of rounding.

This table provides the tonnage of material that needs to be handled by any technology alternative and an estimate of the composition to completely eliminate the need to landfill.

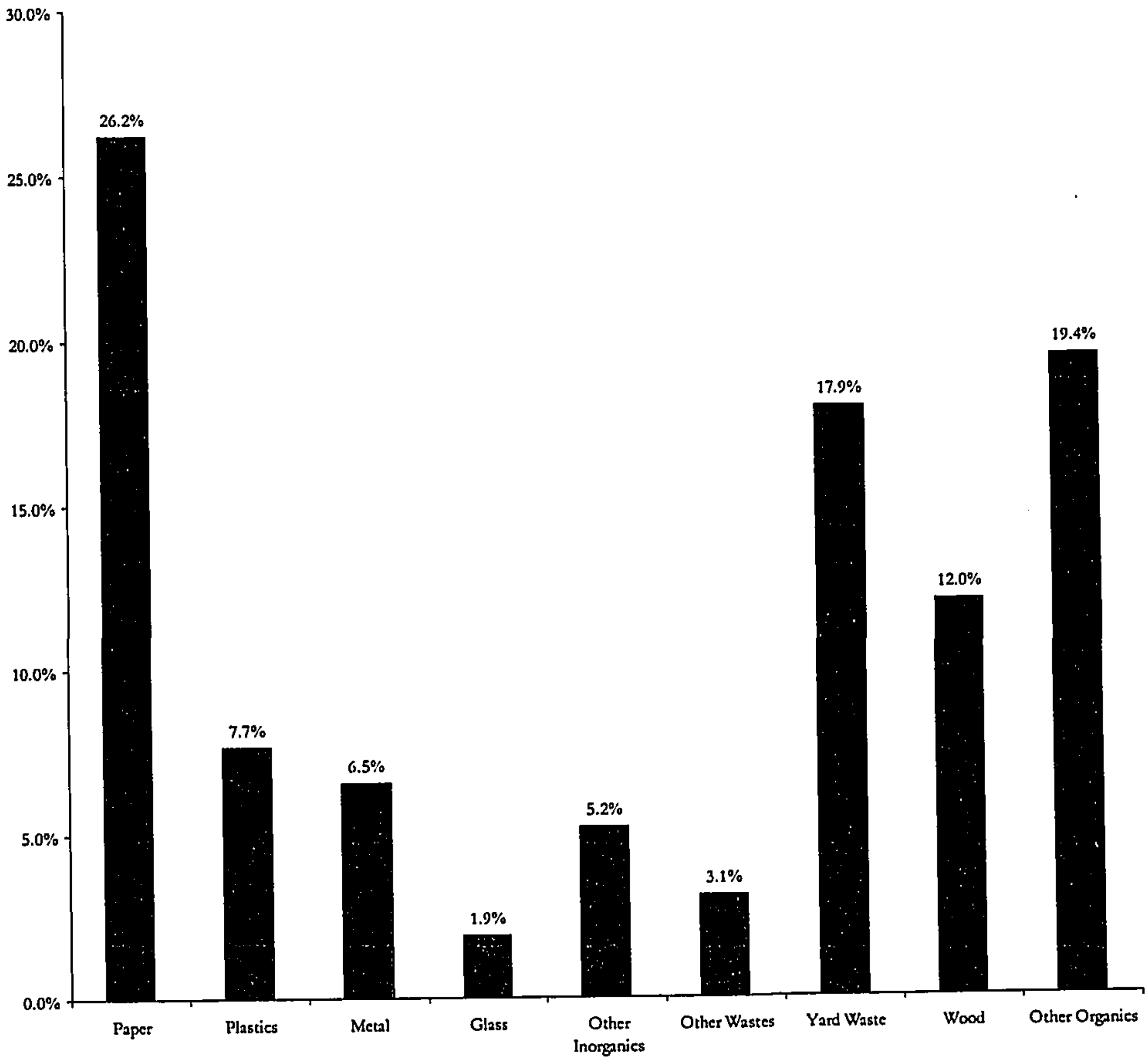


FIGURE 2-5
Waimanalo Gulch Landfill
Overall Waste Composition

Alternatives Analysis for Disposal of Municipal Solid Waste (MSW)

Dept. Of Environmental Services (ENV) • C & C Honolulu
Waste Management of Hawaii, Inc.

R.M. TOWILL CORPORATION

* Source: C & C Honolulu, ENV 2000

Table 2-9 Waimanalo Gulch Landfill Waste Composition

	Composition		Estimated Tons	
Calculated at 90% confidence interval	Mean	+/-	Mean	+/-
Paper	8.9%			
Newspaper	0.2%	0.1%	533	330
Cardboard	5.2%	1.7%	16,529	5,441
High Grade	0.5%	0.4%	1,505	1,147
Low Grade	2.2%	1.7%	6,907	5,407
Compostable	0.3%	0.2%	1,062	593
Other Paper	0.5%	0.3%	1,648	847
Plastics	5.0%			
PET #1 Bottles	0.0%	0.0%	138	78
HDPE #2 Bottles	0.0%	0.0%	90	63
Other Bottles	0.0%	0.0%	52	68
Other Rigid Plastic	1.4%	0.5%	4,533	1,616
Film Plastic	2.5%	1.8%	7,767	5,615
Mixed Plastic/Other Materials	1.0%	0.6%	3,176	1,864
Metal	12.3%			
Aluminum Cans	0.2%	0.2%	680	525
Tin Cans	0.2%	0.1%	666	383
Ferrous	6.7%	2.6%	21,125	8,106
NonFerrous	0.4%	0.2%	1,126	741
Mixed Metals/Other Materials	4.8%	2.1%	15,295	6,652
Glass	0.5%		1,709	-
Glass Containers	0.3%	0.2%	815	650
Other Glass	0.3%	0.2%	893	692
Other Inorganics	20.0%			
Gypsum Wallboard	7.0%	2.9%	22,190	9,276
Asphalt Roofing	1.4%	1.7%	4,577	5,472
Asphalt Paving	1.9%	2.1%	5,955	6,507
Concrete	2.9%	2.3%	9,177	7,274
Sand/Soil/Dirt	4.0%	2.7%	12,589	8,540
Ceramic Products	0.1%	0.1%	268	324
Misc Inorganics	2.7%	2.3%	8,664	7,144
Other Wastes	6.4%			
Hazardous/Chemicals	0.3%	0.2%	921	725
Furniture/Mattresses	5.1%	2.4%	16,093	7,705
Brown Goods (appliances)	1.0%	0.9%	3,208	2,720
Yard Waste	6.0%			
Yard Waste	6.0%	3.4%	19,063	10,693
Wood	31.2%			
Untreated Lumber	5.8%	2.3%	18,468	7,312
Untreated Plywood	2.6%	1.3%	8,233	4,190
Pallets/Crates	7.6%	2.6%	23,921	8,200
Treated Wood	13.9%	4.5%	44,077	14,200
Stumps	1.3%	1.5%	4,139	4,903
Other Organics	9.6%			
Food	1.6%	1.7%	5,087	5,329
Textiles	0.9%	0.6%	2,929	1,990
Carpet	4.5%	2.9%	14,147	9,133
Tires	0.0%	0.0%	5	9
Misc Organics	2.6%	1.8%	8,310	5,655
Total			316,560	

3 ALTERNATIVE SITES

This section reviews the alternative sites that might be considered as a replacement for the Waimanalo Gulch Landfill. The alternative sites were located on Oahu, Hawaii County, and on the mainland. The sites on Oahu are evaluated using siting criteria to eliminate the locations that have fatal flaws with respect to use for a landfill. The siting criteria are established by federal regulations and local policies and requirements with which a site must conform. The sites are then ranked by capacity as the cost and time required to site a new landfill require that the site have sufficient capacity to justify the expenditure.

Additional technical analysis and public review is needed to confirm whether a potential site is appropriate for landfilling. The public process required to obtain formal land use approval and permits to build and operate a landfill needs to be started. Both the additional technical analysis and the permitting process are beyond the scope of this analysis.

One suggestion during the discussion of the EIS on the expansion of the Waimanalo Gulch Landfill was that the C&C establish two landfill sites. The advantages, according to the commentor, was the reduced travel time if the sites were located close to the points of major waste generation.

This analysis recommends that the C&C seek one landfill site. The siting process that will be carried on after this document is completed will result in the listing of more than one potential site. There is a significant amount of technical evaluation needed to confirm the technical suitability for landfilling. There is a significant amount of public outreach needed to gain approval of a new landfill site, particularly on an island with limited land resources. To pursue more than on location simultaneously, would confuse and delay the process. In addition, operation of two sites is more costly than one as the economies of scale are better for a larger operation.

3.1 Siting Overview

The purpose of this section is to identify potential location on Oahu and in other areas that could be appropriate for landfilling. The process to identify technically suitable potential landfill sites involves application of siting criteria to first eliminate inappropriate sites and then rank the remainder. The site evaluation done here used *Exclusion Criteria* and *Landfill Capacity* for the first level evaluation. The completion of this process will involve application of *Screening Criteria* to get the final ranking. The land use and solid waste permitting process must be finished to gain approval to landfill on a site.

The Exclusion Criteria eliminate potential sites from further consideration if they do not comply with limitations established by the Federal Environmental Protection Agency (EPA). These criteria are delineated in Volume 40 of the Code of Federal Regulations (CFR), Part 258 (40CFR258), and by the State DOH in Hawaii Revised Statutes (HRS), Chapter 342.

The landfill capacity considerations involve ranking the potential sites remaining after application of the Exclusion Criteria. The sites are listed in the order of total capacity. The capacity estimate is based on estimated depth of filling and the anticipated acreage that could be filled, considering the needs for buffer areas and infrastructure areas (entrance facilities, office, maintenance shops, and other necessary support facilities). Since there has not been any design work done on the potential landfill sites and a geotechnical investigation has not established the appropriate depth for the landfill, the capacity estimates are rough indicators.

The Screening Criteria is applied after the EIS is completed and involve site specific things that are defined to reflect local considerations. They could include such things as the following factors:

- Ability to protect natural resources including groundwater, surface water, and air quality;
- Compatibility with area land uses including current uses, adjacent uses, proposed development, and future general plans;
- Potential for destruction of natural habitat including displacement of species and loss of biotic diversity;
- Potential for destruction of cultural resources;
- Technical viability including engineering feasibility, cover availability, need for further engineering, site access, and availability of utilities;
- Economic issues including development costs, analysis of haul distances, and material import costs;
- Anticipated site life; and,
- Land acquisition issues.

The steps in the landfill siting process are:

1. Define project requirements (e.g., total site life desired);
2. Identify exclusion criteria in addition to the EPA criteria;
3. Apply exclusion criteria to eliminate unacceptable sites;
4. Working with a siting committee, develop screening criteria and ranking factors;
5. Gather the technical data to enable the screening criteria to be applied;
6. Apply the screening criteria;
7. List the sites in order of overall score, with the most suitable sites listed first; and
8. Develop the environmental, land use, and permitting documentation for the most suitable sites (it may be appropriate to develop that information for the top one or two suitable sites to save time if a problem arises with one of the sites).

This document uses the EPA exclusion criteria and ranks the sites by total capacity (using the capacity data available when the report was prepared).

3.2 Exclusion Criteria

The exclusion criteria promulgated by EPA are:

1. **Airport Restriction** - Owners/operators must demonstrate that the landfill site does not constitute a bird hazard if the facility is located within 10,000 feet of the end of any airport runway used by turbojet aircraft, or within 5,000 of any airport runway used only by piston driven aircraft.

   If the owner/operator proposes construction of a landfill or expansion of an existing landfill within 5 miles of any airport, the airport and the Federal Aviation Administration (FAA) must be notified.

2. **Floodplains** - Landfills located within a 100-year floodplain cannot restrict storm flows within the floodplain, reduce the temporary water storage capacity of the floodplain, or allow the washout of solid waste.

3. **Wetlands** - Owners/operators of a proposed landfill may not build or expand into wetlands. An exception to this rule may be permitted by EPA-approved permitting programs to construct or expand a landfill only if the following can be demonstrated:

   - No other siting alternative is available;

   - Construction and operation of the landfill will not violate applicable State regulations governing water quality or discharges of toxic or hazardous effluent; jeopardize threatened or endangered species, or critical wildlife habitat; or, violate protection of a marine sanctuary;

   - The landfill will not contribute to the significant deterioration of the wetland;

   - Steps are taken to achieve no net loss of wetlands by avoiding potential for impacts where possible, sufficiently minimizing unavoidable impacts; or, making proper compensation for example, through the restoration of damaged wetlands or the creation of manmade wetlands;

4. **Fault Areas** - New landfills or landfill expansions are generally prohibited within 200 feet of fault areas that have shifted since the last Ice Age. However, the DOH Director may permit an alternative setback distance of less than 200 feet if the owner/operator can demonstrate that the landfill will maintain structural integrity in the event of a fault displacement.

5. **Seismic Impact Zones** - Landfills located in a seismic impact zone must demonstrate that the facility including, but not limited to, its liners, leachate collection system, surface water control system, and other engineering features have been designed to resist the effects of ground motion due to earthquakes.

6. **Unstable Areas** - All owners/operators must demonstrate that the structure of their units will not be compromised during geologically destabilizing events including:

   - Debris flows resulting from heavy rainfall or storm conditions;
   - Fast formation of sinkholes caused by excessive groundwater withdrawal;
   - Rockfalls which are initiated by explosives or sonic booms; and,
   - The sudden liquefaction of soil after prolonged periods of repeated wetting and drying.

Local exclusionary criteria could include siting over groundwater resource areas. Groundwater resources of Oahu are protected through the State DOH, Underground Injection Control (UIC) program, and the C&C Board of Water Supply (BWS), Groundwater Zones.

The UIC program was established in 1984. The purpose of the program is to protect the State's potable groundwater resources from pollution by subsurface wastewater disposal. The program regulations are accompanied by UIC maps which demarcate a boundary line known as the "UIC Line." Landfills are restricted on lands that are landward of the UIC Line. Lands seaward of this line, however, are not restricted from subsurface wastewater disposal by underground injection (**Figure 3-1**). Sanitary landfills and waste disposal facilities may therefore be sited makai of this zone.

Prior to 1987, groundwater recharge areas for the Island of Oahu were identified by BWS. Since 1987, the State DOH has administered the No Pass Program (**Figure 3-2**). The BWS Groundwater Zones identify areas of groundwater recharge, areas of brackish groundwater supplies, and additional areas which may be acceptable for landfill development. Areas which are considered critical for groundwater recharge have been designated the "No Pass Zone." Within this area sanitary landfill and waste disposal systems are generally not permitted. All other areas are identified as within the "Pass Zone" and have been determined to be areas where landfills and shallow waste disposal systems may be permitted. These facilities are limited to a maximum depth of 30 feet.

Protection of ground and surface water, and air quality from facilities such as sanitary landfills are through the existing environmental permit process. Protection of ground and surface waters is delegated by the EPA to the State DOH under provisions of the Federal Safe Drinking Water Act (SDWA) and Clean Water Act (CWA). These federal regulations enable the State DOH to protect Hawaii's drinking and surface waters from the siting of facilities, such as sanitary landfills, through Hawaii Administrative Rules (HAR); Chapter 11-23, Underground Injection Control; Chapter 11-55, Water Pollution Control, and the NPDES Permit program. Regulation of air quality standards are similarly delegated from the EPA to the State DOH, through the Clean Air Permit.

The DOH Director has provided some guidance about what might be needed to establish a landfill outside the UIC line.[3] In part that guidance stated:

> "Should a solid waste permit applicant propose to site a landfill over drinking water resources, the permitee will be required to demonstrate that the proposed project is protective of our groundwater resource. As seen in other states, the design of this landfill will likely be at a minimum a double composite liner system. In addition, other requirements, such as screening and monitoring, may become more stringent. Needless to say, siting a landfill over drinking water resources will increase our scrutiny over the design and operation of the landfill, as well as significantly increase the cost to design, construct, and operate the landfill."

3.3 Landfill Capacity

The amount of landfill capacity needed depends on the methods used to process MSW and the residue from those methods. This Alternatives Analysis includes several technologies that could reduce or potentially eliminate the need for a landfill. It also discusses the addition of a third boiler to H-POWER to reduce the volume of waste that needs disposal. Within the five-year horizon of this analysis, the amount of material that will require disposal can be estimated by using the amount of disposal from 2001 as a base and assuming the effectiveness at volume reduction for technologies that could be implemented in less than five years.

[3]Letter dated May 23, 2002 from Dr. Bruce Anderson, Director, StateDepartment of Health to Mr. Timothy Steinberger, Director, City Department of Environmental Services

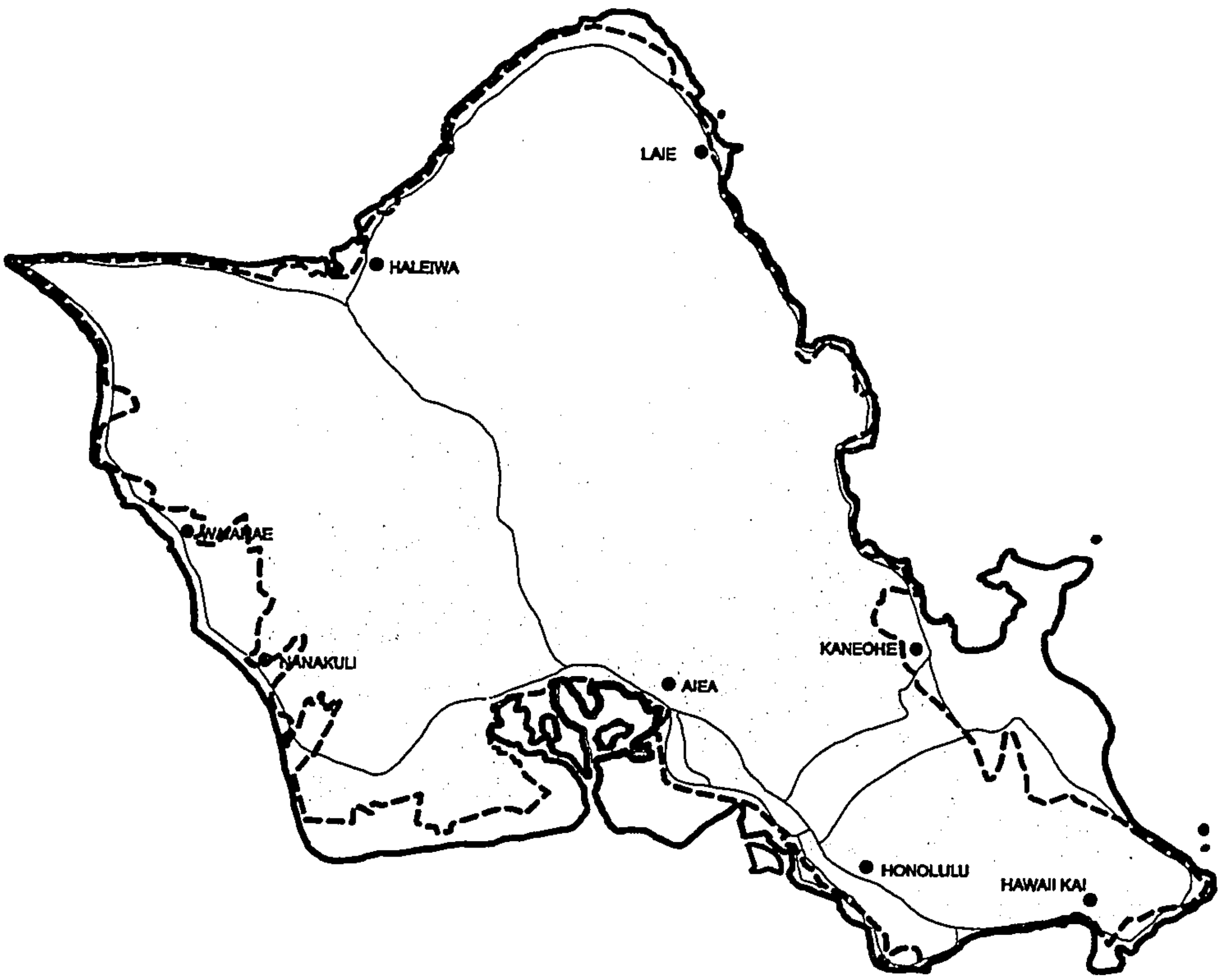
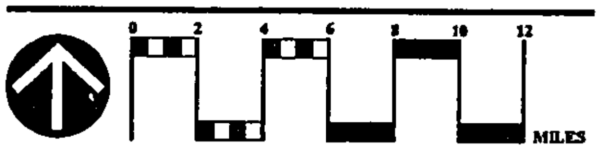


FIGURE 3-1
UIC Line



Alternatives Analysis for Disposal of Municipal Solid Waste (MSW)
Dept. Of Environmental Services (ENV) • C & C Honolulu
Waste Management of Hawaii, Inc.

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* Source: DOH, 2001

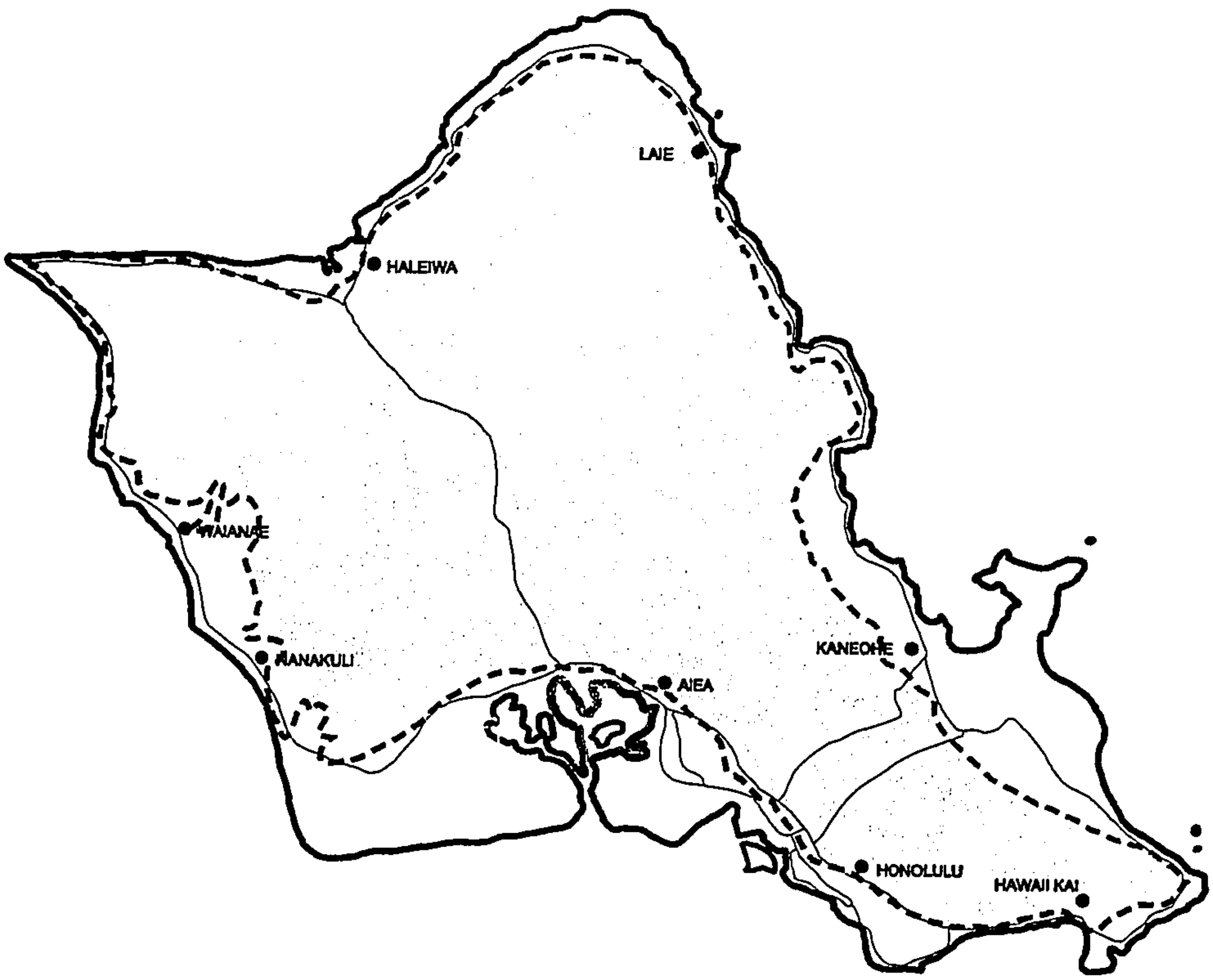


FIGURE 3-2
Board of Water Supply
Groundwater Protection Zone

Alternatives Analysis for Disposal of Municipal Solid Waste (MSW)
Dept. Of Environmental Services (ENV) • C & C Honolulu
Waste Management of Hawaii, Inc.

R.M. TOWILL CORPORATION

* Source: Board of Water Supply, 2001

The technologies that could be implemented within five years include the following:

- Metal recovery
- Gypsum recovery
- Recycling options

The volume estimate is also affected by the other projects that ENV is expecting in the five year horizon. The primary project is processing the sewage sludge that is disposed of at the Waimanalo Gulch Landfill. The disposal estimates do not include this sewage sludge. **Table 3-1,** *Landfill Capacity Needed,* shows the sources of waste and the amounts that were sent to the landfill for disposal in 2001 and will need to be disposed in the five-year period.

Table 3-1, Landfill Capacity Needed

Customer Type	Annual Tons
Residential	93,514
Convenience Center	20,235
Commercial	202,207
Haulers	183,561
Other C&C	16,391
Other Private Parties	2,255
H-POWER Ash	84,421
H-POWER Residue	78,512
Sludge (non-City sources)	1,670
C&C Sources	-
Other Sources	1,670
Other	605
Total Tonnage	**481,163**

The estimated volume that would be used for the tonnage disposed is calculated below. The volume used includes the waste material as compacted before it is covered and the amount of dirt used to cover the waste. The key assumptions in estimating the volume needed are:

- MSW is compacted to a density of 1,600 pounds per cubic yard.
- 20 percent of the MSW volume is cover material.
- The H-POWER ash is covered. It has a density of one ton per cubic yard.
- The H-POWER residue is covered, and has an in-place density of one ton per cubic yard.

The estimated capacity needed is calculated as follows. The sludge is material accepted from other than ENV sources.

Material	Amount
MSW Disposed	316,560 Tons
Sludge from Non-City Sources	605 Tons
Total MSW and Sludge	317,165 Tons
Compaction Ratio	1,600 lbs/cu. yds.
Compacted MSW and Sludge	396,456 cu. yds.
H-POWER Ash	84,421 Tons
H-POWER Residue	78,512 Tons
Total H-POWER Ash and Residue	162,933 Tons
In-Place Density	2,000 lbs/cu. yds.
Compacted Ash and Residue	162,933 cu. yds.
Total Compacted Volume	559,389 cu. yds.
Percentage of Compacted Volume that is Covered	20 %
In-Place Volume of Waste and Cover	671,267 cu. yds

A proposed landfill must provide sufficient capacity to meet anticipated needs, given current and anticipated rates of generation, an estimated 670,000 cubic yards per year. The landfill life should be at least five years, so that has been established as the minimum a site must have to be considered feasible.

There are several reasons why additional life is of significant benefit.

1. Even with use of new technologies that will facilitate the reduction of MSW landfill disposal, both existing and new technologies will require periodic down periods for maintenance, repair, or replacement of machinery. During these periods it is expected that MSW will require disposal in a landfill. Most of the advanced technologies either have a residue that needs disposal or a product that may become a residue if a market is not available (e.g., the glass slag from a plasma system). A landfill will be needed to dispose of this residue and non-marketable material.

2. The need to minimize potential for environmental impacts associated with use of two or more separate and smaller landfill facilities. The proposed development of a municipal landfill will involve the major commitment and use of both financial and environmental resources. Use of a single facility is anticipated to result in lower potential for environmental impacts than two or more separate sites. At the same time, the use of a single facility will require that the site be capable of providing sufficient capacity to meet anticipated needs.

3. Economies of scale from an appropriately sized facility would generally allow for lower refuse disposal costs than a smaller landfill.

4. The State of Hawaii and its major islands are subject to periodic natural weather influences including tropical storms and hurricanes. A landfill facility of sufficient size must be available to facilitate clean up efforts and the disposal of debris. This function is for the maintenance of public health, safety, and welfare.

3.4 Sites Reviewed in Prior City Documents

This section provides details about the sites that the C&C has investigated in prior efforts to locate landfill sites and in previous drafts of this EIS. These sites are used as the starting point for this evaluation.

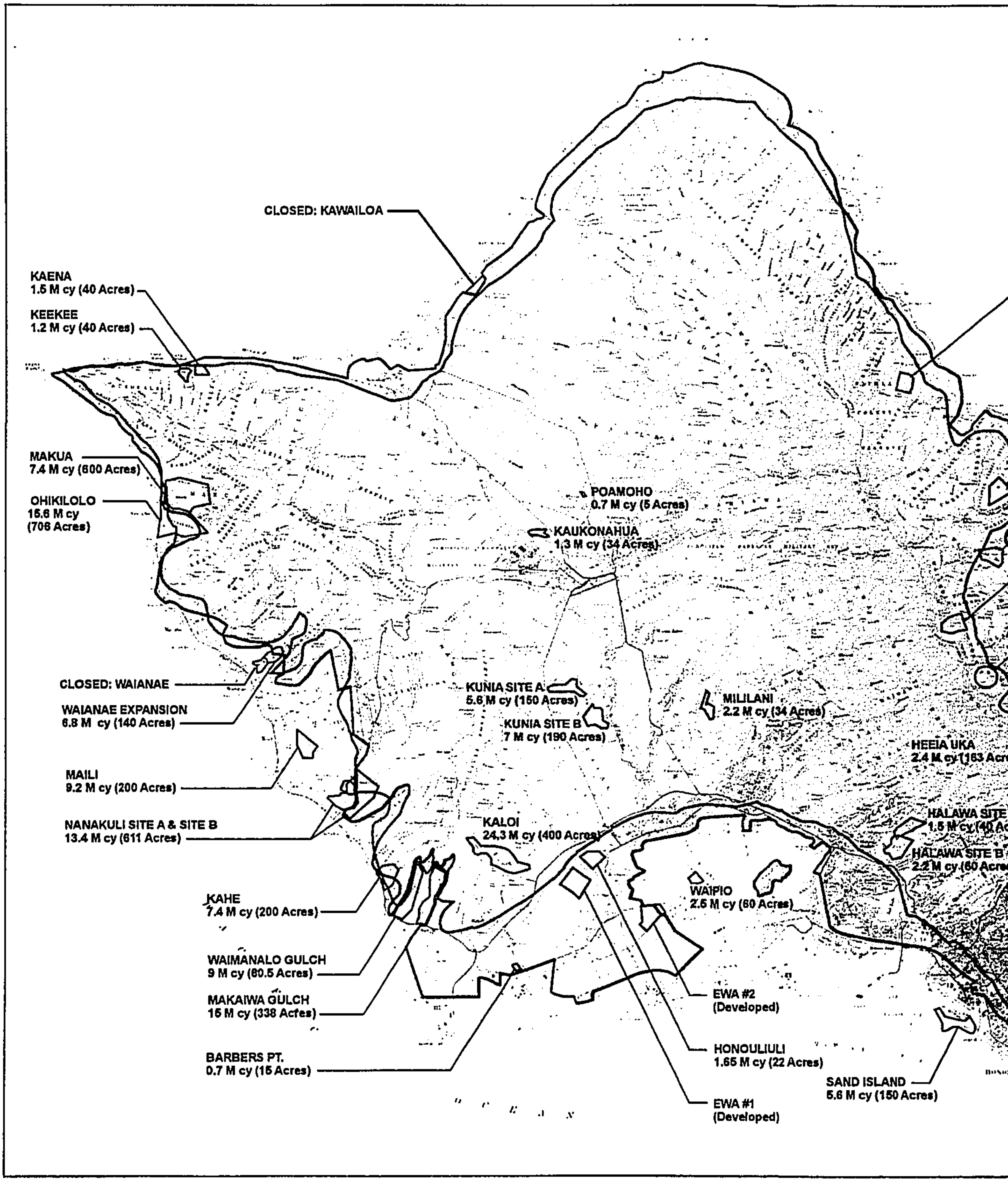
3.4.1 Overview

Over the years the C&C has had several efforts to locate landfill sites to either replace the existing landfill site at the time or provide for disposal capacity for the residue and ash from H-POWER (see Appendices C, D and E). These siting studies used technical information to identify locations that would be appropriate for landfilling from all of the potential locations on the island.

ENV has identified a total of 43 landfill sites (42 on older lists and Makakilo Gulch) based on an on-going analysis and preliminary review of locations with potential for development. These sites are identified in **Figure 3-3**. **Table 3-2** provides an itemized listing including location by name, area (by approximate TMK location), acreage, capacity, and anticipated lifespan based on waste disposal requirements.

3.4.2 Site Information

This section provides a summarized description of each of the landfill sites.


CLOSED: KAWAILOA
KAENA
1.5 M cy (40 Acres)
KEEKEE
1.2 M cy (40 Acres)
MAKUA
7.4 M cy (600 Acres)
OHIKILOLO
15.6 M cy
(706 Acres)
POAMOHO
0.7 M cy (5 Acres)
KAUKONAHUA
1.3 M cy (34 Acres)
CLOSED: WAIANAE
WAIANAE EXPANSION
6.8 M cy (140 Acres)
KUNIA SITE A
5.6 M cy (150 Acres)
KUNIA SITE B
7 M cy (190 Acres)
MILILANI
2.2 M cy (34 Acres)
MAILI
9.2 M cy (200 Acres)
NANAKULI SITE A & SITE B
13.4 M cy (611 Acres)
KALOI
24.3 M cy (400 Acres)
KAHE
7.4 M cy (200 Acres)
WAIPIO
2.5 M cy (60 Acres)
WAIMANALO GULCH
9 M cy (60.5 Acres)
MAKAIWA GULCH
15 M cy (338 Acres)
BARBERS PT.
0.7 M cy (15 Acres)
EWA #2
(Developed)
HONOULIULI
1.65 M cy (22 Acres)
SAND ISLAND
5.6 M cy (150 Acres)
EWA #1
(Developed)
HEEIA UKA
HALAWA SITE
HALAWA SITE B

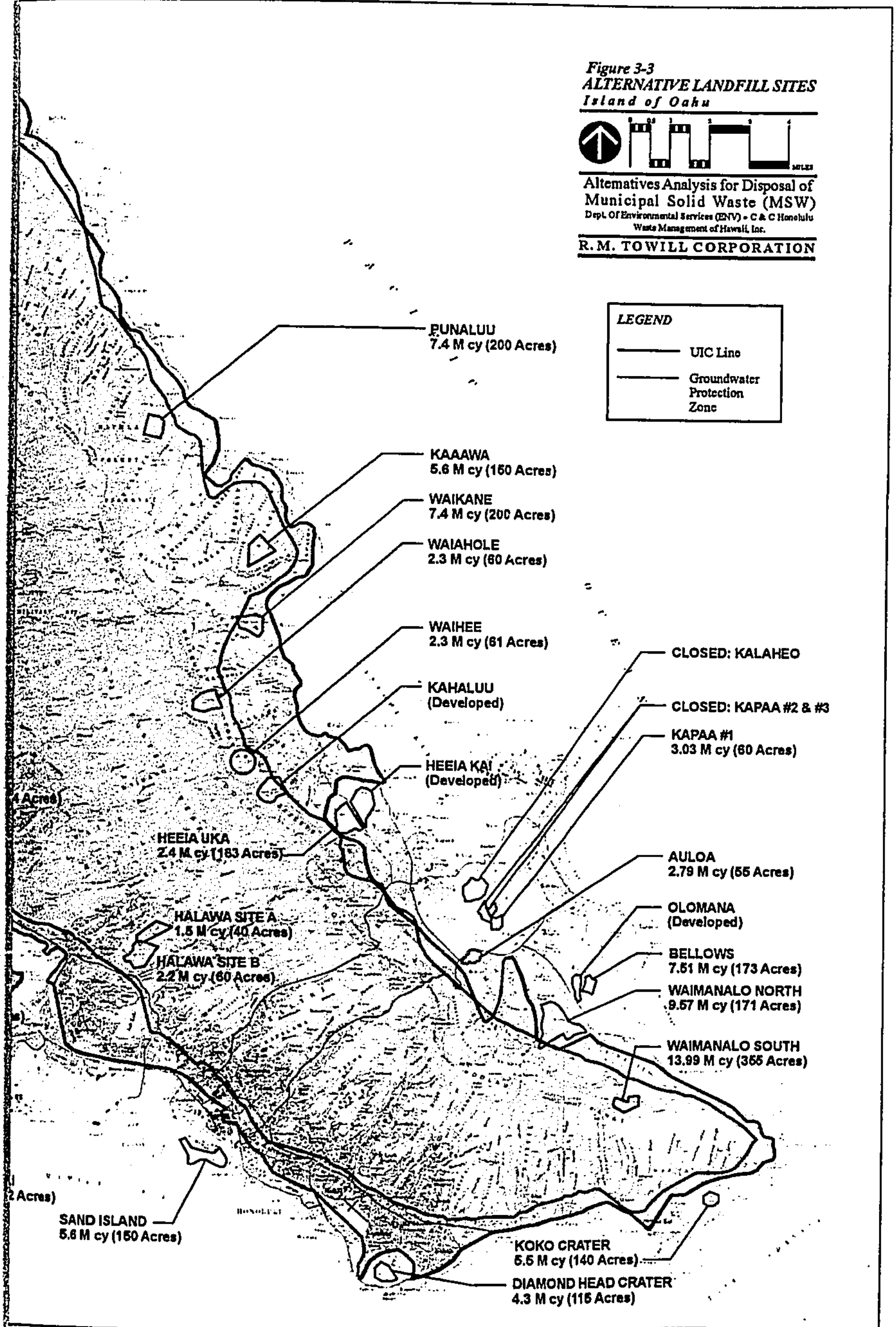


Figure 3-3
ALTERNATIVE LANDFILL SITES
Island of Oahu
Alternatives Analysis for Disposal of Municipal Solid Waste (MSW)
Dept. Of Environmental Services (ENV) • C & C Honolulu
Waste Management of Hawaii, Inc.
R.M. TOWILL CORPORATION
LEGEND
UIC Line
Groundwater Protection Zone
PUNALUU
7.4 M cy (200 Acres)
KAAAWA
5.6 M cy (150 Acres)
WAIKANE
7.4 M cy (200 Acres)
WAIAHOLE
2.3 M cy (60 Acres)
WAIHEE
2.3 M cy (61 Acres)
KAHALUU
(Developed)
HEEIA KAI
(Developed)
HEEIA UKA
2.4 M cy (163 Acres)
HALAWA SITE A
1.5 M cy (40 Acres)
HALAWA SITE B
2.2 M cy (60 Acres)
CLOSED: KALAHEO
CLOSED: KAPAA #2 & #3
KAPAA #1
3.03 M cy (60 Acres)
AULOA
2.79 M cy (55 Acres)
OLOMANA
(Developed)
BELLOWS
7.51 M cy (173 Acres)
WAIMANALO NORTH
9.57 M cy (171 Acres)
WAIMANALO SOUTH
13.99 M cy (355 Acres)
SAND ISLAND
5.6 M cy (150 Acres)
KOKO CRATER
5.5 M cy (140 Acres)
DIAMOND HEAD CRATER
4.3 M cy (115 Acres)

Table 3-2, Inventory of Potential Alternative Landfill Sites Island of Oahu (Completed from reports completed as early as 1977)

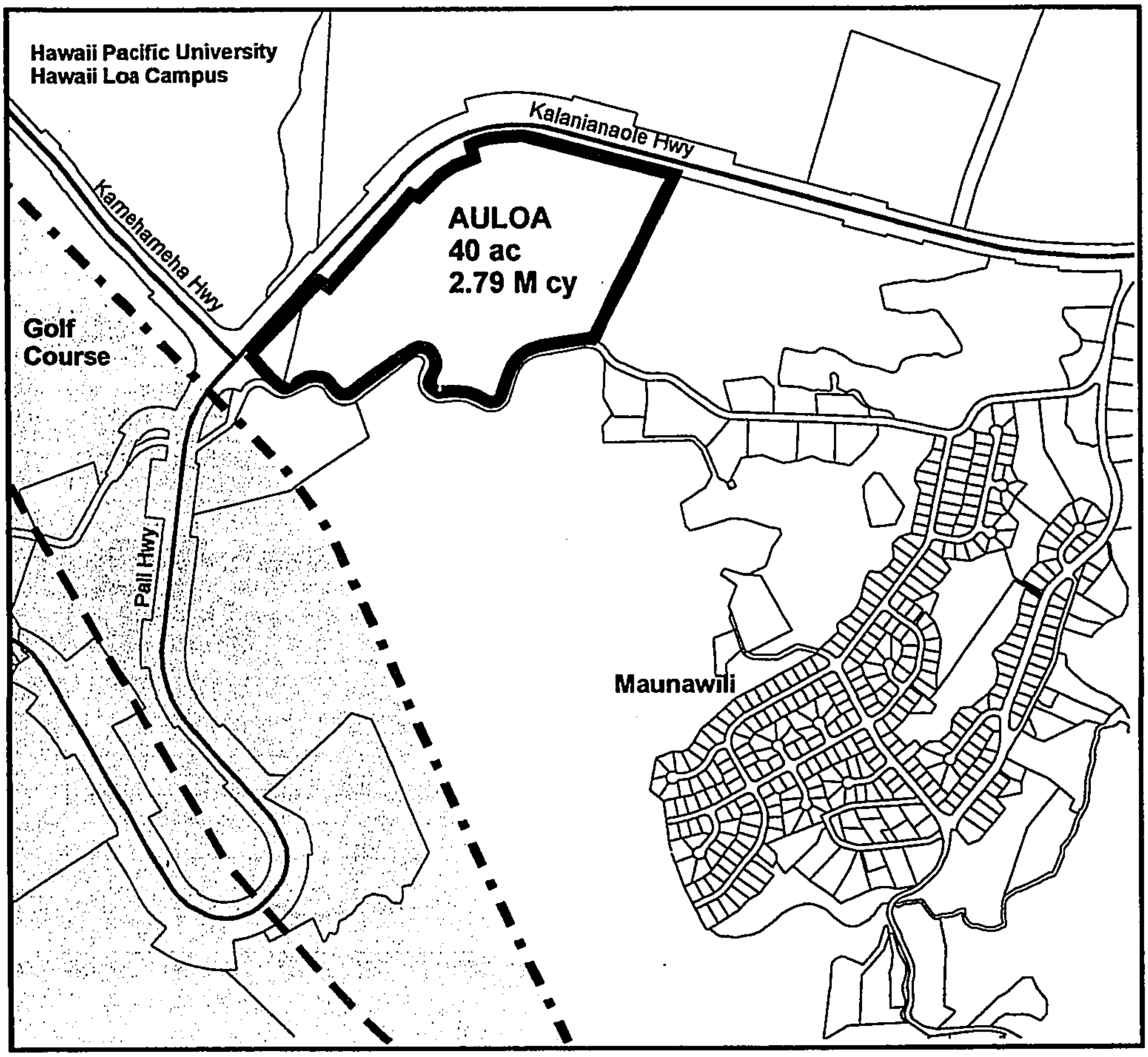
No.	Site Name	TMK	Total Acreage	Mill. Tons Capacity*	Years Lifespan*
1	Auloa	4-2-14:por 1	55.00	2.79	4.7
2	Barbers Point	9-1-16:18, por 1	15.00	0.74	1.2
3	Bellows	4-1-15	173.00	7.51	12.5
4	Diamond Head Crater	3-1-42:por 6	115.00	4.30	7.2
5	Ewa No. 1	9-1-17	-	-	-
6	Ewa No. 2	9-1-10	-	-	-
7	Halawa A	9-9-10:8,9,por 10 & 26	40.00	1.50	2.5
8	Halawa B	9-9-10:27, por 10	60.00	2.20	3.7
9	Heeia Kai	4-6	-	-	-
10	Heeia Uka	4-6-14:01	163.00	2.40	4.0
11	Honouliuli	9-1-17:por 4	22.00	1.65	2.8
12	Kaaawa	5-1	150.00	5.60	9.3
13	Kaena	6-9-1:por 3, 33 & 34	40.00	1.50	2.5
14	Kahaluu	4-7	-	-	-
15	Kahe	9-2-3:por 27	200.00	7.40	12.3
16	Kalaheo (closed)	4-2-15:por 1 & 6	-	-	-
17	Kaloi	9-2-02:por 1; 9-2-3:por 2; 9-2-4:por 5	400.00	24.30	40.5
18	Kapaa No. 1	4-4-14:por 2	60.00	3.03	5.1
19	Kapaa No. 2 & 3 (closed)	4-2-15:por 1, 3, 4, 7	-	-	-
20	Kaukonahua	7-1	34.00	1.30	2.2
21	Keekee	6-9-1:por 3 & 4, 6-9-3: por 2	40.00	1.20	2.0
22	Koko Crater	3-9-12: por 1	140.00	5.50	9.2
23	Kunia A	9-4-4: por 4	150.00	5.60	9.3
24	Kunia B	9-4-3: por 19	190.00	7.00	11.7
25	Maili	8-7-10:3	200.00	9.20	15.3
26	Makaiwa	9-2-3	338.00	15.00	25.0
27	Makua	8-1-1, 8-2-1	600.00	7.40	12.3
28	Mililani	9-5	34.00	2.20	3.7
29	Nanakuli	8-7-9:1 &3 and 8-7-21:26	611.00	13.40	22.3
30	Ohikilolo	8-3-1:13	706.00	15.60	26.0
31	Olomana	4-2	-	-	-
32	Poamoho	7-1	5.00	0.70	1.2
33	Punaluu	5-3	200.00	7.40	12.3
34	Sand Island	1-5-41	150.00	5.60	9.3
35	Waiahole	4-8	60.00	2.30	3.8
36	Waianae Expansion	8-5-3 and 6	140.00	6.80	11.3
37	Waihee	4-7	61.00	2.30	3.8
38	Waikane	4-8	200.00	7.40	12.3
39	Waimanalo Gulch Expansion	9-2-3: 72 & 73	60.50	9.00	15.0
40	Waimanalo North	4-1-08:13	171.00	9.57	16.0
41	Waimanalo South	4-1	355.00	13.99	23.3
42	Waipio	9-3-2	60.00	2.50	4.2

*Capacity is based on analysis of site characteristics, slope, and area available for development by ENV.

**Lifespan is based on capacity divided by disposal rate of 600,000 cubic yards MSW per year.

1. **AULOA** - Located south of Kalanianaole Highway, north of Auloa Road and east of the intersection at Castle Junction in Kailua. This site is comprised of a moderately deep depression between Kalanianaole Highway and Auloa Road. Elevation ranges from approximately 90 feet and rises to 330 feet relative to mean sea level (MSL). The average slope of the site is 10 percent with a low of 3 percent to a high of 40 percent. (**Figure 3-4**).

TMK:	4-2-14:por 1
Acreage:	±55 (±40 usable)
Ownership:	Trust of Harold K.L. Castle, Moanalua Farms, Limited
Adjoining Land Uses:	Adjacent to residential communities of Kailua and Maunawili. Hawaii Pacific University lies to the northwest and the Pali Golf Course lies immediately to the west, across Kamehameha Highway.
Cover Material:	Available on site
Soils Classification:	Helemano silty clay, 30% to 90% slopes Alaeloa Silty clay, 15% to 35% slopes Alaeloa silty clay, 40% to 70% slopes Hanalei stony silty clay, 2% to 6% slopes
City and County of Honolulu Zoning:	Ag-1
State Land Use District:	Conservation
Capacity:	2.79 million cubic yards
Lifespan:	±4.7 years (based on 0.6 million cubic yards per year required)



LEGEND

Site Boundary

Underground Infiltration Control (UIC) Line

Groundwater Protection Zone (GPZ) Line

FIGURE 3-4
Auloa

0 500 1000 1500 2000 FEET

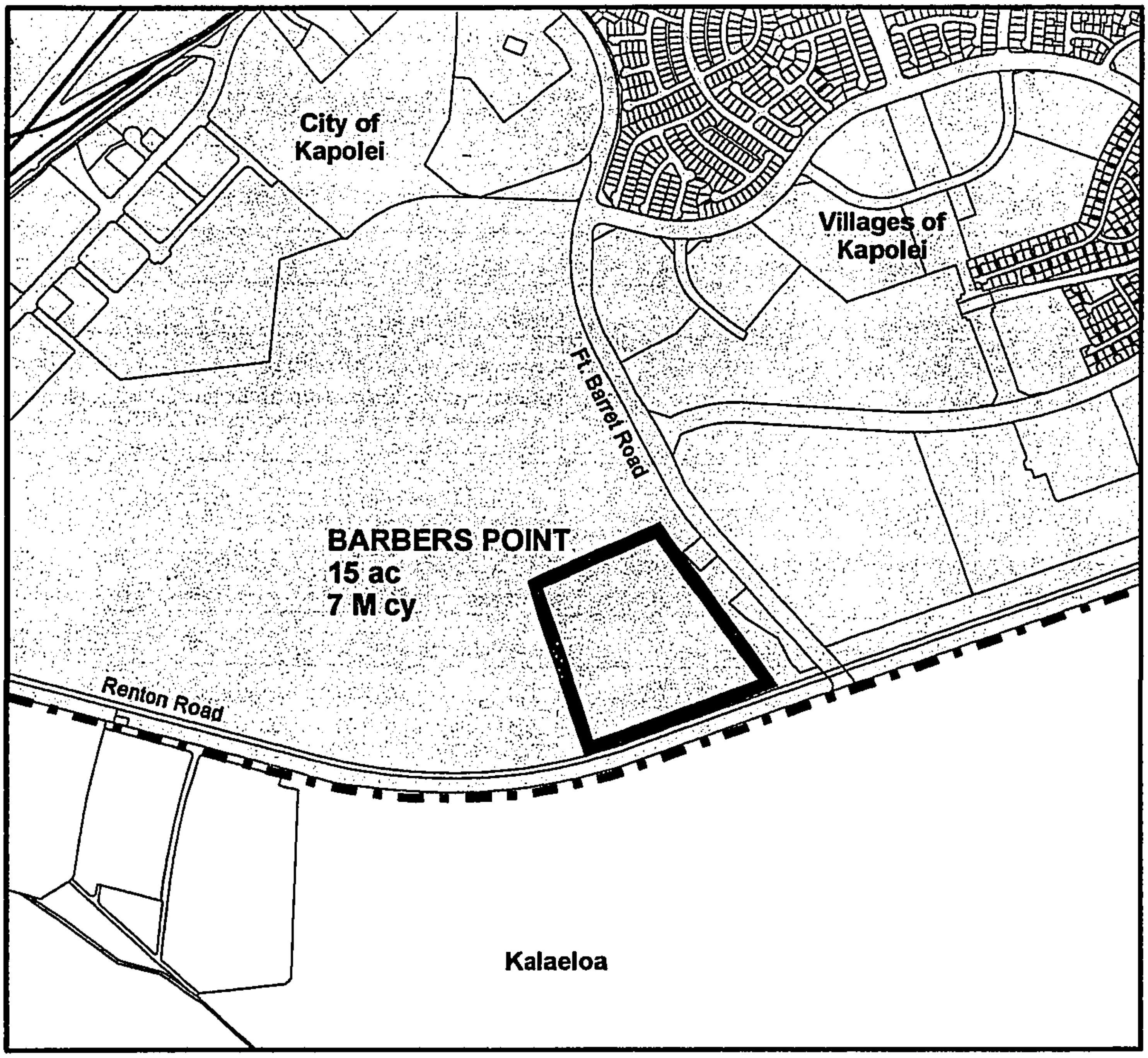
Alternatives Analysis for Disposal of Municipal Solid Waste (MSW)
Dept. Of Environmental Services (ENV) • C & C Honolulu
Waste Management of Hawaii, Inc.

R.M. TOWILL CORPORATION

• Source: C & C Honolulu, ENV 2001
IDS Maps 1998, C & C Honolulu

2. **BARBERS POINT** - Located immediately north of the former Barbers Point Naval Air Station, approximately 1.5 miles south of H-1 freeway, approximately 2 miles southeast of Makakilo. The site is a former pit created through previous coral quarrying activity. Elevation of the site is approximately 40 feet MSL. **(Figure 3-5)**

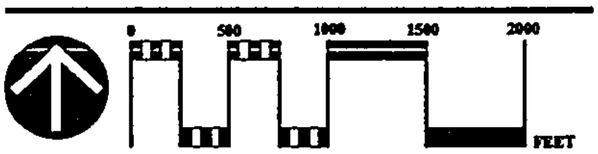
TMK:	9-1-16:18 & por 1
Acreage:	±15
Ownership:	Estate of James Campbell
Adjoining Land Uses:	Adjacent to major residential communities of Kapolei to the north, Ewa Villages to the east, and to the south, military residences of the former Barbers Point Naval Air Station. The pit and surrounding area is situated within the Ewa Plain.
Cover Material:	Must be imported
Soils Classification:	Ewa silty clay loam, moderately shallow, 0 to 2% slopes Mamala stony silty clay loam, 0 to 12% slopes Coral outcrops
City and County of Honolulu Zoning:	Ag-1
State Land Use District:	Agricultural
Capacity:	0.74 million cubic yards
Lifespan:	±1.2 years (based on 0.6 million cubic yards per year required)



LEGEND

(solid line)	Site Boundary
(dashed line)	Underground Infiltration Control (UIC) Line
OUTSIDE	Groundwater Protection Zone (GPZ) Line

FIGURE 3-5
Barbers Point



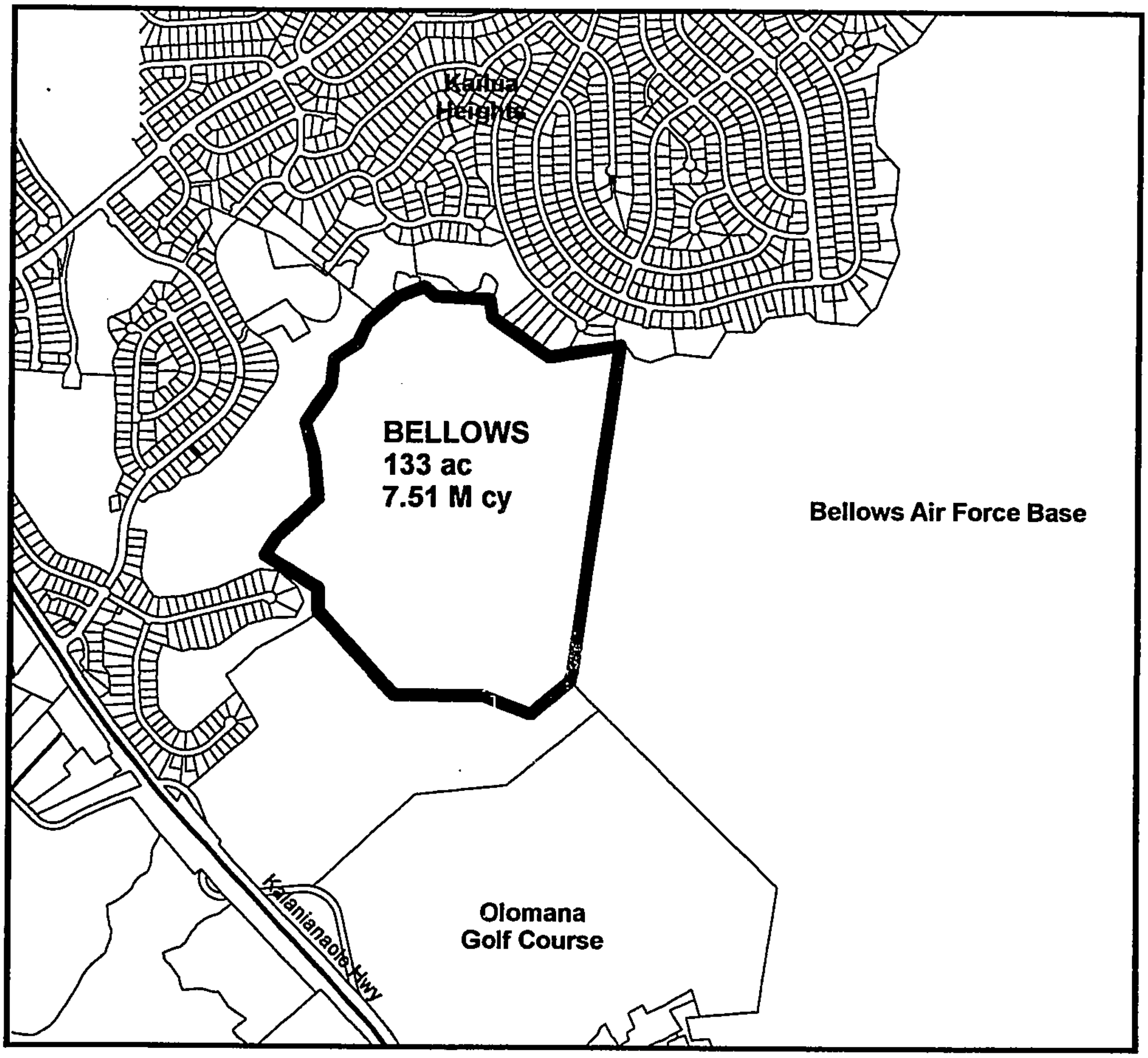
Alternatives Analysis for Disposal of Municipal Solid Waste (MSW)
Dept. Of Environmental Services (ENV) • C & C Honolulu
Waste Management of Hawaii, Inc.

R. M. TOWILL CORPORATION

• Source: C & C Honolulu, ENV 2001
IDS Maps 1998, C & C Honolulu

3. **BELLOWS** - Located at the northern end of the Waimanalo residential community and Bellows Air Force Base in Windward Oahu. The site is relatively open but heavily vegetated in places. Elevation ranges from approximately 40 feet and rises to over 200 feet MSL. **(Figure 3-6).**

TMK:	4-1-15
Acreage:	±133 (±133 usable)
Ownership:	Federal Government (U.S. Military Reservation). Ownership of the site for military purposes would increase difficulty of land acquisition.
Adjoining Land Uses:	Within property of the U.S. Government. Immediately north is the Keolu Hills residential subdivision. To the west is Mount Olomana and immediately south, the Olomana Golf Course.
Cover Material:	Available on site
Soils Classification:	Alaeloa silty clay, 40 to 70% slopes Papaa clay, 6 to 20% slopes Papaa clay, 35 to 70% slopes Kawaihapai silty clay loam, 2 to 7% slopes
City and County of Honolulu Zoning:	P-1/F-1
State Land Use District:	Conservation
Capacity:	7.51 million cubic yards
Lifespan:	±12.5 years (based on 0.6 million cubic yards per year required)



LEGEND

	Site Boundary
OUTSIDE	Underground Infiltration Control (UIC) Line
OUTSIDE	Groundwater Protection Zone (GPZ) Line

FIGURE 3-6
Bellows

Alternatives Analysis for Disposal of Municipal Solid Waste (MSW)
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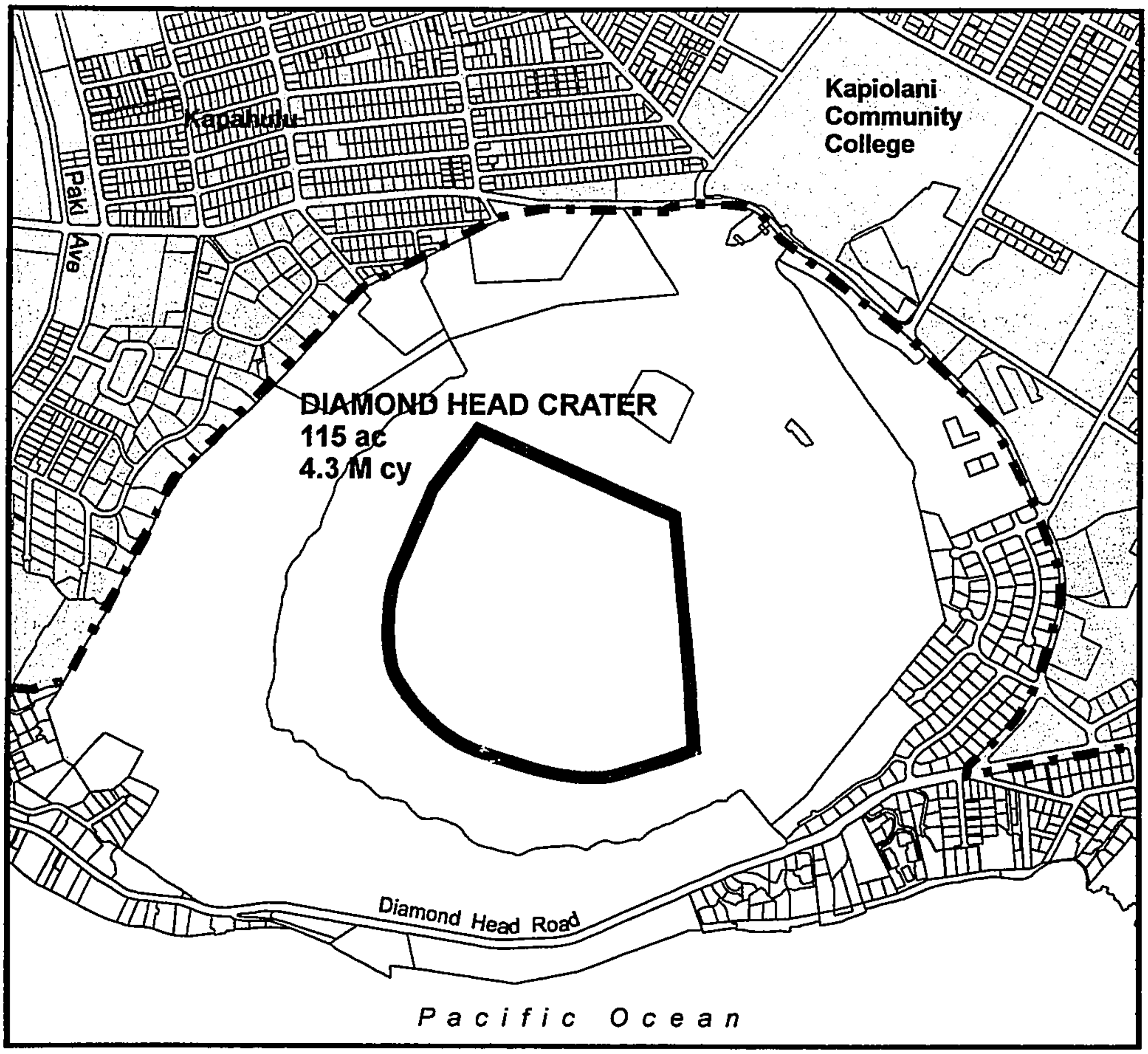
Waste Management of Hawaii, Inc.

R.M. TOWILL CORPORATION

• Source: C & C Honolulu, ENV 2001
IDS Maps 1998, C & C Honolulu

4. **DIAMOND HEAD CRATER** - Located on the southwest end of the island of Oahu. The site is designated a State Monument and Natural Landmark. Elevation of the site ranges from approximately 120 feet to +160 feet MSL. **(Figure 3-7)**.

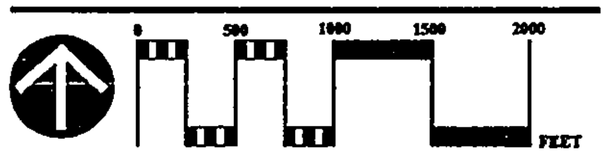
TMK:	3-1-42:por 6
Acreage:	±115
Ownership:	State of Hawaii. Designation of the site as a State Monument and Natural Landmark would increase difficulty of site acquisition.
Adjoining Land Uses:	This location is immediately in proximity to urbanized areas of Diamond Head, Kahala, Waikiki, and Kapahulu. The Hawaii Army National Guard is a current tenant at this facility. Future uses by the State including park facility upgrades also indicate a long term desire to preserve the site.
Cover Material:	Must be imported
Soils Classification:	Makalapa clay, 6 to 12% slopes Makalapa clay, 12 to 20% slopes
City and County of Honolulu Zoning:	P-1
State Land Use District:	Conservation
Capacity:	4.3 million cubic yards
Lifespan:	± 7.2 years (based on 0.6 million cubic yards per year required)



LEGEND

(solid line)	Site Boundary
(dash-dot line)	Underground Infiltration Control (UIC) Line
OUTSIDE	Groundwater Protection Zone (GPZ) Line

FIGURE 3-7
Diamond Head

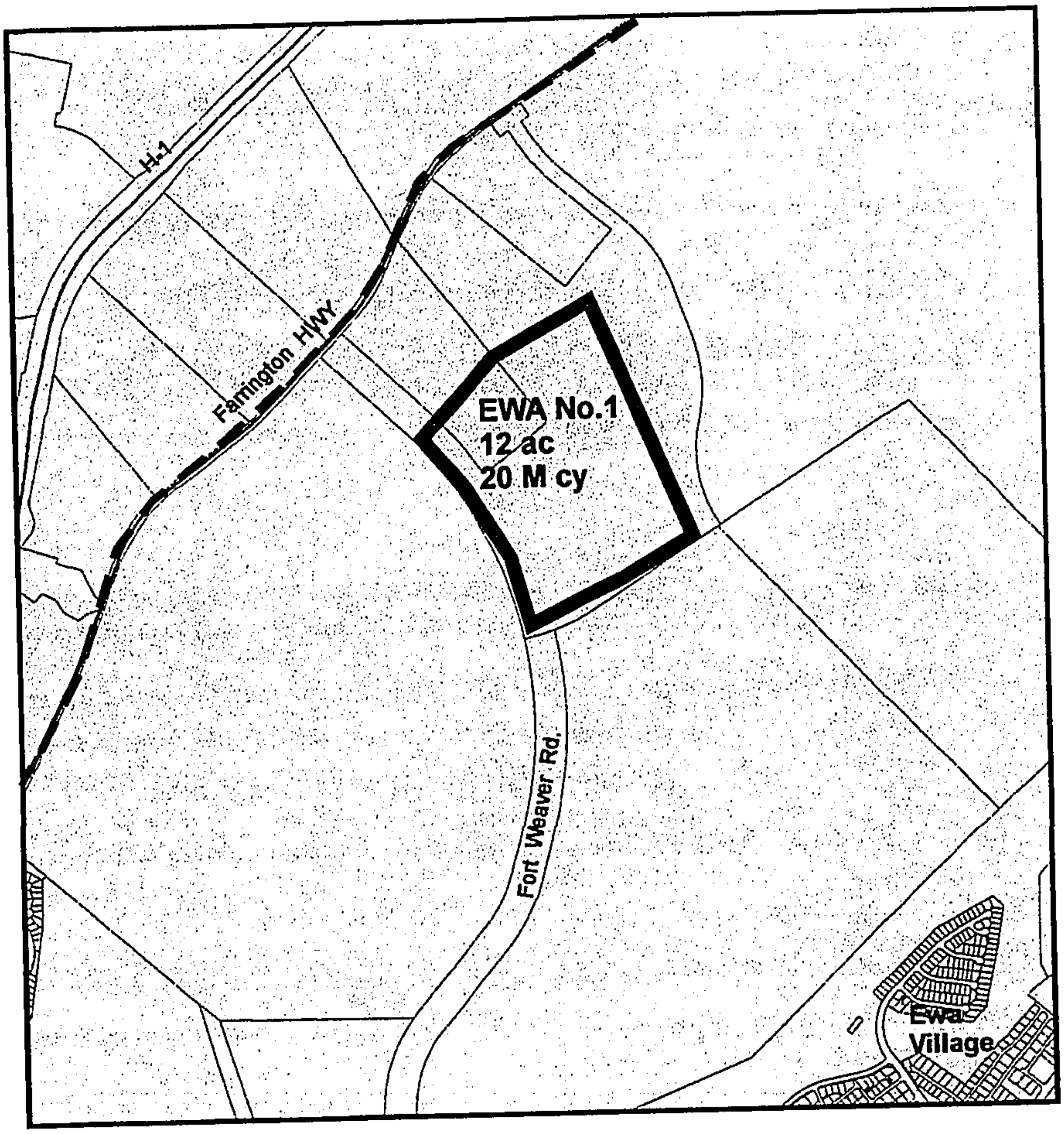


Alternatives Analysis for Disposal of Municipal Solid Waste (MSW)
Dept. Of Environmental Services (ENV) • C & C Honolulu
Waste Management of Hawaii, Inc.

R. M. TOWILL CORPORATION

* Source: C & C Honolulu, ENV 2001
IDS Maps 1998, C & C Honolulu

5. **EWA NO. 1** - This site is no longer viable due to residential development. The identification of this site is provided in **Figure 3-8.**



LGEND

▬▬▬	Site Boundary
INSIDE	Underground Infiltration Control (UIC) Line
▪ ▬ ▬ ▬	Groundwater Protection Zone (GPZ) Line

FIGURE 3-8
Ewa No.1

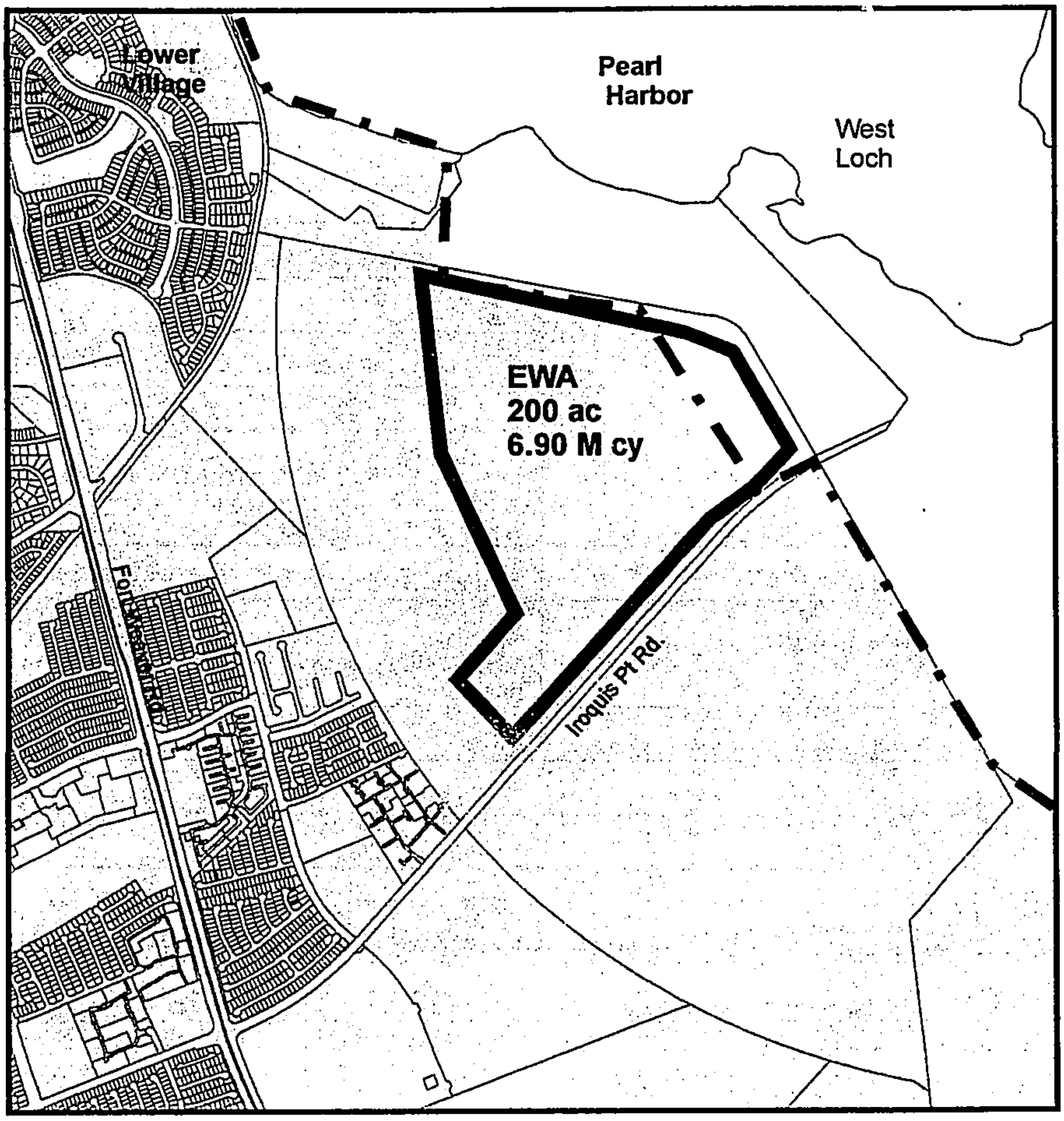
0 500 1000 1500 2000 2500 3000 FEET

Alternatives Analysis for Disposal of Municipal Solid Waste (MSW)
Dept. Of Environmental Services (ENV) • C & C Honolulu
Waste Management of Hawaii, Inc.

R. M. TOWILL CORPORATION

• Source: C & C Honolulu, ENV 2001
IDS Maps 1998, C & C Honolulu

6. **EWA NO. 2** - This site is no longer viable due to residential development. The identification of this site is provided in **Figure 3-9.**



LEGEND

(solid line)	Site Boundary
(dash-dot line)	Underground Infiltration Control (UIC) Line
OUTSIDE	Groundwater Protection Zone (GPZ) Line

FIGURE 3-9
Ewa No. 2

0 500 1000 1500 2000 2500 3000 FEET

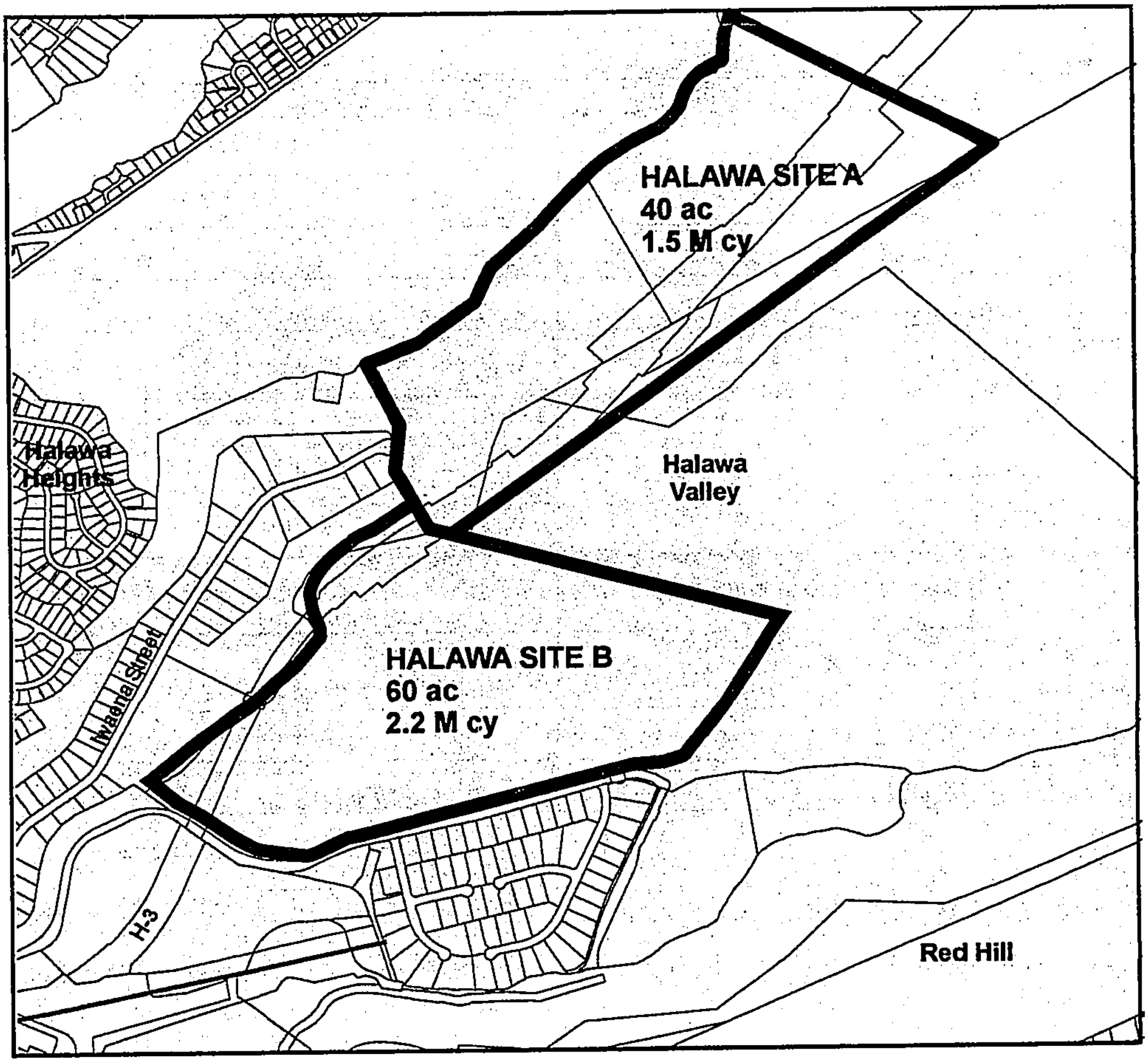
Alternatives Analysis for Disposal of Municipal Solid Waste (MSW)
Dept. Of Environmental Services (ENV) • C & C Honolulu
Waste Management of Hawaii, Inc.

R. M. TOWILL CORPORATION

* Source: C & C Honolulu, ENV 2001
IDS Maps 1998, C & C Honolulu

7. **HALAWA SITE A** - Both Halawa Sites A and B are located in Halawa, mauka of the Moanalua Freeway and east of the H-3 Freeway. Halawa Site A is located in North Halawa Valley above the Halawa Industrial Park. Elevation ranges from approximately 200 feet to +600 feet MSL. **(Figure 3-10).**

TMK:	9-9-10:8, 9, por 10 & 26
Acreage:	±40
Ownership:	City and County of Honolulu
Adjoining Land Uses:	Halawa Industrial Park and Halawa Quarry. Camp Smith Military Reservation is located west, and the Halawa Residential Subdivision is located west and to the south of Camp Smith. Halawa A adjoins the H-3 Freeway.
Cover Material:	Available on site
Soils Classification:	Kaena very stony clay, 10 to 35% slopes Manana silty clay, 8 to 15% slopes Rock land
City and County of Honolulu Zoning:	P-1
State Land Use District:	Urban
Capacity: yards	1.5 million cubic
Lifespan:	± 2.5 years (based on 0.6 million cubic yards per year required)



LEGEND

(thick line)	Site Boundary
OUTSIDE	Underground Infiltration Control (UIC) Line
OUTSIDE	Groundwater Protection Zone (GPZ) Line

FIGURE 3-10
Halawa A & B

0 500 1000 1500 2000 FEET

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8. **HALAWA B** - Halawa B is located within the Halawa Quarry site. Elevation of this site ranges from approximately 120 feet to 360 feet MSL. **(Figure 3-10).**

TMK:	9-9-10:27 & por 10
Acreage:	±60
Ownership:	Queen Emma Foundation
Adjoining Land Uses:	The project site is within portions of the Halawa Quarry. Camp Smith Military Reservation is located west, and the Halawa Residential Subdivision is located west and to the south of Camp Smith. The H-3 Freeway adjoins this site to the west.
Cover Material:	Available on site
Soils Classification:	Rock land Kawaihapai clay loam, 2 to 6% slopes
City and County of Honolulu Zoning:	P-1
State Land Use District:	
Capacity:	2.2 million cubic yards
Lifespan:	± 3.7 years (based on 0.6 million cubic yards per year required)

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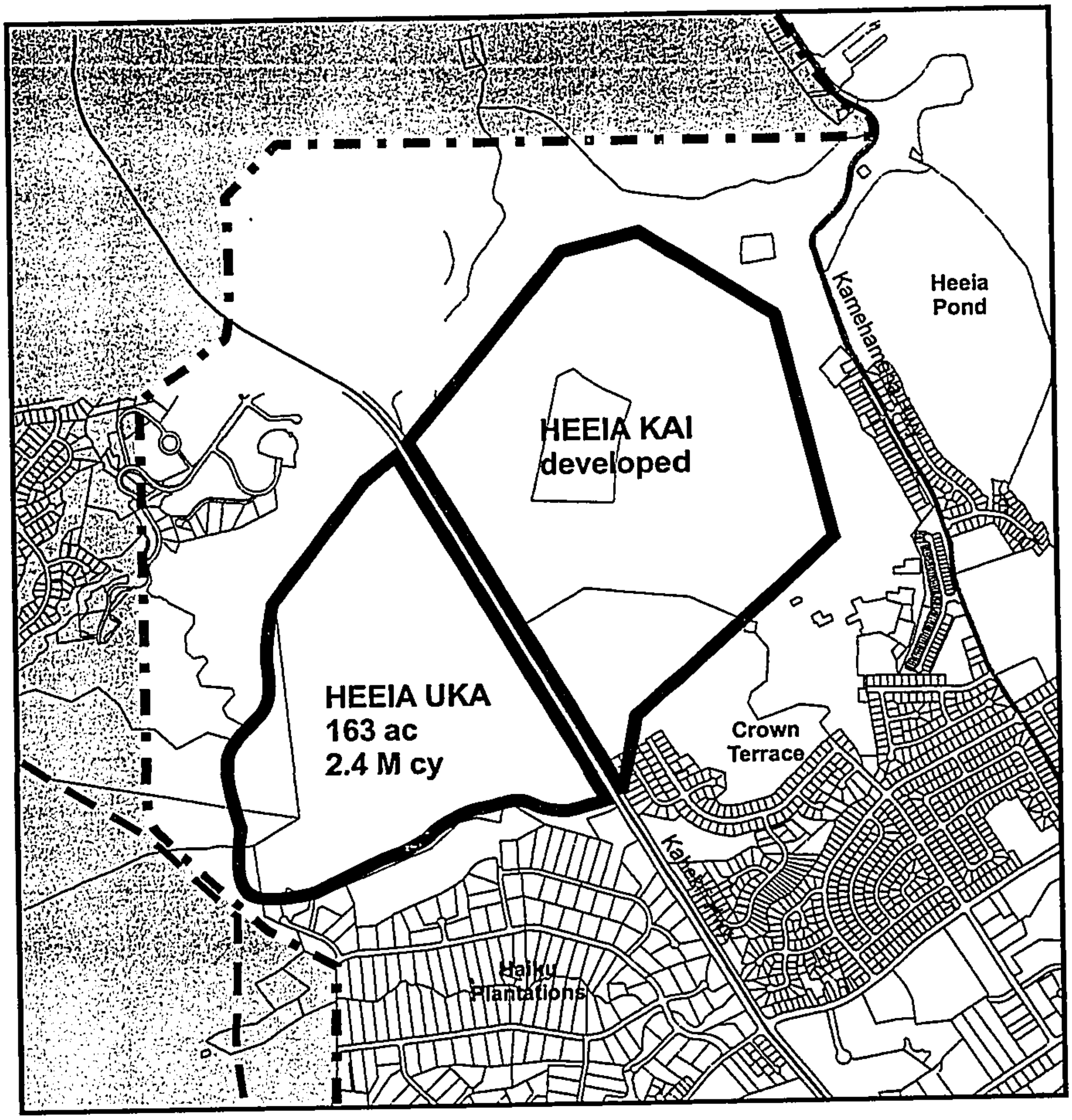
9. **HEEIA KAI** - This site is no longer viable due to residential development. The identification of this site is provided in **Figure 3-11.**

10. **HEEIA UKA** - This is site is located mauka on Kahekili Highway, approximately 2 miles north of the intersection of Kahekili Highway and Likelike Highway. Elevation ranges from approximately 40 feet to 360 feet MSL. (**Figure 3-11**).

TMK:	4-6-14:1
Acreage:	±163 (±50 usable)
Ownership:	Estate of Bernice P. Bishop
Adjoining Land Uses:	Immediately west is the Ahuimanu residential community. To the east is residential housing which extends as part of Kaneohe Town. Further to the west and south is Windward Community College.
Cover Material:	Available on site
Soils Classification:	Waikane silty clay, 25 to 40% slopes
City and County of Honolulu Zoning:	P-1
State Land Use District:	Conservation
Capacity:	2.4 million cubic yards
Lifespan:	± 4.0 years (based on 0.6 million cubic yards per year required)



LEGEND

Site Boundary

Underground Infiltration Control (UIC) Line

Groundwater Protection Zone (GPZ) Line

FIGURE 3-11
HeeiaKai & HeeiaUka

0 500 1000 1500 2000 2500 3000 FEET

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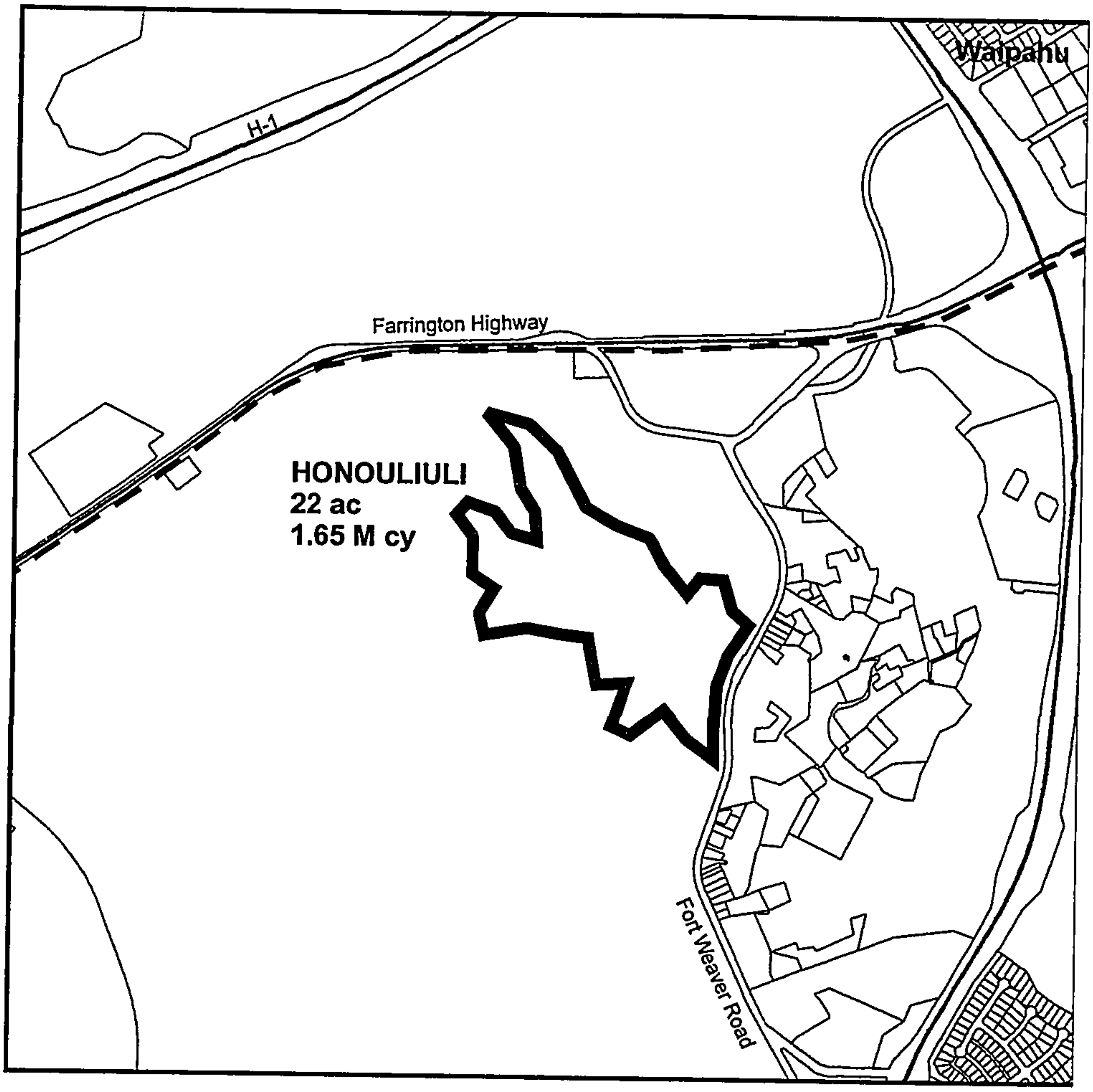
11. **HONOULIULI** - This site is located approximately 2.6 miles east of Puu Makakilo, a half mile south of Farrington Highway which roughly adjoins the site, 2.4 miles east-southeast of Puu Kapuai and 4.5 miles north-northwest of Ewa Beach. Elevation of the site ranges from approximately 40 feet to 120 feet MSL. **(Figure 3-12).**

TMK:	9-1-17:por 4
Acreage:	±22
Ownership:	Estate of James Campbell
Adjoining Land Uses:	This site adjoins Fort Weaver Road and the town of Ewa to the west and to the south. The Waikele residential subdivision lies northwest.
Cover Material:	Available on site
Soils Classification:	Waialua silty clay, 0 to 8% slopes Helemano silty clay, 30 to 90% slopes
City and County of Honolulu Zoning:	Ag-1
State Land Use District:	Agricultural
Capacity:	1.65 million cubic yards
Lifespan:	± 2.8 years (based on 0.6 million cubic yards per year required)



LEGEND

(solid line)	Site Boundary
INSIDE	Underground Infiltration Control (UIC) Line
(dashed line)	Groundwater Protection Zone (GPZ) Line

FIGURE 3-12
Honouliuli

0 500 1000 1500 2000 FEET

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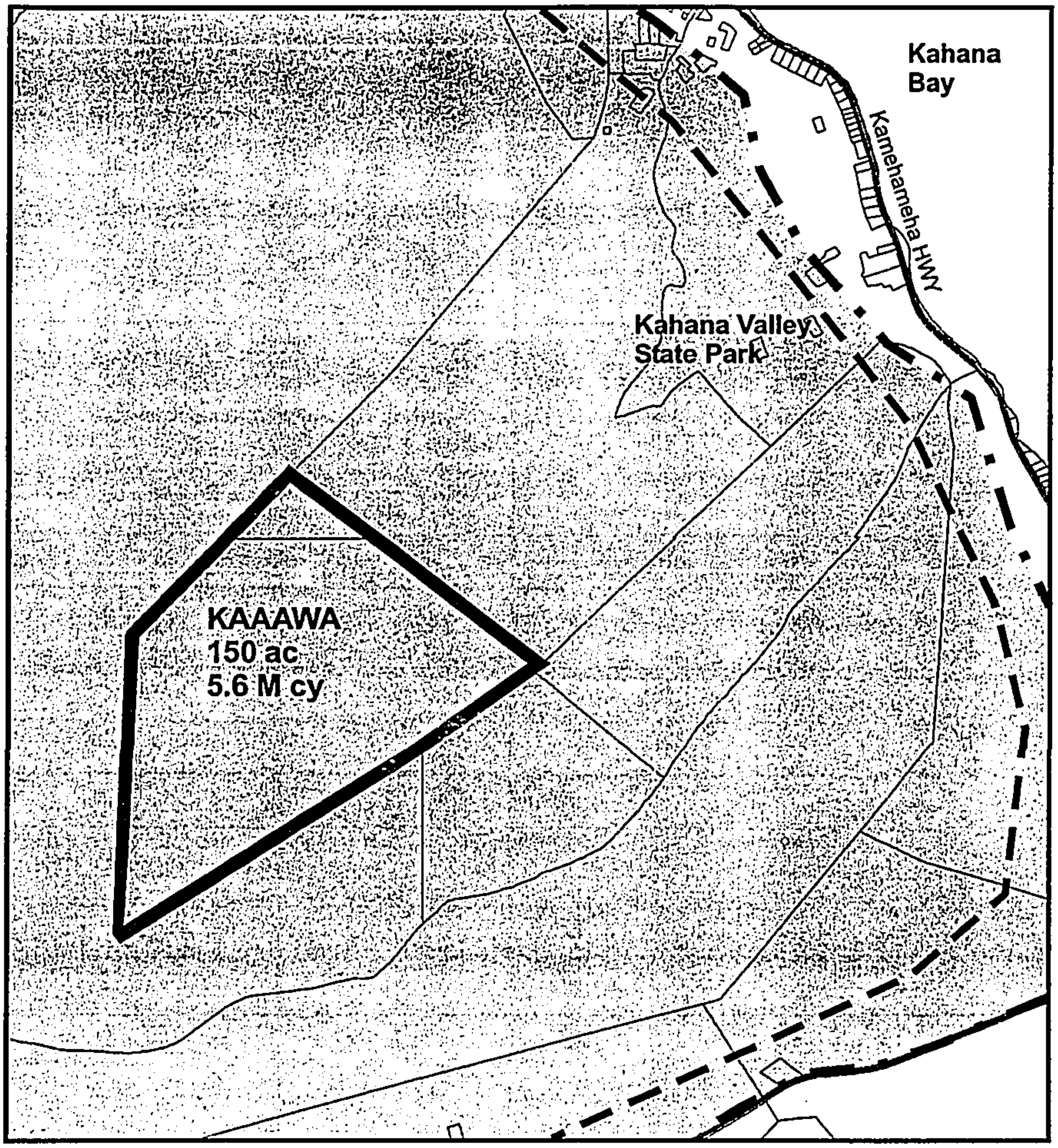
12. **KAAAWA** - The town of Kaaawa lies to the north of the site. Further south are the districts of Kualoa and Waikane. Elevation of the site ranges from approximately 120 feet to 360 MSL. **(Figure 3-13).**

TMK:	5-1
Acreage:	±150
Ownership:	To be determined based on site boundary
Adjoining Land Uses:	Most of the area surrounding this site is either in agriculture or in preservation and open space.
Cover Material:	Cover material is anticipated to be available on site
Soils Classification:	Lolekaa silty clay, 3 to 8% slopes Lolekaa silty clay, 8 to 15% slopes Lolekaa silty clay, 40 to 70% slopes
City and County of Honolulu Zoning:	Ag-2
State Land Use District:	Conservation and Agriculture
Capacity:	5.6 million cubic yards
Lifespan:	±9.3 years (based on 0.6 million cubic yards per year required)



LEGEND

Site Boundary

Underground Infiltration Control (UIC) Line

Groundwater Protection Zone (GPZ) Line

FIGURE 3-13
Kaaawa

0 500 1000 1500 2000 2500 3000 FEET

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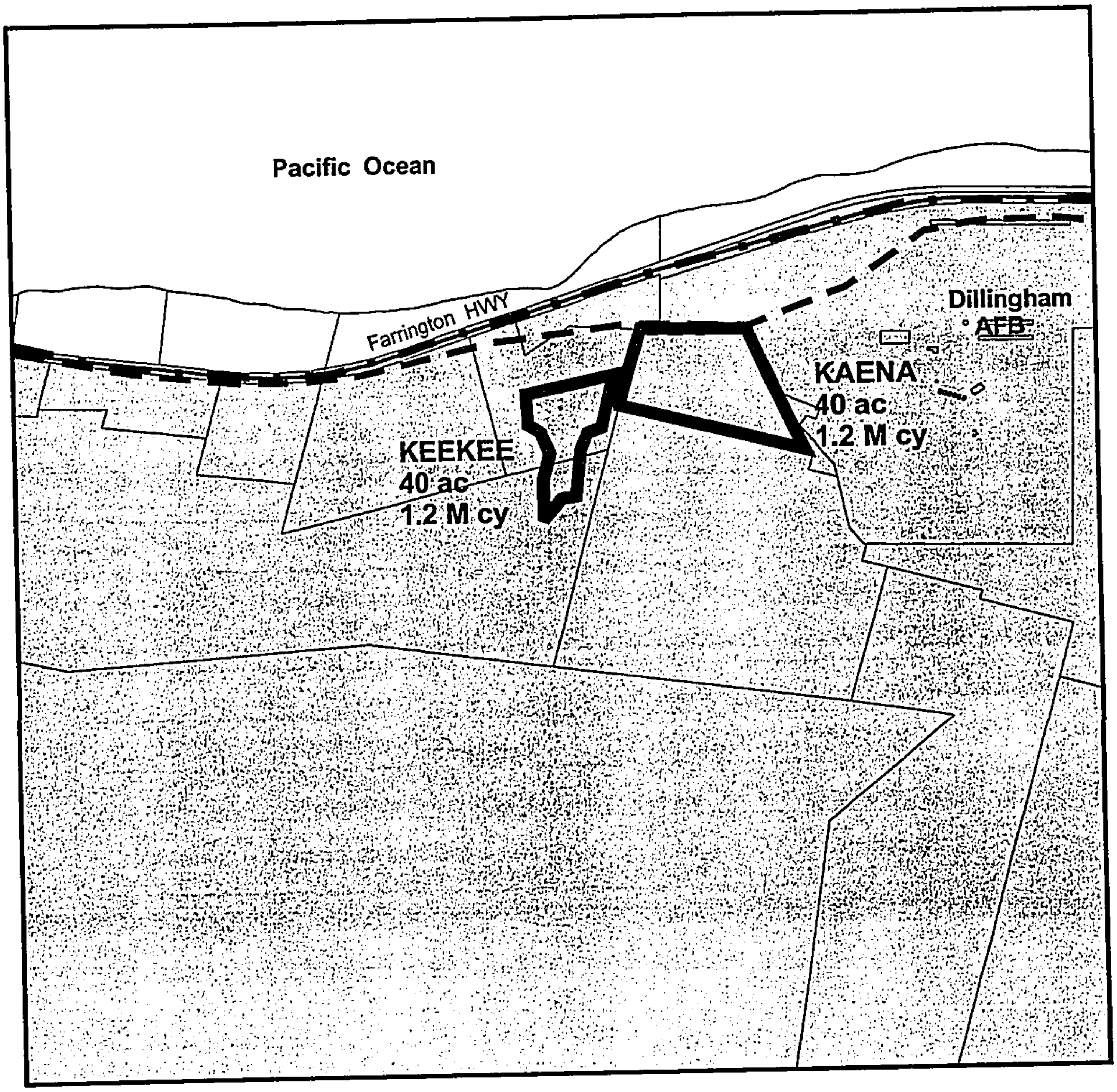
13. **KAENA** - This site is located at the west mauka end of the Dillingham Air Force Base, 1,000 feet mauka of Farrington Highway and 6 miles west of the town of Waialua, North Shore, Oahu. Elevation ranges from approximately 80 to 700 feet MSL. **(Figure 3-14)**.

TMK:	6-9-1:por 3, 33 and 34
Acreage:	±40 (±20 usable)
Ownership:	State of Hawaii and Dillingham Corporation
Adjoining Land Uses:	Portions of the site were once used for quarrying operations. Dillingham AFB is located immediately to the west and the Pacific Ocean shoreline is located approximately 2,000 feet north.
Cover Material:	Available on site
Soils Classification:	Rock land Pulehu clay loam, 0 to 3% slopes
City and County of Honolulu Zoning:	P-1
State Land Use District:	Conservation
Capacity:	1.5 million cubic yards
Lifespan:	±2.5 years (based on 0.6 million cubic yards per year required)



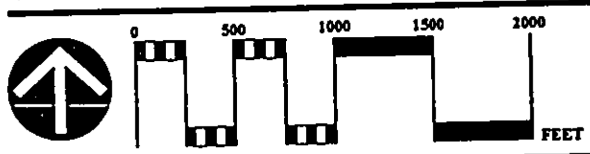
LEGEND

Site Boundary

Underground Infiltration Control (UIC) Line

Groundwater Protection Zone (GPZ) Line

FIGURE 3-14
Kaena & Keekee



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14. **KEEKEE** - This site is adjacent to and west of the Kaena site. The site adjoins Farrington Highway in the North Shore of Oahu. Elevation ranges from approximately 20 feet to over 300 feet MSL. **(Figure 3-14).**

TMK:	6-9-1:por 3 & 4 6-9-3:por 2
Acreage:	±115
Ownership:	State of Hawaii, Lucky S. Dairy
Adjoining Land Uses:	Site is located next to the Kaena Site. Coastal waters of the Pacific Ocean are located immediately north and Dillingham Air Force Base is located east of the site.
Cover Material:	Available on site
Soils Classification:	Rock land Pulehu clay loam, 0 to 3% slopes Stony steep land
City and County of Honolulu Zoning:	P-1
State Land Use District:	Agricultural
Capacity:	1.2 million cubic yards
Lifespan:	±2 years (based on 0.6 million cubic yards per year required)

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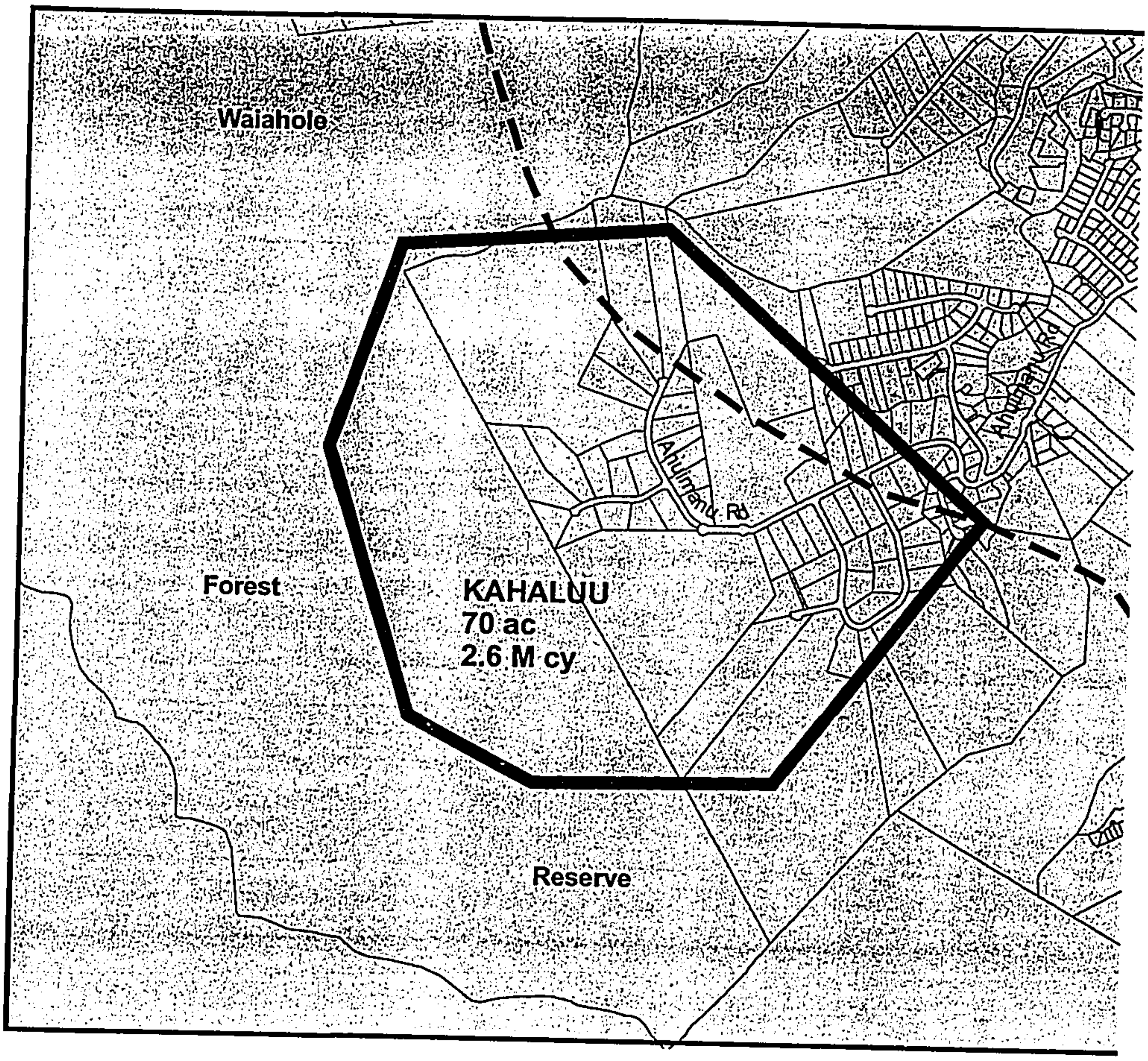
15. **KAHALUU** - This site is no longer viable due to residential development. The identification of this site is provided in **Figure 3-15.**



LEGEND

	Site Boundary
INSIDE	Underground Infiltration Control (UIC) Line
	Groundwater Protection Zone (GPZ) Line

FIGURE 3-15
Kahaluu

0 500 1000 1500 2000 FEET

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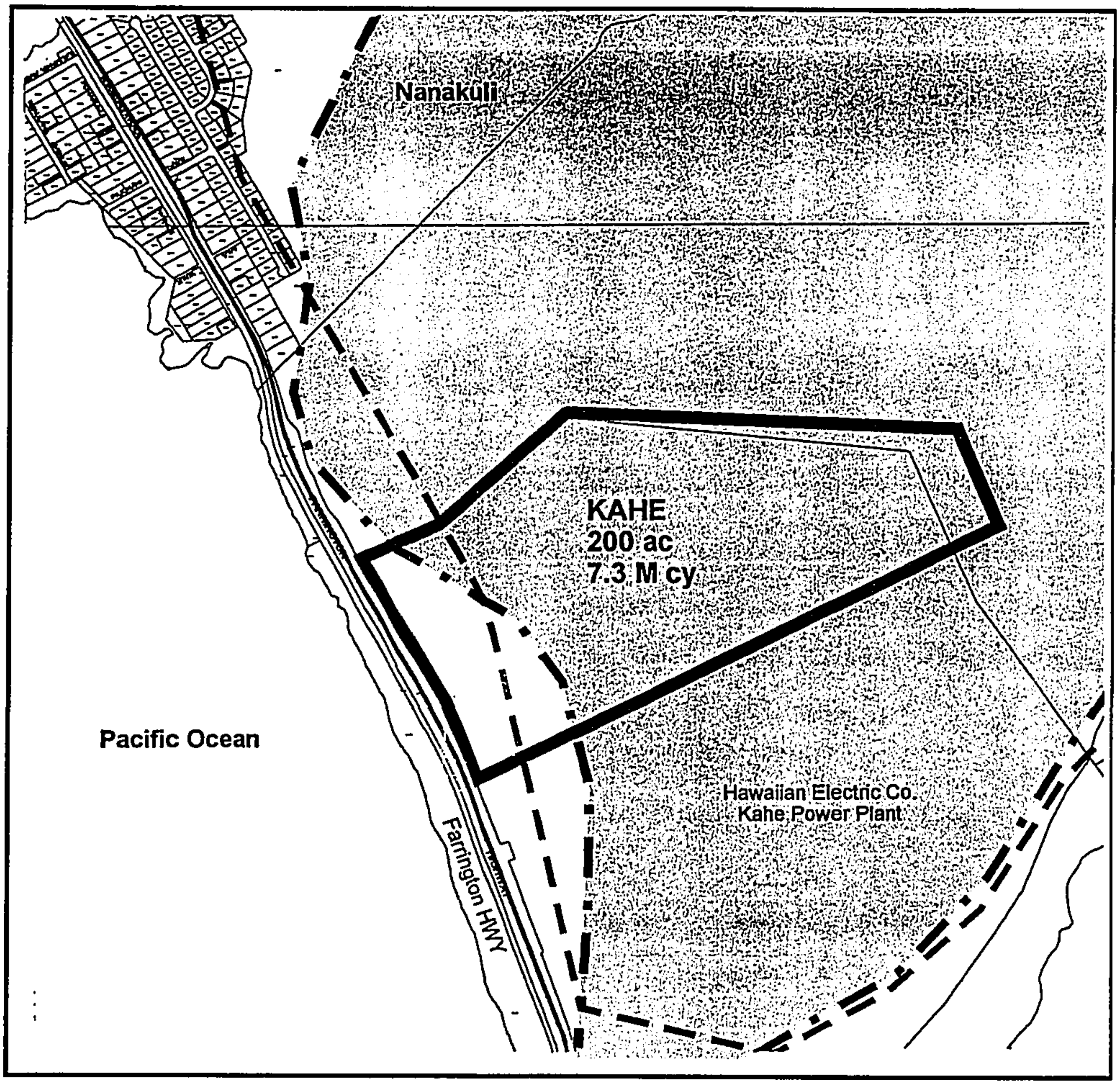
16. **KAHE** - This site is located adjacent to and west of the HECO power generating station located in Leeward Oahu. Coastal waters of the Pacific Ocean are located approximately 500 feet southwest of the site. Elevation ranges from approximately 40 feet to over 800 feet MSL. (**Figure 3-16**).

TMK:	3-1-42:por 6
Acreage:	±200
Ownership:	State of Hawaii
Adjoining Land Uses:	Immediately west of the site is the HECO power generating station. Single family residences of Nanakuli are located further north of the site beyond Pili O Kahe Gulch. To the south is the Kahe Point Beach Park.
Cover Material:	Cover material is anticipated to be available on site
Soils Classification:	Stony steep land Rock land
City and County of Honolulu Zoning:	I-2 and P-1
State Land Use District:	Agricultural and Urban
Capacity:	7.4 million cubic yards
Lifespan:	±12.3 years (based on 0.6 million cubic yards per year required)



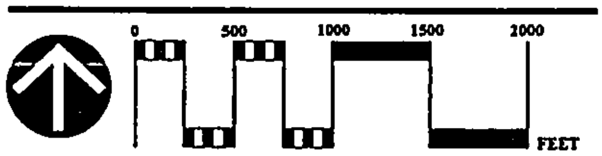
LEGEND

Site Boundary

Underground Infiltration Control (UIC) Line

Groundwater Protection Zone (GPZ) Line

FIGURE 3-16
Kahe



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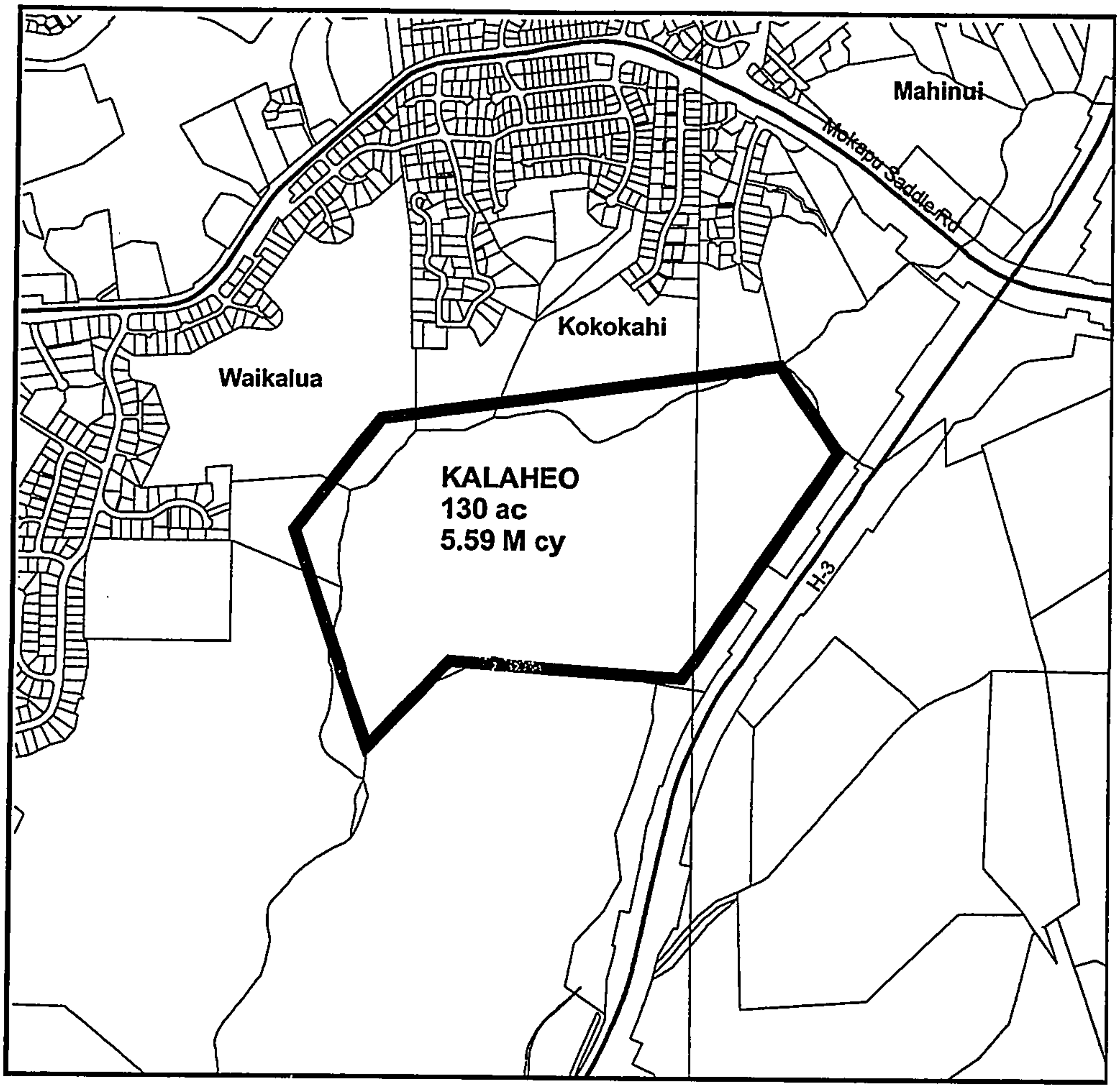
17. **KALAHEO** - This site is located west of the H-3 Freeway and Kawainui Marsh, north of Kapaa Quarry, and south of Mokapu Saddle Road in Kailua. The site is approximately 2,000 feet northwest of the Kapaa Landfill. Elevation of the site ranges from approximately 80 to +600 feet MSL. **(Figure 3-17)**.

This site was used as a C&C landfill and is now closed.



LEGEND

(thick line)	Site Boundary
OUTSIDE	Underground Infiltration Control (UIC) Line
OUTSIDE	Groundwater Protection Zone (GPZ) Line

FIGURE 3-17
Kalaheo

0 500 1000 1500 2000 FEET

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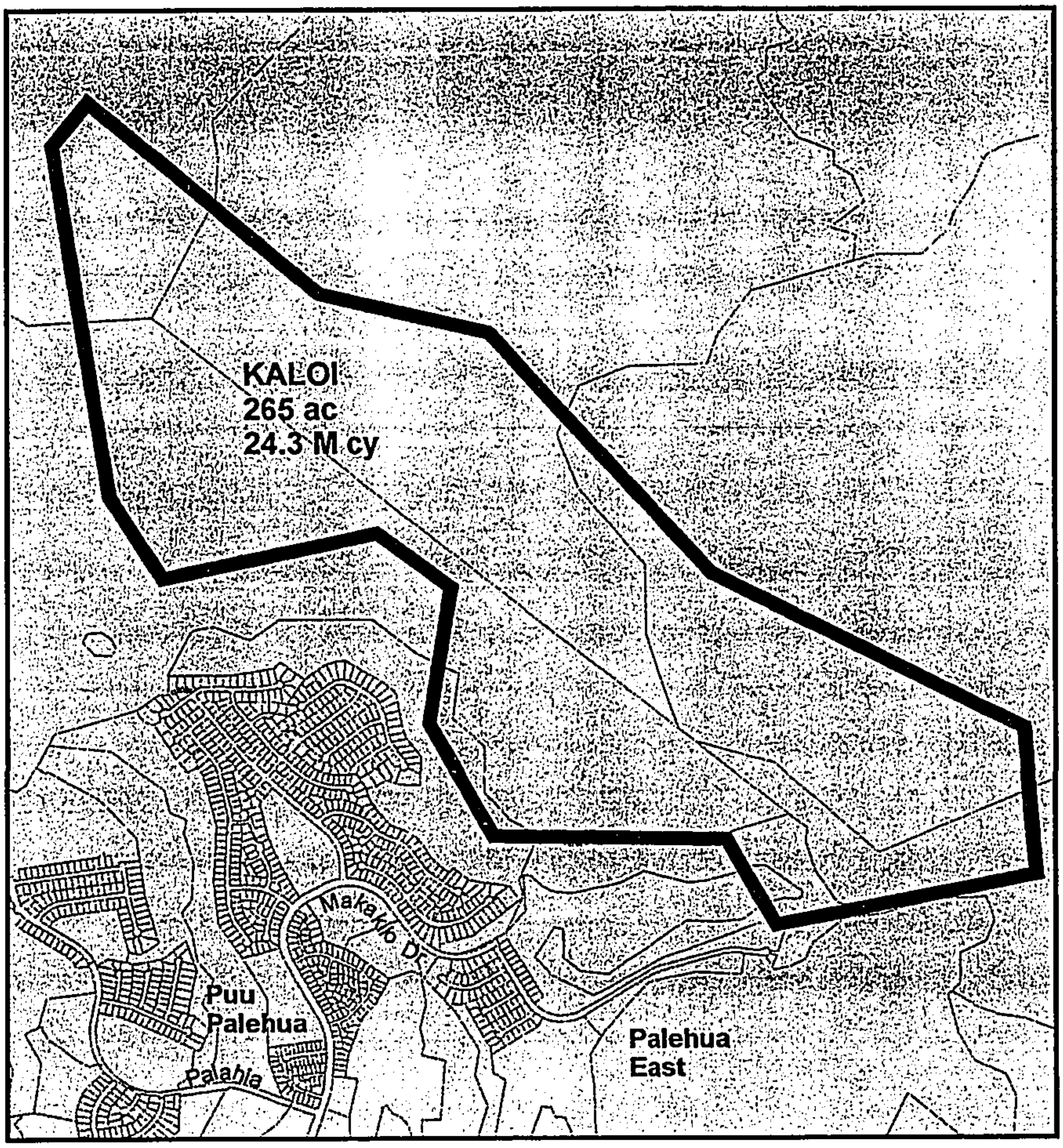
18. **KALOI** - Site is located south of Puu Kapuai and north of Puu Makakilo in Kaloi Gulch, Ewa. Elevation ranges from approximately 340 to +1300 feet MSL. **(Figure 3-18).**

TMK:	9-2-2: por 1 9-2-3:por 2 9-2-4:por 5
Acreage:	±400 (±265 usable)
Ownership:	Estate of James Campbell
Adjoining Land Uses:	Immediately southwest of the site is the Makakilo residential subdivision.
Cover Material:	Some available on site, imported cover necessary
Soils Classification:	Rock land Kawaihapai stony clay loam, 2 to 6% slopes Molokai silty clay loam, 15 to 25% slopes Helemano silty clay, 30 to 90% slopes Mahana badland complex
City and County of Honolulu Zoning:	Ag-1, Ag-2, and P-1
State Land Use District:	Agriculture
Capacity:	24.3 million cubic yards
Lifespan: required)	±40.5 years (based on 0.6 million cubic yards per year



LEGEND

Site Boundary	
INSIDE	Underground Infiltration Control (UIC) Line
INSIDE	Groundwater Protection Zone (GPZ) Line

FIGURE 3-18
Kaloi

0 500 1000 1500 2000 2500 3000 FEET

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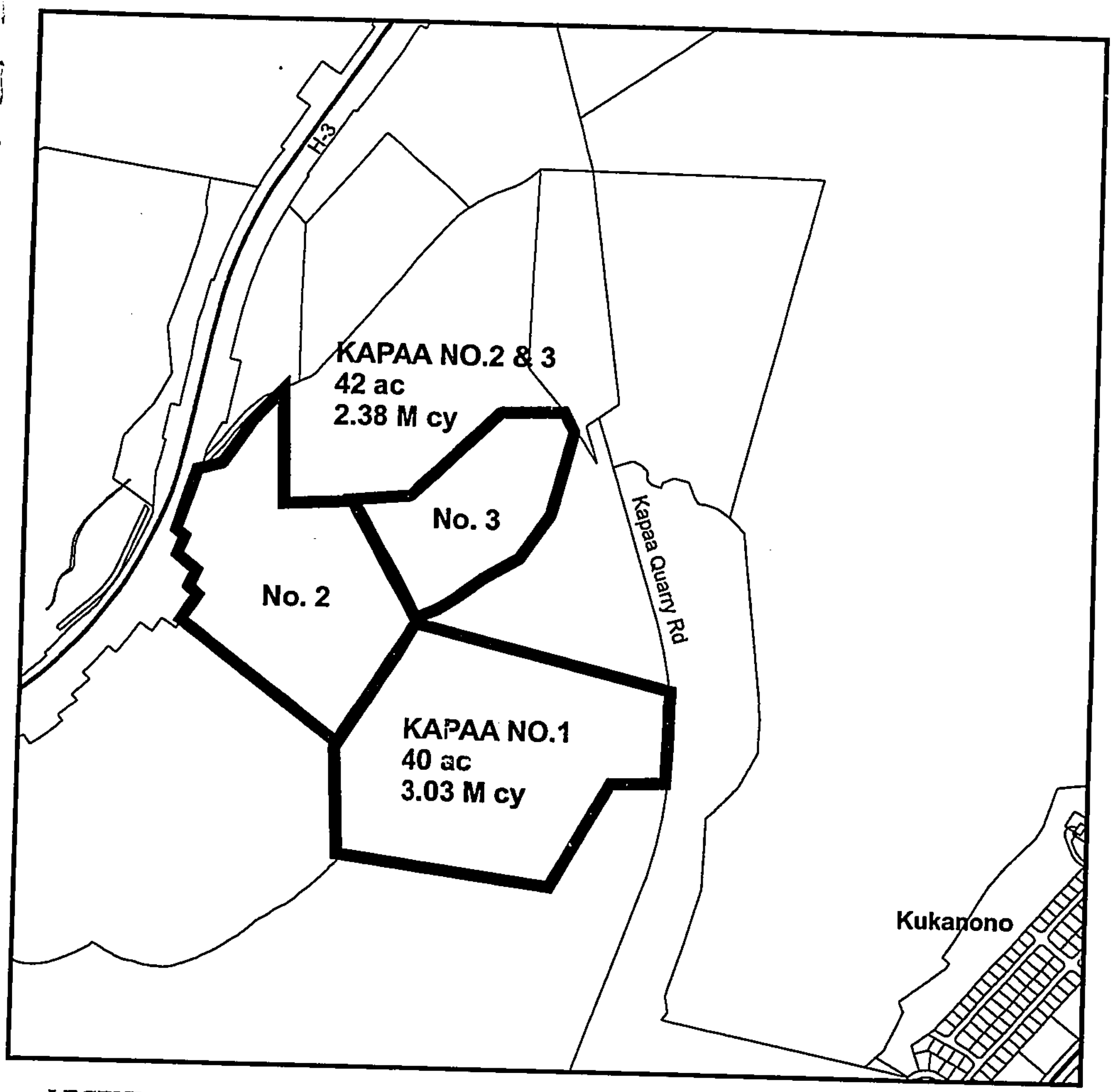
19. **KAPAA NO. 1** - This site is located west of Kapaa Quarry Road and Kawainui Marsh, and east of Ulumawao Peak in Kailua. Elevation ranges from approximately 70 to 500 feet MSL. **(Figure 3-19).**

TMK:	4-4-14: por 2
Acreage:	±60 (±40 usable)
Ownership:	Lou Ellen Tomlinson
Adjoining Land Uses:	The site is approximately 1500 feet southeast of the closed Kapaa Landfill site. Further southeast of the site is the Castle Memorial Hospital, the Maunawili residential subdivision, and Le Jardin School.
Cover Material:	Available on site and from nearby Quarry.
Soils Classification:	Rock land Helemano silty clay, 30 to 90% slopes Alaeloa silty clay, 40 to 70% slopes Alaeloa silty clay, 15 to 35% slopes Kawaihapai clay loam, 6 to 15% slopes Kawaihapai stony clay loam, 2 to 6% slopes
City and County of Honolulu Zoning:	P-1
State Land Use District:	Conservation
Capacity:	3.03 million cubic yards
Lifespan:	±5.1 years (based on 0.6 million cubic yards per year required)



LEGEND

Site Boundary

OUTSIDE Underground Infiltration Control (UIC) Line

OUTSIDE Groundwater Protection Zone (GPZ) Line

FIGURE 3-19
KAPAA No. 1, 2 & 3

0 500 1000 1500 2000 FEET

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20. **KAPAA NO. 2 & 3** - This site adjoins Kapaa No 1. Elevation ranges from approximately 120 feet to +400 MSL. **(Figure 3-19).**

This site was once used for a C&C landfill, but has reached maximum permitted capacity and is now closed.

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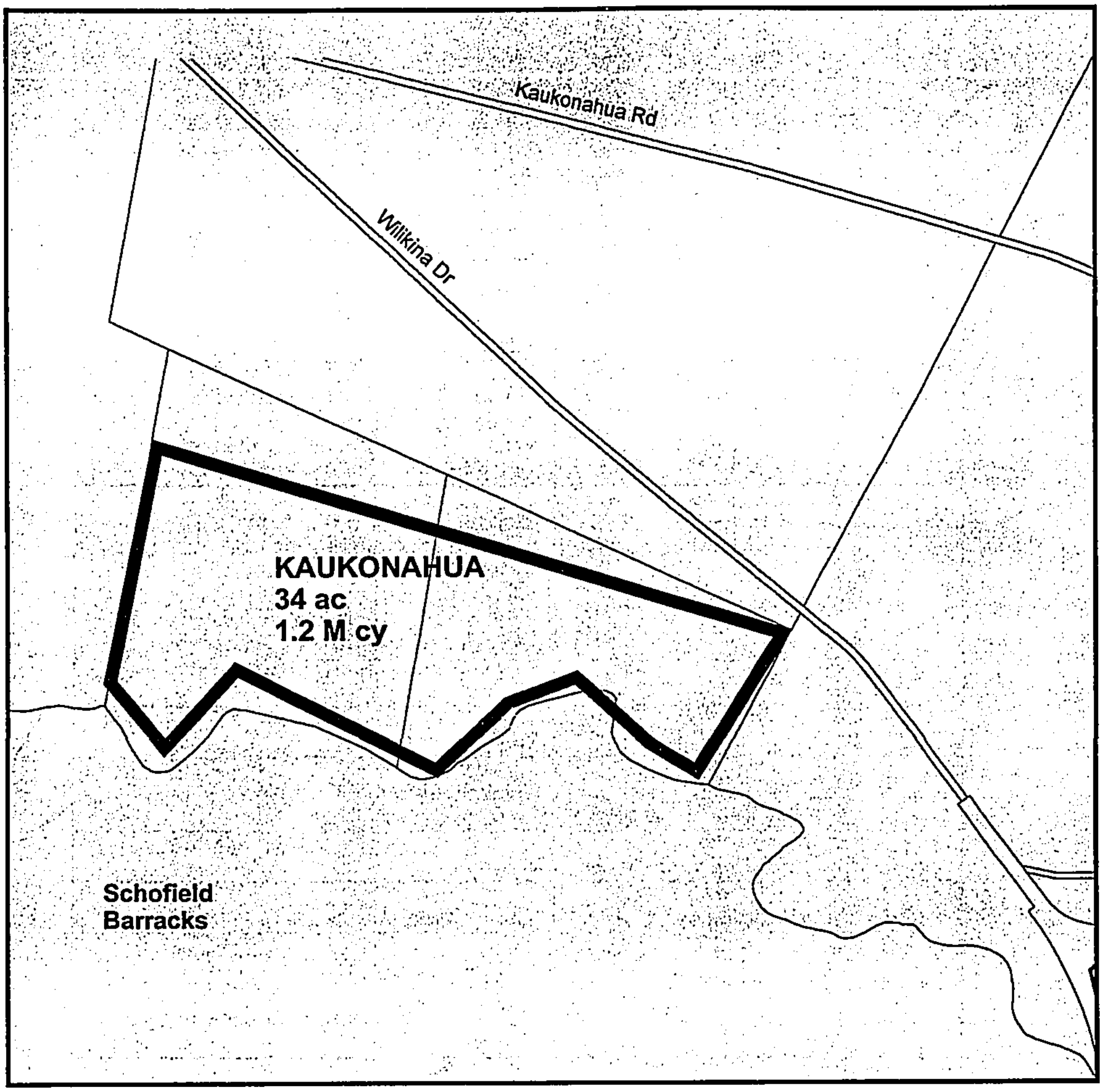
21. **KAUKONAHUA** - This site is located north of Schofield Barracks Military Reservation, adjacent to the town of Wahiawa in Central Oahu. Kaukonahua Road is located to the north. Elevation ranges from approximately 680 feet to 920 feet MSL. **(Figure 3-20).**

TMK:	7-1
Acreage:	±34
Ownership:	To be determined based on site boundary
Adjoining Land Uses:	Schofield Barracks Military Reservation is located immediately to the south. The area is primarily in agriculture and open space.
Cover Material:	Cover material is anticipated to be available on site
Soils Classification:	Helemano silty clay, 30 to 90% slopes Wahiawa silty clay, 3 to 8% slopes
City and County of Honolulu Zoning:	Ag-1
State Land Use District:	Agricultural
Capacity:	1.3 million cubic yards
Lifespan:	±2.2 years (based on 0.6 million cubic yards per year required)



LEGEND

	Site Boundary
INSIDE	Underground Infiltration Control (UIC) Line
INSIDE	Groundwater Protection Zone (GPZ) Line

FIGURE 3-20
Kaukonahua

0 500 1000 1500 2000 FEET

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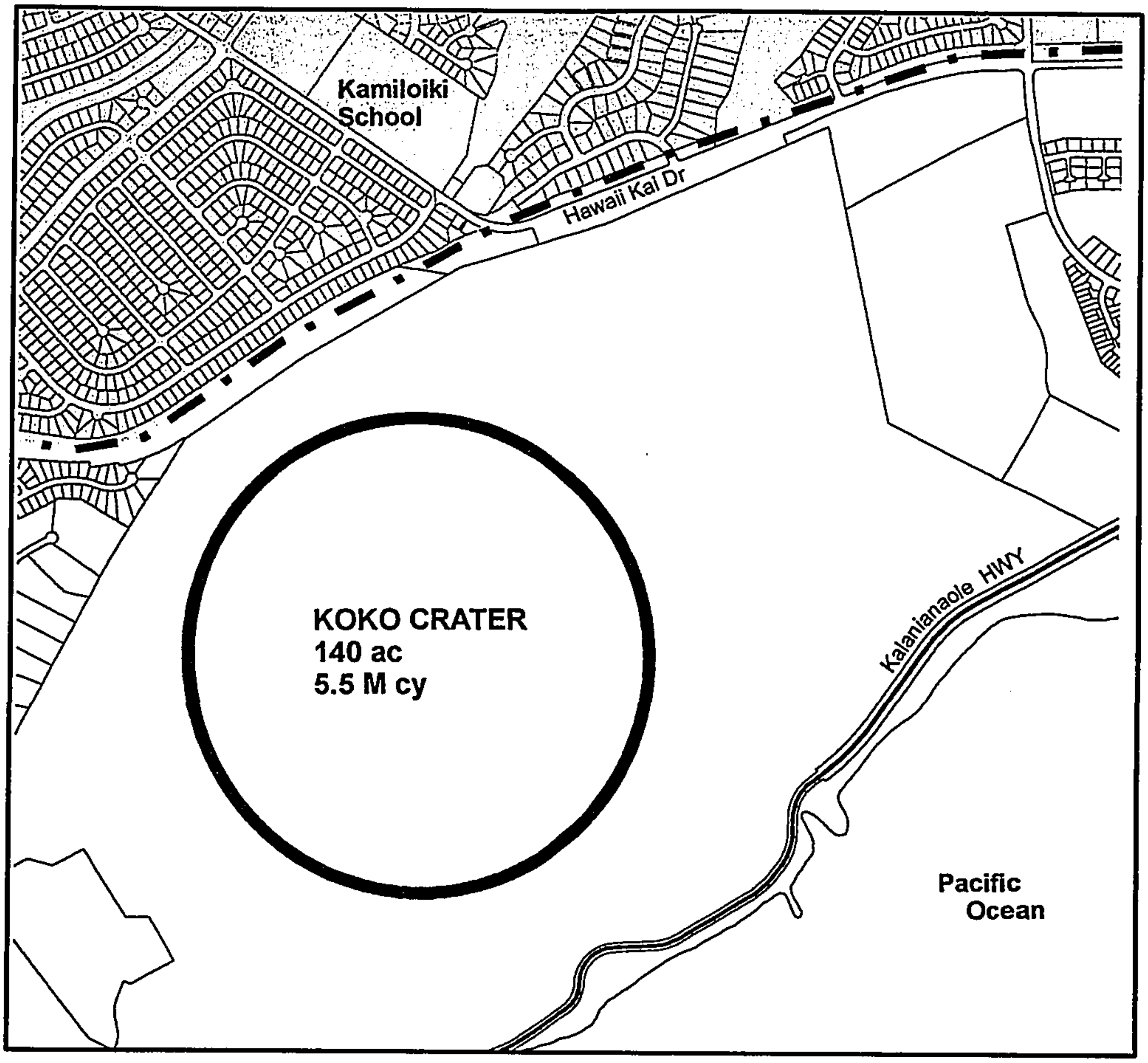
22. **KOKOHEAD CRATER** - This site is located at the southeastern tip of Oahu, 2.5 miles west-southwest of Makapuu Point, one mile east of Kuapa Pond, and 1.3 miles northwest of Hanauma Bay. Elevation of the site ranges from approximately 230 feet to 1,200 feet MSL. **(Figure 3-21).**

TMK:	3-19-12:por 1
Acreage:	±75
Ownership:	City and County of Honolulu. Use of the site as a designated park and regional landmark would increase difficulty of site acquisition for landfill use.
Adjoining Land Uses:	Land uses within the crater include a public park, and police and public firing range. A botanical garden occupies a small portion the crater. Hawaii Kai and Kalama Valley residential developments are located north and to the west of the site. Kaiser High School is located immediately west of the site.
Cover Material:	Must be imported
Soils Classification:	Koko silt loam, 6 to 12% slopes Rock land
City and County of Honolulu Zoning:	P-1
State Land Use District:	Conservation
Capacity:	5.5 million cubic yards
Lifespan:	±9.2 years (based on 0.6 million cubic yards per year required)



LEGEND

▬▬▬	Site Boundary
▬ ▪ ▬ ▪ ▬	Underground Infiltration Control (UIC) Line
OUTSIDE	Groundwater Protection Zone (GPZ) Line

FIGURE 3-21
Koko Crater

0 500 1000 1500 2000 FEET

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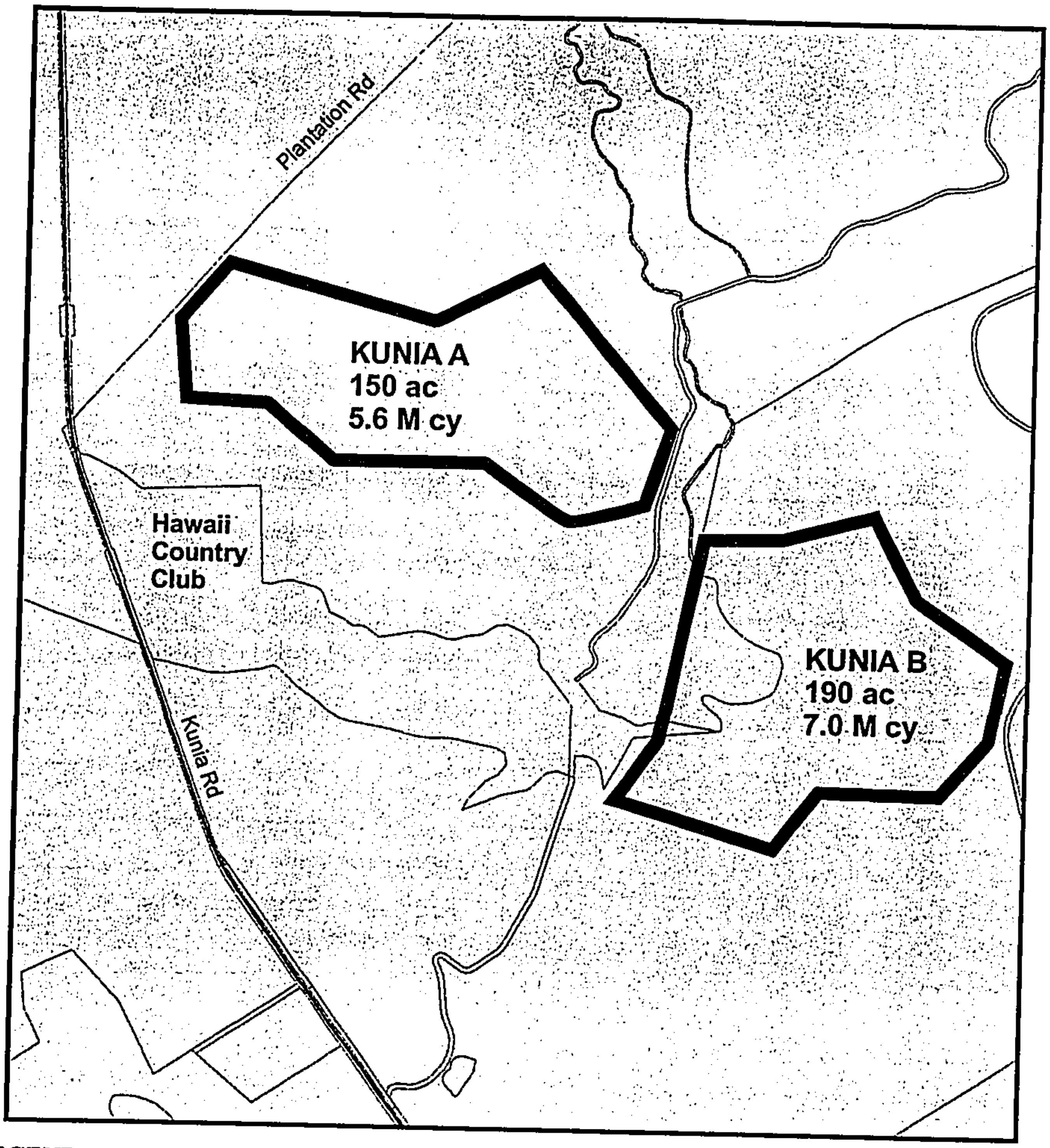
23. **KUNIA SITE A** - Both Kunia Sites A and Site B are located in Hoaeae, north of the H-1 Freeway, and east of Kunia Road. Site A is located in Huliwai Gulch. Elevation of the site ranges from approximately 600 feet to 760 feet MSL (**Figure 3-22**).

TMK:	9-4-4:por 4
Acreage:	±150
Ownership:	Estate of James Robinson et al
Adjoining Land Uses:	This site adjoins the Hawaii Country Club which is located to the south. East of the site is the Mililani residential development.
Cover Material:	Cover material is anticipated to be available on site
Soils Classification:	Kawaihapai clay loam, 2 to 6% slopes Wahiawa silty clay, 3 to 8% slopes Kolekole silty clay loam, 1 to 6% slopes Kunia silty clay, 3 to 8% slopes Helemano silty clay, 30 to 90% slopes
City and County of Honolulu Zoning:	Ag-1
State Land Use District:	Agricultural
Capacity:	5.6 million cubic yards
Lifespan:	±9.3 years (based on 0.6 million cubic yards per year required)



LEGEND

▬▬▬	Site Boundary
INSIDE	Underground Infiltration Control (UIC) Line
INSIDE	Groundwater Protection Zone (GPZ) Line

FIGURE 3-22
Kunia A & B

0 500 1000 1500 2000 2500 3000 FEET

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24. **KUNIA SITE B** - Kunia Site B is located in Ekahanui Gulch and a portion of Poliwai Gulch, adjacent to and east of the Hawaii Country Club Golf Course. Site elevation ranges from approximately 400 feet to 560 feet MSL. (**Figure 3-22**).

TMK:	9-4-3:por 19
Acreage:	±190
Ownership:	Estate of James Robinson
Adjoining Land Uses:	This site adjoins the Hawaii Country Club which is located to the west. East of the site is the Mililani residential development.
Cover Material:	Cover material is anticipated to be available on site
Soils Classification:	Lahaina silty clay, 7 to 15% slopes Wahiawa silty clay, 3 to 8% slopes Wahiawa silty clay, 8 to 15% slopes Kunia silty clay, 0 to 3% slopes Kunia silty clay, 3 to 8% slopes
City and County of Honolulu Zoning:	Ag-1
State Land Use District:	Agricultural
Capacity:	7 million cubic yards
Lifespan:	±11.7 years (based on 0.6 million cubic yards per year required)

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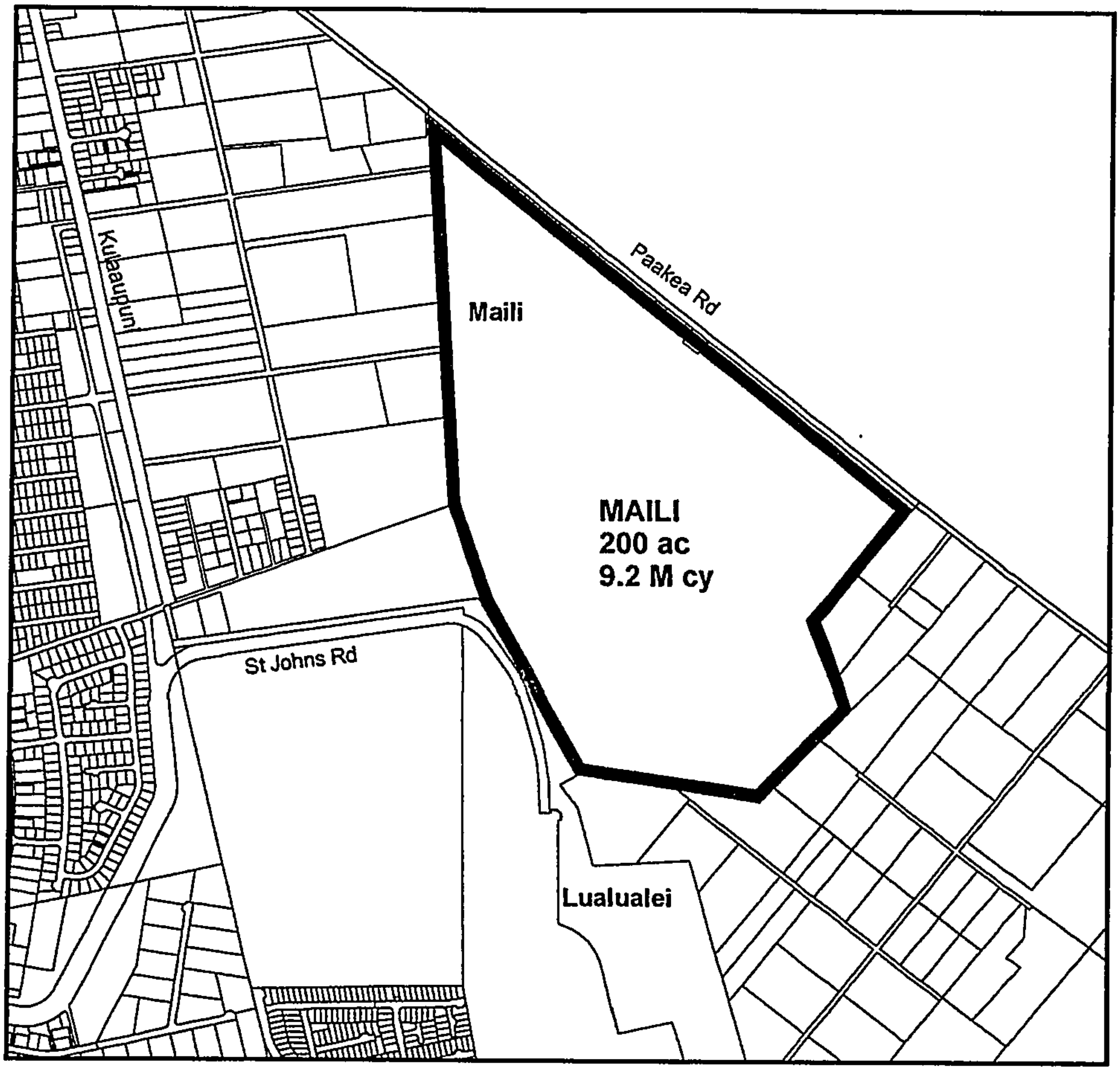
25. **MAILI** - This site is located in the Waianae District of Leeward Oahu. The site is 3,500 feet mauka of Farrington Highway, 4 miles northwest of Nanakuli and 3 miles south of Waianae. Elevation of the site averages approximately 40 feet MSL. **(Figure 3-23)**.

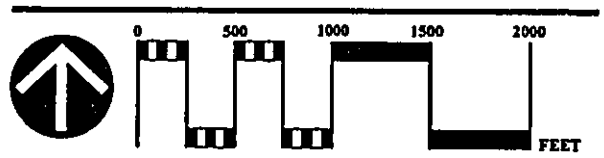
TMK:	8-7-10:3
Acreage:	±200
Ownership:	Lone Star Hawaii
Adjoining Land Uses:	The site is currently used for limestone quarrying operations. The adjoining town of Waianae is located immediately surrounding the site.
Cover Material:	Available on site
Soils Classification:	Mamala stony silty clay loam, 0 to 12% slopes Lualualei clay, 0 to 2% slopes
City and County of Honolulu Zoning:	Ag-1
State Land Use District:	Agricultural
Capacity:	9.2 million cubic yards
Lifespan:	±15.3 years (based on 0.6 million cubic yards per year required)



LEGEND

(thick black line)	Site Boundary
OUTSIDE	Underground Infiltration Control (UIC) Line
OUTSIDE	Groundwater Protection Zone (GPZ) Line

FIGURE 3-23
Maili



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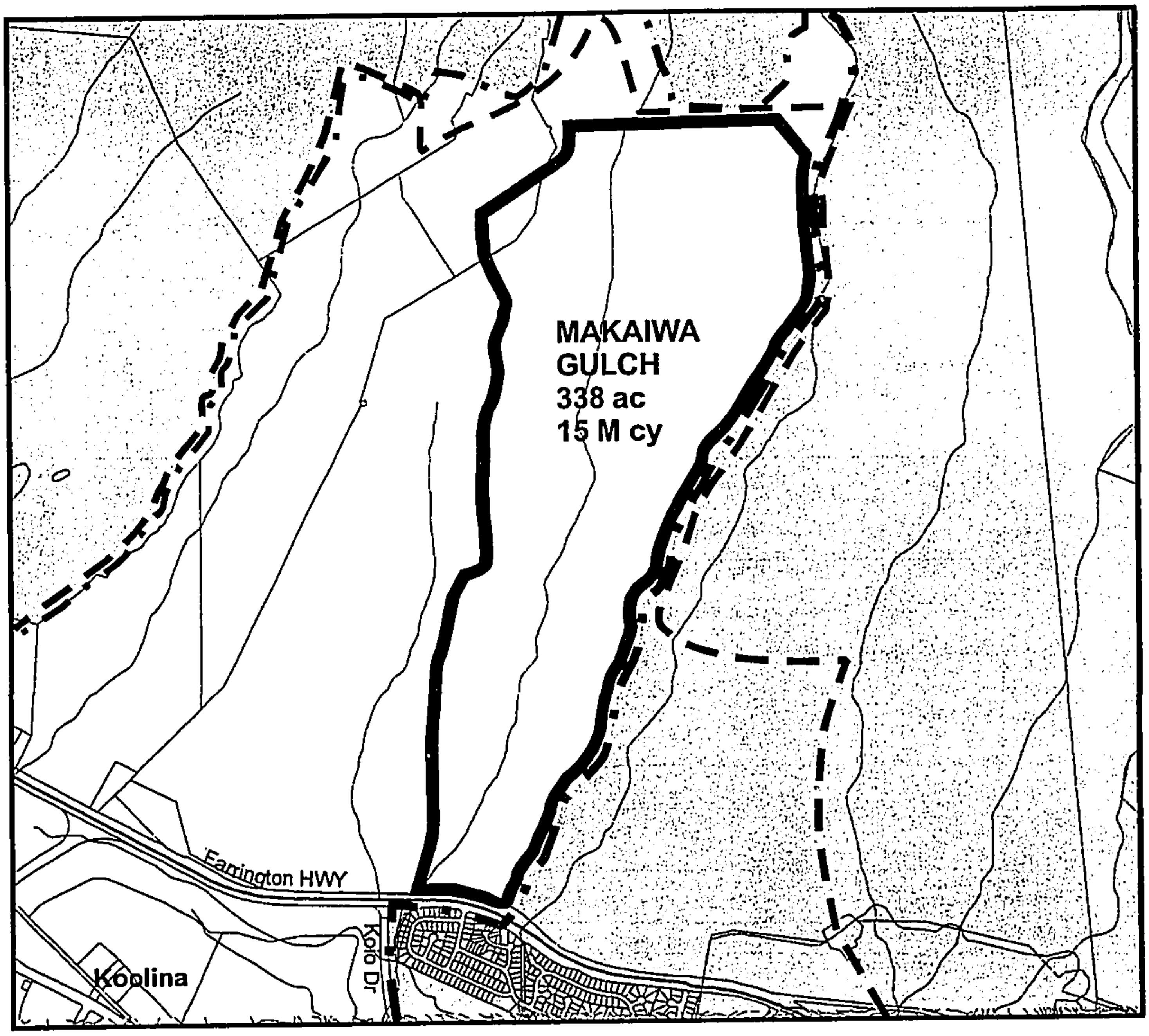
26. **MAKAIWA** - This site is located 1.5 miles northwest of Puu Palailai, north of Farrington Highway, 1.6 miles south of Puu Manawahua, and 1.3 miles east of Kahe Point. Elevation ranges from approximately 120 feet to +600 feet MSL (**Figure 3-24**).

TMK:	9-2-3
Acreage:	±338 (±254 usable)
Ownership:	Estate of James Campbell
Adjoining Land Uses:	The Honokai Hale residential subdivision is located immediately across Farrington Highway, southwest of the site. Waimanalo Gulch Sanitary Landfill is located north and to the west of the site.
Cover Material:	Available on site
Soils Classification:	Stony steep land Mahana Badland Complex Lualualei extremely stony clay, 3 to 35% slopes Helemano silty clay, 30 to 90% slopes
City and County of Honolulu Zoning:	Ag-2
State Land Use District:	Agricultural
Capacity:	15 million cubic yards
Lifespan:	±25 years (based on 0.6 million cubic yards per year required)



LEGEND

Site Boundary

Underground Infiltration Control (UIC) Line

Groundwater Protection Zone (GPZ) Line

FIGURE 3-24
Makaiwa Gulch

0 500 1000 1500 2000 2500 3000 FEET

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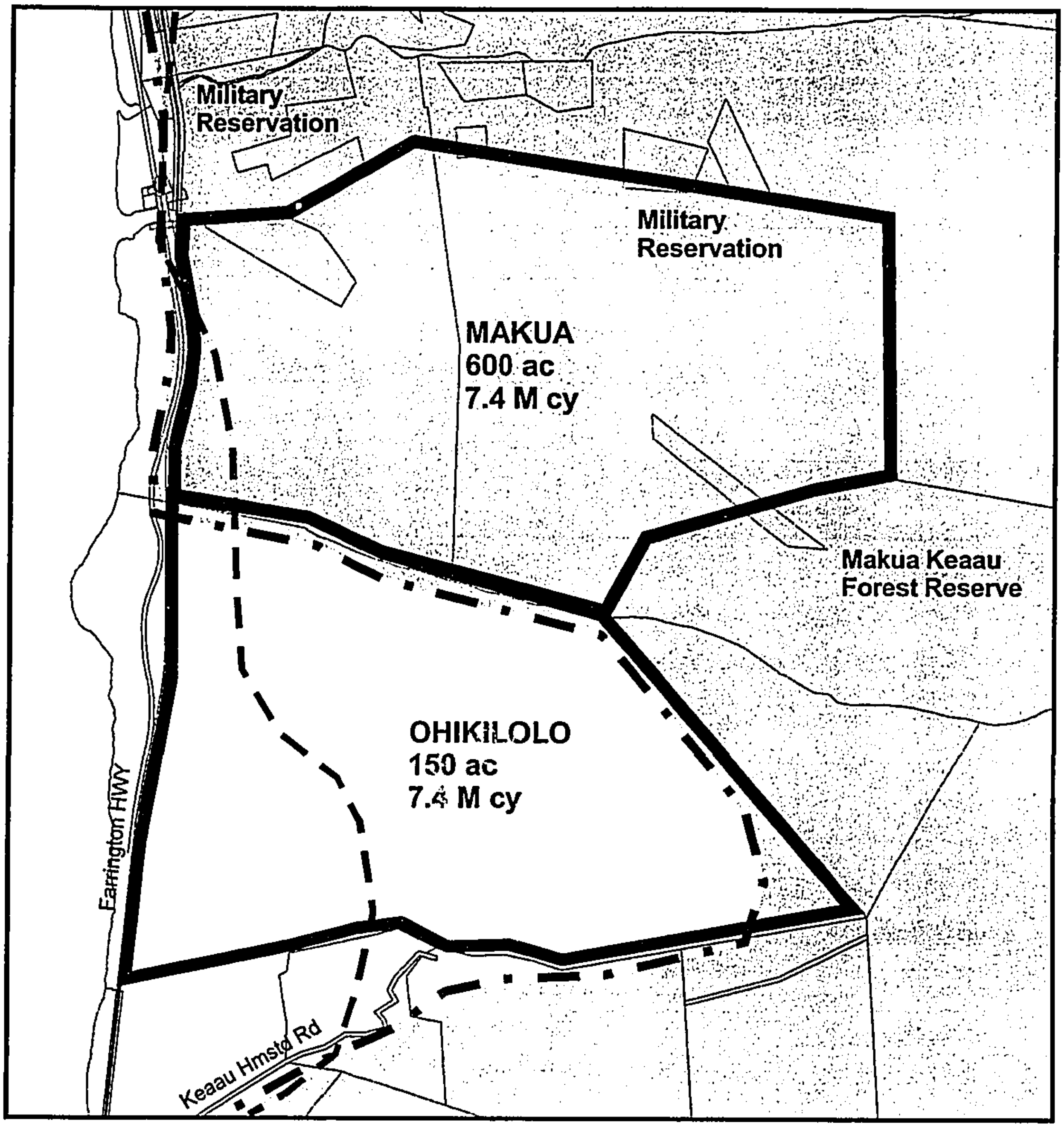
• Source: C & C Honolulu, ENV 2001
IDS Maps 1998, C & C Honolulu

27. **MAKUA** - This site is located in Makua Valley, 5 miles southeast of Kaena Point, 4 miles north of Makaha Valley on the northwestern coast of Leeward Oahu. Elevation ranges from approximately 50 feet to +400 feet MSL. (**Figure 3-25**).

TMK:	8-1-1 and 8-2-1
Acreage:	±600
Ownership:	Federal Government (U.S. Military Reservation). Use of the site for military purposes would increase difficulty of site acquisition.
Adjoining Land Uses:	Farrington Highway is west of the site with coastal waters of the Pacific Ocean beyond. Further north is the Kaena Point State Park.
Cover Material:	Available on site
Soils Classification:	Stony land Lualualei extremely stony clay, 3 to 35% slopes Rock outcrop Pulehu very stony clay loam, 0 to 12% slopes
City and County of Honolulu Zoning:	P-1
State Land Use District:	Conservation
Capacity:	7.4 million cubic yards
Lifespan:	±12.3 years (based on 0.6 million cubic yards per year required)



LEGEND

Site Boundary

Underground Infiltration Control (UIC) Line

Groundwater Protection Zone (GPZ) Line

FIGURE 3-25
Makua & Ohikilolo

0 500 1000 1500 2000 2500 3000 FEET

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28. **OHIKILOLO** - This site is located adjacent and south of the Makua Landfill Site. It is located in Ohikilolo in the north portion of Keaau Valley, 3 miles north of Makaha Valley, and 1 mile south of Makua Valley in Leeward Oahu **(Figure 3-25)**.

TMK:	8-3-1:13
Acreage:	±706
Ownership:	Alpha Kai Corporation et al
Adjoining Land Uses:	The site is immediately south of the Makua Landfill Site alternative.
Cover Material:	Some available on site, but imported cover material is necessary
Soils Classification:	Lolekaa silty clay, 15 to 25% slopes Lualualei clay, 0 to 2% slopes Lualualei stony clay, 2 to 6% slopes Lualualei extremely stony clay, 3 to 35% slopes Pulehu clay loam, 0 to 3% slopes Pulehu very stony clay loam, 0 to 12% slopes Rock land Rock outcrop Stony land Stony steep land
City and County of Honolulu Zoning:	Ag-2 and P-1
State Land Use District:	Agricultural and Conservation
Capacity:	15.6 million cubic yards
Lifespan:	±26 years (based on 0.6 million cubic yards per year required)

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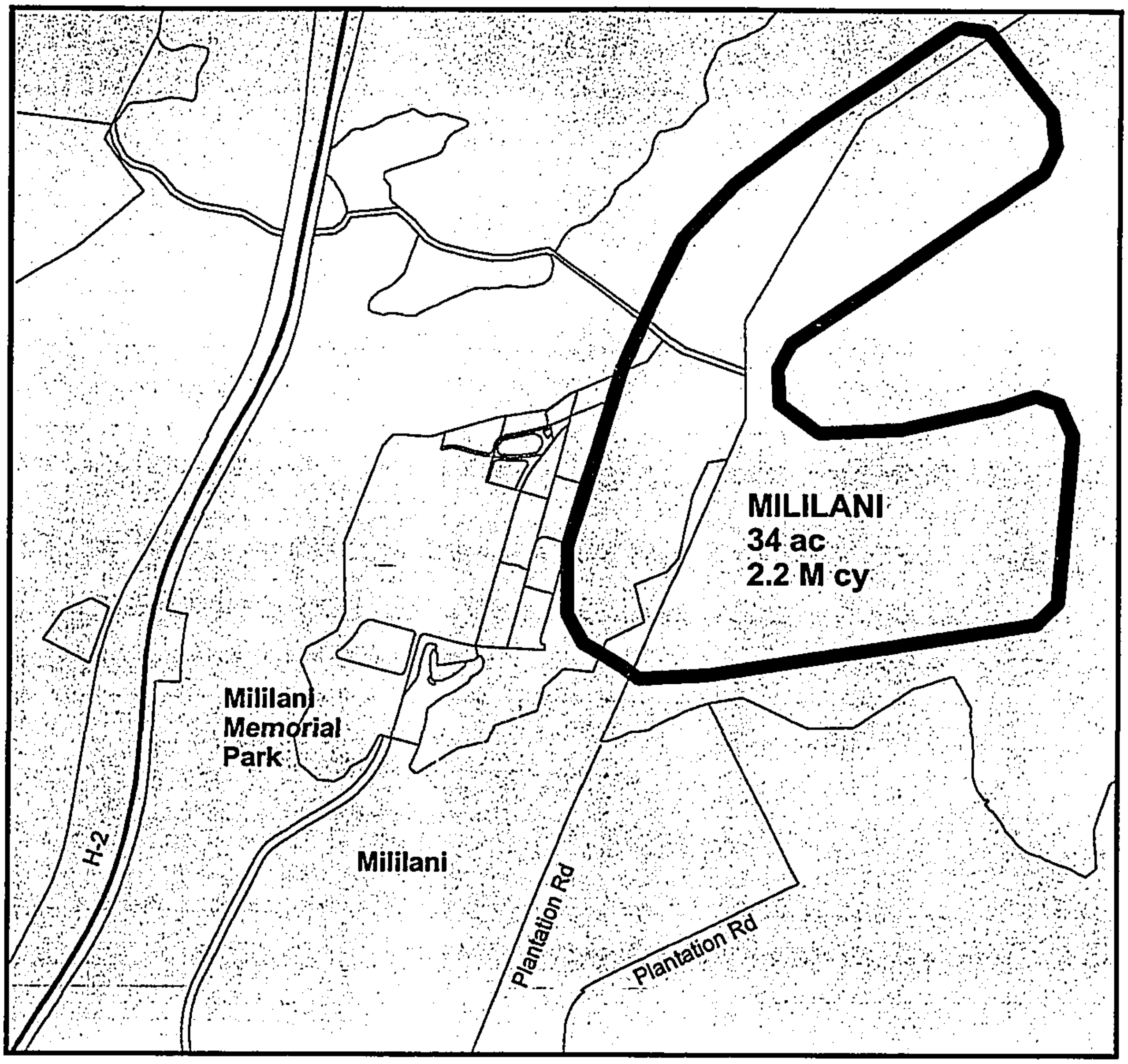
29. **MILILANI** - This site is comprised of one of the major gullies connected to Panakauahi Gulch, adjacent to the Mililani Memorial Park. The site is roughly adjacent and east of the H-1 Freeway. Elevation ranges from approximately 560 feet to +600 feet MSL **(Figure 3-26)**.

TMK:	9-5
Acreage:	±34
Ownership:	Castle and Cooke, Inc., and the Estate of Bernice P. Bishop
Adjoining Land Uses:	
	Mililani Town lies west of the site and Gentry Waipio lies further south and to the west of the site.
Cover Material:	Available on site
Soils Classification:	Manana silty clay, 12 to 25% slopes, eroded Wahiawa silty clay, 0 to 3% slopes Wahiawa silty clay, 3 to 8% slopes Manana silty clay, 3 to 8% slopes Manana silty clay loam, 2 to 6% slopes
City and County of Honolulu Zoning:	P-2
State Land Use District:	Agricultural
Capacity:	2.2 million cubic yards
Lifespan:	±3.7 years (based on 0.6 million cubic yards per year required)



LEGEND

▬▬▬	Site Boundary
INSIDE	Underground Infiltration Control (UIC) Line
INSIDE	Groundwater Protection Zone (GPZ) Line

FIGURE 3-26
Mililani

0 500 1000 1500 2000 FEET

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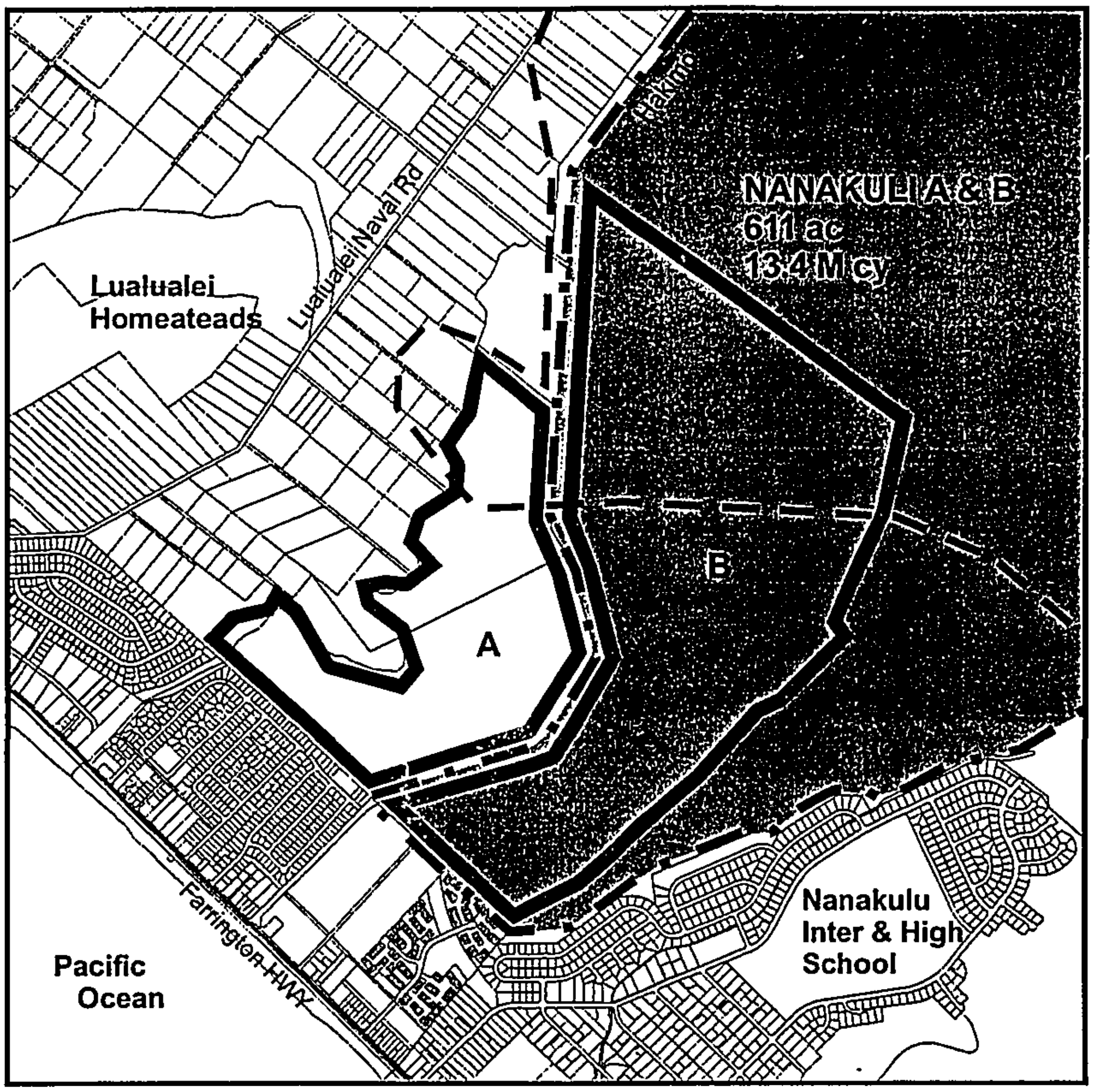
30. **NANAKULI** - This site is located 2,000 feet mauka of Farrington Highway and Nanaikapono Beach Park, 4,000 feet west of Puu Helakala, and 4,000 feet east, southeast of Puu O Hulu Uka. Elevation ranges from approximately 40 feet to +300 feet MSL. **(Figure 3-27).**

TMK:	8-7-9:1 & 3 and 8-7-21:26
Acreage:	±611 (±288 usable)
Ownership:	PVT Holdings, Inc., and PVT Land Company Ltd.
Adjoining Land Uses:	Commercial uses within Nanakuli town are located immediately west and south of the site. Agricultural lots are located immediately tot he northwest. South and west of the site are residences and the Nanakuli Intermediate and High School.
Cover Material:	Cover material is anticipated to be available on site
Soils Classification:	Lualualei clay, 2 to 6% slopes Lualualei extremely stony clay, 3 to 35% slopes Mamala stony silty clay loam, 0 to 12% slopes Pulehu very stony clay loam, 0 to 12% slopes Rock land
City and County of Honolulu Zoning:	P-1, Ag-2
State Land Use District:	Urban, Agricultural, and Conservation
Capacity:	13.4 million cubic yards
Lifespan:	±22.3 years (based on 0.6 million cubic yards per year required)



LEGEND

Site Boundary

Underground Infiltration Control (UIC) Line

Groundwater Protection Zone (GPZ) Line

FIGURE 3-27
Nanakulia & B

0 500 1000 1500 2000 2500 3000 FEET

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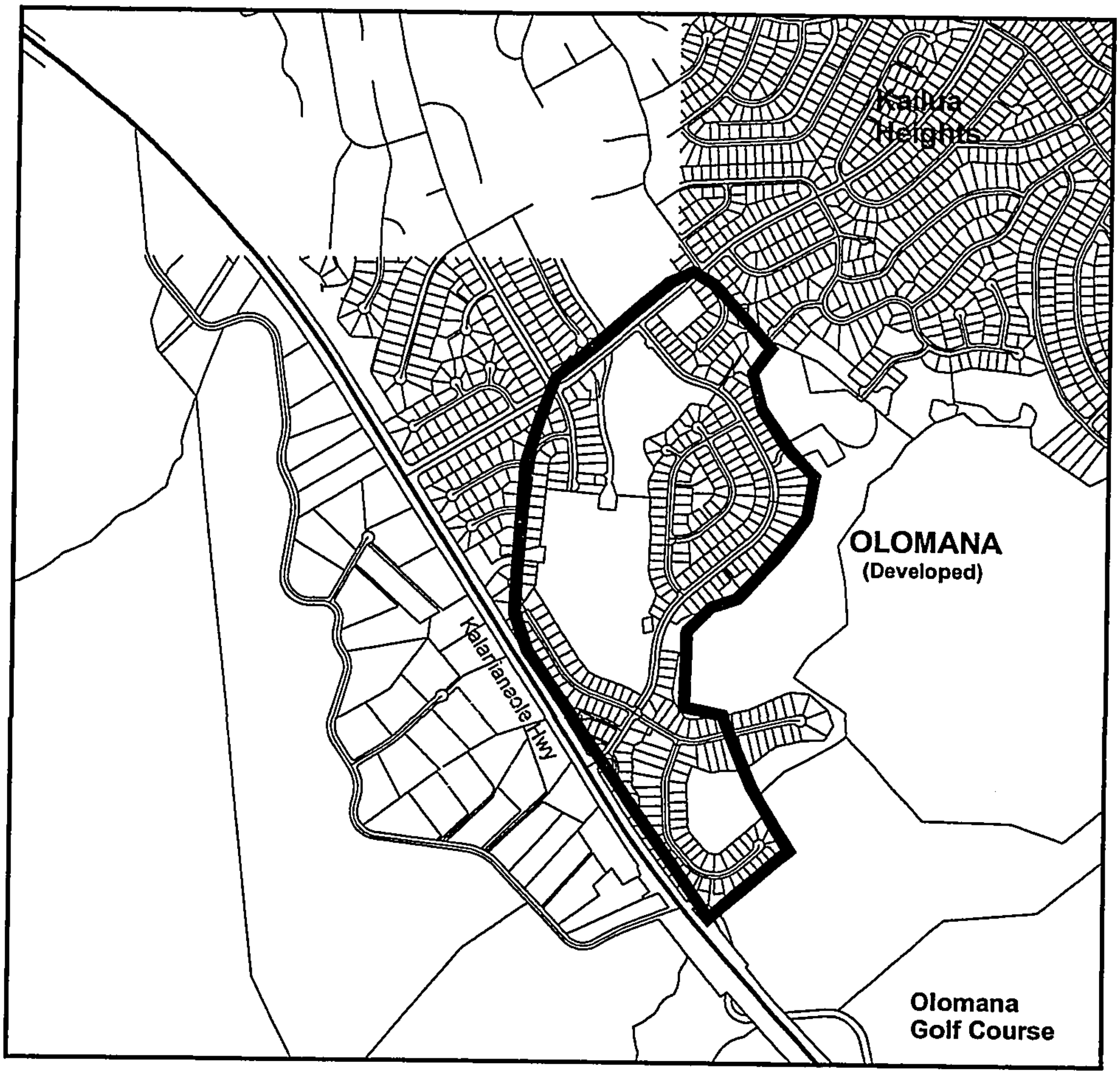
31. **OLOMANA** - No longer viable for development. The identification of this site is provided in **Figure 3-28.**



LEGEND

(thick line)	Site Boundary
OUTSIDE	Underground Infiltration Control (UIC) Line
OUTSIDE	Groundwater Protection Zone (GPZ) Line

NOTE: TMK Parcel Information For upper Quadrant unavailabie on IDS Map.

FIGURE 3-28
Olomana

0 500 1000 1500 2000 FEET

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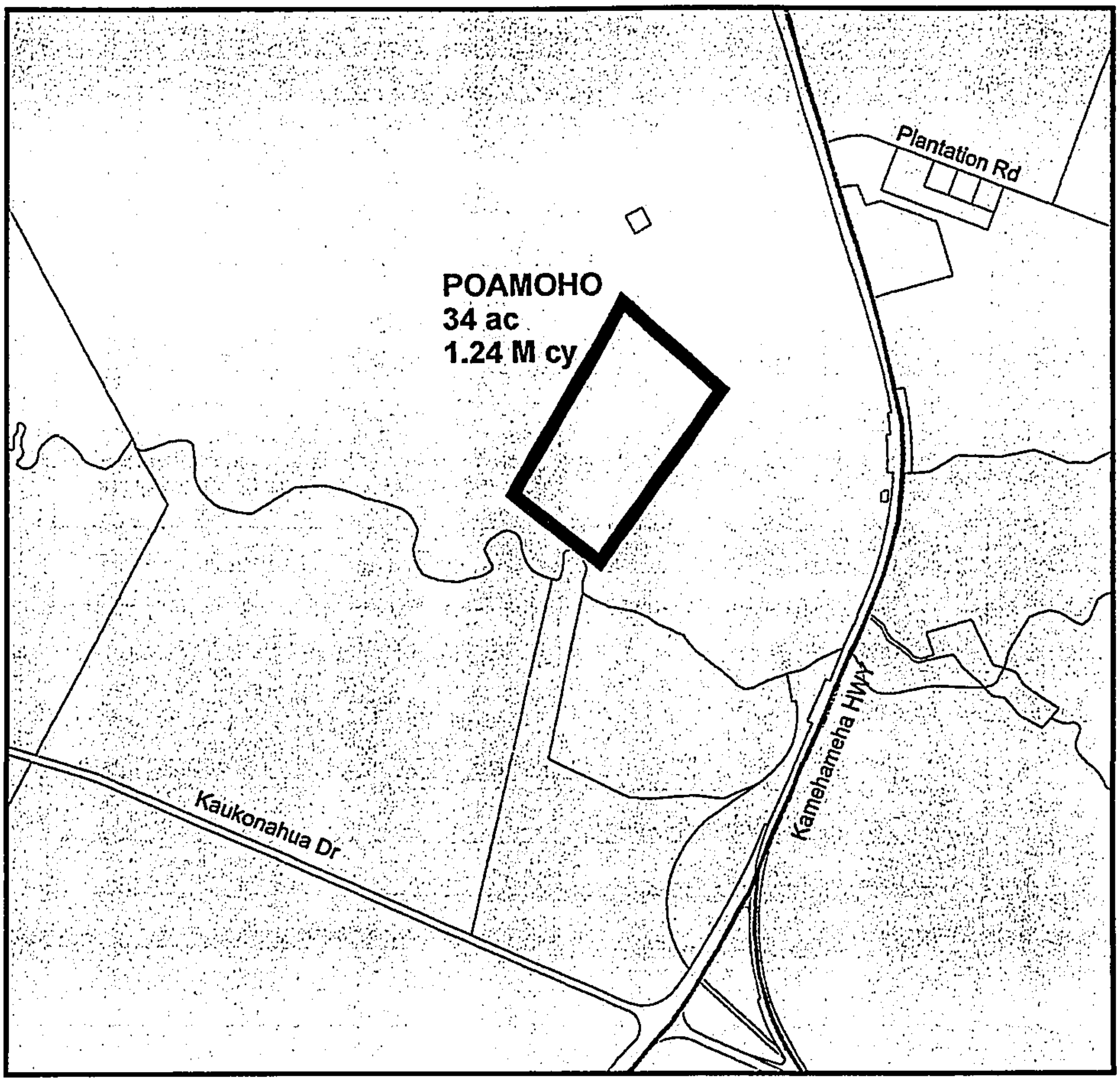
32. **POAMOHO** - This site is located adjacent to agricultural fields and is approximately 2.6 miles north of the town of Wahiawa. Kamehameha Highway is located to the east of the site. Elevation of the site ranges from approximately 840 feet to 920 feet MSL. **(Figure 3-29).**

TMK:	4-2
Acreage:	±5
Ownership:	To be determined based on site boundary
Adjoining Land Uses:	The site is primarily in open space agricultural uses. Poamoho Camp is located approximately 0.25 miles to the south and the town of Whitmore Village is located southeast approximately 0.5 miles away.
Cover Material:	Cover material is anticipated to be available on site
Soils Classification:	Wahiawa silty clay, 3 to 8% slopes Wahiawa silty clay, 8 to 15% slopes Helemano silty clay, 30 to 90% slopes
City and County of Honolulu Zoning:	Ag-1
State Land Use District:	Agricultural
Capacity:	0.7 million cubic yards
Lifespan:	±1.2 years (based on 0.6 million cubic yards per year required)



LEGEND

(thick line)	Site Boundary
INSIDE	Underground Infiltration Control (UIC) Line
INSIDE	Groundwater Protection Zone (GPZ) Line

FIGURE 3-29
Poamoho

0 500 1000 1500 2000 FEET

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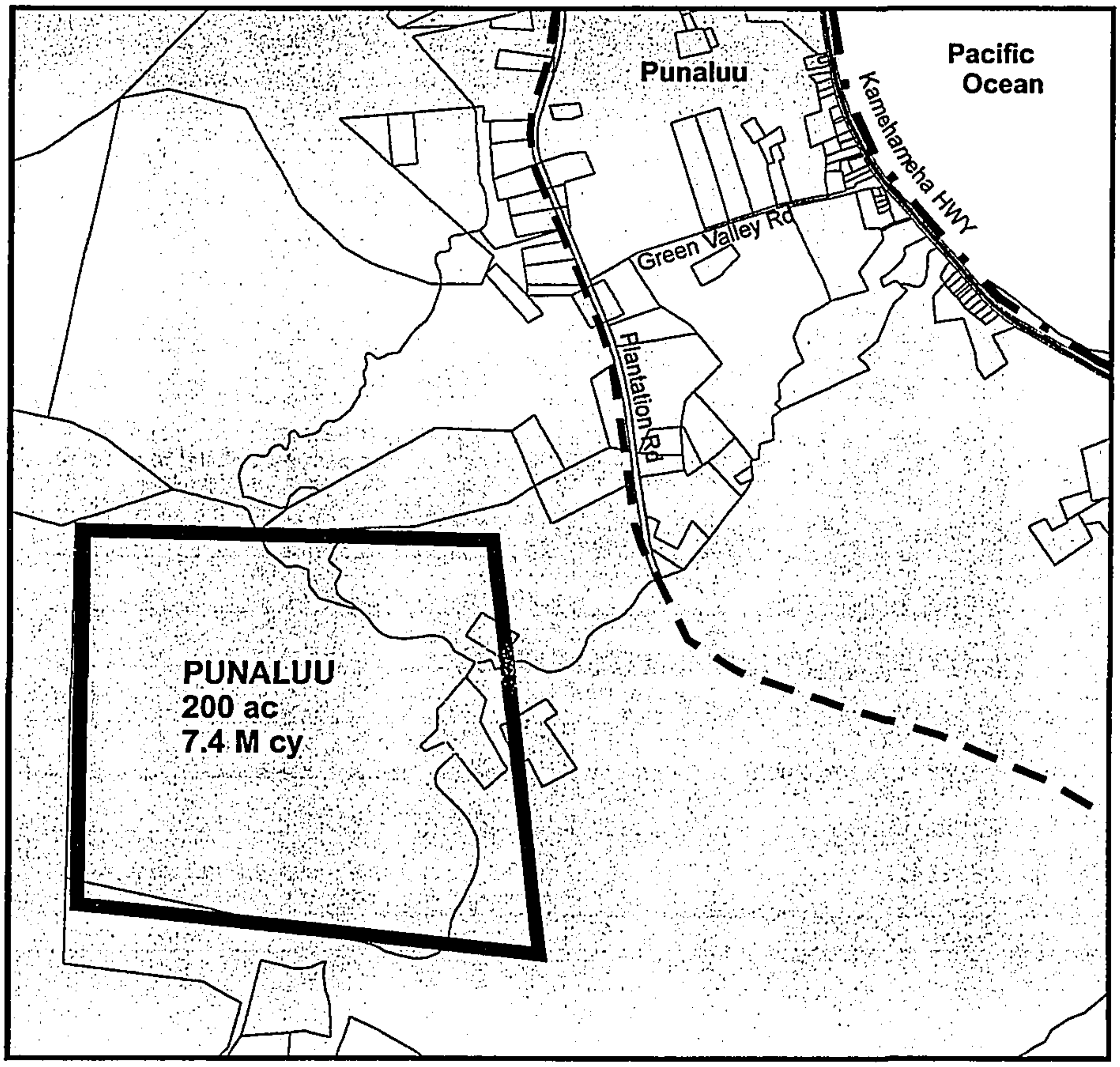
33. **PUNALUU** - This site is located in Windward Oahu, in Punaluu. The site is surrounded by agricultural land uses with Kamehameha Highway located east, northeast of the site. Elevation ranges from approximately 40 feet to +300 feet MSL. **(Figure 3-30)**.

TMK:	5-3
Acreage:	±200
Ownership:	To be determined based on site boundary
Adjoining Land Uses:	Adjoining land uses include agriculture and open space. Punaluu Beach Park and the Pacific Ocean are located east, northeast of the site. Along Kamehameha Highway are single family residences and farm lots.
Cover Material:	Cover material is anticipated to be available on site
Soils Classification:	Lolekaa silty clay, 8 to 15% slopes Lolekaa silty clay, 25 to 40% slopes Lolekaa silty clay, 40 to 70% slopes Waikane silty clay, 40 to 70% slopes, eroded Hanalei silty clay, 2 to 6% slopes Waialua stony silty clay, 3 to 8 percent slopes
City and County of Honolulu Zoning:	Ag-2
State Land Use District:	Agricultural
Capacity:	7.4 million cubic yards
Lifespan:	±12.3 years (based on 0.6 million cubic yards per year required)



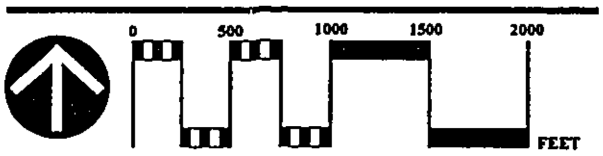
LEGEND

Site Boundary

Underground Infiltration Control (UIC) Line

Groundwater Protection Zone (GPZ) Line

FIGURE 3-30
Punaluu



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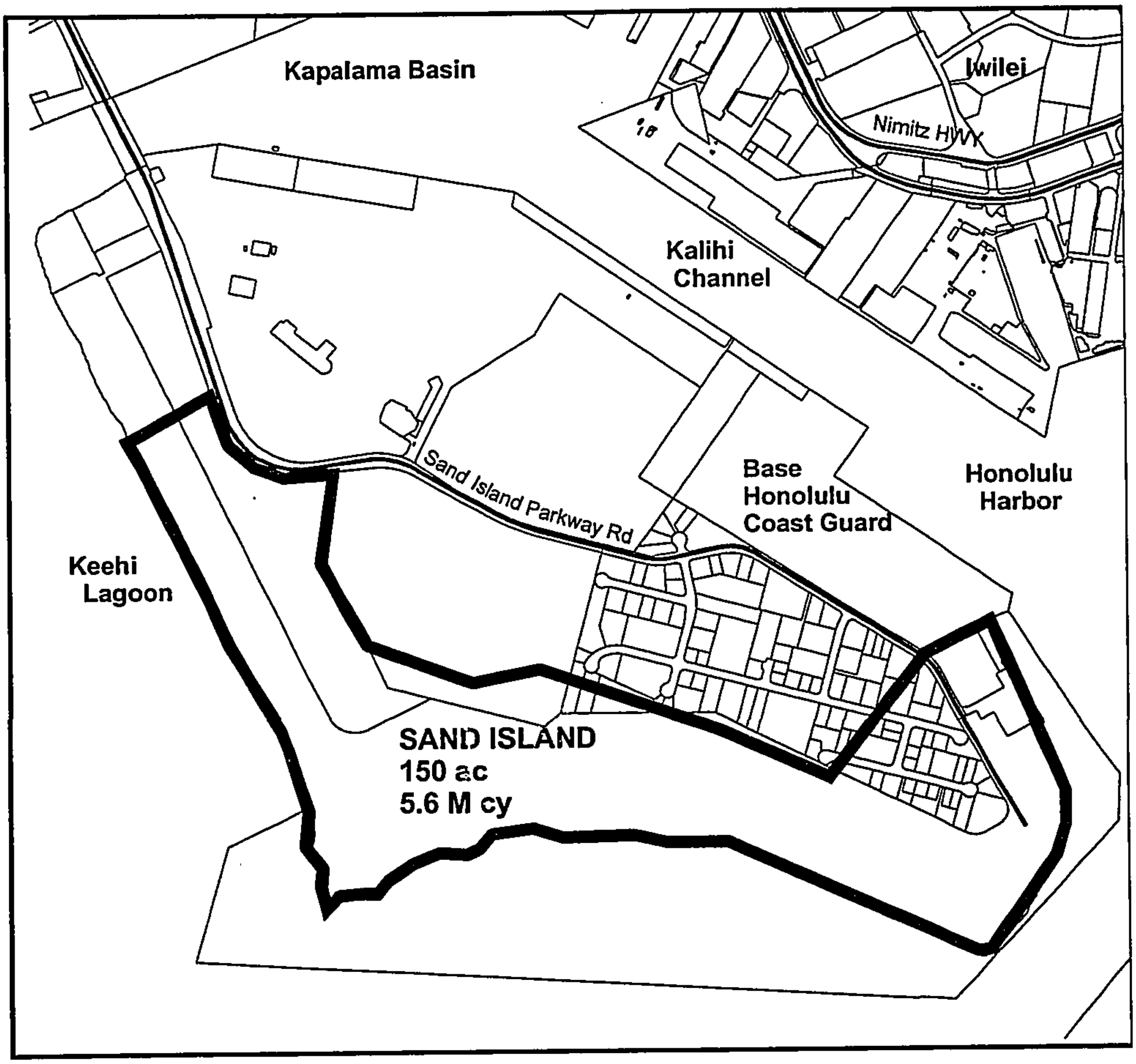
34. **SAND ISLAND** - This site is located at Sand Island State Park on the south and east sides of Sand Island in Honolulu Harbor across the downtown commercial and Iwilei Industrial areas on the south Leeward Coast of Oahu. Elevation of the site averages approximately 40 feet MSL **(Figure 3-31)**.

TMK:	1-5-41:por 6
Acreage:	±150
wnership:	State of Hawaii
Adjoining Land Uses:	Existing site is a State Park. Surrounding land uses include commercial and industrial activities. The Sand Island Wastewater Treatment Plant is located in the approximate center of Sand Island.
Cover Material:	Must be imported
Soils Classification:	Fill land
City and County of Honolulu Zoning:	P-2
State Land Use District:	Urban
Capacity:	5.6 million cubic yards
Lifespan:	±9.3 years (based on 0.6 million cubic yards per year required)



LEGEND

	Site Boundary
OUTSIDE	Underground Infiltration Control (UIC) Line
OUTSIDE	Groundwater Protection Zone (GPZ) Line

FIGURE 3-31
Sand Island

0 500 1000 1500 2000 FEET

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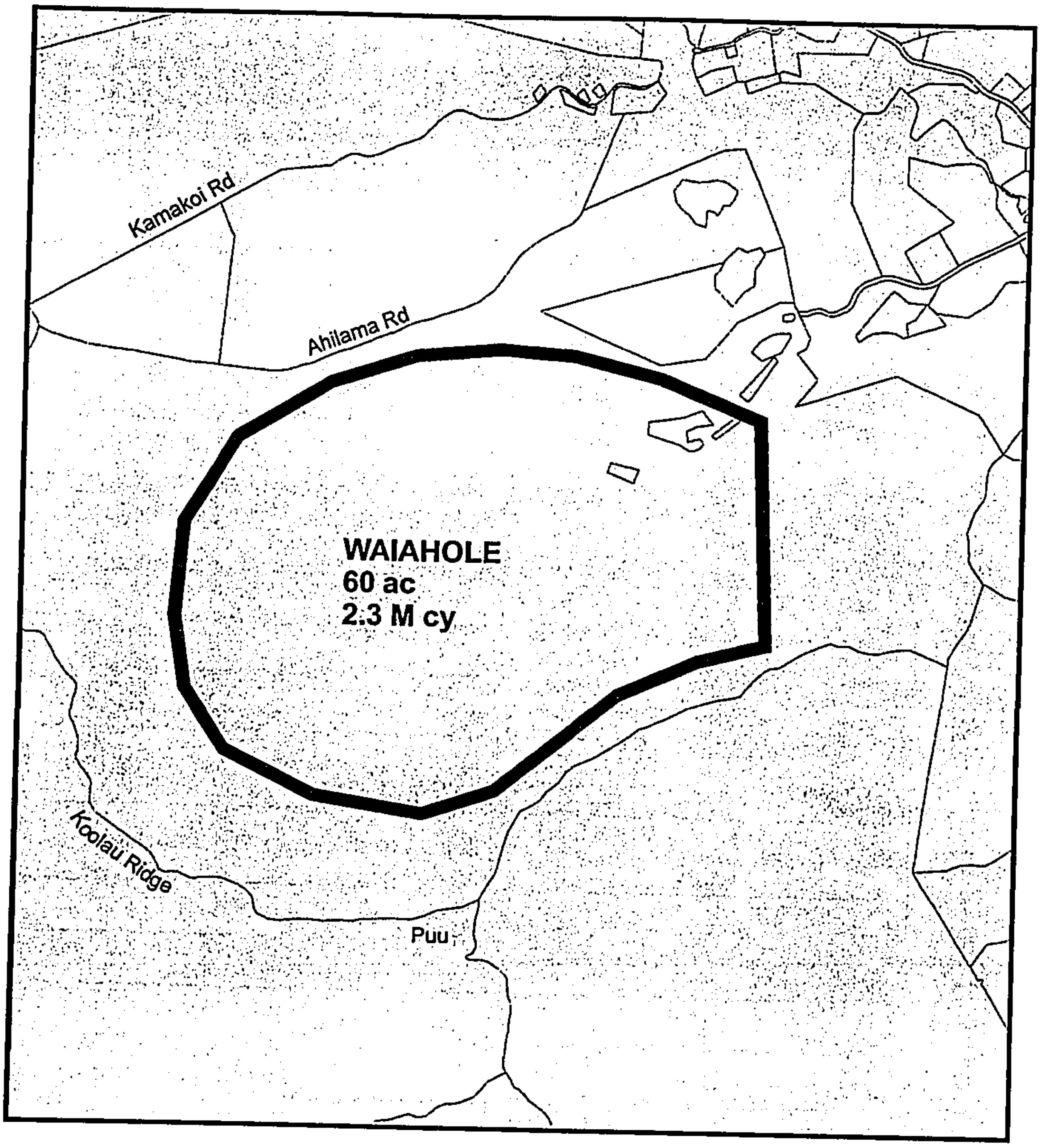
35. **WAIAHOLE** - This site is located in Windward Oahu in Waihole. The site is surrounded by open space and agricultural land uses. Kamehameha Highway is located east of the site. Elevation ranges from approximately 160 feet to +400 feet MSL **(Figure 3-32)**.

TMK:	4-8
Acreage:	±60
Ownership:	To be determined based on site boundary
Adjoining Land Uses:	Adjoining land uses include agriculture and open space. Waihole Elementary and Intermediate School is located east of the site with the Waihole Beach Park and Pacific Ocean located further east. Along Kamehameha Highway are single family residences and farm lots.
Cover Material:	Cover material is anticipated to be available on site.
Soils Classification:	Waikane silty clay, 25 to 40% slopes Hanalei silty clay, 0 to 2% slopes
City and County of Honolulu Zoning:	P-1 and Ag-2
State Land Use District:	Conservation and Agricultural
Capacity:	2.3 million cubic yards
Lifespan:	±3.8 years (based on 0.6 million cubic yards per year required)



LEGEND

(heavy line)	Site Boundary
INSIDE	Underground Infiltration Control (UIC) Line
INSIDE	Groundwater Protection Zone (GPZ) Line

FIGURE 3-32
Waiahole

0 500 1000 1500 2000 2500 3000 FEET

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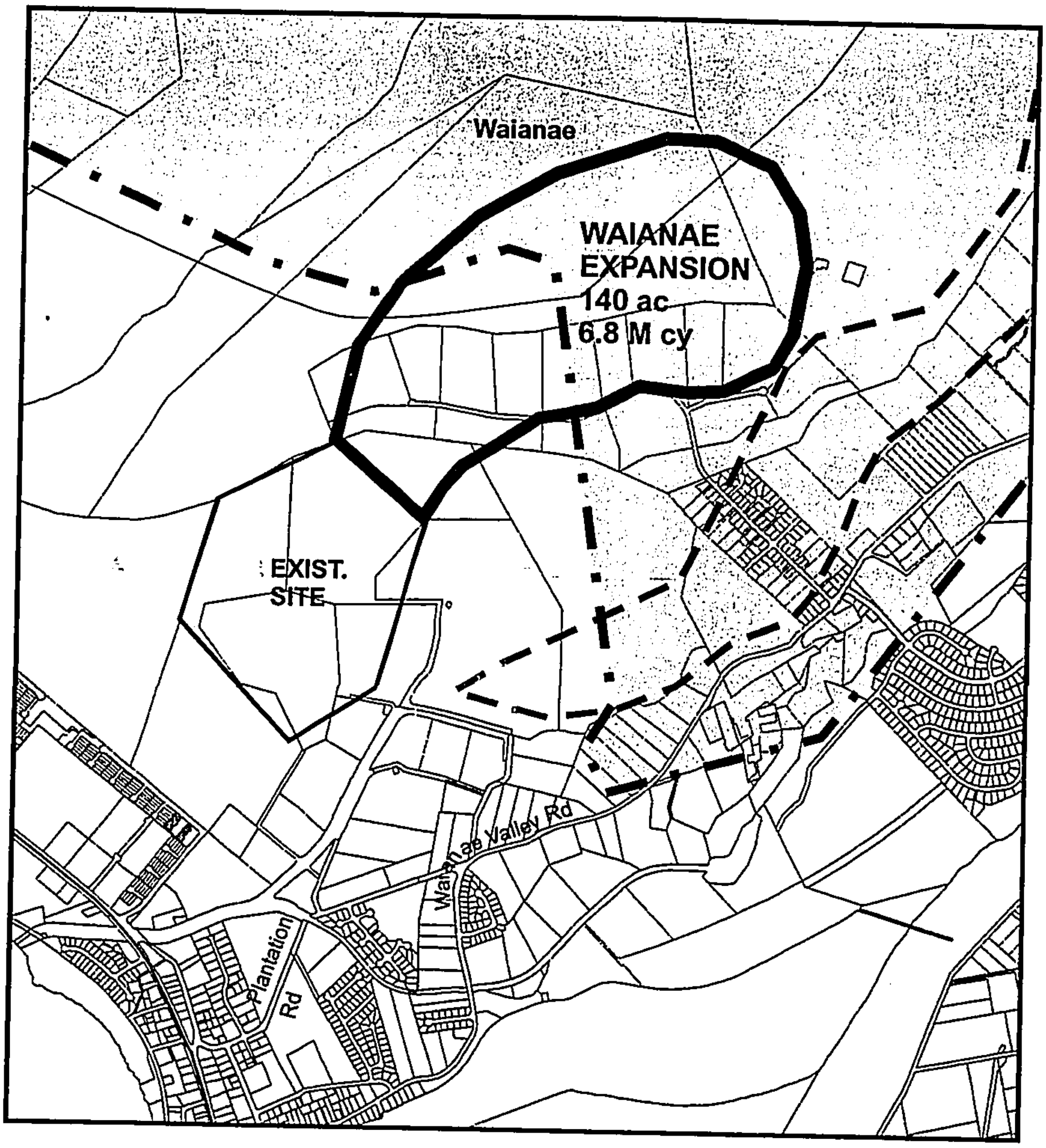
36. **WAIANAE EXPANSION** - This site is located adjacent to the old Waianae Landfill, approximately 0.9 miles mauka of Farrington Highway. Elevation of the expansion site ranges from approximately 40 feet to +800 feet MSL. **(Figure 3-33).**

TMK:	8-50-3:1, 29 - 32 8-5-6:10
Acreage:	±140 (±130 usable)
Ownership:	City and County of Honolulu, Herbert K. Horita Investment Inc., and World Union Industrial Corp.
Adjoining Land Uses:	The land is surrounded by agricultural lots, some of which remain in open space and uncultivated. Southwest of the site is the Waianae Intermediate School and Farrington Highway which adjoins the school. Coastal waters of the Pacific Ocean are located further southwest, across Farrington Highway at the Waianae Regional Park..
Cover Material:	Some cover available on site. Additional cover material must be imported.
Soils Classification:	Stony Lualualei Clay, 3 to 35% slopes Rock land
City and County of Honolulu Zoning:	Ag-2
State Land Use District:	Agricultural and Conservation
Capacity:	6.8 million cubic yards
Lifespan:	±22.3 years (based on 0.6 million cubic yards per year required)



LEGEND

Site Boundary

Underground Infiltration Control (UIC) Line

Groundwater Protection Zone (GPZ) Line

FIGURE 3-33
Waianae Expansion

0 500 1000 1500 2000 2500 3000 FEET

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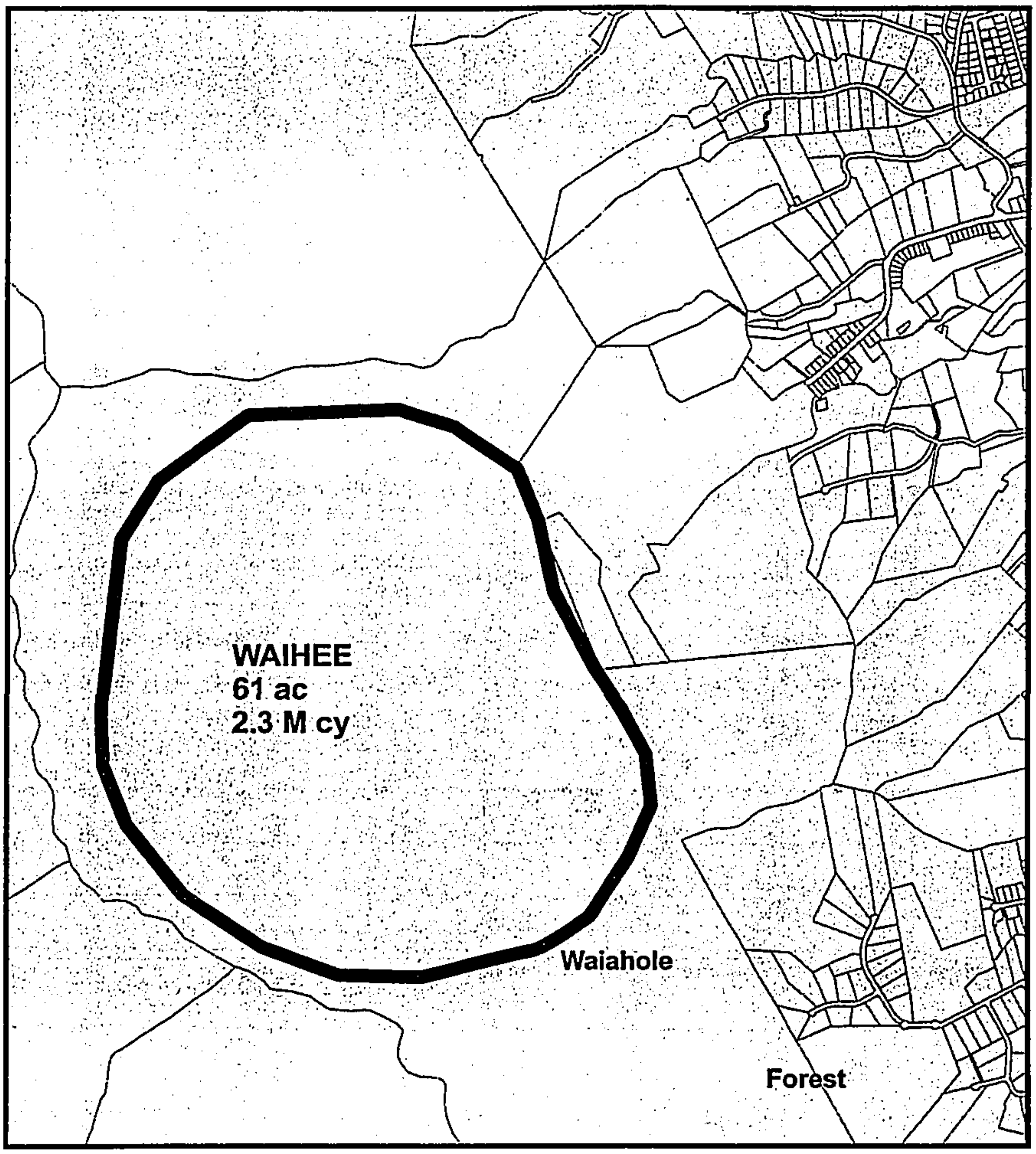
37. **WAIHEE** - This site is located roughly between the Kahaluu and Waihole landfill sites in Windward Oahu. The site is located mauka of Kamehameha Highway and above the town of Kahaluu. Elevation of the site ranges from approximately +200 feet to +700 feet MSL. **(Figure 3-34).**

TMK:	4-7
Acreage:	±61
Ownership:	To be determined based on site boundary
Adjoining Land Uses:	Adjoining the site to the east is the Waihee Valley Nature Park located Mauka of Kamehameha Highway. Further Makai of the park are residences and large lot agricultural parcels. Above the landfill site is the Waihole Forest Reserve boundary.
Cover Material:	Cover material is anticipated to be available on site.
Soils Classification:	Waikane silty clay, 40 to 70% slopes Rock outcrop
City and County of Honolulu Zoning:	P-1
State Land Use District:	Conservation
Capacity:	2.3 million cubic yards
Lifespan:	±3.8 years (based on 0.6 million cubic yards per year required)



LEGEND

Site Boundary

Underground Infiltration Control (UIC) Line

Groundwater Protection Zone (GPZ) Line

FIGURE 3-34
Waihee

0 500 1000 1500 2000 2500 3000 FEET

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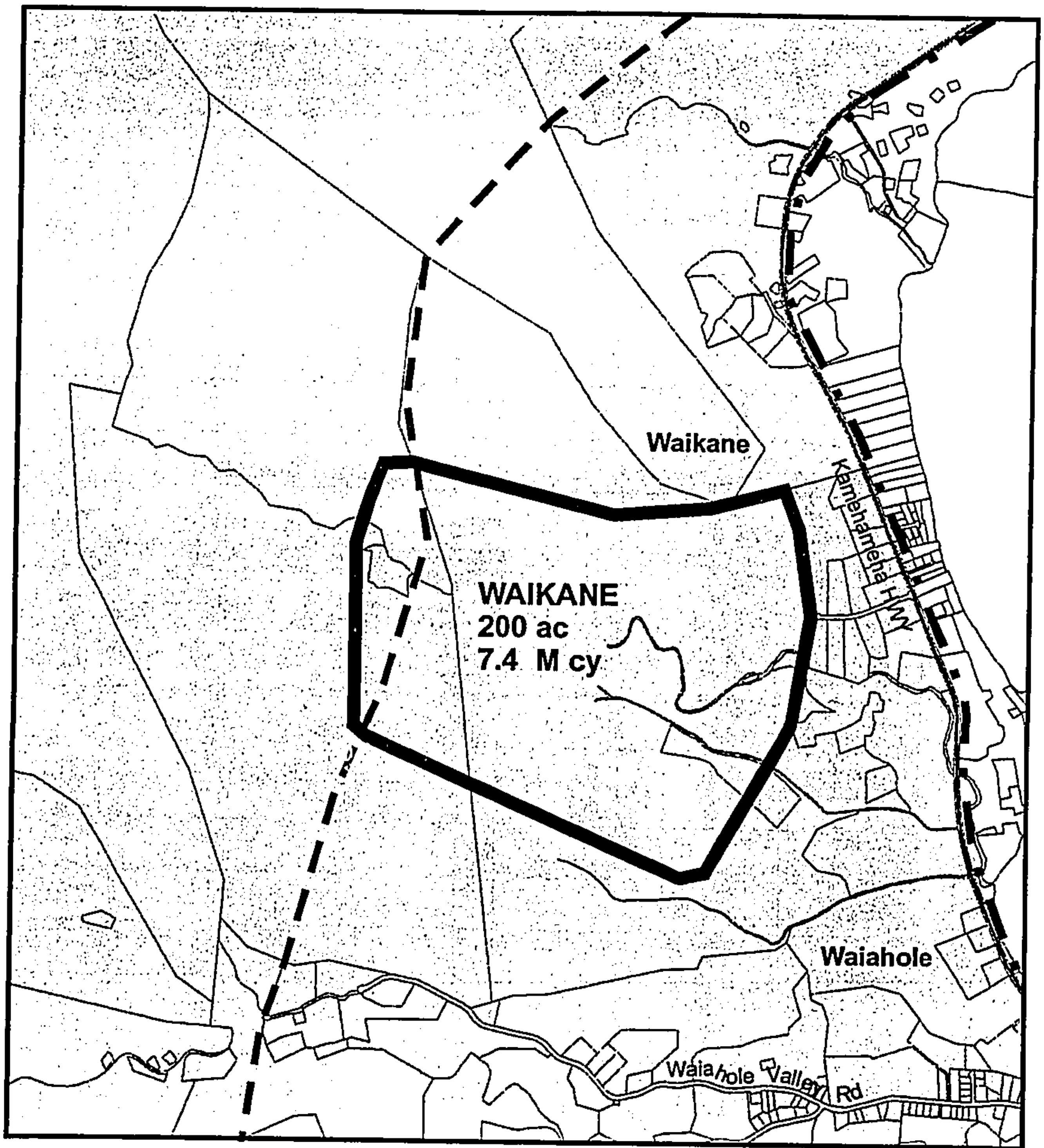
38. **WAIKANE** - This site is located in Windward Oahu and is roughly between the Kaaawa and Waihole alternative landfill sites. The site is located Mauka of Kamehameha Highway and situated in the Waikane district of Oahu. Elevation ranges from approximately 120 feet to +800 feet MSL. **(Figure 3-35)**.

TMK:	4-8
Acreage:	±200
Ownership: *Adjoining Land Uses:*	To be determined based on site boundary Adjoining the site to the east is Kamehameha Highway and Kaneohe Bay. Kualoa Regional Park and Molii Pond is located north, northwest of the site. Residences and agricultural parcels adjoin Kamehameha Highway.
Cover Material:	Cover material is anticipated to be available on site.
Soils Classification:	Waikane silty clay, 40 to 70% slopes Waikane silty clay, 40 to 70% slopes, eroded Lolekaa silty clay, 40 to 70% slopes
City and County of Honolulu Zoning:	Ag-2 and P-1
State Land Use District:	Agricultural and Conservation
Capacity:	9 million cubic yards
Lifespan:	±15 years (based on 0.6 million cubic yards per year required)



LEGEND

Site Boundary

Underground Infiltration Control (UIC) Line

Groundwater Protection Zone (GPZ) Line

FIGURE 3-35
Waikane

0 500 1000 1500 2000 2500 3000 FEET

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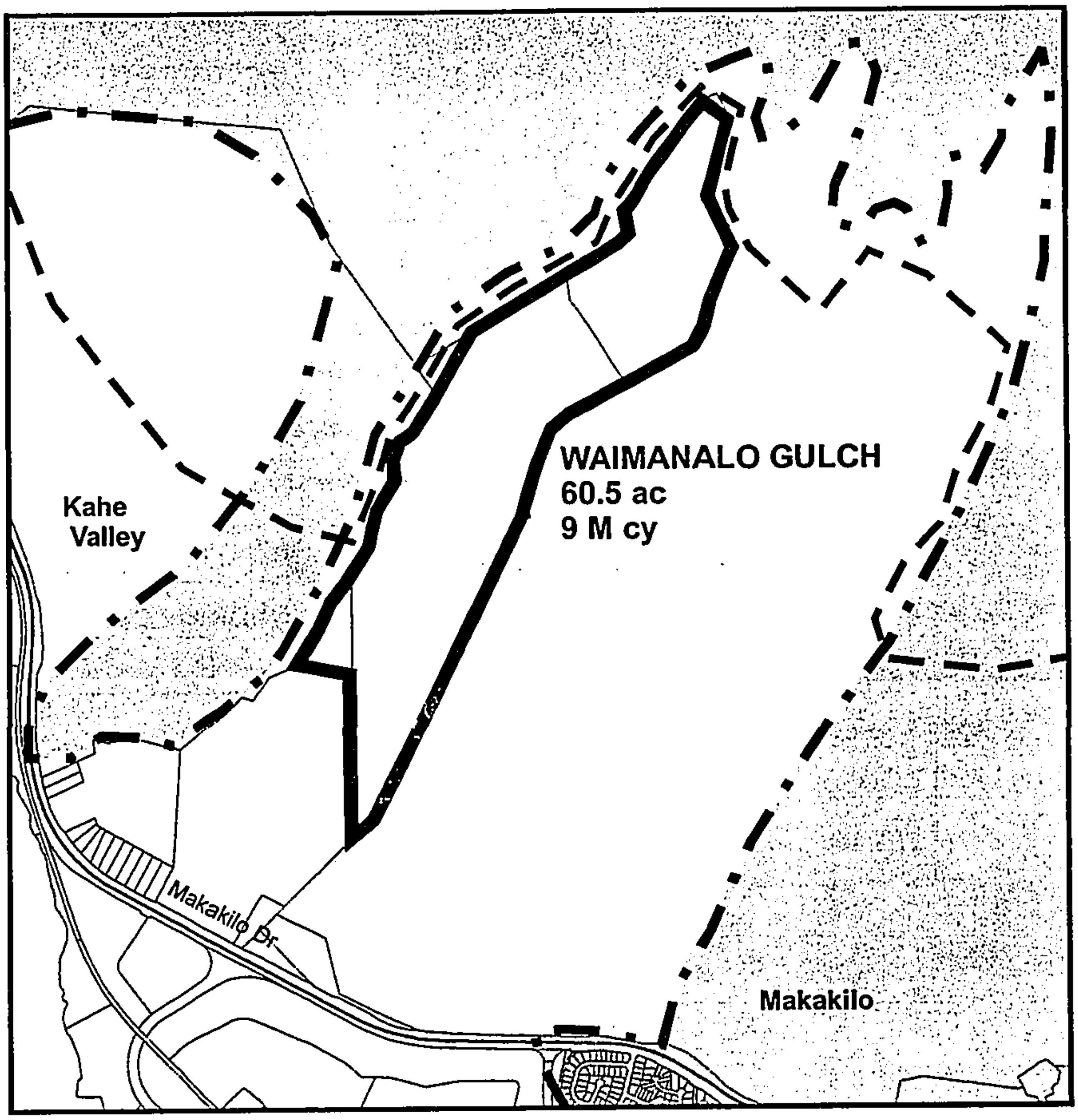
39. **WAIMANALO GULCH EXPANSION** - This site is within the location of the existing Waimanalo Gulch Sanitary Landfill. South of the site is the Campbell Industrial Park, Barbers Point Deep Draft Harbor, and the Ko Olina Resort which is located nearby. Southeast of the site is the Honokai Hale residential subdivision and to the east is the Makakilo residential subdivision. Immediately to the northwest are the Hawaiian Electric Power Generating Station and the Kahe Point Beach Park. Elevation of the site ranges from approximately 150 feet to +700 feet MSL. **(Figure 3-36).**

TMK:	9-2-3:72 & 73
Acreage:	±60.5
Ownership:	City and County of Honolulu
Adjoining Land Uses:	The site adjoins Farrington Highway. To the northwest is the Hawaiian Electric Kahe Power Generating Station. South of the site is Ko Olina and the Ihilani Resort. Southeast of the site is the Honokai Hale residential subdivision. Farrington Highway adjoins the landfill site.
Cover Material:	Available on site
Soils Classification:	Rock land Stony steep land
City and County of Honolulu Zoning:	Ag-2
State Land Use District:	Agricultural
Capacity:	9 million cubic yards
Lifespan:	±15 years (based on 0.6 million cubic yards per year required)



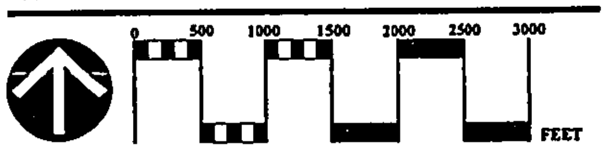
LEGEND

Site Boundary

Underground Infiltration Control (UIC) Line

Groundwater Protection Zone (GPZ) Line

FIGURE 3-36
Waimanalo Gulch



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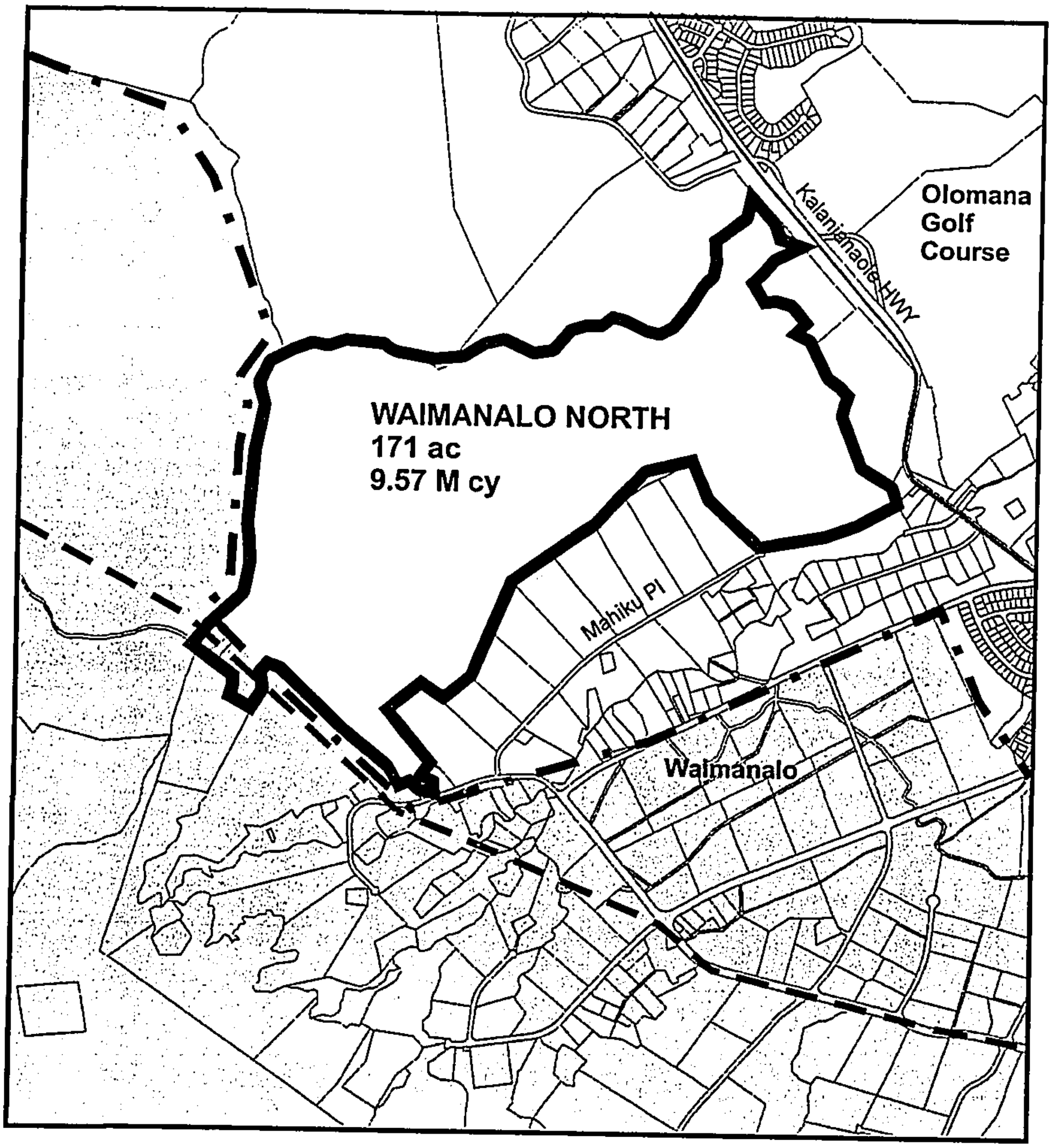
40. **WAIMANALO NORTH** - Site is located south of Kailua, west of Olomana Golf Course and Bellows Air Force Base, northwest of Waimanalo urban areas, north of Waimanalo farm lands and approximately one mile southeast of Olomana Peak. Elevation of the site ranges from approximately 160 feet to +240 feet MSL. **(Figure 3-37)**.

TMK:	4-1-8:13
Acreage:	±171 (±131 usable)
Ownership:	State of Hawaii
Adjoining Land Uses:	The site is within an old quarry. The Kailua Ditch roughly adjoins the site to the west. North and east of the site is Kalanianaole Highway.
Cover Material:	Available on site
Soils Classification:	Alaeloa silty clay, 40 to 70% slopes
City and County of Honolulu Zoning:	Ag-2
State Land Use District:	Agricultural
Capacity:	9.57 million cubic yards
Lifespan:	±16 years (based on 0.6 million cubic yards per year required)



LEGEND

Site Boundary

Underground Infiltration Control (UIC) Line

Groundwater Protection Zone (GPZ) Line

FIGURE 3-37
WaimanaloNorth

0 500 1000 1500 2000 2500 3000 FEET

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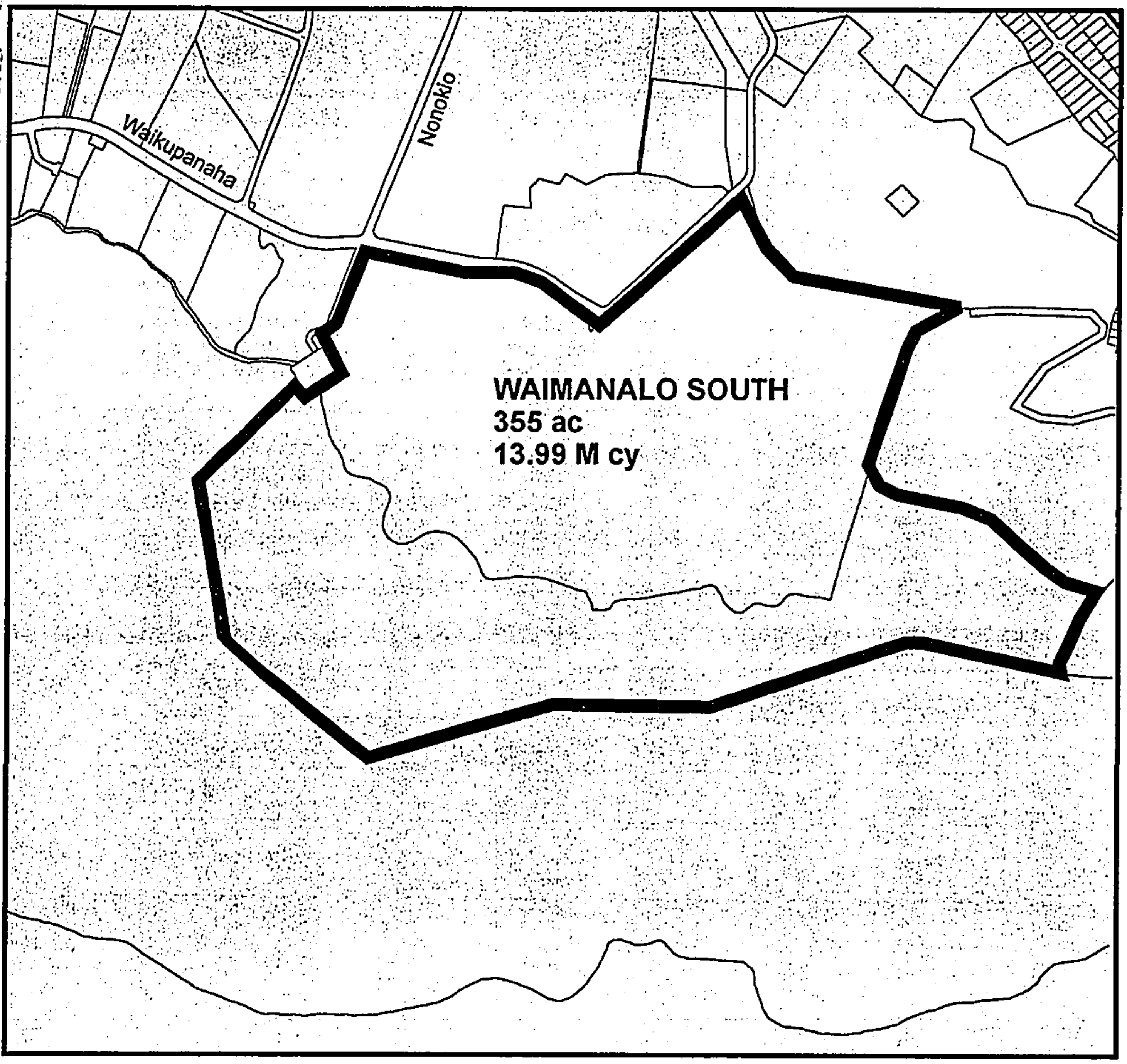
41. **WAIMANALO SOUTH** - This site is located mauka and west of Waimanalo Beach Park and south of the University of Hawaii Agriculture Experiment Station. Elevation of the site ranges from approximately 320 feet to +1,000 feet MSL. **(Figure 3-38).**

TMK:	4-1
Acreage:	±355
Ownership:	State of Hawaii
Adjoining Land Uses:	Land uses surrounding the site include Waimanalo agricultural farm lots located north and to the west. Northeast of the site are urbanized lands of Waimanalo.
Cover Material:	Cover material is anticipated to be available on site
Soils Classification:	Rock outcrop Kaena very stony clay, 10 to 35% slopes Alaeloa silty clay, 40 to 70% slopes
City and County of Honolulu Zoning:	Ag-2 and P-1
State Land Use District:	Agricultural and Conservation
Capacity:	13.99 million cubic yards
Lifespan:	± 23.3 years (based on 0.6 million cubic yards per year required)



LEGEND

	Site Boundary
INSIDE	Underground Infiltration Control (UIC) Line
INSIDE	Groundwater Protection Zone (GPZ) Line

FIGURE 3-38
WaimanaloSouth

0 500 1000 1500 2000 FEET

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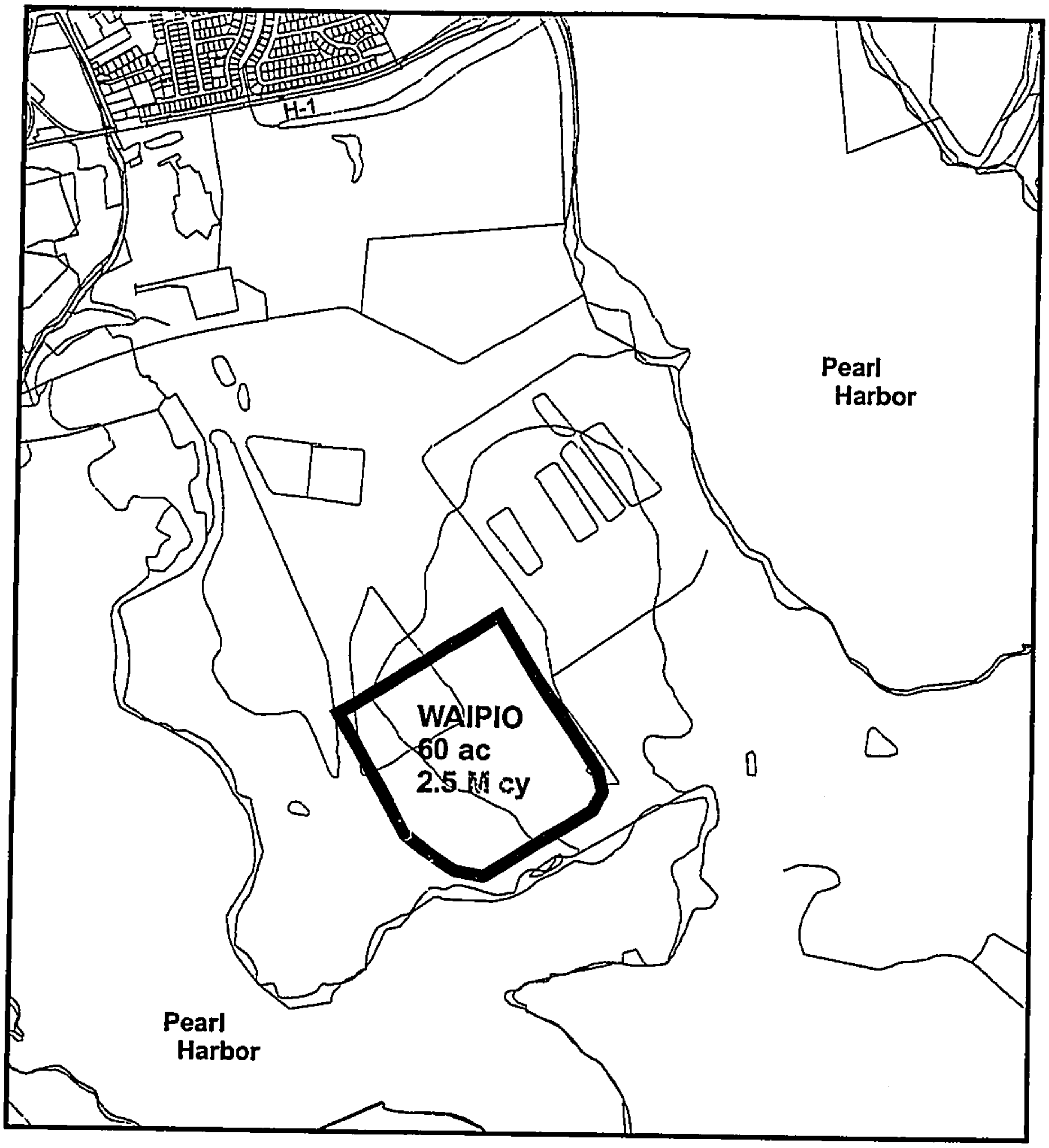
• Source: C & C Honolulu, ENV 2001
IDS Maps 1998, C & C Honolulu

42. **WAIPIO** - The entire lower Waipio Peninsula is a U.S. Naval Reservation. The site was once leased to Oahu Sugar Company for cultivation of sugarcane. **(Figure 3-39)**.

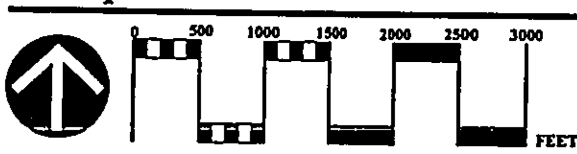
TMK:	4-2-15:por 1 & 6
Acreage:	±160
Ownership:	Federal Government (U.S. Military Reservation). Use of the site for military purposes would increase difficulty of site acquisition.
Adjoining Land Uses:	The site is contained within the Waipio Peninsula between the Middle and West Lochs of Pearl Harbor. North of the site is the town of Waipahu.
Cover Material:	Must be imported
Soils Classification:	Fill land Waste land
City and County of Honolulu Zoning:	F-1
State Land Use District:	Agricultural
Capacity:	*2.5 million cubic yards*
Lifespan:	±4.2 years (based on 0.6 million cubic yards per year required)



LEGEND

(thick black line)	Site Boundary
OUTSIDE	Underground Infiltration Control (UIC) Line
OUTSIDE	Groundwater Protection Zone (GPZ) Line

FIGURE 3-39
Waipio



Alternatives Analysis for Disposal of Municipal Solid Waste (MSW)
Dept. Of Environmental Services (ENV) • C & C Honolulu
Waste Management of Hawaii, Inc.

R.M. TOWILL CORPORATION

* Source: C & C Honolulu, ENV 2001
IDS Maps 1998, C & C Honolulu

3.5 Sites Not Reviewed in Prior Environmental Documents

Three additional sites were included in the analysis. The City & County staff recommended one. Another was the subject of a state legislative proposal. The third was suggested to the C&C by commenters on the *Revised Draft Supplemental EIS*. The report was titled *Alternative Landfill Operations Report for Municipal Solid Waste Disposal City and County of Honolulu, Hawaii* (dated September 17, 2001) prepared for the Ko Olina Community Association (see Appendix F). That report suggested that the Ameron Quarry be identified as a possible long-term disposal sites that was not included in the revised draft SEIS (the Kapaa 1 site is included). The report recommended that:

> "Pursue development of a landfill at the Kapaa 1 site with longer range plans being for developing a landfill at the Ameron quarry site. Long–term development of the Ameron site as a landfill serves both the goals of the long–term disposal capacity for solid waste and provides for reclamation of the current quarry operations."

In a February 5, 2002 letter [4] representatives of Ameron Quarry made the following statement regarding use of the Ameron Quarry as a landfill:

> "... we will mine from Phase I in the next several years. After our Phase I reserves are exhausted Ameron will still require the use of the Phase I area. Our need is well known for expanded water retention capacity to maintain optimal storm water control to meet State requirements.... These uses are consistent with our current operating plans, and will enhance our efforts to return the mined–out areas to a more natural reclaimed state."

There has been a bill before the state legislature to gain approval of a new central Oahu landfill site. Since the location of that site is not clear, the data on the site, similar to the data provided for the other sites, is not available.

The Makakilo Quarry has been proposed for consideration as an alternative site. The data for that site is provided later.

Figures 3-40 and **3-41** provide the information for the Ameron and Makakilo sites, respectively, as was provided for the other sites.

3.6 Site Evaluation

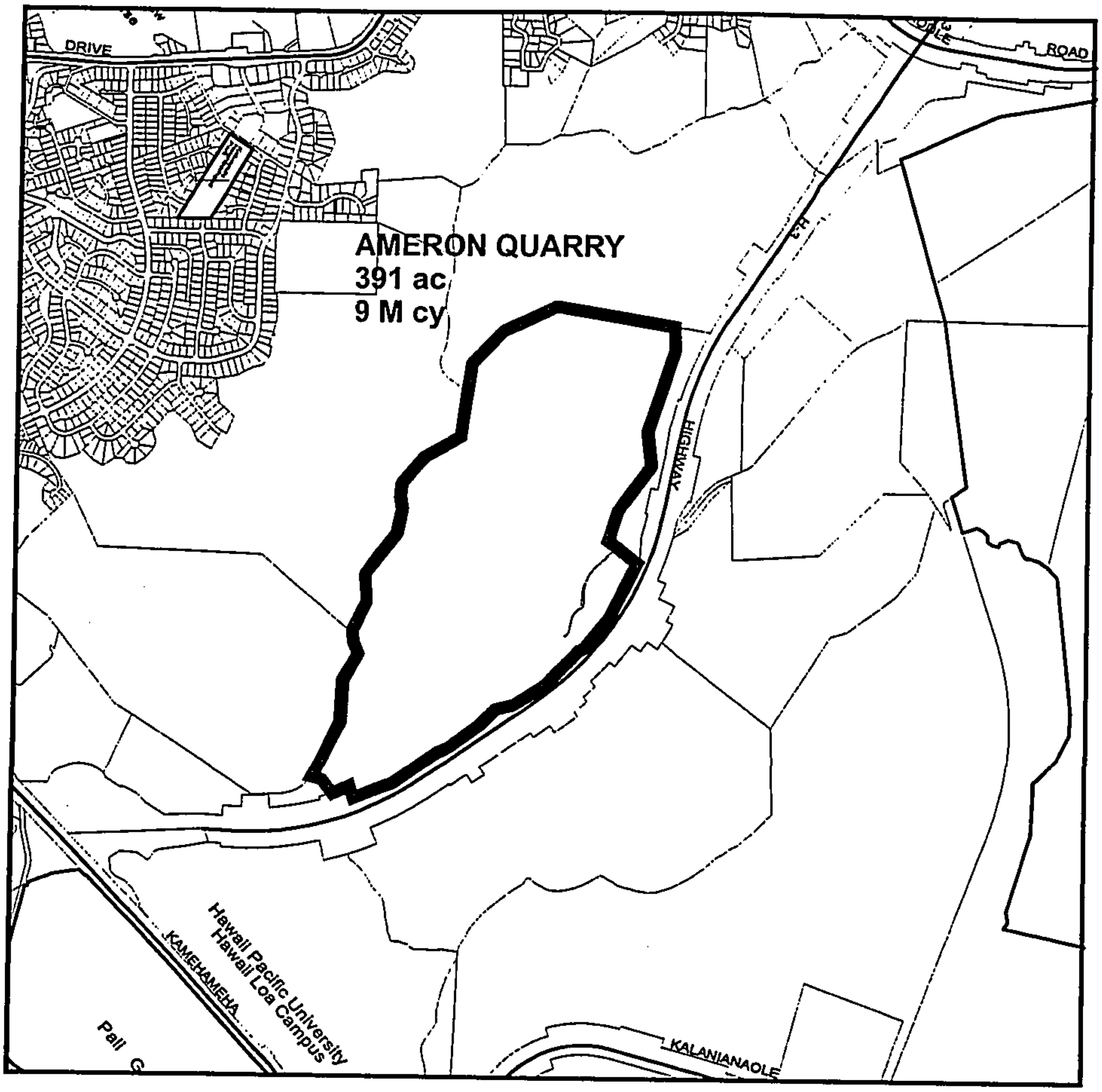
This section uses the *Exclusion Criteria* and the data about the sites that was provided regarding total capacity to suggest sites that bear further evaluation.

Table 3-3, Sites Location Restrictions in 40CFR258 shows the sites from those listed in **Table 3-2** that did not conform to the EPA exclusion criteria.

[4] February 5, 2002 letter from Linda F. Goldstein, Manager, Environmental, Health, and Safety for Ameron International to Wilma Namumnart, Chief of the Planning Engineering Branch of the C&C Division of Refuse Collection & Disposal.

Ameron Quarry - This site is located in Kapaa, Kailua (**Figure 3-40**).

TMK:	4-2-015-001
Acreage:	391.163
Ownership:	Michael C. Baldwin Trust/etal
Adjoining Land Uses:	Kapaa Transfer Station within 1 mile and within 1 mile of population. Ridge buffers Kaneohe residences and Kawainui Swamp buffers Kailua residences.
Cover Material:	Some cover available within proximity of quarry.
Soils Classification:	Helemano silty clay; Alaeloa silty clay.
City and County of Honolulu Zoning:	Industrial
State Land Use District:	Agricultural, preservation
Capacity:	9 million cu. yds.
Lifespan:	18 years as combined C&D landfill and MSW landfill.



LEGEND

(thick line)	Site Boundary
OUTSIDE	Underground Infiltration Control (UIC) Line
OUTSIDE	Groundwater Protection Zone (GPZ) Line

FIGURE 3-40
Ameron Quarry

0 750 1500 2250 3000 FEET

Alternatives Analysis for Disposal of Municipal Solid Waste (MSW)
Dept. Of Environmental Services (ENV) • C & C Honolulu
Waste Management of Hawaii, Inc.

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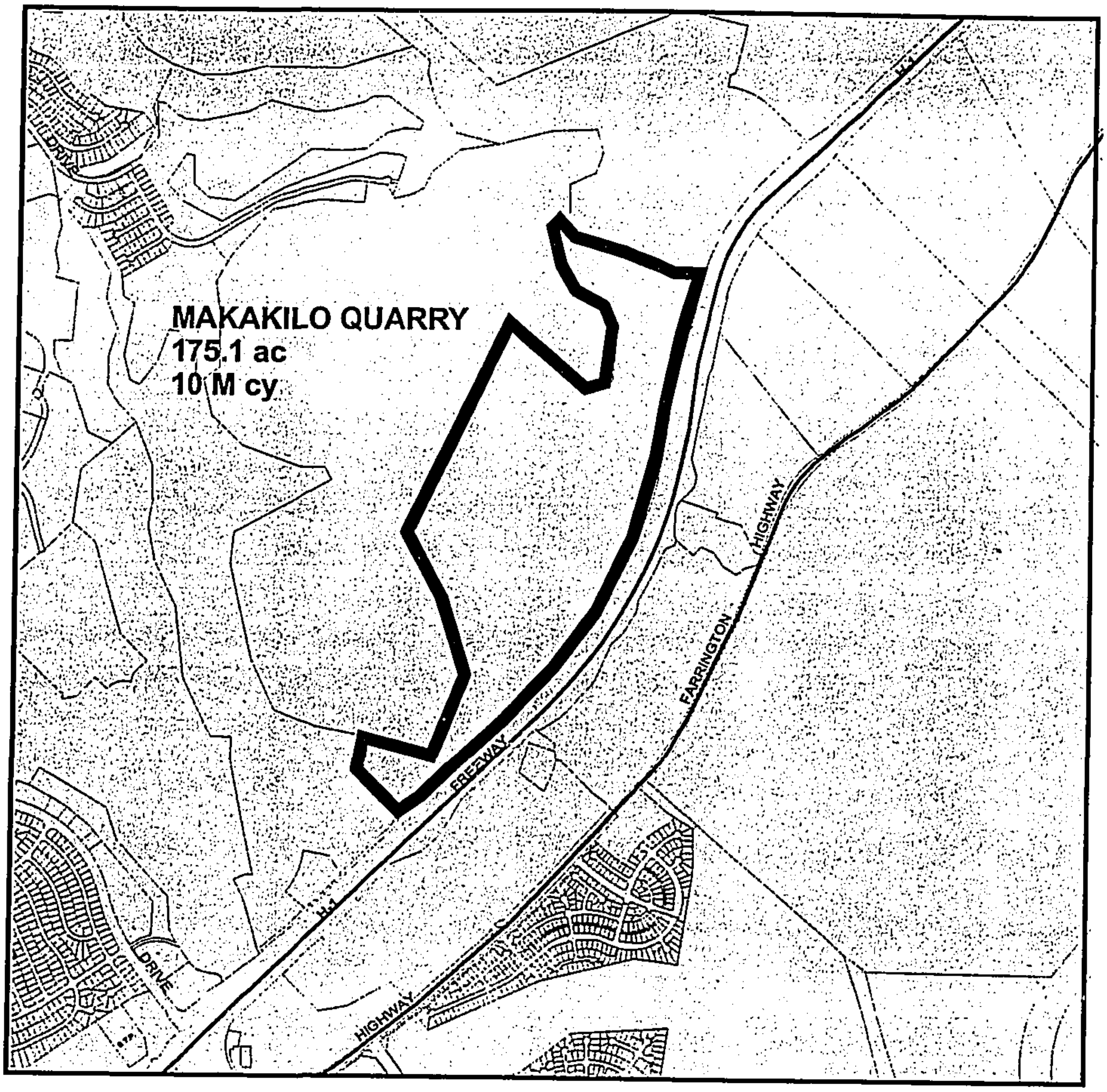
* Source: C & C Honolulu, ENV 2001
IDS Maps 1998, C & C Honolulu

Makakilo Quarry - This site is located in Makakilo/Kapolei mauka of H-1 on the east slopes of Puu Makakilo (**Figure 3-41**).

TMK:	9-2-003-082
Acreage:	175.068 acres
Ownership:	James Campbell Estate
Adjoining Land Uses:	Kapolei, Makakilo, Waipahu within 3 miles; 4 miles from H-POWER.
Cover Material:	Good cover material available.
Soils Classification:	Mahana-Badland Complex; silty clay loam volcanic ash origin.
City and County of Honolulu Zoning:	Agricultural, preservation
State Land Use District:	A-2 Restricted
Capacity:	10 million cu. yds.
Lifespan:	16 years



LEGEND

▬▬▬	Site Boundary
INSIDE	Underground Infiltration Control (UIC) Line
INSIDE	Groundwater Protection Zone (GPZ) Line

FIGURE 3-41
Makakilo Quarry

0 750 1500 2250 3000 FEET

Alternatives Analysis for Disposal of Municipal Solid Waste (MSW)
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* Source: C & C Honolulu, ENV 2001
IDS Maps 1998, C & C Honolulu

Table 3-3, Sites Location Restrictions in 40CFR258		
No.	Site	Restriction
2	Barbers Point	1. Airport Restriction - This is due to the proximity of the site less than 10,000 feet of the end of the runways of the former Barbers Point Naval Air Station. These runways are slated for future use as part of a general aviation reliever airport. Distance from the landfill site to the runways is approximately 1.0 miles.
4	Diamond Head	3. Wetlands - the floor of Diamond Head crater is a designated wetland. Historical information indicates the floor of Diamond Head crater was once submerged and later developed into a wetland site with associated characteristics including hydric soils, and wetland associated plant species and avifauna.
13 21	Kaena Keekee	1. Airport Restriction - Both of these sites are subject to location in proximity to the Dillingham airfield located east of the roughly adjoining landfill sites. Kaena is less than approximately 1,500 from the end of the Dillingham airfield runway and Keekee is approximately 2,500 feet from the runway end.
34	Sand Island	1. Airport Restriction - Distance from runways of Honolulu International Airport to the site is less than 10,000 feet. 2. Floodplain - The site is within the tsunami inundation zone and within an area inundated by the 100-year flood zone.

Because of location siting restrictions the above identified sites were removed from further consideration.

3.6.1 Capacity Ranking

The sites were sorted by landfill capacity. **Table 3-4**, *Site Capacity*, shows the sites in order of years of life. There are several sites that are not on the list because they have special conditions that eliminate them from further consideration as a landfill. Those sites have been removed from the list of potential sites. They are identified below. They have not been listed in **Table 3-4**.

Two of the sites identified in **Table 3-2** are shown with zero capacity and are close to residential areas. They are Heeia Kai (number 9) and the Olomana site (number 31).

The Ewa Nos. 1 and 2 sites (numbers 5 and 6) and Kahaluu site (number 15) have capacity, but are near residential areas. Nearby residential development is incompatible with landfilling.

Kapaa Nos. 2 and 3 (number 19 on the list) and Kalaheo (number 16) have reached the capacity of the site so no additional waste can be placed there.

Koko Crater (number 22) is a public park, a use that would be destroyed by landfilling.

Table 3-4 - Site Capacity

Site No.	Original Site Designation	Site	Years
1	17	Kaloi	37
2	30	Ohikilolo	24
3	26	Makaiwa	23
4	41	Waimanalo South	21
5	29	Nanakuli	20
6	NA	Ameron Quarry	18
7	NA	Makakilo Quarry	16
8	25	Maili	14
9	39	Waimanalo Gulch Expansion	14
10	3	Bellows	11
11	27	Makua	11
12	33	Punaluu	11
13	38	Waikane	11
14	24	Kunia B	11
15	36	Waianae Expansion	10
16	12	Kaaawa	9
17	23	Kunia A	9
18	18	Kapaa No. 1	5
19	1	Auloa	4
20	14	Kahaluu	4
21	42	Waipio	4
22	10	Heeia Uka	4
23	35	Waiahole	4
24	37	Waihee	4
25	8	Halawa B	3
26	28	Mililani	3
27	11	Honouliuli	3
28	7	Halawa A	2
29	13	Kaena	2
30	20	Kaukonauhua	2
31	21	Keekee	2
32	2	Barbers Point	1
33	32	Poamoho	1

3.7 Potential Sites Suggested for Further Consideration

The sites that have the greatest capacity are suggested for further consideration. Significant technical data will be needed to confirm the appropriateness of all except the Waimanalo Gulch Landfill, about which there is a large body of existing data. The capacity of other sites is based on information drawn from other sources and may be based on observation or on geotechnical investigations. To confirm the capacity of those sites will require extensive investigation.

The additional sites suggested, the Ameron Quarry and the Makakilo Quarry are listed. The Ameron Quarry is listed although condemnation may be needed to enable use of the site. Condemnation may also be needed for other sites. The central Oahu site is not listed as information about the capacity of that site or the specific location was not available.

Table 3-5 lists the sites with the most capacity.

Table 3-5 - Sites Suggested for Further Consideration

Site No.	Site	TMK	Years
17	Kaloi	9-2-2, 3, 4	37
30	Ohikilolo	8-3-1:13	24
26	Makaiwa	9-2-3	23
41	Waimanalo South	4-1	21
29	Nanakuli	8-7-9:1 & 3 and	20
NA	Ameron Quarry	4-2-015-001	18
NA	Makakilo Quarry	9-2-003-082	16
25	Maili	8-7-10:3	14
39	Waimanalo Gulch Expansion	9-2-3:72 & 73	14
3	Bellows	4-1-15	11
27	Makua	8-1-1 and 8-2-1	11
33	Punaluu	5-3	11
38	Waikane	4-8	11
24	Kunia B	9-4-3:por 19	11
36	Waianae Expansion	8-50-3/;1, 29-32	10

3.7.1 Recommended Site - Waimanalo Gulch Landfill Expansion

Waimanalo Gulch Expansion is recommended as the first choice as it is in operation.

3.7.2 Other Recommended Sites

The other sites on **Table 3-5** should be evaluated in the order listed. It is not clear that any of them can be processed through final site selection, preparation of technical studies, preparation of environmental documentation, processing of land use and solid waste permits, and the public process to be in operation before the end of the period covered by this document.

In addition, the discussion in section 3.8 identifies the potential for using sites not located on Oahu. The mainland option should also be considered. It can be done within the five year horizon (potentially in much less than five years), but the anticipated cost is much higher than the use of the Waimanalo Gulch Landfill.

3.8 Sites Not Located on Oahu

It is possible that a landfill site located off of Oahu could be used for waste from the C&C. The U.S. Supreme Court [5] has struck down local actions that prevent importation of waste from outside the jurisdiction. That action has been tested by several jurisdictions and has been found to prevent restricting the importation of waste either through bans or differential pricing (that does not reflect a differing cost of handling the material).

The amount of material that needs to be handled is the waste flow going to the Waimanalo Gulch Landfill, including the ash and residue from H–POWER. The total amount of material is 480,098 tons annually (in 2001).

3.8.1 Sites Located in the State of Hawaii

According to the DOH staff[6], the only site in Hawaii, other than the Waimanalo Gulch Landfill, that could accept the volume of waste expected is the West Hawaii site in Hawaii County. This site has 60 years of capacity at the current rate of filling (about 93,000 tons in 2001). The effect of the addition of waste from Honolulu would be to reduce the site life.

The amount of reduction in site life can be estimated. Based on WMI data, the annualized fill rate at the landfill for 2002 is 99,500 tons. That rate is up six percent from 2001, but we ignored that rate of increase in estimating the life. Assuming that the fill rate held constant for the 60 years of life, we calculated the total tonnage that would go into the landfill. Adding the 480,098 tons of waste from Honolulu to the West Hawaii tonnage and dividing that into the total tonnage that could go to that landfill suggests a life of 10 years. That is, if the Honolulu waste were disposed at the West Hawaii Landfill, the life of that site would be reduced from 60 years to 10 years. In essence, Honolulu would have transferred its disposal problem to another county forcing them to locate a new landfill site 50 years earlier than otherwise would have been needed.

In addition, the Hawaii County Council has directed that its landfill not accept loads from out of the county.[7]

3.8.2 Sites Not Located in Hawaii

This section discusses the potential of exporting the waste that would be accepted at Waimanalo Gulch Landfill to sites on the mainland. We have evaluated the opportunity of using this alternative at a site, the Altamont Landfill located near Oakland, California. That site has sufficient permitted capacity to accept the material and enough site life to allow for longer-term contracts. Two considerations must be included in the discussion of off-island sites:

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[5] C & A Carbone v. Town of Clarkstown, NY, May 15, 1994
[6] Meeting with Steven Change and Lene Ichinotsubo of the DOH Solid and Hazardous Waste Branch on Nov. 13, 2002.
[7] Minutes from the June 19, 2001 Hawaii County Council meeting.

- A shipping strike could cause significant disruption in the flow of waste and the C&C could be without disposal capacity for an unpredictable duration.

- Restrictions on importing materials from outside the state of California that may have pests that could damage the agricultural economy.

Both the U.S. Department of Agriculture and the California State Department of Food and Agriculture have restrictions. The USDA has established their restrictions in regulation. [8] Those regulations mandate that the process and equipment used to move the waste to the mainland be inspected by Federal and state inspectors, that it be held in water tight containers, and that it either be incinerated or sterilized. The incinerators in both Honolulu and California are at capacity and cannot accept more material. This review includes the cost of autoclaving the waste to sterilize it (an autoclave is now used in Honolulu for waste from ships and airplanes).

A generalized cost analysis is included here to estimate the additional cost to handle the material. The costs reflect the larger items and recognize that there may be other costs that arise during additional investigation of this alternative that will dramatically increase the cost and or time required to implement. **Table 3-6,** *Estimate of Disposal Cost at Off-Island Landfills*, summarizes the cost estimate. The assumptions used and the methods used to calculate the costs are summarized below.

- The amount of waste was calculated in tons per week as the shipping companies move cargo only one or two days per week. The annual tonnage was divided by 52 to get tons per week.

- The ash and residue were handled separately from the MSW and sludge. A small amount of sludge is accepted at the landfill from commercial sources. The majority of the sludge is from the C&C waste water treatment plant and that should be eliminated from disposal by a new dryer facility that is now in the permitting process.

- Only the MSW, residue, and sludge need to be autoclaved. The cost of autoclaving equals the cost of autoclaving the waste from airplanes and ships. The autoclave will be constructed to handle the waste stream within the five year horizon of this document. These materials need to be autoclaved as they have not been through a high temperature combustion process that will kill agricultural pathogens. High temperature treatment is required by state and/or federal regulations or policies to ship off island to another county or to the mainland.

- The shipping containers are purchased for this project as they must be in control of the C&C to avoid holding up disposal due to the lack of containers. Twice as many containers are required as was calculated to be needed on a weekly basis to account for those tied up in transit and maintenance. The cost of containers was amortized at 5 percent interest and assumed a 5 year container life (the duration of this project). The annual cost of containers was added to the total annual shipping cost. There are other costs of loading and unloading that were not included in this estimate.

- MSW will be compacted into the shipping containers at the Keehi Transfer Station and/or at H-POWER using the existing equipment. No additional cost will be incurred for handling the material at either the transfer station or H-POWER.

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[8] See Title 7 of the Code of Federal Regulations, part 330, section 330.400 and Title 9 of the Code of Federal Regulations, part 94, section 94.5

Other assumptions are specified in **Table 3-6**, Estimate of Disposal Cost at Off-Island Landfills.

This alternative is achievable within the five-year time horizon of this document. There are several impacts of this alternative.

The total cost estimate for shipping and disposal on the mainland ranges between $925 and $974 per ton. The cost to ship and dispose in Hawaii County is $881 per ton. With the additional review needed to actually enter into contracts for transportation and disposal and the infrastructure changes that will be needed (additional staff and other changes), the cost of export to an off-island landfill for disposal will increase over the estimate provided here, probably significantly. There are also opportunities for cost reductions due to the volume of the shipping and the interest expected from the shipping companies in handling the cargo.

The cost of shipping will increase the cost of disposal at H-POWER, assuming that all of the costs are recovered through that facility. An estimate of that cost increase follows.

- Current tip fee at H-POWER, including taxes and surcharges —$87.71 per ton (in 2003)
- Estimated annual disposal at H-POWER — 602,000 tons
- Lowest estimate of off-island shipping and disposal — $423,104,000 per year.
- Estimated cost of off-island disposal if collected only from H-POWER tonnage - will increase the tip fee to $791 to $865 per ton.

The potential impacts from such a large increase in disposal costs (nearly 10 times increase) are

- Dramatically increased illegal dumping on the roadside, in remote areas and in unpermitted unregulated disposal sites, most of which has been in the Waianae area. With the large increase in tip fees, even some of the waste haulers may be tempted to illegally dispose of waste in more remote areas to remain profitable.

- A shipping strike could disrupt disposal, threatening the operation of H-POWER (if there were no alternate disposal point for the ash and residue).

- In addition to the impact of reducing the life of the West Hawaii Landfill from 60 years to 10 years, the transportation route from the port to the landfill passes through residential areas. The numbers of trucks (about 400 per week) carrying waste from the port to the landfill may trigger environmental review prior to that site accepting the waste.

Table 3-6 - Estimate of Disposal Cost at Off-Island Landfills

	Altamont Landfill, California		West Hawaii, Hawaii
Assumptions			
Amount of MSW (Tons/Week)		6,088	6,088
Amount of ash (Tons/Week)		1,623	1,623
Amount of residue (Tons/Week)		1,510	1,510
Amount of sludge (Tons/Week)		12	12
Compacted density of MSW and sludge		2,000	2,000
Compacted density of ash and residue		500	500
Autoclave cost (per pound of MSW and sludge)	$0.50	$0.50	$0.50
Shipping container size (feet)		40	40
Shipping container weight limit (Lb)		60,000	60,000
Shipping container volume (cubic yards)	89	89	89
Number of shipping containers (per week)			
MSW and sludge (volume limited)		275	275
Ash and residue (weight limited)		104	104
Total number of shipping containers (per week)		379	379
Cost of Shipping ($/container, round trip)	$4,600.08	$2,701.08	$422.00
Trucking & load/unload time at port (hrs/rd trip)			
Honolulu	3	3	3
Destination	4	4	2
Cost of trucking (per hour, round trip)	$18.00	$18.00	$18.00
Cost of disposal (per ton)	$33.00	$33.00	$35.00
Cost Estimate			
Shipping company	Matson	CSX	Young
Autoclaving (per year)	$396,677,374	$396,677,374	$158,582,505
Origin & destination transportation (per year)	$2,484,926	$2,484,926	$1,774,947
Shipping (per year)	$29,651,872	$53,269,712	$8,322,530
Container cost (per year)	$525,600	$525,600	$525,600
Disposal (per year)	$15,843,234	$15,843,234	$16,803,430
Total cost (per year)	$444,183,005	$467,800,846	$423,103,881
Autoclaving (per ton of all waste shipped)	$824	$824	$824
Origin & destination transportation (per ton)	$5	$5	$4
Shipping and container cost (per ton)	$63	$112	$18
Disposal (per ton)	$33	$33	$35
Total cost (per ton)	$925	$974	$881

4 ALTERNATIVE TECHNOLGIES

This section summarizes the evaluation of alternative technologies for disposal of the MSW that is now disposed of at Waimanalo Gulch Landfill. The section is organized with an introduction that provides the general background for the discussion. The C&C has provided some basic criteria that any alternative to the landfill needs to meet to be considered for full-scale implementation. Following the introduction, a summary of the past evaluations of alternatives is provided.

There have been several evaluations of alternatives. The first was done in 1999 as part of a larger project that reviewed all types of potential approaches to reduce landfill disposal and to replace the Waimanalo Gulch Landfill disposal capacity. That effort is summarized in section 4.2. The New Systems Research for Refuse Disposal (see Appendix B) short-listed several plasma arc ideas, metal recycling, and gypsum recycling. Metal recycling and gypsum recycling are discussed in section 4.6 and are recommended for implementation. The plasma arc technology was subjected to several additional evaluations and is discussed in more detail later in a separate section.

Following the summary of the *New Systems Research for Refuse Disposal* we provide a discussion of plasma arc, Hydromex, and expansion of H–POWER. Plasma arc and the H–POWER expansion have been mentioned earlier. Hydromex is another technology that has been proposed to handle the Waimanalo Gulch Landfill waste stream by compressing it into a building material.

4.1 Introduction

The consideration of alternative technologies to reduce disposal or eliminate the need for the Waimanalo Gulch Landfill has been ongoing in the C&C for many years. Those efforts have included implementing new recycling programs, bans on taking certain recyclable materials to the landfill and issuance of requests for proposals to handle specific segments of the waste stream. Where the anticipated method of handling the segment of the waste stream involves equipment to process the waste, the C&C identified the critical factors in its analysis as:

- A technology must have significantly fewer and/or less severe environmental impacts than current disposal methods.
- Costs must be comparable to the existing system, although some additional expense may be justified for a particularly beneficial technology.
- The technology must be feasible on the scale required by the City for disposal of municipal solid waste and ash.

The third factor is particularly important. The test used to determine if a technology satisfies this consideration is whether it has been used successfully for at least two years processing about the same amount of material as proposed for the City. None of the technologies evaluated have met the third test.

4.2 Summary of the Evaluation New Systems Research for Refuse Disposal

4.2.1 Introduction

A study on alternative technologies for the disposal of solid waste was commissioned by ENV as part of the Oahu Municipal Refuse Disposal Alternatives Study. In April 2000, the findings of the study were provided in the report, New Systems Research for Refuse Disposal. The purpose of the report was to investigate new and innovative technologies that could reduce dependency on use of sanitary landfills such as Waimanalo Gulch.

4.2.2 Recommended Technologies

The details of the evaluation and screening of the technologies can be found in the *New Systems Research for Refuse Disposal* report. That evaluation resulted in a listing of the following alternatives that received the highest scores and were recommended for further evaluation.

- *Plasma Gasification/Vitrification Followed by Converting Syngas to Electricity.* This alternative uses a series of high-temperature plasma torches to decompose all organic components of the bulk waste stream and to melt inorganic residues into a glass-like slag. This alternative was ranked in the top three because of several advantages, including environmentally safe treatment of preservative contaminated wood wastes, environmental friendliness, production of needed electricity for the region, and significant reduction in the City's landfill space requirements

- *Metal Recycling.* The metals recovery and recycling alternative uses magnetic fields and eddy currents to remove metals from a stream of shredded waste that passes by on a belt conveyor or similar device. Typically, magnets recover ferrous metals and eddy-current devices remove non-ferrous metals. This alternative was short-listed for further evaluation because ferrous metal recovery is a proven recycling method and there is no need for further research and development of this technology. The City is already practicing metal recovery at H-POWER and a metal recycling application to the Waimanalo Gulch Sanitary Landfill refuse stream could also be implemented without major difficulty.

- *Gypsum Recycling.* The scrap gypsum wallboard recycling technology was short-listed for further evaluation because the technology is a proven recycling method and there is a likely market for its product in Hawaii.

4.3 Plasma Arc Systems

As part of the review of earlier environmental documents supporting expansion of the Waimanalo Gulch Landfill, the C&C evaluated several plasma arc processes and the Hydromex process (discussed later). The evaluation of the plasma arc process has involved a review of two plasma systems in 2001, a test of a system located near the H–POWER plant in 2002, visits to a plasma system using MSW and auto shredder waste in 2002, and a broader evaluation of plasma systems that was done in 2002. This section discusses all three of these evaluations and summarizes the results of the plant visit.

4.3.1 Summary of Evaluation of Selected Technology Alternatives to Landfill Disposal

An evaluation [9] of technology alternatives to landfilling (except incineration as it was a proven technology) was prepared following suggestions made at public meetings to discuss an earlier environmental document for the expansion of the Waimanalo Gulch Landfill. The evaluation included two plasma arc systems and the Hydromex system. The summary of the report on the Hydromex system is provided later.

[9] See report titled "Evaluation of Selected Technology Alternatives to Landfill Disposal, September 2001" by Pacific Waste Consulting Group.

4.3.1.1 Overview

The C&C had received three proposals to use alternative technologies to replace the Waimanalo Gulch Landfill. The proposals were:

1. A proposal to Mayor Jeremy Harris delivered on July 3, 2001, by Waste to Energy. They proposed the use of a plasma arc system provided by SUI (Scientific Utilization, Inc.).

2. A proposal made verbally at a meeting on August 28, 2001, by APET (Asia Pacific Environmental Technologies) to use the plasma arc system provided by IET (International Environmental Technologies LLC). They currently have a plant operating in Campbell Industrial Park to process medical waste and suggested a test with 100 tons of H-POWER ash over one week.

3. A proposal by Hydromex that was delivered to City staff on August 24, 2001, that uses a proprietary chemical to mix with ash to form building materials. They have proposed constructing a full size test plant in Campbell Industrial Park to process 100 TPD of H-POWER ash and contaminated wood.

Each of the proposers was advised that the C&C staff and consultant would visit with them to determine the specifics of their proposals. Correspondence to the plant operators stated that the staff and consultant would visit with the vendors with the intention to:

> "Gather facts and observations that would enable the officials in the City & County of Honolulu to determine if the plasma arc process was far enough along in its development to offer an opportunity to treat the waste being taken to the Waimanalo Gulch Landfill. One test to be applied is whether the process was used on MSW, the existence of at least one plant in the size range needed for this waste stream, and how long the plant(s) had been operating."

The report provides the details of the review. This section summarizes the report.

4.3.1.2 Summary of Findings

The three technologies reviewed were two plasma arc systems and Hydromex. The two plasma arc project proponents were two local firms, Hawaii Medical Vitrification and Waste to Energy. The general findings that applied to all there technologies evaluated were:

> "None of the three processes has a plant that has been operating on MSW, so all three fail the primary evaluation criterion.
>
> However, the proposals by HMV and Hydromex are for them to provide a demonstration project to the City to prove their technology. Those two proposals deserve further consideration.
>
> The proposal from Waste to Energy is for the City to invest about $300,000,000 in a process that is unproven and untested with MSW. The process has several areas with questions that are not answered, and the proposal has several critical defects. If the proponent is able to propose a no cost test for the City, that approach may prove to be worth investigating further."

The report further identifies what was needed for the demonstration projects proposed by Hydromex and HMV, the owner of the plasma arc system located in Campbell Industrial Park.

4.3.2 HMV Demonstration Program

One of the results of the earlier evaluation of plasma arc systems and Hydromex was a recommendation to run a test program to show whether the HMV plasma system could process MSW and H–POWER ash and whether the system would produce more energy than it used while processing MSW. The energy production was one of the key factors in the claim that the cost of this plasma system was comparable to the cost of H–POWER.

The report for this test was to be reviewed by HMV, which was to prepare its own report, and by the C&C staff. No response or report was received from HMV. C&C representatives asked that a review of available data be made and a short report on the outcome of the testing prepared.

This summary was extracted from that report, which was titled Hawaii Medical Vitrification Tests of H-POWER Residue on January 11-12, 2002 (see Appendix G) and was prepared by Hualalai Engineering.

4.3.2.1 Scope of the Demonstration

The testing of refused derived fuel (RDF) destruction in the "plasma assisted melting" system at the HMV plant at Kapolei took place on January 11 and 12, 2002. The system used by HMV was supplied by Integrated Environmental Technology, LLC (IET). The system was designed for processing up to 4 tons per day of medical waste. Reportedly, IET provides similar systems up to 10 tons per day capacity.

Tests were conducted using RDF from H-POWER packed into round cardboard containers. The process rate was reportedly designed to stay within the facility's DOH air permit limit of one ton per 24 hours.

This test was a simplified Input/Output test where the input material feed was weighed, the electric energy consumption measured and the synthetic gas output analyzed and measured. More detailed testing was to be performed later, once the plant's Syngas engine generators were replaced. The follow up tests have not been done as the engine generators have not been replaced.

The report analyzed two reasonably long uninterrupted runs as representative of the process inputs and outputs. Run A was the period from 2253-2350 hours on January 11 and Run B was the period from 0404-0449 hours on January 12.

The testing went reasonably well until the early morning hours of January 12. On that day, a cardboard container got hung up in the in-feed to the plasma unit. The run was resumed after noon and continued until all the containerized RDF was consumed.

4.3.2.2 Summary of Conclusions

The test did not demonstrate that the HMV plasma-enhanced melter system is more energy efficient that H-POWER. Further, the tests indicated the system is an inefficient producer of hydrogen gas (the fuel component of syngas).

The thermal gasification efficiency varied between 47 and 49 percent, not considering the inefficiency of using Syngas to produce electric energy or the inefficiency of producing the electric energy for gasification. This efficiency compares to some other biomass gasification systems, which project maximum thermal efficiency of 60 percent.

Comparing the net electric energy produced per ton of RDF, the tests indicate the HMV facility would have produced a negative 3,366 kWh per ton of RDF if the Syngas had been burned in an efficient combined cycle generating system (the HMV facility uses less efficient engine generators). By comparison, H-POWER produced a positive 712 kWh per ton of RDF in 2001. Both energy values exclude the energy required to prepare the RDF from MSW.

There is another way of looking at the overall conversion efficiency of this process. The HMV system consumed electric energy during the testing at the rate of approximately 303.2 kW and produced Syngas capable of generating 94.4 kW of electric energy. Therefore at the test conditions, this process consumed more than three times the electric energy than it was capable of producing.

With this test data it was not possible to estimate the effect on electric energy conversion efficiency of scaling up the system. However, if the processing capacity were increased to the four tons per day design capacity, and if the electric energy input remained the same, the HMV plant would still have produced less electric energy than it consumed (a negative 299.2 kWh per ton of RDF). If the process were scaled up to the equivalent of 150 tons of MSW per day, the process still has a negative electrical output per ton of RDF.

To determine the effect of scaling on hydrogen production, they assumed that the hydrogen gas could be sold as fuel for the price projected by the National Hydrogen Association for year 2010 ($6.35 per 1000 cubic foot, which equates to an equivalent gasoline price of $2.50 per gallon). If the HMV process were scaled up handle 150 tons of MSW, the value of the hydrogen would be less than the cost of electric energy needed to produce it.

4.3.3 Plasma Arc Project Inspection Trips

The C&C staff has been evaluating plasma systems worldwide to find one that has been using MSW as a fuel. This section reviews an inspection trip of a plasma system.

4.3.3.1 Background

During the period October 13 to 15, 2002, the ENV staff visited a plasma system located in Utashinai, Japan. The plant capacity is 166 tons per day, but was processing 66 tons per day during the visit. The feedstock was auto shredder waste. They plan to process MSW on December 1, 2002 and expect to be processing 77 tons per day by April 2003. At the time of the visit, the longest run had been for five days.

4.3.3.2 Summary of Results

While this unit is in the size range that could be replicated to provide the 800 tons per day of capacity needed to replace the Waimanalo Gulch Landfill, it has not operated on MSW at all and not at full capacity. In addition, they have not processed ash. The data on energy production was not available, so the economics of the process cannot be estimated.

4.3.4 RW Beck Evaluation

The C&C commissioned an evaluation by RW Beck, a nationally recognized consulting firm, to review the state of development of plasma systems. This section summarizes the conclusions from that report, which was titled Review of Plasma Arc Technology for Waste Disposal (see Appendix H). The conclusions were provided in sections that address the key aspects of financing and operating technologies that process MSW. There is a long history of financing MSW projects and any proponent of any new technology (or any long proven technology) will have to address these concerns and conditions to be financed.

4.3.4.1 Summary

The summary was provided in categories of Existing Facilities, Status of Technologies, Energy Recovery, Overall Efficiencies, Environmental Performance, Facility Economics, Financing New Technologies, and Risk Allocation.

Existing MSW Plasma Projects

There are two MSW disposal facilities using plasma arc technology currently operating in Japan. R.W. Beck was unable to identify any other MSW-plasma facilities operating in the rest of the world. There is one other MSW plasma facility currently reported to be under construction in Rome, Italy. There are no operating facilities in the United States and no municipalities have issued or are in the process of issuing an RFP for an MSW plasma facility, according to Beck's research.

One facility located in Yoshii, Japan, is designed to process 24 TPD of MSW in a single train. The other plant, the EcoValley Facility in Utashinai, Japan was commissioned in late 2002 and still in start-up. It has two 83 TPD trains for a total capacity of 166 TPD. Although the plant has been designed for both automobile shredder residue (ASR) and MSW, it has been using exclusively ASR during start-up. It is scheduled to begin processing MSW in December 2002.

A facility is proposed for Rome, Italy. It is reportedly under construction and is anticipated to be fully commissioned sometime in 2004. It is designed to have a capacity of 336 TPD. One of the project drivers is the electric rate of 14 cents per Kwh above prevailing rate guaranteed by the Italian Government. The current rate for selling power to HECO on Oahu is 8 cents per kwh.

Status of Technologies

The disposal of MSW using conventional waste-to-energy technology, such as H-POWER, is well established. According to the USEPA, in 2000, the 102 waste-to-energy facilities, most with multiple boilers, in the U.S. accounted for the disposal of approximately 35 million tons of MSW, approximately 14% of the total amount of MSW generated in the U.S. The facilities have an average throughput of more than 900 tons per day and have, on average, been operating for more than 10 years. The oldest WTE plant has been operating continuously since the 1970's.

By contrast, disposal of MSW using plasma technology is just beginning. There are no continuously operating MSW plasma facilities in the United States and only two operating in the rest of the world. These two facilities have an average throughput of less than 100 tons per day and the oldest facility has been operating since 1999. As noted above, there are plasma facilities disposing of other kinds of waste throughout the world.

Energy Recovery

Modern WTE facilities recover energy from the waste. The 102 WTE plants in the U.S. produce more than 2,800 MW of electricity. Most incinerators that are too small or too inefficient to recover energy have disappeared in the United States because they cannot compete economically with other forms of waste disposal.

Although any plasma facility can be designed to recovery energy, not all these facilities actually do so. The economies of power generation are site-specific. Of the two MSW plasma facilities currently operating in Japan, one recovers energy and one does not. When using auto shredder residue as a feedstock, the EcoValley facility produces approximately 7,900 Kw gross and consumes 3,800 Kw to operate, resulting in a net positive output of 4,100 Kw. Because plasma facilities, such as the Yoshii MSW plasma facility, are relatively small, the cost of installing and operating an energy recovery unit cannot be justified.

Overall Efficiencies

A typical WTE facility can be expected to produce between 400 kwh and 600 kwh per ton of waste processed. For example, H-Power produces 534 kwh per ton of waste processed. MSW with a high moisture content or a high percentage of non-combustibles will reduce the efficiency of any WTE plant.

With a 4,100 KW net output for 183 TPD per day of waste, the EcoValley facility generates approximately 537 kwh per ton of waste processed. However, the auto shredder residue that the EcoValley facility is processing typically has a higher heating value than MSW and would be expected to generate more net energy. Once the EcoValley facility begins to process MSW, it will be possible to calculate its efficiency for this feedstock and make a more accurate comparison.

Based on performance of other types of gasifiers as compared to their combustion counterparts (e.g., coal gasification combined cycle plants), a plasma facility with a combustion turbine might be more efficient at producing electricity than a state-of-the-art WTE plant, but there are no commercial plasma facilities with combustion turbines with which to confirm this supposition. An MSW-plasma facility with a combustion turbine is anticipated to begin operation in 2004.

Environmental Performance

In evaluating the performance of plasma technology for MSW disposal, a critical characteristic is its impact on the environment. This impact is related to the quality of the gases (air emissions), solids (ash or slag), and liquids (water) that are emitted from the facility. All commercial waste disposal facilities must meet regulations that set limits on the amount of certain substances that can be emitted.

The only plasma facility currently processing MSW is the Yoshii facility and we have been unable to obtain testing data from the facility. The EcoValley facility at Utashinai is in start-up and will not begin to process MSW until December of 2002.

Facility Economics

The lack of operating history is an inherent problem with new technologies. Previous experience with WTEs shows that the nature of MSW, particularly its heterogeneity, presents a set of problems that are solved only through operating experience.

There is also the matter of scale. The throughput of existing MSW plasma facilities is well below what the C&C will need to meet its waste disposal needs in the short-term. The only plant now disposing of MSW, the Yoshii plant, has a throughout of only 24 tons per day. The EcoValley plant will process 166 tons per day, but it is not scheduled to begin processing MSW until December, 2002. Scaling-up a facility, regardless of the process, can present a number of technical problems that affect both capital and operating costs.

The net operating costs will also be affected by the amount of electric power the plasma facility generates, if any, and the price it receives for this power.

Financing New Technologies

The financing of a new-technology project, such as a plasma-arc facility to dispose of MSW, will require both debt and equity. Typically, a project like this, in the current market environment and without a similar operating unit with several years of experience, would require a 30-40 percent or higher equity contribution or government support to secure non-resource project debt. The equity participant(s) would accept complete risk in return for an appropriate return on their investment.

The difficulty with new technologies that have not been previously financed is that lenders typically require more stringent guarantees from the engineering, procurement, and construction (EPC) contractor. In addition, the time and effort required by the Project Developer to raise the required debt and equity can be prolonged. It is not unusual for the financing process for a new technology to take several years. Overall, using Project Financing to finance an MSW plasma facility will depend on the terms of the EPC contract, the insurance available, and the financial strength of the owner.

Risk Allocation

There is risk associated with the disposal MSW if the project is delayed, operates below design capacity, or does not work at all. To illustrate the risk for the project proponent, assume that a 15-year contract is awarded for a plant to dispose of 150 TPD of MSW for a tipping fee of $75 per ton. In the worst case scenario, the plant does not work, so that the proponent must repay its loan and is responsible for disposing of 150 TPD of waste at a price that may exceed the tipping fee for the next 15 years. For the proponent of a new technology, this additional risk may limit or eliminate their interest.

If the City accepts a portion of this "disposal" risk by paying for the cost of disposing of the non-processed MSW, the risk to the project proponent is limited to its investment. By accepting all, or portion of the disposal risk, the City must still address the long-term disposal of MSW. This could include the short-term landfill disposal costs and the costs of developing a new long-term alternative.

If the city does not accept a portion of this "disposal" risk, the proponent's risk could increase beyond the original investment. Whether the risk is limited to a specific dollar amount or is unlimited will have a bearing on the proponent's ability to obtain financing for the project. Although this "disposal" risk is common in the MSW facilities with which we are familiar, it is a key consideration with a new technology. In Hawaii with its limited access to alternative means of disposal, it will have a clear bearing on the proponent's interest in the Project.

Of course, if the C&C accepts the risk of failure of the new technology to process the amount of waste proposed, City's cost of disposal would be expected to increase dramatically.

4.4 Hydromex

4.4.1 Background

The Hydromex process combines waste material with a chemical in the presence of heat and pressure to extrude cross sections that can be used in construction. The waste material needs to be sized to enable the chemical reaction to have sufficient surface area to be complete. The building materials have been suggested for use as railroad ties and replacements for cement blocks.

As part of its evaluation of alternative technologies [10] in 2001, the C&C discussed the Hydromex process with the local company representative and reviewed the proposal they had made for a demonstration project. In general, the proposal was to

> "... provide the City with the services of one 50-ton-per-shift (eight hours) plant. Since the plant would be operated for two shifts per day, the daily capacity would be 100 TPD. The $4,000,000 cost for the plant would be paid through a leasing arrangement that The Environmental Group or Hydromex would have with an offshore leasing company. The cost of permitting the facility and all costs of operations would be the responsibility of Hydromex.

[10] See report titled "Evaluation of Selected Technology Alternatives to Landfill Disposal, September 2001" by Pacific Waste Consulting Group.

"The City's obligation would be to provide the 100 TPD of ash and contaminated wood to the plant. A period of time would be provided during which the Hydromex staff would prove that the plant can process the ash and contaminated wood, that the process will produce the building products claimed, and that there is a market for the building products. At the end of that time, the City could assume ownership of the plant and equipment. During the meeting, an estimate of at least 12 months was discussed as that time period.

"They want to locate the plant on H-POWER land or near the H-POWER plant. They are prepared to begin constructing the plant when the City agrees to the terms of an agreement."

4.4.2 Summary of Conclusions

The evaluation suggested that the C&C may wish to consider the Hydromex proposal, with the following comments and questions:

"The Hydromex proposal has several areas that are critical to the project economics that need to be updated to reflect the proposed project.
Availability of Lease Funds – The lease commitment is several years old and does not reflect conditions Hydromex now proposes. It needs to be updated.
The letters expressing interest in purchasing the product are several years old and need to be updated."

4.5 General Comments about Alternative Technologies

The evaluation of these alternatives is based on several conditions that need to be satisfied for any one or a combination of them can be considered as realistic alternatives to the Waimanalo Gulch Landfill. The conditions are:

1. They have to be operational within the five years remaining permitted life at the landfill.

2. If they are proposed to handle the entire waste stream at the Waimanalo Gulch Landfill (the metal, wood and gypsum recycling options would handle only part of the waste), they need have a project in operation for at least one year handling a similar volume of the same waste as disposed at Waimanalo Gulch Landfill (including the ash, residue and MSW).

The second condition reflects several realities of waste management on Oahu and in a municipal situation. There are fewer alternatives in an island setting if a less proven disposal alternative should fail. As a result, having a proven alternative becomes even more necessary. Since the C&C is supported by public funds, it has a responsibility to use management techniques that are proven and for which the cost is known. The C&C is not in the risk taking business when it comes to evaluating new technologies. The evaluation process is the role of the private sector, which makes profits for taking the risk of technology advancement. As such, the second condition is appropriate.

Only the metal recycling, wood recycling, and gypsum recycling technologies that were suggested by the New Systems Research for Refuse Disposal investigation have been used on the waste stream suggested in the volumes disposed a the Waimanalo Gulch Landfill. The other technologies have not been demonstrated on MSW or incinerator ash in the amounts currently handled at the Waimanalo Gulch Landfill.

In addition, the permitting history of the plasma arc systems is unknown while they are operating on MSW, so it is not clear that they can provide the technical information needed to convince the regulatory agencies and the public that they can meet the stringent regulations imposed on waste disposal operations in the size necessary to handle the waste stream at the Waimanalo Gulch Landfill. The process of scaling up can require significant time and expenditure.

The reports of evaluations that the C&C has engaged to look at plasma systems (those most often suggested as replacement for the landfill and H-POWER) came to the following conclusions.

- None of the three processes has a plant that has been operating on MSW, so all three fail the primary evaluation criterion.

- The tests indicate the HMV facility would have produced a negative 3,366 kWh per ton of RDF if the Syngas had been burned in an efficient combined cycle generating system (the HMV facility uses less efficient engine generators). By comparison, H-POWER produced a positive 712 kWh per ton of RDF in 2001. Both energy values exclude the energy required to prepare the RDF from MSW.

- If the processing capacity were increased to the four tons per day design capacity, and if the electric energy input remained the same, the HMV plant would still have produced less electric energy than it consumed (a negative 299.2 kWh per ton of RDF).

- The disposal of MSW using conventional waste-to-energy technology, such as H-POWER, is well established. The oldest WTE plant has been operating continuously since the 1970's. By contrast, disposal of MSW using plasma technology is just beginning. There are no continuously operating MSW plasma facilities in the United States and only two operating in the rest of the world. These two facilities have an average throughput of less than 100 tons per day and the oldest facility has been operating since 1999.

- A typical WTE facility can be expected to produce between 400 kwh and 600 kwh per ton of waste processed. For example, H-POWER produces 534 kwh per ton of waste processed. The EcoValley plasma facility generates approximately 537 kwh per ton of auto shredder waste processed (auto shredder has a higher heating value than MSW and would be expected to generate more net energy). Once the EcoValley facility begins to process MSW, it will be possible to calculate its efficiency for this feedstock and make a more accurate comparison.

- The lack of operating history is an inherent problem with new technologies. Previous experience with WTEs shows that the nature of MSW, particularly its heterogeneity, presents problems that are solved only through operating experience.

- It is not unusual for the financing process for a new technology to take several years.

- There is risk associated with the disposal MSW if the project is delayed, operates below design capacity, or does not work at all. To illustrate the risk for the project proponent, assume that a 15-year contract is awarded for a plant to dispose of 150 TPD of MSW for a tipping fee of $75 per ton. In the worst case scenario, the plant does not work, so that the proponent must repay its loan and is responsible for disposing of 150 TPD of waste at a price that may exceed the tipping fee for the next 15 years. For the proponent of a new technology, this additional risk may limit or eliminate the interest in responding to the RFP.

- If the city does not accept a portion of the disposal risk, the proponent's risk could increase beyond the original investment. Whether the risk is limited to a specific dollar amount or is unlimited will have a bearing on the proponent's ability to obtain financing for the project. Although this "disposal" risk is common in the MSW facilities with which we are familiar, it is a key consideration with a new technology. In Hawaii with its limited access to alternative means of disposal, it will have a clear bearing on the proponent's interest in the Project.

We understand that the City & County is planning to issue a request for proposal for a 200-ton per day plasma system. While this report details technical and financial reasons not to proceed, we acknowledge the City's interest in encouraging the technology vendors. However, a 200-ton per day facility will not eliminate the need either for expansion of H-POWER or the landfill.

4.6 H-POWER Expansion

Expanding H-POWER will add the capacity to generate energy from the waste and reduce the volume and weight of material that needs to be disposed. Adding another boiler unit to H-POWER will not eliminate the need for a landfill if no beneficial use for all of the ash is permitted. The ash consists of bottom ash from the incinerator itself and the fly ash from the air pollution control equipment. They are commingled and disposed at the landfill.

The C&C and its H-POWER operator, Coventa, have requested that the DOH allow alternative uses for the ash rather than sending it for disposal. One of the uses, replacement for the soil used to cover the waste at the landfill, will not eliminate any need for the landfill as the material still would be sent to a disposal site, although it would not increase the fill rate.

Another alternative is to use the ash in the asphalt mix used for repairing roads. The DOH has advised the C&C [11] that such a use is not allowed.

The expansion of H-POWER is a vital method to reduce the dependence on landfilling, but it alone will not eliminate the need for a landfill. Reviewing **Table 2-9**, which shows the composition of the waste that was taken to the Waimanalo Gulch Landfill in 2001, about 131,000 tons (41 percent) of the material would be acceptable in an incinerator.

The expansion should be pursued as it will reduce the usage of landfill capacity and generate energy from locally produced non–fossil fuel.

4.7 Recycling Programs

Recycling programs can be expected to reduce certain components of the waste stream now being disposed, but not eliminate the need for a landfill. The reduction of need for disposal will affect materials now being sent to H–POWER and those that are sent to the landfill. As a result, the recycling programs will allow more capacity at H–POWER for combustible materials that are now sent to the landfill as well as reducing the need for landfill capacity. Taken in combination, recycling programs can have a measurable effect on the need for landfill capacity. However, recycling results in a residue must be either landfilled or burned.

The programs discussed here build on those that the C&C now has.

[11] April 12, 2001 letter from Gary Gill, Deputy Director for Environmental Health for the State Department of Health to Frank Doyle, of the City and County of Honolulu

4.7.1 Expanded Curbside Residential Green Waste

The C&C is reviewing the potential for increasing the collection of green waste from twice per month to weekly collection. In addition, the method of collection would be changed from manual (waste placed in the customer's container or bags and hand loaded into the truck) to a semi–automated or automated system. The semi–automated system would use collection trucks retrofitted with a mechanism that picks up a 96–gallon wheeled can into which the householder has placed the green waste. The program would also be expanded from covering 85 percent of the residential customers to covering nearly 100 percent.

According to a recent study [12] completed for the C&C, the potential increase in green waste collections due to the changes in the program are estimated to be 46,000 tons, up from 6,900 tons collected from residential customers in 2001.

The C&C should implement the expanded green waste collection system as the processing infrastructure and markets for the product are in place. There will be a cost of new containers, but the cost of the collection vehicles and the labor can be minimized through the use of existing older automated vehicles and reallocation of collection staff from three to one–person trucks.

4.7.2 Establish User Fees

Waste collection and disposal services for residential customers are paid for by property taxes. The C&C is reviewing the possibility establishing a user fee that would have the resident paying for refuse collection and disposal. The user fee is an important mechanism to encourage the public to reduce disposal when it is in their economic interest to do so.

Use of volume based fees provides an even stronger encouragement to recycling. Under that system, the charge varies with the size of the container. There is an economic benefit to recycle more so one can use a smaller disposal container. As an illustrative example only (the fees, if any will be established by the City Council and would be based on local analysis and considerations), under a proportional rate system, if a 96-gallon garbage container were charged a monthly fee of $21, a 64-gallon container would cost $14, and a 32-gallon container would cost $7.

There are some potential disadvantages. Some people may elect an insufficient level of service for waste disposal and dump their excess waste in a neighbor's rubbish can or dispose of it improperly. Such considerations need to a part of any process to establish rates, especially when charging for rubbish collection is new to the community.

The U.S. Environmental Protection Agency has a program titled "Pay–As–You–Throw" that encourages the use of volume-based rates. Their documentation makes the following statement:

> "Some communities with unit pricing programs report that unit pricing helped their municipality achieve reductions of 25 to 45 percent in the amount of waste shipped to disposal facilities."[13]

This strategy alone will not eliminate the need for a landfill as the need for disposal will continue.

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[12] Residential Curbside Recycling with Container Deposit Legislation" by SCS Engineers and Pacific Waste Consulting Group, December 2002.
[13] Pay–As–You–Throw, Lessons Learned About Unit Pricing, US EPA.

4.7.3 Curbside Recycling

The C&C is reviewing the possibility of instituting a residential curbside collection program for bottles, cans, and paper. The evaluation is reviewing the cost and benefits of the C&C providing the service through its collection crews or subsidizing private subscription services. Two subscription services now provide curbside collection service in selected areas.

The curbside program is expected to work with the beverage container deposit legislation program to enhance recycling. The combined program was estimated to increase the diversion from the residential sector. With the City-operated curbside program alone, the diversion from residential sources is estimated to increase by 8 percent. With the combination of the curbside and container deposit program, the diversion was estimated to increase by 19 percent.

4.7.4 Beverage Container Deposit Program

The State legislature approved a beverage container deposit program that will encourage recycling of aluminum, plastic, and glass beverage containers. The purchaser of a beverage will pay a 1.5 cent fee per container at purchase. When the container is turned in at the redemption center, the recycler receives five cents per container. The program is expected to increase the amount of beverage container recycling so that markets are more easily sustained and the cost of shipping decreased (on a per pound recycled basis). It is expected to strengthen all of the recycling companies equally without giving one an advantage over the other, as may be the case with other recycling programs in C&C. The program impacts the resident and visitor equally. Programs that encourage recycling by visitors are more difficult as the visitor population is often not interested in recycling and is interim and transient. With the redemption program, the resident or recycling collector can recycle the visitor's container for the redemption value.

The City should continue working with the State to implement the program.

4.7.5 Metal Recovery at the Landfill

There is metal being disposed in the landfill as shown in **Table 2-9**. Based on the 2001 disposal, a total of 37,546 tons of metal are disposed, much of which could be recovered. The total metal will range between 22,000 and 53,000 tons per year. The average amount of metal represents nearly 12 percent of the total waste going into the landfill. That material could be recovered with a magnet or hand separation for the non-magnetic materials.

There are safety and operational concerns with metal recovery at the landfill. Concerns include safety of the workers that would be removing the non–magnetic materials by hand, movement of waste and landfill equipment that could be restricted by the magnetic equipment, and cost..

While the removal of metals will not eliminate the need for a landfill, it will reduce the amount to be landfilled. Metal recovery should be pursued.

4.7.6 Metal Recovery from Residents

The C&C now collects white goods (appliances like refrigerators and washers are taken to metal recyclers) from residents on a once every two month basis. Residents in rural areas call in for the service. The City could add collection of bulky metal items that could be recycled. It would add to this costly collection method, but would decrease the amount of metal that goes to H–POWER, making room for more combustible materials and reducing the cost of removing the metal either before or after combustion.

4.7.7 Enhanced Enforcement of Landfill Bans and Restrictions

The C&C now has bans on disposal of the following materials at the landfill.

- Green waste (yard trimmings) from commercial and government generators is restricted from disposal. Commercial and government trucks are limited to a maximum of 10% green waste per load, effective January 1998.

- Cardboard from commercial and government generators is restricted from disposal. Commercial and government trucks are limited to a maximum of 10% cardboard per load, effective January 1998.

- Tires, auto batteries, white goods and scrap metals are banned from all City disposal sites, effective 1994.

- Bars and restaurants serving alcoholic beverages are required to recycle glass containers, effective July 1, 1996.

- Office buildings with 20,000 square feet or more of office space are required to recycle office paper, newspaper and cardboard, effective July 1, 1996.

For each of the restrictions or bans, there are alterative methods of recycling the materials. For example, composting facilities accept green waste for a fee and process it into soil amendment products. Local paper recyclers pay for cardboard. State law requires dealers to accept old tires and recycle them.

Enforcement of these bans is through direct enforcement at the landfill. Inspectors monitor trucks unloading at the landfill, H-POWER and transfer stations. The inspector visually assess whether a truckload is over the limit on restricted materials or contains any amount of banned materials. The company is notified of violations.

The company, not the individual truck driver, is responsible for compliance of all trucks affiliated with the company. Violations are counted and assessed on a company basis within 12-month monitoring periods.

Actions taken depend on the number of violations with a 12-month monitoring period.

- 1-2 Violations per company - The company is notified of violations by telephone, provided the details of the violations, and asked to rectify the problem.

- 3-4 Violations per company - The inspector instructs the driver to reload the offending materials. If assistance is required, the driver has one hour to make arrangements for help from his company. Other wise, an onsite disposal crew assists in the reloading, and the company is billed for the cost.
- 5+ Violations per company - The company's use of City disposal sites may be restricted or prohibited. The Chief of the Refuse Division determines the penalty and duration.

Possible changes to the program are to increase the penalty for violation of the ban or restriction and use the funds generated for public education. Also, the restriction on the use of the landfill for violators can be increased.

The effectiveness of the bans is difficult to assess, as the complete contents of every load cannot be checked. The C&C has limited resources that need to be directed to the most effective programs.

Increasing enforcement of landfill bans should be considered within the limitations of the C&C resources, which might focus on the penalties rather than increasing the inspection staff.

4.7.8 Increased Disposal Fees at the Landfill

Increasing disposal fees encourages recycling to avoid paying the higher tip. The process to separate the material for recycling is more cost efficient when the cost of disposal is higher. The higher fees may encourage illegal dumping and cause recycling companies to pay more to dispose of residuals after cleaning recyclables (the C&C has increased its discount to recyclers from 50 percent of the tip fee to an 80 percent discount).

The C&C already has the highest disposal fees in the state. It is not clear how this strategy would provide noticeable reduction in landfill disposal.

4.7.9 Recovery of Wood from the Landfill

Untreated wood can be removed by hand at the landfill, ground up, and used either for mulch or feedstock to the composting process. The sorting personnel will need to use care to avoid mixing the treated wood as it is contaminated and not consistent with either use as compost or mulch.

The waste composition estimates that about 50,500 tons of untreated wood (includes untreated lumber plywood, and pallets/crates) were disposed at the landfill in 2001 (the range of disposal was 31,000 to 70,000 tons).

One drawback is the potential worker safety issues with separation at the landfill. This program could be started quickly and would result in immediate reduction in disposal. The C&C should consider it.

4.7.10 Beneficial Uses of H–POWER Ash

The C&C had proposed to use the H–POWER ash for daily cover at the landfill and for use in asphalt paving material. Either of those alternatives would have removed some or all of the ash from disposal.

The State DOH responded to the C&C request in an April 12, 2001 letter[14] and stated:

> "With regard to the use of MSW ash outside the confines of the Waimanalo Gulch Landfill, the Department cannot support the proposals presented (use as final cover and in asphalt mix). Our policy is to treat your ash in the same way we allow management of contaminated materials of similar concentrations. Based on human health and environmental risk, the preferred management option has been disposal."

4.7.11 Summary of the Landfill Based Recycling Programs

Several programs to divert material at the Waimanalo Gulch Landfill are available that could be started within the five year horizon of this document. None of them have the potential to eliminate the need for the landfill. Some of them need to have a market for the material proven (gypsum recycling) before initiation. Another, the beneficial use of the ash, is precluded by the regulatory agency.

---

[14] Letter dated April 12, 2001 from Gary Gill Deputy Director for Environmental Health, State Department of Health to Mr. Frank Doyle of the C&C.

5 NO ACTION ALTERNATIVE

This alternative is required in the EIS. It describes what would occur if the C&C did nothing regarding extension of the Waimanalo Gulch Landfill permit, which is due to expire. The date of expiration is not fixed as the closure is based on the fill reaching a specified height and that date depends on the amount of material received.

This alternative would have landfilling at the Waimanalo Gulch Landfill cease with no alternative site or technology available. That condition will result in the shutdown of the H-POWER incinerator, as there will be no disposal location for ash produced. Shutting down H-POWER will also stop disposal of most of the solid waste that is generated in the C&C. Taken together these actions will result in a health and safety catastrophe.

APPENDICES

Appendix A	*Waste Composition Study, Oahu Municipal Refuse Disposal Alternatives Study, May 1999*
Appendix B	*New Systems Research for Refuse Disposal, Oahu Municipal Refuse Disposal Alternatives Study, April 2000 Department of Public Works, August 1977*
Appendix C	*Inventory Study of Potential Sanitary and Demolition Landfill Sites, City and County of Honolulu, Department of Public Works, August 1977*
Appendix D	*Supplement to Inventory of Potential Sanitary and Demolition Landfill Sites on the Island of Oahu, City and County of Honolulu, Department of Public Works, November 1979*
Appendix E	*Solid Waste Integrated Management Plan, City and County of Honolulu, Department of Public Works, 1995, Chapter 10*
Appendix F	*Evaluation of Selected Technology Alternatives to Landfill Disposal*
Appendix G	*Hawaii Medical Vitrification Tests of H-POWER Residue on January 11-12, 2002*
Appendix H	*Review of Plasma Arc Technology for Waste Disposal , December 10, 2002*

APPENDIX A

Waste Composition Study
Oahu Municipal Refuse Disposal Alternatives Study

May 1999

City and County of Honolulu
Department of Public Works

August 1977

OAHU MUNICIPAL REFUSE DISPOSAL ALTERNATIVES STUDY

WASTE COMPOSITION STUDY

MAY 1999

PREPARED FOR:

CITY & COUNTY OF HONOLULU
Department of Environmental Services
Refuse Division
650 South King Street
Honolulu, Hawaii 96813

PREPARED BY:

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OAHU MUNICIPAL REFUSE DISPOSAL ALTERNATIVES STUDY

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MAY 1999

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EXECUTIVE SUMMARY

Effective solid waste management planning begins with knowing what is in the waste stream—how much of which types of material is disposed by each generator type. This basic information is essential to all aspects of waste management policy and program implementation. Thus, the City and County of Honolulu commissioned this waste composition study to obtain data to characterize the overall waste stream.

The objective of the waste composition analyses was to provide statistically valid data on the composition of disposed solid waste from the residential, commercial, and convenience center substreams. This study measured only waste disposal, not waste generation (the sum of the amount of waste disposed and the amount recycled). The composition of the recycled waste was not analyzed.

All waste samples were taken from loads destined for combustion at H-POWER or landfilling at Waimanalo Gulch. In particular, this study focused on the amounts of paper and green waste disposed in the residential substream, and the amounts of wood and recyclables disposed in the commercial substream.

For any specific geographic area, the total waste stream is composed of various substreams. A "substream" is determined by the particular generation, collection, or composition characteristics which make it a unique portion of the total waste stream. This study targets three main substreams:

- The **residential** substream is comprised of waste collected by the City's Refuse Division. The residential substream primarily includes waste generated at single-family households, but also includes some apartment buildings and commercial facilities.
- The **commercial** substream is comprised of wastes collected by non-Refuse Division vehicles, including private commercial waste haulers, other City & County departments, and the public (including individual businesses and residential self-haulers). It primarily includes waste generated at businesses, institutions, multi-family residences and condominiums.
- The **convenience center** substream is composed of waste destined for either combustion or the landfill that is deposited, mainly by residents, at the six drop-off stations operated by the City.

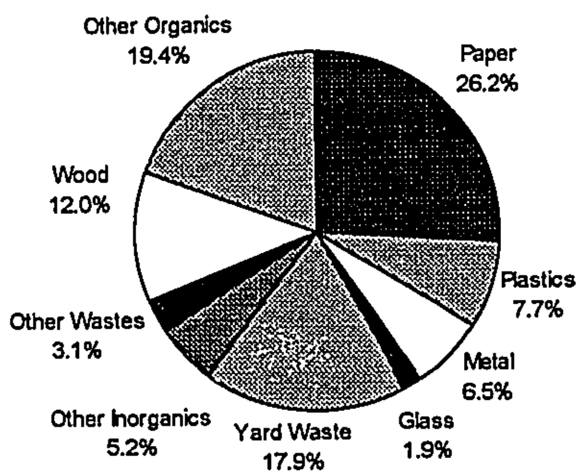
The waste was sampled from the truck that delivered it to the disposal facility. The entire truckload of waste was dumped. Wherever possible, an imaginary 8-section, 2-layer grid (16 cells total) was superimposed on the load, and a randomly selected cell was identified for sampling. Approximately 250 pounds of waste from the cell were placed onto a tarp for sorting.

Each sample was sorted by hand into the defined component groups. The weights of all materials were recorded on tally sheets, and the composition of the entire load was calculated.

In 1998, a total of 821,437 tons of waste were disposed by the residential, commercial, and convenience center substreams in the City & County (this total does not include construction and demolition waste). As shown in Figure ES-1, the most prevalent materials in the City & County's overall waste stream are paper, other organics (which includes food, carpet, and textiles), and yard waste. The paper, other organics, and yard waste categories account for well over half (63.5%) of the overall waste stream. The percentages may not add to 100 because of rounding.

Figure ES-1 Overview of Overall Waste Composition Results

March 1998 – February 1999



The largest components of the City & County's overall waste stream, which account for nearly half (45.6%) of the overall waste stream, are listed below.

• Yard waste	17.9%	(147,047 tons)
• Food	12.0%	(98,914 tons)
• Low grade paper	9.0%	(73,594 tons)
• Cardboard	6.7%	(55,147 tons)

The following four components accounted for well over half (62.0%) of the **residential** waste.

• Yard waste	28.7%
• Food	15.4%
• Low grade paper	11.4%
• Newspaper	6.5%

The residential composition results from the City & County were compared with results from three other waste characterization studies, including the City of Seattle, City of San Diego, and King County (Washington State). Honolulu had similar proportions of waste in the paper, plastic, metal, glass, other wastes, wood, and other organics categories as Seattle, San Diego, and King County. Honolulu had a much larger percentage of yard waste and a lower percentage of other inorganics (which includes various construction debris) than the other three locations.

The composition of the **commercial** waste stream was assessed at both H-POWER and the Waimanalo Gulch Landfill. The results at Waimanalo Gulch were very different from those at H-POWER. The paper and other organics (which includes food and textiles) categories accounted for the bulk of the waste hauled to H-POWER (53.6%). At Waimanalo Gulch, paper and other organics only accounted for 18.5% of the waste. The difference between the other organics categories is primarily a result of more food waste at H-POWER.

At Waimanalo Gulch, the wood and other inorganics (which includes various construction debris) categories accounted for the bulk of the commercial waste (51.2%). At H-POWER, wood and other inorganics only accounted for 14.8% of the waste. The greater proportions of gypsum wallboard, sand/soil/dirt, and concrete at Waimanalo Gulch result in the higher percentage for the other inorganics category.

Yard waste accounted for a higher proportion of waste at H-POWER, and metal accounted for a higher proportion of waste at Waimanalo Gulch.

The waste composition results for the commercial substream were compared with the results of similar studies in Seattle, San Diego, and King County (Washington State). Honolulu showed similar composition percentages in the paper, plastics, metal, glass, and other wastes categories. The proportion of yard waste and wood was higher in Honolulu than in the other locations. The proportion of waste in the other organics category, specifically food waste, was similar to San Diego but much less than Seattle and King County.

Waste from **convenience centers** was sampled at H-POWER and Waimanalo Gulch. Yard waste was the largest waste type disposed at H-POWER (27.4%), followed by the paper (17.9%), other organics (17.5%), and wood categories (14.9%). At Waimanalo Gulch, the wood, other wastes (which includes furniture/mattresses and hazardous materials), and yard waste categories accounted for the majority of the waste (62.5%).

The greater proportion of cardboard and low grade paper accounted for the higher proportion of paper at H-POWER. At Waimanalo Gulch, the higher proportion of other wastes and wood resulted from the greater amount of furniture/mattresses and treated wood, respectively.

SECTION 1

BACKGROUND

1.1 INTRODUCTION

Effective solid waste management planning begins with knowing what is in the waste stream—how much of which types of material is disposed by each generator type. This basic information is essential to all aspects of waste management policy and program implementation. Thus, the City and County of Honolulu commissioned this waste composition study to obtain data in order to characterize the overall waste stream. In particular, this study focused on the amounts of paper and green waste disposed in the residential substream, and the amounts of wood and recyclables disposed in the commercial substream.

This report was prepared for the City & County of Honolulu, Department of Environmental Services, Refuse Division. It is a part of an evaluation of key portions of the City's waste collection and diversion programs. The report includes an overview of the solid waste system, as well as waste composition estimates for both residential and commercial generators. Sampling of the City & County's waste stream was conducted between March 1998 and February 1999. R.M. Towill Corporation served as the prime contractor for this research, and assistance was provided by Cascadia Consulting Group in association with Sky Valley Associates and Solid Waste Associates.

The report is organized into seven segments: *Section 1* provides background information, and *Section 2* provides an overview of Honolulu's existing solid waste system. *Section 3* briefly summarizes the project's methodology. *Section 4* presents the overall results for the City & County's waste stream. Complete results of the residential sampling are described in *Section 5*, while the commercial results are examined in *Section 6*. *Section 7* provides the results from the convenience center sampling. Detailed appendices, including the sampling and analyses methodology, follow the main body of the report.

This report refers to the City & County of Honolulu as the City & County or the City, as the context requires.

1.2 PROJECT OVERVIEW

The analyses contained in this report are part of a comprehensive study to evaluate the collection and disposal system in the City & County of Honolulu. The purpose of this study was to determine if the waste collection and disposal system is operating in the most cost-effective manner, and whether the waste collection system is diverting the highest amount of materials possible.

Several components of the solid waste system were studied and evaluated under the direction of R. M. Towill Corporation, with the assistance and project management support of Solid Waste Associates (SWA). Descriptions of the individual studies and evaluations, and companies involved with those studies are listed below.

- A *Waste Composition Analysis* of the residential, commercial, and convenience center waste streams and of construction and demolition waste. Data collection and analysis was conducted by Cascadia Consulting Group and Sky Valley Associates. They were assisted by SWA.

- A *Study of Managed Competition* in waste collection and transfer services. This study was prepared by HDR Engineering, Inc.

- An *Evaluation of Green Waste Collection, Processing, and Marketing* to address the infrastructure needed for expanded green waste collection. This evaluation was prepared by Total Compliance Management, Inc. in association with SWA.

- An *Evaluation of Once-Per-Week Waste Collection* to assess the cost savings and operational impacts of collecting residential waste from single-family dwellings once per week rather than twice per week. The evaluation was prepared by Franklin Associates.

- An *Evaluation of Curbside Recyclable Collection* from single–family dwellings. This evaluation, conducted by Franklin Associates, was to determine the cost of implementing a curbside program compared to the existing drop-off system.

- A *Request for Proposals for Food Waste Bioconversion Technologies* to identify a technology that could be appropriate for the City. SWA and RM Towill prepared this RFP.

- An *Evaluation of Emerging Waste Management Technologies* to identify those that might be appropriate for the City to investigate further. This evaluation was prepared by AGT, Inc.

- An *Evaluation of Market Subsidies for Recyclable Materials* prepared by Skumatz and Associates.

This report discusses the first of these components, the Waste Composition Analysis.

This waste composition analysis was supported by the City & County and by DOH (the State Department of Health), DBEDT (the State Department of Business, Economic Development, and Tourism), and Island Demo, Inc. The analysis was originally intended to cover just the waste stream being disposed in the City & County disposal facilities (the H–POWER incinerator and the Waimanalo Gulch Landfill.) DOH added funding to evaluate the waste being disposed from the Convenience Centers and expanded upon the number of samples being taken of the residential waste stream. In addition, DOH supported the evaluation of the City & County ban on disposal of beverage containers from bars and restaurants and of office paper from certain offices. That evaluation involved sampling of waste from the rubbish bins of bars and restaurants and from offices. It is reported in a separate document.

The funding provided by DBEDT and Island Demo supported the evaluation of the C&D waste disposed at the PVT Landfill in Nanakuli. The report of that evaluation is in a separate document.

The information provided herein, and in the other reports, is the most detailed, thorough, and current data available on the disposed waste stream in Oahu. We appreciate the support of these agencies and Island Demo, the cooperation of the businesses whose waste was sampled, and the cooperation of the operators of the PVT Landfill.

SECTION 2

OVERVIEW OF THE EXISTING SOLID WASTE SYSTEM

The following description of the City's solid waste system is based on conditions that existed during the 1998/99 sampling period.

2.1 COLLECTION

The City & County of Honolulu are divided into seven collection districts. Waste from the districts is sent either to one of three transfer stations or directly to the disposal site, depending on distance from the route to the disposal point.

Residential waste from single-family dwellings is collected by the Refuse Division. The Refuse Division also collects some residential apartment building and commercial waste. Private haulers collect most of the waste from apartment buildings and commercial facilities.

Both automated and manual trucks are used for residential waste collection. In districts with automated collection services, green waste is collected separately once per month. Some automated service areas have additional on-call green waste collection services due to the large amount of the material generated. In areas with manual collection, green waste is collected with the rubbish. Residential waste is collected twice per week.

The City also operates a system of six convenience centers where residents can drop off their waste. Depending on the type, waste from convenience centers is recycled, combusted, or disposed of in a landfill.

2.2 DIVERSION

The waste diversion program includes the following components:

- A drop-off system currently located at many schools around the island. Materials collected include paper, plastic, aluminum cans, and glass. The drop-off system is being expanded to include additional schools and some commercial facilities, such as grocery stores and supermarkets.

- Green waste processing is done at three locations – two private operations and one operated by the Refuse Division (located at the Kapaa Landfill). The private operations produce both mulch and compost. The finished product is marketed in retail stores and in wholesale bulk. The Refuse Division operation produces mulch, which is provided free to the City parks and other departments and to the public.

- A statewide advance disposal fee for glass provides an incentive for recycling that material. A fee of 1.5 cents is collected for each glass container entering the state. The processor is paid six cents per pound for the recycled glass.

- The Partnership for the Environment is a City-supported organization comprised of representatives of companies that have extensive commercial recycling activities. The Partnership acts as an information source for expanding commercial recycling on Oahu.

- The City requires recycling of glass containers from bars and restaurants. It also requires office buildings greater than 20,000 square feet in size to recycle office paper, newspaper, and cardboard.

- Restaurants and other facilities that generate food waste are required to recycle that material.

- The City has a program to recycle materials from its offices.

- While not City-sponsored, there are commercial programs to recycle construction and demolition waste, tires, and appliances.

2.3 DISPOSAL

The City of Honolulu operates two disposal facilities, and a third is privately operated. The City facilities are the Waimanalo Gulch Landfill and H-POWER. H-POWER is a waste-to-energy plant that processes about 2,000 tons of waste per day (approximately 620,000 tons of waste in 1998) and generates electricity. At H-POWER, ferrous metals are reclaimed prior to incineration of waste, and non-ferrous metals are reclaimed from the ash following incineration.

The Waimanalo Gulch Landfill accepts waste, including the ash from H-POWER, mostly from private waste haulers and commercial self-haulers.

PVT Land Company operates the private landfill. It accepts construction and demolition materials. Construction and demolition wastes are characterized in a separate study conducted by the State Department of Business, Economic Development, and Tourism.

SECTION 3

METHODOLOGY OVERVIEW

The objective of the waste composition analyses was to provide statistically valid data on the composition of disposed solid waste from the residential, commercial, and convenience center substreams.[1] All waste samples were taken from loads destined for combustion at H-POWER or landfilling at Waimanalo Gulch.

3.1 SUBSTREAM DEFINITIONS

For any specific geographic area, the total waste stream is composed of various substreams. A "substream" is determined by the particular generation, collection, or composition characteristics which make it a unique portion of the total waste stream. This study targets three main substreams:

- The **residential** substream is comprised of waste collected by the Refuse Division. The residential substream primarily includes waste generated at single-family households, but also includes some apartment buildings and commercial facilities.
- The **commercial** substream is comprised of wastes collected by non-Refuse Division vehicles, including private commercial waste haulers, other City & County departments (CNC), and the public (including individual businesses and residential self-haulers). It primarily includes waste generated at businesses, institutions, multi-family residences and condominiums.
- The **convenience center** substream is composed of waste destined for either combustion or the landfill that is deposited, mainly by residents, at the six drop-off stations operated by the City.

Table 3-1 shows the amount of waste disposed, by substream, for the City & County of Honolulu in 1998.

Table 3-1 Amount of Waste Disposed, by Substream

	Waste Disposed in 1998	
	Tons	*Percentage*
Residential	316,491	39%
Commercial	477,770	58%
Convenience Center	27.176	3%
TOTAL	821,437	100%

[1] This study measured only waste disposal, not waste generation. (Waste generation equals the sum of disposed and recycled amounts.) Tonnage collected through recycling or yard waste composting programs was not considered in this study.

3.2 SAMPLE DISTRIBUTION

Residential: There are seven solid waste collection districts within the City and County. Samples of residential waste were collected from the five districts that dispose the largest quantities of residential waste: Honolulu, Ewa, Koolaupoko, Wahiawa, and Waianae. Based on statistical power analyses of data collected in similar projects, it was estimated that 40 samples from each district would provide enough data to estimate the composition of the paper categories within one or two percentage points and the /composition of yard waste within four or five percentage points.

Residential loads from Honolulu were categorized further as to whether they originated from East Honolulu or West Honolulu. The dividing line was Nuuanu Avenue, which was also the origin of the street numbering in the east and west directions. Additional samples were allocated to the Honolulu district to ensure adequate representation of the east and west regions.

Residential waste is disposed at H–POWER.

Commercial: Commercial waste is hauled either to H-POWER or Waimanalo Gulch. Based on statistical power analyses of data collected in other projects, it was estimated that sorting 80 samples from each site would provide enough data to estimate the composition of wood debris within five or six percentage points.

Convenience Center: Convenience Center waste is hauled to either H-POWER or Waimanalo Gulch. A total of 40 samples were allocated to each facility based on the analysis done for the residential districts.

3.3 SAMPLING SCHEDULE

In order to account for seasonal differences, the residential and commercial waste sampling was conducted over a six-month period. The sampling occurred in three intervals during that time: March-April, May-June, and August-September. After the study had begun, it was decided that the convenience center substream should also be sampled. The convenience center sampling occurred in May-June, August, and January-February.

Whenever possible, residential and commercial sorting was scheduled on each day of the week for each district and each site during all three sampling periods. In instances where this was not possible, the days of the week that typically had the most loads and tonnage were selected.

Table 3-2 compares the number of samples planned with the actual number of samples sorted, by site and substream. Samples were collected from the residential and commercial substreams at Keehi, H-POWER, Waimanalo Gulch, and Kapaa between March and August 1998. Convenience center waste was sampled at Waimanalo Gulch in May and August 1998 and at H-POWER in January and February 1999. Sufficient convenience center loads were not delivered to H–POWER during the sampling period to allow collection of the planned number of samples.

Table 3-2 Planned and Actual Number of Samples, by Substream and Period

March 1998 – February 1999

	Residential		Commercial		Convenience Center	
	Planned	*Actual*	*Planned*	*Actual*	*Planned*	*Actual*
Mar. 30 - Apr. 8, 1998						
H-POWER	48	48	32	32		
Keehi	32	33	7	7		
Waimanalo Gulch			40	40		
May 27 - June 4, 1998						
H-POWER	48	44	32	36		
Kapaa	20	20				
Waimanalo Gulch			20	20	20	20
Aug. 24 - Sept. 2, 1998						
H-POWER	12	14	8	6		
Kapaa	20	20				
Keehi	20	32				
Waimanalo Gulch			20	20	20	20
Jan. 29 - Feb. 3, 1999						
H-POWER					40	16
Total	200	211	159	161	80	56

3.4 SAMPLE SELECTION AND SORTING

Load and tonnage data obtained from the City were used to establish sampling frequencies for each type of waste at each facility. As each designated sample load arrived, the field supervisor noted the hauler name, vehicle number and vehicle type. At the end of the shift, the field supervisor also recorded the net weight of each sample load.

The entire truckload of waste was dumped. Wherever possible, an imaginary 8-section, 2-layer grid (16 cells total) was superimposed on the load, and a randomly selected cell was identified for sampling. Approximately 250 pounds of waste from the cell were placed onto a tarp for sorting.

Each sample was sorted by hand into the defined component groups (see Appendix A for sorting categories and definitions). The weights of all materials were recorded on tally sheets, shown in Appendix E. A detailed description of the study's methodology is provided in Appendix B.

3.5 INTERPRETING THE RESULTS

All composition calculations are based on the sorted materials' weight (as opposed to volume or some other measurement). The results were derived using a 90% confidence interval. This means there is a 90% certainty that the actual composition is within the calculated range.[2] In waste composition charts throughout this report, the values graphed represent the mean component percentage, not the range. For more information about the calculations, please refer to Appendix D.

[2] For example, in the overall composition estimates, newspaper is estimated to account for 3.7% of the waste, plus or minus 0.3 percentage points—therefore, the "calculated range" is between 3.4% and 4.0%, with the most probable value being 3.7%.

SECTION 4

OVERALL COMPOSITION RESULTS

In 1998, a total of 821,437 tons of waste was disposed by the residential, commercial, and convenience center substreams in the City & County (this total excludes construction and demolition waste). As shown in **Figure 4-1**, the most prevalent materials in the City & County's overall waste stream are paper, other organics (which includes food, carpet, and textiles), and yard waste. The paper, other organics, and yard waste categories account for well over half (63.5%) of the overall waste stream. The percentages may not add to 100 because of rounding.

Figure 4-1 Overview of Overall Waste Composition Results

March 1998 – February 1999

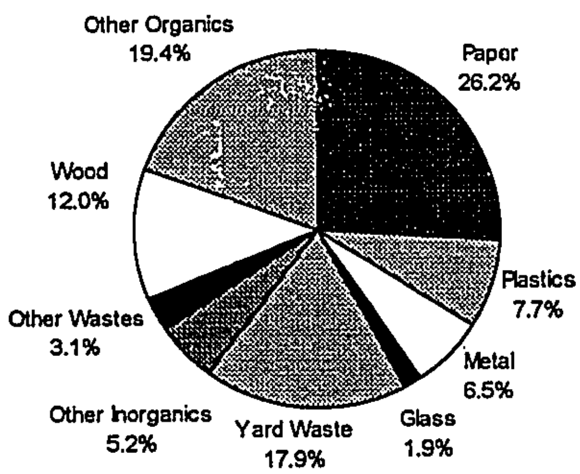


Table 4-1 illustrates the detailed composition results for the City & County's overall waste stream. The largest components, which account for nearly half (45.6%) of the overall waste stream, are listed below.

- Yard waste 17.9% (147,047 tons)
- Food 12.0% (98,914 tons)
- Low grade paper 9.0% (73,594 tons)
- Cardboard 6.7% (55,147 tons)

Table 4-1 Overall Waste Composition, City & County of Honolulu, By Weight
March 1998 – February 1999

	Composition		Estimated Tons	
Calculated at 90% confidence interval	Mean	+/-	Mean	+/-
Paper	**26.2%**		**215,399**	
Newspaper	3.7%	0.3%	30,268	2,458
Cardboard	6.7%	0.7%	55,147	5,935
High Grade	1.6%	0.4%	13,242	3,517
Low Grade	9.0%	0.7%	73,594	5,486
Compostable	3.9%	0.6%	31,985	4,870
Other Paper	1.4%	0.2%	11,163	2,013
Plastics	**7.7%**		**63,056**	
PET #1 Bottles	0.4%	0.0%	3,380	392
HDPE #2 Bottles	0.4%	0.0%	3,694	311
Other Bottles	0.1%	0.0%	952	215
Other Rigid Plastic	2.4%	0.2%	19,435	1,790
Film Plastic	3.6%	0.4%	29,908	3,289
Mixed Plastic/Other Materials	0.7%	0.1%	5,687	1,214
Metal	**6.5%**		**53,741**	
Aluminum Cans	0.5%	0.0%	3,945	398
Tin Cans	0.9%	0.1%	7,473	811
Ferrous	2.2%	0.5%	17,801	4,042
NonFerrous	0.4%	0.2%	3,195	1,611
Mixed Metals/Other Materials	2.6%	0.6%	21,327	5,182
Glass	**1.9%**		**15,537**	
Glass Containers	1.6%	0.2%	13,054	1,374
Other Glass	0.3%	0.1%	2,484	1,130
Other Inorganics	**5.2%**		**42,648**	
Gypsum Wallboard	1.4%	0.5%	11,905	4,382
Asphalt Roofing	0.3%	0.3%	2,666	2,383
Asphalt Paving	0.3%	0.3%	2,625	2,801
Concrete	0.6%	0.4%	4,971	3,193
Sand/Soil/Dirt	0.9%	0.5%	7,452	3,745
Ceramic Products	0.2%	0.2%	2,013	1,746
Misc Inorganics	1.3%	0.6%	11,016	4,968
Other Wastes	**3.1%**		**25,386**	
Hazardous/Chemicals	0.3%	0.1%	2,816	1,008
Furniture/Mattresses	1.9%	0.6%	15,882	4,615
Brown Goods (appliances)	0.8%	0.5%	6,687	3,999
Yard Waste	**17.9%**		**147,047**	
Yard Waste	17.9%	1.7%	147,047	13,581
Wood	**12.0%**		**98,899**	
Untreated Lumber	1.8%	0.5%	14,401	4,197
Untreated Plywood	0.9%	0.4%	7,516	3,190
Pallets/Crates	4.8%	2.1%	39,292	17,059
Treated Wood	3.9%	0.9%	32,155	7,005
Stumps	0.7%	0.3%	5,535	2,693
Other Organics	**19.4%**		**159,724**	
Food	12.0%	1.1%	98,914	9,093
Textiles	1.7%	0.3%	14,362	2,601
Carpet	1.9%	0.8%	15,846	6,309
Tires	0.1%	0.1%	1,070	1,120
Misc Organics	3.6%	0.5%	29,532	3,867
Number of Samples/Total Tonnage	428		821,437	

SECTION 5

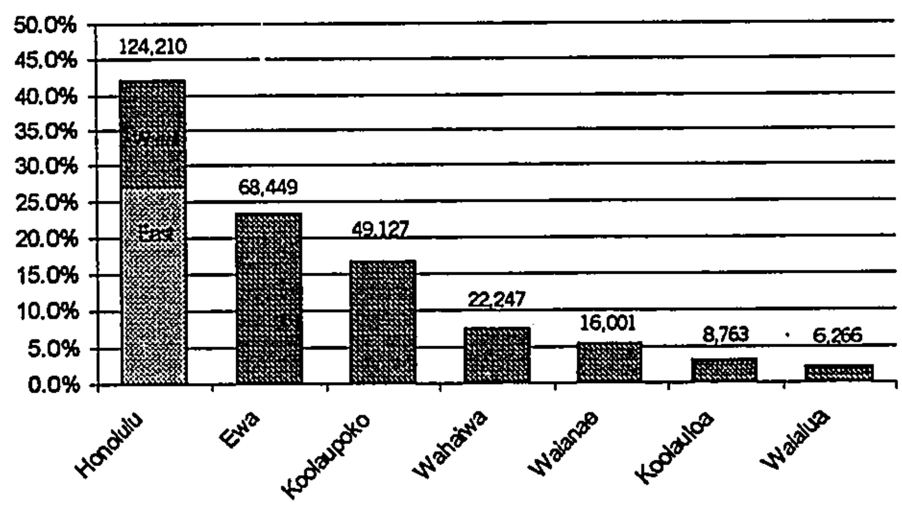
THE RESIDENTIAL STREAM

5.1 OVERALL RESIDENTIAL

A total of 211 samples were selected from the single-family residential sector (waste collected by Refuse Division vehicles). Samples were collected from five districts, including Honolulu (divided into East and West), Ewa, Koolaupoko, Wahiawa, and Waianae. In order to accurately characterize the overall residential waste stream, composition estimates were calculated by performing a weighted average based on the five districts/areas. (Please see Appendix D for more detail regarding the weighted average calculations.) In 1998, the residential substream disposed a total of 316,491 tons. **Figure 5-1** illustrates the proportion of the total residential waste disposed by each district.

Figure 5-1 Proportion of Residential Waste Disposed by Each District

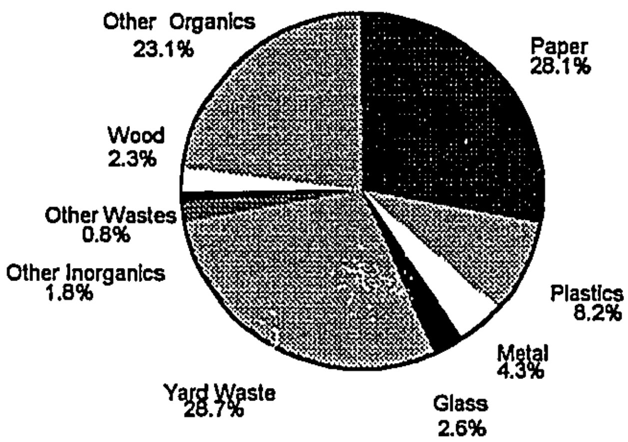
January – December 1998



The overall residential composition results, by weight, for each of the broad categories are illustrated in **Figure 5-2**. As shown, paper, yard waste, and other organics (primarily food) accounted for 79.9% of the waste in the residential substream. The percentages may not add to 100 because of rounding.

Figure 5-2 Overview of Overall Residential Sampling Results, by Weight

March – August 1998



Detailed analysis of each category is presented in Table 5-1. The following four components accounted for well over half (62.0%) of the residential waste.

• Yard waste	28.7%
• Food	15.4%
• Low grade paper	11.4%
• Newspaper	6.5%

Table 5-1 Overall Residential Waste Composition, By Weight

March – August 1998

	Composition		Estimated Tons	
Calculated at 90% confidence interval	Mean	+/-	Mean	+/-
Paper	28.1%		89,013	
Newspaper	6.5%	0.5%	20,672	1,579
Cardboard	4.6%	0.4%	14,643	1,285
High Grade	1.1%	0.2%	3,542	725
Low Grade	11.4%	0.6%	35,993	1,815
Compostable	3.2%	0.2%	10,008	685
Other Paper	1.3%	0.2%	4,155	603
Plastics	8.2%		26,012	
PET #1 Bottles	0.5%	0.0%	1,562	126
HDPE #2 Bottles	0.7%	0.0%	2,161	144
Other Bottles	0.2%	0.0%	506	108
Other Rigid Plastic	2.4%	0.2%	7,536	512
Film Plastic	3.8%	0.2%	12,123	565
Mixed Plastic/Other Materials	0.7%	0.2%	2,125	580
Metal	4.3%		13,653	
Aluminum Cans	0.6%	0.1%	1,837	172
Tin Cans	1.2%	0.1%	3,804	293
Ferrous	0.7%	0.2%	2,352	653
NonFerrous	0.3%	0.1%	906	187
Mixed Metals/Other Materials	1.5%	0.3%	4,754	924
Glass	2.6%		8,283	0
Glass Containers	2.4%	0.2%	7,438	677
Other Glass	0.3%	0.2%	844	526
Other Inorganics	1.8%		5,828	
Gypsum Wallboard	0.2%	0.2%	716	750
Asphalt Roofing	0.1%	0.1%	338	183
Asphalt Paving	0.0%	0.0%	63	89
Concrete	0.2%	0.1%	496	274
Sand/Soil/Dirt	0.5%	0.2%	1,468	570
Ceramic Products	0.1%	0.1%	282	264
Misc Inorganics	0.8%	0.3%	2,466	811
Other Wastes	0.8%		2,634	
Hazardous/Chemicals	0.4%	0.2%	1,190	543
Furniture/Mattresses	0.1%	0.1%	302	218
Brown Goods (appliances)	0.4%	0.2%	1,142	613
Yard Waste	28.7%		90,728	
Yard Waste	28.7%	1.9%	90,728	6,086
Wood	2.3%		7,258	
Untreated Lumber	0.5%	0.1%	1,737	447
Untreated Plywood	0.1%	0.1%	243	189
Pallets/Crates	0.0%	0.0%	51	59
Treated Wood	1.0%	0.2%	3,169	760
Stumps	0.6%	0.3%	2,057	1,070
Other Organics	23.1%		73,081	
Food	15.4%	1.0%	48,766	3,036
Textiles	2.2%	0.3%	6,843	989
Carpet	0.9%	0.2%	2,849	736
Tires	0.0%	0.1%	154	180
Misc Organics	4.6%	0.4%	14,469	1,418
Number of Samples/Total Tonnage	211		316,491	

5.2 RESULTS BY DISTRICT

Table 5-2 shows the planned and actual number of samples sorted from the five districts. Some samples from Ewa, Wahiawa, and Waianae were reallocated to the Honolulu district in order to obtain an adequate number of samples from the east and west regions. (Appendix C includes a detailed discussion of each district's location and demographic characteristics.)

Table 5-2 Planned and Actual Number of Residential Samples, by District

	Number of Samples	
	Planned	*Actual*
Honolulu (East and West)	40	65
Ewa	40	36
Koolaupoko	40	40
Wahiawa	40	35
Waianae	40	35
Total	200	211

Figure 5-3 provides an overview of each district's sorting results. As shown, the composition percentages for each of the broad waste categories are relatively similar among the districts. The proportion of yard waste was slightly higher at Koolaupoko (35.7%) than the other districts. Ewa and Wahiawa had the lowest proportions of yard waste (23.8% and 24.3%, respectively). In East Honolulu, West Honolulu and Waianae, yard waste ranged from 27.3% to 30.6%.

Paper constituted a slightly lower proportion of the waste in Koolaupoko and Waianae (24.0-24.1%), than the other districts (28.1-30.4%). The proportion of other organics (which includes food and textiles) at East Honolulu, West Honolulu, and Koolaupoko (19.4-21.4%) were slightly less than at Ewa, Wahiawa, and Waianae (24.7-29.0%). In these districts, the higher percentages of other organics were primarily due to the higher amounts of food and miscellaneous organics[3]. The percentages on the charts in **Figure 5-3** may not add to 100 because of rounding.

The largest components (each accounting for at least 5% of the total tonnage) for each collection district (with the Honolulu district divided into east and west areas) are shown in **Table 5-3**. Various paper grades, yard waste and food waste were prevalent in each district. "Miscellaneous organics" includes such items as diapers and animal wastes. (Refer to Appendix A for a detailed description of each waste category.) **Table 5-4** shows the detailed composition results for each district.

[3] No statistical tests were performed to compare residential composition results by district, as described in Section 5.2.

Figure 5-3 Overview of Residential Sampling Results, by District

March - August 1998

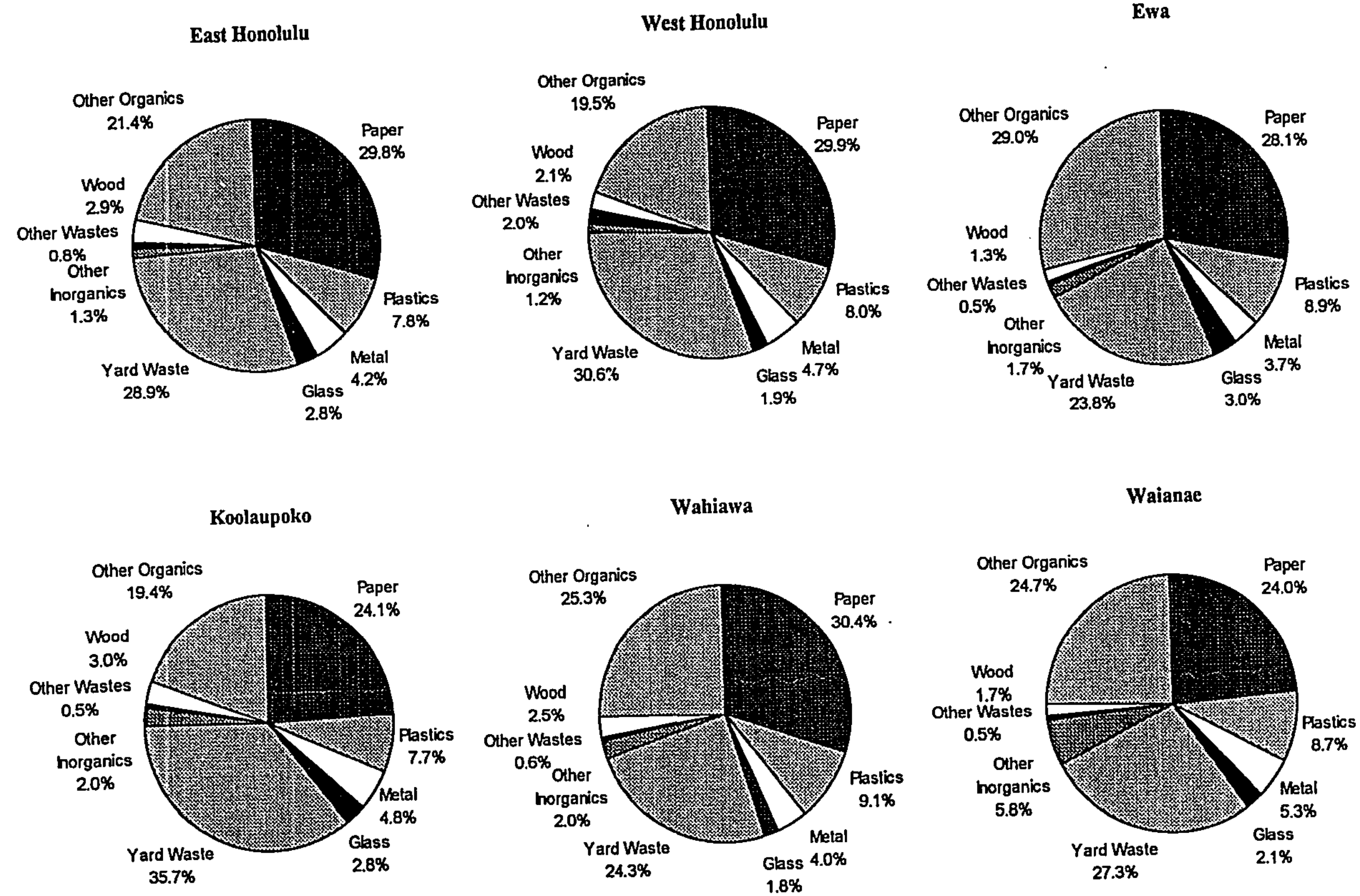


Table 5-3 Largest Residential Waste Components, by District

March - August 1998

	East Honolulu	West Honolulu	Ewa	Koolaupoko	Wahiawa	Waianae
Newspaper	7.9%	8.0%	5.5%		6.5%	5.5%
Cardboard					5.5%	
Low Grade Paper	11.4%	11.1%	12.1%	10.2%	12.9%	10.0%
Yard Waste	28.9%	30.6%	23.8%	35.7%	24.3%	27.3%
Food	15.0%	13.1%	19.0%	13.3%	17.1%	12.9%
Miscellaneous Organics			6.6%		5.1%	7.8%

Table 5-4 Residential Waste Composition for Each District, By Weight
March- August 1998

	East Honolulu		West Honolulu		Ewa		Koolaupoko		Wahiawa		Waianae	
Calculated at 90% confidence	*Mean*	*+/-*	*Mean*	*+/-*	*Mean*	*+/-*	*Mean*	*+/-*	*Mean*	*+/-*	*Mean*	*+/-*
Paper	**29.8%**		**29.9%**		**28.1%**		**24.1%**		**30.4%**		**24.0%**	
Newspaper	7.9%	1.1%	8.0%	1.5%	5.5%	1.0%	4.8%	0.7%	6.5%	1.1%	5.5%	1.1%
Cardboard	4.8%	0.9%	4.4%	0.9%	4.9%	0.9%	3.8%	0.7%	5.5%	0.9%	4.4%	1.1%
High Grade	1.1%	0.2%	2.3%	1.2%	0.9%	0.4%	0.7%	0.2%	0.9%	0.9%	0.4%	0.2%
Low Grade	11.4%	1.3%	11.1%	1.2%	12.1%	1.3%	10.2%	1.0%	12.9%	1.5%	10.0%	1.1%
Compostable	3.0%	0.4%	2.9%	0.5%	3.9%	0.6%	3.0%	0.4%	3.2%	0.4%	2.3%	0.4%
Other Paper	1.6%	0.6%	1.2%	0.3%	0.9%	0.2%	1.5%	0.3%	1.3%	0.5%	1.4%	0.4%
Plastics	**7.8%**		**8.0%**		**8.9%**		**7.7%**		**9.1%**		**8.7%**	
PET #1 Bottles	0.5%	0.1%	0.4%	0.1%	0.5%	0.1%	0.5%	0.1%	0.6%	0.1%	0.5%	0.1%
HDPE #2 Bottles	0.6%	0.1%	0.7%	0.1%	0.7%	0.1%	0.6%	0.1%	0.8%	0.1%	0.8%	0.1%
Other Bottles	0.2%	0.0%	0.2%	0.1%	0.1%	0.1%	0.2%	0.1%	0.1%	0.0%	0.3%	0.2%
Other Rigid Plastic	2.1%	0.3%	2.3%	0.4%	2.5%	0.4%	2.4%	0.4%	2.8%	0.6%	2.4%	0.3%
Film Plastic	3.8%	0.4%	3.7%	0.5%	4.1%	0.4%	3.4%	0.3%	4.4%	0.4%	4.2%	0.3%
Mixed Plastic/Other Materials	0.7%	0.3%	0.7%	0.3%	0.9%	0.6%	0.5%	0.1%	0.4%	0.2%	0.5%	0.2%
Metal	**4.2%**		**4.7%**		**3.7%**		**4.8%**		**4.0%**		**5.3%**	
Aluminum Cans	0.6%	0.1%	0.4%	0.1%	0.7%	0.1%	0.6%	0.1%	0.6%	0.1%	0.7%	0.1%
Tin Cans	1.2%	0.2%	1.1%	0.2%	1.4%	0.2%	1.0%	0.1%	1.2%	0.2%	1.6%	0.2%
Ferrous	0.8%	0.5%	0.7%	0.4%	0.5%	0.3%	0.9%	0.5%	1.0%	0.4%	0.8%	0.4%
NonFerrous	0.3%	0.2%	0.2%	0.1%	0.3%	0.1%	0.3%	0.1%	0.2%	0.1%	0.4%	0.2%
Mixed Metals/Other Materials	1.4%	0.5%	2.4%	1.1%	0.8%	0.3%	2.0%	0.9%	1.1%	0.4%	1.8%	0.7%
Glass	**2.8%**		**1.9%**		**3.0%**		**2.8%**		**1.8%**		**2.1%**	
Glass Containers	2.6%	0.5%	1.7%	0.5%	2.5%	0.4%	2.7%	0.5%	1.7%	0.4%	2.0%	0.4%
Other Glass	0.2%	0.1%	0.3%	0.3%	0.5%	0.6%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Other Inorganics	**1.3%**		**1.2%**		**1.7%**		**2.0%**		**2.0%**		**5.8%**	
Gypsum Wallboard	0.0%	0.0%	0.0%	0.0%	0.7%	0.9%	0.2%	0.3%	0.1%	0.1%	0.0%	0.0%
Asphalt Roofing	0.0%	0.0%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.4%	0.4%	0.4%	0.4%
Asphalt Paving	0.0%	0.0%	0.1%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Concrete	0.0%	0.0%	0.3%	0.3%	0.0%	0.0%	0.1%	0.1%	0.1%	0.1%	1.2%	1.3%
Sand/Soil/Dirt	0.5%	0.4%	0.1%	0.1%	0.2%	0.3%	0.0%	0.0%	0.5%	0.7%	3.8%	1.8%
Ceramic Products	0.1%	0.1%	0.0%	0.0%	0.2%	0.3%	0.1%	0.0%	0.0%	0.0%	0.0%	0.1%
Misc Inorganics	0.7%	0.4%	0.5%	0.4%	0.6%	0.7%	1.5%	0.7%	0.9%	0.7%	0.3%	0.2%
Other Wastes	**0.8%**		**2.0%**		**0.5%**		**0.5%**		**0.6%**		**0.5%**	
Hazardous/Chemicals	0.6%	0.6%	0.3%	0.2%	0.1%	0.1%	0.3%	0.2%	0.5%	0.5%	0.4%	0.2%
Furniture/Mattresses	0.0%	0.0%	0.3%	0.3%	0.2%	0.2%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%
Brown Goods (appliances)	0.2%	0.2%	1.4%	1.1%	0.2%	0.2%	0.2%	0.3%	0.0%	0.0%	0.1%	0.1%
Yard Waste	**28.9%**		**30.6%**		**23.8%**		**35.7%**		**24.3%**		**27.3%**	
Yard Waste	28.9%	5.0%	30.6%	3.9%	23.8%	3.5%	35.7%	3.9%	24.3%	3.7%	27.3%	3.2%
Wood	**2.9%**		**2.1%**		**1.3%**		**3.0%**		**2.6%**		**1.7%**	
Untreated Lumber	0.6%	0.3%	0.4%	0.2%	0.6%	0.3%	0.7%	0.3%	0.4%	0.3%	0.2%	0.1%
Untreated Plywood	0.2%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Pallets/Crates	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.0%	0.0%	0.1%	0.2%
Treated Wood	1.3%	0.7%	0.8%	0.3%	0.7%	0.3%	1.1%	0.5%	1.4%	1.1%	0.6%	0.3%
Stumps	0.7%	0.8%	1.0%	1.1%	0.0%	0.0%	1.2%	1.0%	0.7%	0.8%	0.7%	0.9%
Other Organics	**21.4%**		**19.5%**		**29.0%**		**19.4%**		**25.3%**		**24.7%**	
Food	15.0%	2.4%	13.1%	1.7%	19.0%	2.1%	13.3%	1.5%	17.1%	2.6%	12.9%	1.7%
Textiles	2.4%	0.7%	2.4%	1.0%	1.9%	0.5%	1.8%	0.5%	2.3%	0.9%	2.6%	1.0%
Carpet	0.6%	0.3%	0.6%	0.5%	1.6%	0.8%	0.7%	0.3%	0.8%	0.3%	1.3%	0.4%
Tires	0.0%	0.0%	0.2%	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Misc Organics	3.4%	1.0%	3.3%	0.7%	6.6%	1.1%	3.6%	0.7%	5.1%	1.0%	7.8%	1.7%
Number of Samples	40		25		36		40		35		35	

5.3 COMPARISON OF YARD WASTE IN HONOLULU

Yard waste from the Honolulu district was compared between routes that have green waste service and those that do not using a t-test. A t-test is a standard statistical test used to assess whether the differences between two groups is significant, in this case samples from routes that have green waste service and samples from those that do not. From the t-test, a p-value can be calculated. A p-value is a measure of the difference between the two groups. (Please see Appendix D for the calculation formulae).

A p-value of 0.0034 was calculated when the proportion of yard waste was compared in the two groups of routes. For this study, p-values below 0.1000 are considered to be statistically different. Since the calculated p-value is less than 0.1000, there is a significant difference between the two groups. As shown in **Table 5-5**, residents with green waste service disposed of significantly more yard waste than those who do not have this service. These results are the opposite of what was expected; we expected they would use the green waste collection service and not have as much in their waste. The result does indicate that the City's collection services are targeted appropriately to the areas generating the most yard waste. This result could imply that the residents are not using the monthly green waste collection services and/or the amount of waste is greater than what can be collected separately. Since the City's green waste collection crews do not collect full loads in these areas, the collection services appear to be underutilized. Expanding the green waste program will require significant education effort.

Table 5-5 Significant Differences in Yard Waste for the City of Honolulu

March – August 1998

	Mean Ratio *(Material Wt/Total Wt)*		t-Statistic	p-Value *(Cut-off for statistically valid difference = 0.1000)*
	No	*Yes*		
Yard Waste	23.1%	35.0%	3.0434	0.0034 *
Number of Samples	*31*	*34*		

5.4 COMPARISON TO OTHER STUDIES

The residential composition results from the City & County of Honolulu were compared with results from three other waste characterization studies, including the City of Seattle[4], City of San Diego[5], and King County[6] (Washington State). **Table 5-6** illustrates the composition results for the nine broad waste categories for Honolulu, San Diego, Seattle, and King County.

Honolulu had similar proportions of waste in the paper, plastic, metal, glass, other wastes, wood, and other organics categories as Seattle, San Diego, and King County. Honolulu had a much larger percentage of yard waste and a lower percentage of other inorganics (which includes various construction debris) than the other three locations[7].

Table 5-6 Comparison of Residential Waste Composition Estimates, by Weight, Between Honolulu and Selected Cities/County

	Honolulu 1998	San Diego 1996	Seattle 1994/95	King County 1995/96
Paper	28.1%	28.5%	36.2%	29.2%
Plastics	8.2%	6.5%	9.1%	9.7%
Metal	4.3%	3.8%	5.1%	4.3%
Glass	2.6%	3.4%	4.6%	2.7%
Yard Waste	28.7%	17.4%	3.6%	5.4%
Other Inorganics	1.8%	9.0%	6.1%	9.2%
Other Wastes	0.8%	5.8%	1.6%	1.6%
Wood	2.3%	2.7%	2.4%	4.3%
Other Organics	23.1%	22.7%	31.5%	33.8%

[4] *1994/95 Residential Waste Stream Composition Study*, prepared for the City of Seattle, Department of Engineering, Solid Waste Utility, by Cascadia Consulting Group, Inc.

[5] *1996 Waste Characterization Study*, prepared for the City of San Diego, Environmental Services Department, by Cascadia Consulting Group, Inc.

[6] *Waste Monitoring Program: Comprehensive Waste Stream Characterization (1995-96)*, prepared for King County Solid Waste Division, Department of Public Works, by Cascadia Consulting Group, Inc.

[7] No statistical tests were performed to compare the residential composition results between studies, as described in Section 5.4.

SECTION 6

THE COMMERCIAL STREAM

6.1 OVERALL COMMERCIAL

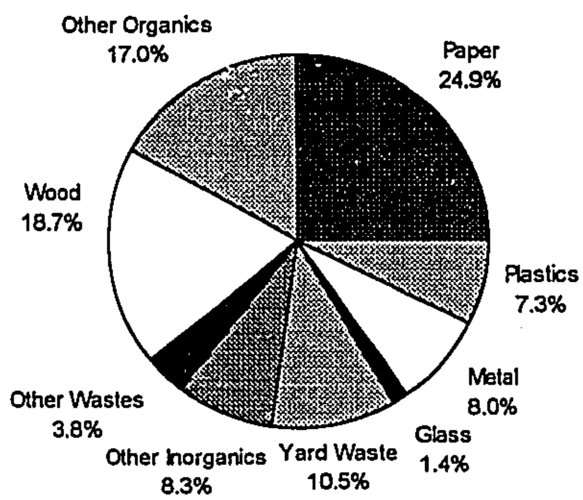
Commercial waste is collected/hauled by non-Refuse Division vehicles, including private commercial waste haulers, other City & County departments, and the public (individuals and self-haulers)[8]. In 1998, the commercial substream disposed a total of 477,770 tons of waste (341,563 at H-POWER and 136,207 at Waimanalo Gulch).

A total of 161 samples were selected from Honolulu's commercial waste stream. The samples were collected from loads destined for the H-POWER and Waimanalo Gulch facilities.

The overall commercial composition results, by weight, are illustrated in **Figure 6.1**. As shown, the paper, other organics (including food, carpeting, and textiles), and wood categories accounted for 60.6% of the overall commercial waste. The percentages may not add to 100 because of rounding.

Figure 6-1 Overview of Commercial Sampling Results, by Weight

March – August 1998



[8] Small residential self-haul were not sampled (i.e., they were not part of the sampling universe.)

Table 6-1 provides the detailed composition results. The following six components account for half (50.6%) of the overall waste in the commercial substream.

- Yard waste 10.8%
- Food 10.4%
- Cardboard 8.3%
- Pallets/crates 8.1%
- Low grade paper 7.8%
- Treated wood 5.2%

6.2 RESULTS BY SITE

A total of 81 samples were sorted from the loads hauled to H-POWER, and a total of 80 samples were sorted from the loads hauled to Waimanalo Gulch.

The composition results at Waimanalc Gulch were very different from those at H-POWER. As shown, the paper and other organics (which includes food and textiles) categories accounted for the bulk of the waste hauled to H-POWER (53.6%). At Waimanalo Gulch, paper and other organics, only accounted for 18.5% of the waste. The difference between the other organics categories is primarily a result of more food waste at H-POWER.

At Waimanalo Gulch, the wood and other inorganics (which includes various construction debris) categories accounted for the bulk of the commercial waste (51.2%). At H-POWER, wood and other inorganics only accounted for 14.8% of the waste. The greater proportions of gypsum wallboard, sand/soil/dirt, and concrete at Waimanalo Gulch result in the higher percentage for the other inorganics category[9].

Yard waste accounted for a higher proportion of waste at H-POWER, and metal accounted for a higher proportion of waste at Waimanalo Gulch. **Figure 6-2** summarizes the results for each facility. The percentages may not add to 100 because of rounding.

[9] No statistical tests were performed to compare the commercial composition results, between sites, as described in Section 6.2.

Table 6-1 Overall Commercial Composition By Weight
March – August 1998

	Composition		Estimated Tons	
Calculated at 90% confidence interval	Mean	+/-	Mean	+/-
Paper	26.0%		124,445	
Newspaper	2.0%	0.4%	9,370	1,880
Cardboard	8.3%	1.2%	39,802	5,791
High Grade	2.0%	0.7%	9,628	3,441
Low Grade	7.8%	1.1%	37,121	5,175
Compostable	4.6%	1.0%	21,837	4,821
Other Paper	1.4%	0.4%	6,686	1,904
Plastics	7.5%		35,794	
PET #1 Bottles	0.4%	0.1%	1,800	372
HDPE #2 Bottles	0.3%	0.1%	1,520	275
Other Bottles	0.1%	0.0%	444	187
Other Rigid Plastic	2.3%	0.4%	11,177	1,691
Film Plastic	3.7%	0.7%	17,589	3,239
Mixed Plastic/Other Materials	0.7%	0.2%	3,264	1,058
Metal	7.7%		36,977	
Aluminum Cans	0.4%	0.1%	2,056	358
Tin Cans	0.8%	0.2%	3,609	755
Ferrous	3.0%	0.8%	14,294	3,962
NonFerrous	0.5%	0.3%	2,187	1,599
Mixed Metals/Other Materials	3.1%	1.1%	14,830	5,073
Glass	1.5%		7,087	
Glass Containers	1.2%	0.2%	5,535	1,194
Other Glass	0.3%	0.2%	1,552	998
Other Inorganics	7.4%		35,588	
Gypsum Wallboard	2.3%	0.9%	10,850	4,312
Asphalt Roofing	0.4%	0.5%	2,049	2,358
Asphalt Paving	0.5%	0.6%	2,562	2,800
Concrete	0.9%	0.7%	4,366	3,177
Sand/Soil/Dirt	1.2%	0.8%	5,857	3,697
Ceramic Products	0.3%	0.4%	1,619	1,719
Misc Inorganics	1.7%	1.0%	8,284	4,895
Other Wastes	3.6%		17,191	
Hazardous/Chemicals	0.3%	0.2%	1,596	848
Furniture/Mattresses	2.2%	0.9%	10,519	4,458
Brown Goods (appliances)	1.1%	0.8%	5,076	3,943
Yard Waste	10.8%		51,778	
Yard Waste	10.8%	2.5%	51,778	12,087
Wood	17.8%		84,964	
Untreated Lumber	2.5%	0.9%	11,769	4,161
Untreated Plywood	1.4%	0.7%	6,829	3,164
Pallets/Crates	8.1%	3.6%	38,927	17,056
Treated Wood	5.2%	1.4%	24,960	6,887
Stumps	0.5%	0.5%	2,479	2,402
Other Organics	17.6%		83,946	
Food	10.4%	1.8%	49,536	8,568
Textiles	1.4%	0.5%	6,926	2,393
Carpet	2.5%	1.3%	12,091	6,234
Tires	0.1%	0.2%	659	1,081
Misc Organics	3.1%	0.8%	14,734	3,588
Number of Samples/Total Tonnage	161		477,770	

Figure 6-2 Overview of Commercial Sampling Results, by Site

March – August 1998

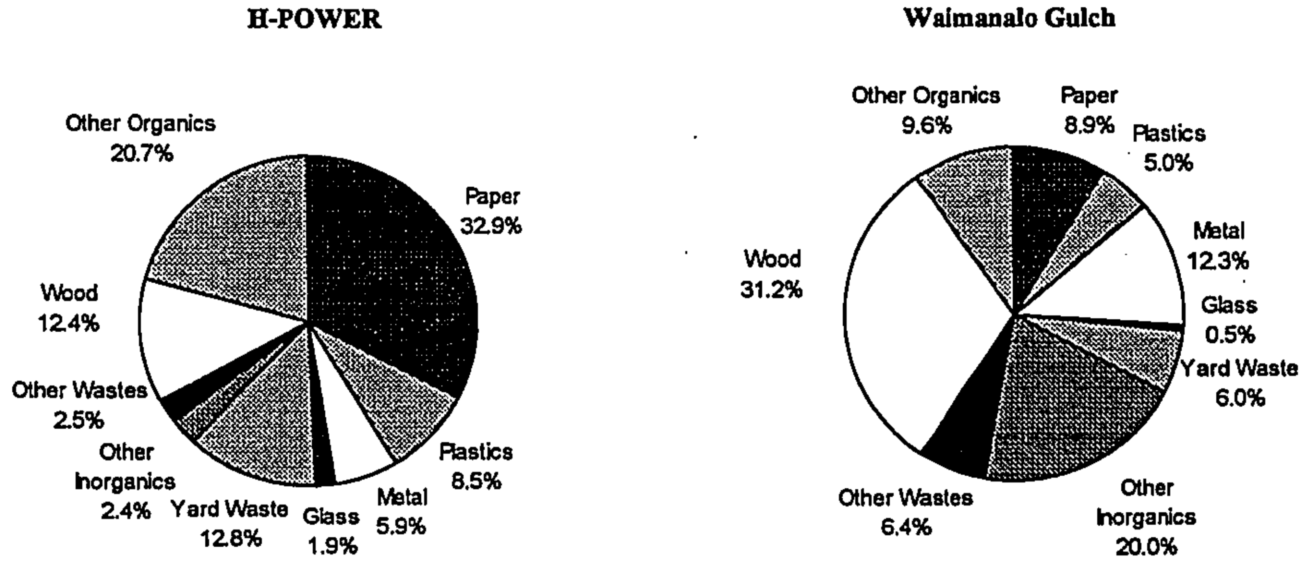


Table 6-2 shows the largest components (greater than 5%) for each facility in the commercial substream. Cardboard, yard waste, and pallets/crates were prevalent at both sites. Similar to the residential substream, various paper grades and food waste accounted for substantial portions of the H-POWER commercial tonnage. At Waimanalo Gulch, construction-related materials comprised much of the debris. The detailed composition results are shown in Table 6-3.

Table 6-2 Largest Commercial Components, by Weight
March – August 1998

	H-POWER	Waimanalo Gulch
Cardboard	9.6%	5.2%
Low Grade Paper	10.0%	
Compostable Paper	6.3%	
Ferrous Metal		6.7%
Yard Waste	12.8%	6.0%
Gypsum Wallboard		7.0%
Furniture/Mattresses		5.1%
Untreated Lumber		5/8%
Pallets/Crates	8.4%	7.6%
Treated Wood		13.9%
Food	13.9%	

6.3 VEHICLE TYPE

Commercial samples were analyzed according to the type of vehicle used to haul them to the H-POWER and Waimanalo Gulch facilities. At H-POWER, 25 samples were sorted from commercial roll-offs, and 56 samples were sorted from packers. Paper was the predominant material hauled by each vehicle type (31.2% as compared to 33.7%). Organic materials including yard waste, wood, and other organics (primarily food), were the other principal components for each vehicle type. Roll-offs hauled higher percentage of wood than packers (25.6% as compared to 5.8%), primarily a result of the higher proportion of pallets/crates. Packers hauled more yard waste (15.4% as compared to 7.6%) and other organics (22.9% as compared to 16.4%) than roll-offs. The greater proportion of other organics is primarily due to a larger amount of food waste hauled by packers.

At Waimanalo Gulch, 58 samples were sorted from commercial roll-offs and 22 samples were sorted from other vehicles (commercial self-haul delivered by individual businesses and other governmental agencies, including the military). Approximately half the waste hauled by the commercial roll-offs and other vehicles consisted of waste in the wood and the other inorganics categories (49.4% and 56.1%, respectively). For the other inorganics category, roll-offs hauled slightly more gypsum wallboard than the other vehicles, and the other vehicles hauled slightly more sand/soil/dirt, asphalt roofing, and asphalt paving. Metal accounted for a greater proportion of the waste hauled by roll-offs (14.3% as compared to 7.2%), and yard waste accounted for a greater proportion of waste hauled by other vehicles (15.0% as compared to 2.5%)[10].

[10] No statistical tests were performed to compare commercial composition results for each site, by vehicle, as described in Section 6.3.

Table 6-3 Commercial Waste Composition for H-POWER and Waimanalo Gulch, By Weight
March – August 1998

	H-POWER		Waimanalo Gulch	
Calculated at 90% confidence interval	*Mean*	*+/-*	*Mean*	*+/-*
Paper	32.9%		8.9%	
Newspaper	2.7%	0.5%	0.2%	0.1%
Cardboard	9.6%	1.6%	5.2%	1.7%
High Grade	2.6%	1.0%	0.5%	0.4%
Low Grade	10.0%	1.4%	2.2%	1.7%
Compostable	6.3%	1.4%	0.3%	0.2%
Other Paper	1.7%	0.5%	0.5%	0.3%
Plastics	8.5%		5.0%	
PET #1 Bottles	0.5%	0.1%	0.0%	0.0%
HDPE #2 Bottles	0.4%	0.1%	0.0%	0.0%
Other Bottles	0.1%	0.1%	0.0%	0.0%
Other Rigid Plastic	2.7%	0.5%	1.4%	0.5%
Film Plastic	4.2%	0.6%	2.5%	1.8%
Mixed Plastic/Other Materials	0.6%	0.2%	1.0%	0.6%
Metal	5.9%		12.3%	
Aluminum Cans	0.5%	0.1%	0.2%	0.2%
Tin Cans	1.0%	0.2%	0.2%	0.1%
Ferrous	1.5%	0.6%	6.7%	2.6%
NonFerrous	0.5%	0.5%	0.4%	0.2%
Mixed Metals/Other Materials	2.4%	1.2%	4.8%	2.1%
Glass	1.9%		0.5%	
Glass Containers	1.5%	0.3%	0.3%	0.2%
Other Glass	0.3%	0.3%	0.3%	0.2%
Other Inorganics	2.4%		20.0%	
Gypsum Wallboard	0.4%	0.5%	7.0%	2.9%
Asphalt Roofing	0.0%	0.0%	1.4%	1.7%
Asphalt Paving	0.0%	0.0%	1.9%	2.1%
Concrete	0.1%	0.2%	2.9%	2.3%
Sand/Soil/Dirt	0.1%	0.1%	4.0%	2.7%
Ceramic Products	0.4%	0.5%	0.1%	0.1%
Misc Inorganics	1.3%	1.1%	2.7%	2.3%
Other Wastes	2.5%		6.4%	
Hazardous/Chemicals	0.4%	0.2%	0.3%	0.2%
Furniture/Mattresses	1.1%	0.9%	5.1%	2.4%
Brown Goods (appliances)	1.1%	1.1%	1.0%	0.9%
Yard Waste	12.8%		6.0%	
Yard Waste	12.8%	3.3%	6.0%	3.4%
Wood	12.4%		31.2%	
Untreated Lumber	1.1%	0.8%	5.8%	2.3%
Untreated Plywood	1.0%	0.8%	2.6%	1.3%
Pallets/Crates	8.4%	4.9%	7.6%	2.6%
Treated Wood	1.8%	0.9%	13.9%	4.5%
Stumps	0.2%	0.3%	1.3%	1.5%
Other Organics	20.7%		9.6%	
Food	13.9%	2.4%	1.6%	1.7%
Textiles	1.7%	0.7%	0.9%	0.6%
Carpet	1.8%	1.4%	4.5%	2.9%
Tires	0.2%	0.3%	0.0%	0.0%
Misc Organics	3.3%	0.8%	2.6%	1.8%
Number of Samples	81		80	

Table 6-4 illustrates the composition percentages by site and vehicle type for the commercial samples.

Table 6-4 - Commercial Waste Composition for Each Site and Vehicle Type, By Weight
March – August 1998

	H-POWER				Waimanalo Gulch			
	Roll-Offs		Packers		Roll-Offs		Other Vehicles	
Calculated at 90% confidence	*Mean*	*+/-*	*Mean*	*+/-*	*Mean*	*+/-*	*Mean*	*+/-*
Paper	31.2%		33.7%		10.3%		5.4%	
Newspaper	1.5%	0.6%	3.3%	0.7%	0.2%	0.1%	0.1%	0.1%
Cardboard	10.3%	3.1%	9.2%	1.7%	6.1%	2.1%	3.0%	2.7%
High Grade	2.0%	1.2%	2.9%	1.4%	0.5%	0.4%	0.4%	0.7%
Low Grade	8.5%	2.8%	10.7%	1.4%	2.5%	2.2%	1.4%	2.1%
Compostable	7.7%	3.6%	5.5%	1.1%	0.4%	0.2%	0.2%	0.2%
Other Paper	1.2%	0.6%	2.0%	0.8%	0.6%	0.4%	0.2%	0.3%
Plastics	8.2%		8.7%		5.7%		3.1%	
PET #1 Bottles	0.5%	0.2%	0.5%	0.1%	0.1%	0.0%	0.0%	0.0%
HDPE #2 Bottles	0.3%	0.1%	0.5%	0.1%	0.0%	0.0%	0.0%	0.0%
Other Bottles	0.1%	0.1%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%
Other Rigid Plastic	2.9%	0.9%	2.6%	0.5%	1.5%	0.6%	1.3%	1.0%
Film Plastic	3.8%	1.3%	4.4%	0.7%	3.3%	2.5%	0.4%	0.2%
Mixed Plastic/Other Materials	0.6%	0.4%	0.5%	0.2%	0.9%	0.7%	1.4%	1.1%
Metal	5.7%		6.0%		14.3%		7.2%	
Aluminum Cans	0.5%	0.2%	0.5%	0.1%	0.3%	0.2%	0.0%	0.0%
Tin Cans	0.9%	0.4%	1.0%	0.2%	0.3%	0.2%	0.1%	0.1%
Ferrous	1.8%	1.1%	1.4%	0.6%	7.6%	3.4%	4.2%	3.0%
NonFerrous	0.2%	0.2%	0.6%	0.7%	0.4%	0.3%	0.3%	0.4%
Mixed Metals/Other Materials	2.3%	2.6%	2.5%	1.3%	5.7%	2.8%	2.6%	2.1%
Glass	1.9%		1.8%		0.5%		0.6%	
Glass Containers	1.5%	0.6%	1.5%	0.4%	0.4%	0.3%	0.0%	0.0%
Other Glass	0.4%	0.5%	0.3%	0.3%	0.2%	0.2%	0.6%	0.6%
Other Inorganics	2.0%		2.6%		17.7%		26.0%	
Gypsum Wallboard	0.1%	0.2%	0.5%	0.7%	7.9%	3.7%	4.9%	4.4%
Asphalt Roofing	0.1%	0.1%	0.0%	0.0%	0.6%	0.7%	3.6%	5.9%
Asphalt Paving	0.0%	0.0%	0.0%	0.0%	1.4%	2.0%	3.2%	5.2%
Concrete	0.0%	0.0%	0.2%	0.2%	2.6%	2.5%	3.6%	5.1%
Sand/Soil/Dirt	0.1%	0.2%	0.1%	0.2%	3.1%	2.8%	6.3%	6.5%
Ceramic Products	0.0%	0.0%	0.7%	0.8%	0.1%	0.1%	0.0%	0.0%
Misc Inorganics	1.8%	2.7%	1.1%	1.0%	2.0%	1.5%	4.5%	7.2%
Other Wastes	1.4%		3.0%		5.9%		7.7%	
Hazardous/Chemicals	0.5%	0.5%	0.3%	0.3%	0.1%	0.1%	0.8%	0.7%
Furniture/Mattresses	0.6%	1.1%	1.3%	1.2%	5.0%	2.9%	5.4%	4.7%
Brown Goods (appliances)	0.3%	0.4%	1.5%	1.6%	0.8%	1.0%	1.5%	1.8%
Yard Waste	7.6%		15.4%		2.5%		15.0%	
Yard Waste	7.6%	4.1%	15.4%	4.3%	2.5%	1.5%	15.0%	10.5%
Wood	25.6%		5.8%		31.7%		30.1%	
Untreated Lumber	0.7%	0.6%	1.3%	1.2%	7.2%	3.1%	2.5%	1.9%
Untreated Plywood	0.6%	0.9%	1.1%	1.1%	2.1%	1.4%	3.7%	3.2%
Pallets/Crates	22.1%	12.9%	1.4%	1.0%	9.8%	3.3%	1.8%	2.9%
Treated Wood	2.1%	1.6%	1.6%	1.1%	12.4%	4.6%	17.8%	11.0%
Stumps	0.0%	0.0%	0.3%	0.5%	0.1%	0.2%	4.3%	5.4%
Other Organics	16.4%		22.9%		11.5%		5.0%	
Food	10.6%	3.8%	15.5%	3.0%	2.1%	2.3%	0.3%	0.4%
Textiles	2.5%	1.8%	1.2%	0.4%	1.0%	0.8%	0.8%	0.8%
Carpet	1.0%	0.8%	2.1%	2.1%	5.5%	3.9%	2.0%	1.7%
Tires	0.0%	0.0%	0.3%	0.5%	0.0%	0.0%	0.0%	0.0%
Misc Organics	2.3%	1.2%	3.7%	1.0%	2.9%	2.3%	1.9%	2.3%
Number of Samples	25		56		58		22	

6.4 COMPARISON TO OTHER STUDIES

The waste composition results for the commercial substream were compared with the results of similar studies in Seattle[11], San Diego, and King County (Washington State)[12].

Table 6-5 illustrates the composition results for the nine broad waste categories for Honolulu, San Diego, Seattle, and King County. Honolulu showed similar composition percentages in the paper, plastics, metal, glass, and other wastes categories. The proportion of yard waste and wood was higher in Honolulu than in the other locations. The proportion of waste in the other organics category, specifically food waste, was similar to San Diego, but much less than Seattle and King County[13].

Table 6-5 Comparison of Commercial Composition Results between Honolulu and Selected Cities/County

	Honolulu *1998*	San Diego *1996*	Seattle *1996*	King County *1995/96*
Paper	26.0%	25.6%	33.3%	32.6%
Plastics	7.5%	7.2%	11.0%	13.1%
Metal	7.7%	7.7%	6.5%	8.3%
Glass	1.5%	1.9%	2.5%	2.4%
Yard Waste	10.8%	4.3%	2.6%	4.3%
Other Inorganics	7.4%	28.7%	6.7%	6.6%
Other Wastes	3.6%	4.0%	1.8%	2.3%
Wood	17.8%	8.3%	7.9%	7.8%
Other Organics	17.6%	12.3%	27.6%	22.7%

[11] *1996 Commercial and Self-Haul Waste Streams Composition Study* prepared for Seattle Public Utilities by Cascadia Consulting Group, Inc.

[12] City of San Diego and King County studies were the same as referenced in Section 5.4.

[13] No statistical tests were performed to compare commercial composition results between studies, as described in Section 6.4.

SECTION 7

CONVENIENCE CENTERS

7.1 OVERALL CONVENIENCE CENTERS

A total of 56 samples were collected from convenience centers. Samples were sorted at both H-POWER and Waimanalo Gulch. In 1998, a total of 27,176 tons of waste was deposited at the convenience centers (2,122 at H-POWER and 25,054 at Waimanalo Gulch). Combustible waste is sent to H–POWER and the non-combustible waste is sent to recyclers or Waimanalo Gulch.

Composition estimates for the overall convenience center substream are shown in **Figure 7-1.** As shown, the wood, the other wastes (primarily furniture/mattresses), and the yard waste categories accounted for 61.8% of the waste. The percentages may not add to 100 because of rounding.

Figure 7-1 Overview of Overall Convenience Center Sampling, by Weight

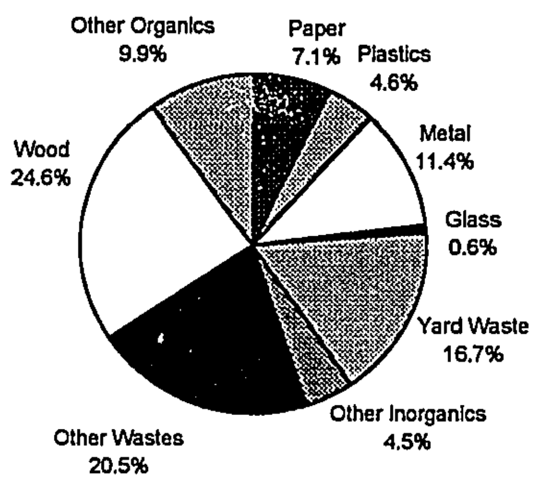


Table 7-1 presents the detailed results for the overall convenience center substream. Over half of the waste (50.1%) consisted of the following four components.

- Furniture/mattresses 18.6%
- Yard waste 16.7%
- Treated wood 14.8%
- Mixed metals/Other materials 6.3%

Table 7-1 Overall Convenience Centers Waste Composition, By Weight
May 1998 – February 1999

	Composition		Estimated Tons	
Calculated at 90% confidence	*Mean*	*+/-*	*Mean*	*+/-*
Paper	7.1%		1,940	
Newspaper	0.8%	0.4%	226	122
Cardboard	2.6%	0.7%	701	190
High Grade	0.3%	0.3%	71	79
Low Grade	1.8%	0.5%	480	147
Compostable	0.5%	0.4%	140	99
Other Paper	1.2%	0.9%	322	261
Plastics	4.6%		1,250	
PET #1 Bottles	0.1%	0.0%	18	10
HDPE #2 Bottles	0.0%	0.0%	12	6
Other Bottles	0.0%	0.0%	3	2
Other Rigid Plastic	2.7%	1.0%	722	292
Film Plastic	0.7%	0.2%	197	63
Mixed Plastic/Other Materials	1.1%	0.5%	298	141
Metal	11.4%		3,110	
Aluminum Cans	0.2%	0.1%	52	31
Tin Cans	0.2%	0.1%	59	39
Ferrous	4.3%	1.7%	1,155	474
NonFerrous	0.4%	0.2%	101	64
Mixed Metals/Other Materials	6.4%	1.9%	1,743	532
Glass	0.6%		168	
Glass Containers	0.3%	0.2%	80	51
Other Glass	0.3%	0.2%	87	54
Other Inorganics	4.5%		1,233	
Gypsum Wallboard	1.2%	0.8%	339	229
Asphalt Roofing	1.0%	1.1%	279	295
Asphalt Paving	0.0%	0.0%	0	0
Concrete	0.4%	0.6%	108	160
Sand/Soil/Dirt	0.5%	0.6%	128	174
Ceramic Products	0.4%	0.6%	112	164
Misc Inorganics	1.0%	1.0%	266	267
Other Wastes	20.5%		5,561	
Hazardous/Chemicals	0.1%	0.1%	31	30
Furniture/Mattresses	18.6%	4.3%	5,061	1,205
Brown Goods (appliances)	1.7%	1.0%	469	269
Yard Waste	16.7%		4,541	
Yard Waste	16.7%	4.2%	4,541	1,167
Wood	24.6%		6,678	
Untreated Lumber	3.3%	1.1%	895	316
Untreated Plywood	1.6%	1.3%	444	370
Pallets/Crates	1.2%	1.1%	314	296
Treated Wood	14.8%	3.8%	4,026	1,057
Stumps	3.7%	2.1%	999	594
Other Organics	9.9%		2,696	
Food	2.3%	0.9%	612	243
Textiles	2.2%	0.9%	592	256
Carpet	3.3%	2.3%	906	653
Tires	0.9%	0.9%	258	237
Misc Organics	1.2%	0.9%	329	258
Number of Samples/Total	56		27,176	

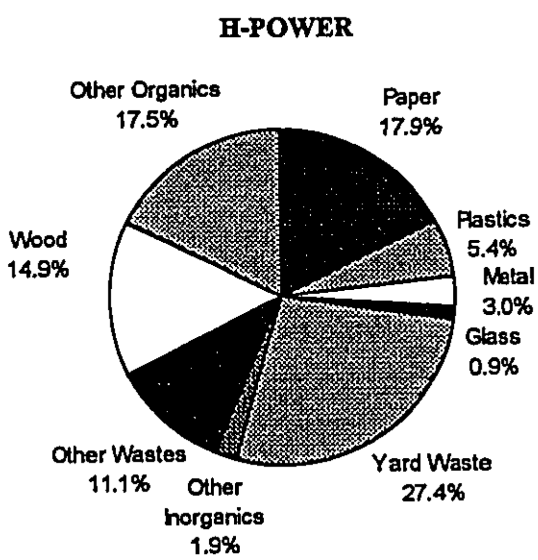
7.2 RESULTS BY SITE

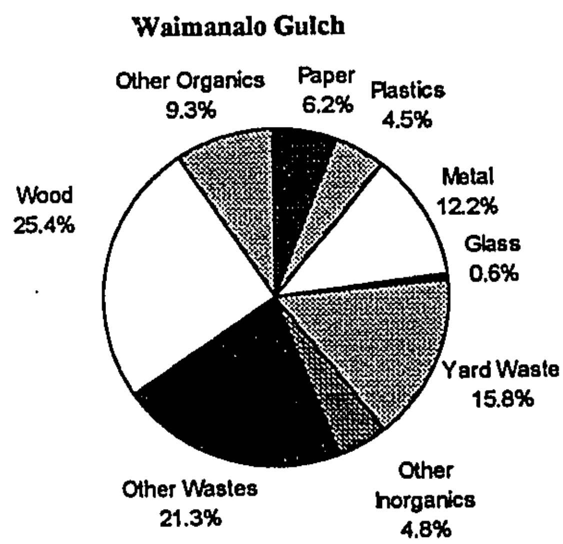
Figure 7-2 summarizes the sorting results completed at H-POWER and Waimanalo Gulch. As shown, yard waste was the largest waste type disposed at H-POWER from convenience centers (27.4%), followed by the paper (17.9%), other organics (17.5%), and wood categories (14.9%). At Waimanalo Gulch, the wood, other wastes (which includes furniture/mattresses and hazardous materials), and yard waste categories accounted for the majority of the waste (62.5%).

The greater proportion of cardboard and low grade paper accounted for the higher proportion of paper at H-POWER. At Waimanalo Gulch, the higher proportion of other wastes and wood resulted from the greater amount of furniture/mattresses and treated wood, respectively.[14] The percentages may not add to 100 because of rounding.

Figure 7-2 Overview of Convenience Center Sampling, by Site

May 1998 – February 1999





[14] No statistical tests were performed to compare the convenience center composition results between sites, as described in Section 7.2.

Table 7-2 illustrates the largest waste components for the convenience center waste, which is delivered to H-POWER and Waimanalo Gulch. Various paper grades, food, and yard waste accounted for significant portions of H-POWER's waste, which is similar to the residential and commercial substreams at that facility. **Table 7-3** shows the full detail for each facility.

Table 7-2 Largest Waste Components, by Weight, for Convenience Centers

May 1998 – February 1999

	H-POWER	Waimanalo Gulch
Cardboard	7.8%	
Low Grade Paper	5.8%	
Yard Waste	27.4%	15.8%
Mixed Metals/Other materials		6.9%
Furniture/Mattresses	9.2%	19.4%
Treated Wood		15.8%
Stumps	10.1%	
Food	7.5%	

Table 7-3 Convenience Center Waste Composition, By Weight
May 1998 – February 1999

Calculated at 90% confidence interval	H-POWER Mean	H-POWER +/-	Waimanalo Gulch Mean	Waimanalo Gulch +/-
Paper	17.9%		6.2%	
Newspaper	1.9%	1.0%	0.7%	0.5%
Cardboard	7.8%	3.2%	2.1%	0.7%
High Grade	0.3%	0.3%	0.3%	0.3%
Low Grade	5.8%	2.8%	1.4%	0.5%
Compostable	1.2%	0.7%	0.5%	0.4%
Other Paper	0.9%	0.4%	1.2%	1.0%
Plastics	5.4%		4.5%	
PET #1 Bottles	0.3%	0.2%	0.1%	0.0%
HDPE #2 Bottles	0.1%	0.1%	0.0%	0.0%
Other Bottles	0.0%	0.0%	0.0%	0.0%
Other Rigid Plastic	1.8%	0.6%	2.7%	1.1%
Film Plastic	1.6%	0.7%	0.7%	0.2%
Mixed Plastic/Other Materials	1.6%	1.1%	1.1%	0.5%
Metal	3.0%		12.2%	
Aluminum Cans	0.2%	0.1%	0.2%	0.1%
Tin Cans	0.4%	0.2%	0.2%	0.2%
Ferrous	1.2%	1.1%	4.5%	1.8%
NonFerrous	0.6%	0.8%	0.4%	0.2%
Mixed Metals/Other Materials	0.6%	0.5%	6.9%	2.1%
Glass	0.9%		0.6%	
Glass Containers	0.7%	0.4%	0.3%	0.2%
Other Glass	0.2%	0.1%	0.3%	0.2%
Other Inorganics	1.9%		4.8%	
Gypsum Wallboard	0.0%	0.0%	1.4%	0.9%
Asphalt Roofing	1.1%	1.2%	1.0%	1.1%
Asphalt Paving	0.0%	0.0%	0.0%	0.0%
Concrete	0.0%	0.0%	0.4%	0.6%
Sand/Soil/Dirt	0.0%	0.0%	0.5%	0.7%
Ceramic Products	0.8%	1.0%	0.4%	0.6%
Misc Inorganics	0.1%	0.1%	1.1%	1.0%
Other Wastes	11.1%		21.3%	
Hazardous/Chemicals	0.1%	0.1%	0.1%	0.1%
Furniture/Mattresses	9.2%	5.6%	19.4%	4.7%
Brown Goods (appliances)	1.8%	1.7%	1.7%	1.0%
Yard Waste	27.4%		15.8%	
Yard Waste	27.4%	7.7%	15.8%	4.5%
Wood	14.9%		25.4%	
Untreated Lumber	0.5%	0.4%	3.5%	1.2%
Untreated Plywood	0.8%	0.9%	1.7%	1.4%
Pallets/Crates	0.1%	0.1%	1.2%	1.2%
Treated Wood	3.5%	2.2%	15.8%	4.1%
Stumps	10.1%	9.5%	3.1%	2.2%
Other Organics	17.5%		9.3%	
Food	7.5%	4.1%	1.8%	0.9%
Textiles	4.1%	2.1%	2.0%	1.0%
Carpet	2.8%	2.0%	3.4%	2.5%
Tires	0.0%	0.0%	1.0%	0.9%
Misc Organics	3.1%	1.9%	1.0%	1.0%
Number of Samples	16		40	

APPENDICES

Appendix A Waste Component Categories

Waste samples were sorted by hand into 40 waste component categories. A list of component categories and definitions follows.

Paper

Newspaper Printed newsprint. (Advertising "slicks" (glossy paper) are included in this category if found mixed with newspaper; otherwise, ad slicks are included with low grade recyclable paper.)

Cardboard/Kraft, Unwaxed Unwaxed/uncoated corrugated boxes, unbleached Kraft paper

High Grade/Office/Computer Paper White or lightly colored sulfite/sulfate bond, copy papers, computer print-outs, printing and writing papers, envelopes without windows, filed folders, index cards

Low Grade Recyclable Paper Low-grade, potentially recyclable papers, including junk mail, magazines, heavy colored papers, bleached Kraft, boxboard, mailing tubes, envelopes with windows, paperback books and directories

Compostable Paper Paper towels, paper plates and cups, waxed paper and cardboard, tissues

Other Paper Polycoated and/or aseptic packaging, carbon/carbonless copy paper, carbons, hardcover books, photographs, other papers not elsewhere described

Plastic

#1 PET Bottles Polyethylene terephthalate bottles, such as soda, liquor and other beverage bottles

#2 HDPE Bottles High-density polyethylene bottles, such as milk, juice and detergent bottles

Other Bottles All plastic bottles (containers with a narrow neck) not included above

Other Rigid Plastic All other plastic containers that hold a shape (such as tubs, clam shells, salad trays and lids); rigid plastic products, such as toys and baskets

Film Plastic Film packaging and products, such as plastic garbage bags, bread bags and shrink wrap

Mixed Plastic and Other Materials Predominately plastic, with other materials attached, such as disposable razors, pens, lighters, toys and 3-ring binders

Metal

Aluminum Cans Aluminum beverage cans and bi-metal cans made mostly of aluminum

Tin Cans Tinned steel food containers, including bi-metal cans made mostly of steel

Ferrous Metals All other materials composed of ferrous and alloyed ferrous scrap

NonFerrous Metals All other materials composed of metals not derived from iron, including copper, brass, bronze, aluminum bronze, lead, pewter, zinc, and other metals to which a magnet will not adhere

Mixed Metals and Other Materials Materials composed both of ferrous and nonferrous metals and/or have contaminants (such as wood or plastic) attached; small appliances, tools, white goods

Glass

Containers All glass containers, of any color, including beverage bottles and food jars.

Other Glass All other glass, such as light bulbs, window glass, mirrors and glassware.

Other Inorganics

Gypsum Wallboard New and demolition gypsum wallboard

Asphalt Roofing Asphalt shingles, tar paper or built-up roofing

Asphalt Paving Asphalt paving

Concrete Portland cement mixtures (set or unset)

Sand/Soil/Dirt Sand, soil, dirt and mixed fines smaller than 2" in diameter

Ceramic/Porcelain Products Finished ceramic or porcelain products, such as sinks, toilets, dishes and planters

Miscellaneous Inorganics Any other inorganic materials, such as ash, rock more than 2" in diameter, brick, kitty litter

Other Wastes

Household Hazardous/Chemicals Hazardous wastes such as paints, adhesives, cleaning products, pesticides, motor oil and batteries, medical waste

Furniture/Mattresses Furniture (composed of any material) and mattresses

Brown Goods Televisions, stereos, radios, computers

Wood

Untreated Lumber Unpainted dimensional lumber

Untreated Plywood Unpainted plywood, fiberboard, chipboard

Pallets/Crates Wood pallets and crates

Treated/Painted/Contaminated Wood Lumber and wood products which have been painted or treated; or those with adhering concrete or other contaminants

Stumps/Logs/Green Wood Stumps of trees and shrubs, with any adhering soil, and other natural wood, such as logs or branches that are greater than four inches in diameter

Yard Waste

Yard Waste Leaves, grass clippings, garden wastes and brush up to four inches in diameter

Other Organics

Food Food wastes and scraps, including bone, rinds, etc. Excludes the weight of food containers, except when container weight is not appreciable compared to the food inside or container can't be opened in the field (such as a new can of food)

Textiles Fabric materials, including natural and synthetic textiles such as cotton, wood, silk, woven nylon, rayon, polyester and other materials; without non-textile attachments

Carpet General category of flooring applications consisting of various natural or synthetic fibers bonded to a backing material; also includes shoes, belts and handbags

Tires Vehicle tires of all types

Miscellaneous Organics All other organics, such as diapers, personal hygiene products, animal feces, animal bedding, sawdust, wax, soap, cigarette butts, fur, hair and vacuum cleaner bags

Appendix B Sampling Methodology

Objective

The objective of the Waste Composition Analysis project was to provide statistically significant data on the composition of the following Honolulu waste substreams:

- overall residential
- residential, by district
- overall commercial
- commercial, by disposal site
- overall convenience centers
- convenience centers, by disposal site

Substream Definition

For any specific geographic area, the total waste stream is composed of various substreams. A "substream" is determined by the particular generation, collection, or composition characteristics which make it a unique portion of the total waste stream. This study targets three main substreams:

- The **residential** substream is comprised of waste collected by the Refuse Division. The residential substream primarily includes waste generated at single-family households, but also includes some apartment buildings and commercial facilities.
- The **commercial** substream is comprised of wastes collected by non-Refuse Division vehicles, including private commercial waste haulers, other City & County departments (CNC), and the public (including individual businesses and residential self-haulers). It primarily includes waste generated at businesses, institutions, multi-family residences and condominiums.
- The **convenience center** substream is composed of waste destined for either combustion or landfilling that is deposited, mainly by residents, at the six drop-off stations operated by the City.

It should be noted that this study measures waste disposal, not generation. (Waste generation equals the sum of disposed and recycled amounts.) The samples were taken from loads destined for combustion at H-POWER or landfilling at Waimanalo Gulch. Tonnage collected through recycling or yard waste composting programs is not included.

Sample Distribution

Residential: There are seven solid waste districts within the City and County of Honolulu. Samples of residential waste were collected from the five districts that dispose the largest quantities of residential waste (Honolulu, Ewa, Koolaupoko, Wahiawa, and Waianae). Based on statistical power analyses of data collected in similar projects, it was estimated that 40 samples from each district would provide composition estimates within one or two percentage points for the paper categories and between four and five percentage points for yard waste.

Residential loads from Honolulu were categorized further as to whether they originated from East Honolulu or West Honolulu. The dividing line was Nuuanu Avenue, which was also the origin of the street numbering in the east and west directions. Additional samples were allocated to the Honolulu district to ensure adequate representation of the east and west regions.

Commercial: Commercial waste is hauled either to recyclers, H-POWER, or Waimanalo Gulch. Based on statistical power analyses of data collected in other projects, it was estimated that sorting 80 samples from each site would provide composition estimates within five or six percentage points for wood debris.

Convenience Center: Convenience Center waste is hauled to either H-POWER or Waimanalo Gulch. A total of 40 samples were allocated to each facility based on the statistical power analysis done for the residential districts.

Sampling Calendar

In order to account for seasonal differences, the residential and commercial waste sampling was conducted over a six-month period. The sampling occurred in three intervals during that time: March-April, May-June, and August-September. After the study had begun, it was decided that the convenience center substream should also be sampled. The convenience center sampling occurred in May-June, August, and January-February.

Whenever possible, residential and commercial sorting was scheduled for each district and each site during all three sampling periods, and on each day of the week. In instances where this was not possible due to scheduling constraints, the days of the week that typically had the most loads and tonnage were selected.

Table B-1 compares the number of samples planned with the actual number of samples sorted, by site and substream. Samples were collected from the residential and commercial substreams at Keehi, H-POWER, Waimanalo Gulch, and Kapaa between March and August 1998. Convenience center waste was sampled at Waimanalo Gulch in May and August 1998 and at H-POWER in January and February 1999.

Table B-1 Planned and Actual Number of Samples, by Substream and Period

	Residential		Commercial		Convenience Center	
	Planned	*Actual*	*Planned*	*Actual*	*Planned*	*Actual*
Mar. 30 - Apr. 8, 1998						
H-POWER	48	48	32	32		
Keehi	32	33	7	7		
Waimanalo Gulch			40	40		
May 27 - June 4, 1998						
H-POWER	48	44	32	36		
Kapaa	20	20				
Waimanalo Gulch			20	20	20	20
Aug. 24 - Sept. 2, 1998						
H-POWER	12	14	8	6		
Kapaa	20	20				
Keehi	20	32				
Waimanalo Gulch			20	20	20	20
Jan. 29 - Feb. 3, 1999						
H-POWER					40	16
Total	200	211	159	161	80	56

Sample Selection

Load and tonnage data were obtained from the City and County and used to establish sampling frequencies (every *n*th truck) for each type of waste at each facility.

As each sample load arrived, the field supervisor noted the hauler name, truck number and type, and for residential loads verified the collection district. At the end of the shift, the field supervisor also recorded the net weight of each sample load.

The entire truckload of waste was dumped into the pit. Wherever possible, an imaginary 8-section, 2-layer grid (16 cells total) was superimposed on the load, and a randomly selected cell was identified for sampling. Approximately 250 pounds of waste were dumped from the loader onto a tarp for sorting.

Each sample was sorted by hand into the defined component groups (listed in Appendix A). Food containers were separated from the food and classified according to the containers' material. The weights of all materials were recorded on tally sheets, shown in Appendix E.

Appendix C Residential Collection Districts

As shown in Figure C-1, there are seven solid waste collection districts. (The Honolulu district is informally divided into East and West Honolulu, for a total of eight districts.) The districts were developed to reflect the geographical conditions on the island that influence the travel time for collection trucks to get to the disposal location or transfer station. Because of the influence of geographical conditions, the districts also somewhat reflect the different meteorological conditions on the island. For example, refuse from some districts may be wetter than others. Some of the districts also have differing residential growth.

In this study, residential samples were selected from six of the eight districts: East Honolulu, West Honolulu, Ewa, Wahiawa and Waianae. Residential samples were not collected from Koolauloa or Waialua.

Honolulu District

The Honolulu district is the largest on the basis of population served. It is also one of the more difficult in which to collect waste due to the density of the homes and the narrow width of the streets. The district is large enough that the Refuse Division staff has informally divided it in two: East Honolulu and West Honolulu. The dividing line is Nuuanu Avenue, which is also the origin of the street numbering in the east and west directions in the city. Nuuanu Avenue is adjacent to the Pali Highway.

This district has the densest residential and commercial development on the island. It includes the popular Waikiki tourist area, the major business area downtown and the densely populated multi-family area of Makiki. Older single-family homes are located on many routes in this district.

Some of the older homes are built on *flag lots*. Flag lots are larger parcels that originally had one single-family dwelling. With the increasing land values, these larger lots were subdivided to add one or more homes. The additional homes share one driveway access down one side of the original lot, thus the name flag lot.

With several homes located on one lot, there will need to be space along the curb in front of the home closest to the street to place the rubbish cart (for automated collection). Many of the streets that have homes on flag lots are also narrower. With parking restricted in the homes that have been added on the flag lot, many people park on the street. Some of the narrow streets also have restricted turning areas, limiting the maneuvering room for the larger automated trucks. The combination of street parking, narrow streets, and the need for multiple carts makes collecting the waste with automated trucks difficult in some areas. When collected manually, the waste in these areas can be piled in smaller available spaces.

Ewa District

One of the fastest growing areas of the island, this district has the H-POWER facility located within it. Most of the waste collected in this area is hauled directly to the disposal site. Both single-family and multi-family dwellings are served in this district. Most homes have automated collection.

Koolaupoko District

This district is located over the Koolau Mountains from the Honolulu district and is on the windward side of the island. It gets more rain than most other parts of island and generates more green waste as a result. Homes in this area are predominantly single-family dwellings, but there are also some multi-family dwellings. Many homes in this district are on larger lots and most have automated collection.

Wahiawa District

This district is located in the center of the island traversed by H–2, one of the three freeways on the island. It has one of the fastest growing residential areas of the island in the *Mililani* area. The residential units are split between single-family dwellings and multi-family dwellings.

Waianae District

The Waiane district is on the western end of the island. It is one of the drier areas and, as a result, produces less green waste than most other areas of the island. Most of the homes in this district are single-family dwellings or farms. Some of the single-family dwellings are homes to more than one family. It has the City and County landfill at Waimanalo Gulch located within it.

Koolauloa District

Residential waste samples were not selected from this district.

This district is located in the northeastern portion of the island. It is generally sparsely populated, with many single-family dwellings. Some of the more famous surfing beaches are located in this district (Sunset Beach, Pipeline) as is the Polynesian Cultural Center.

Waialua District

Residential waste samples were not selected from this district.

The Haleiwa area of the island is located in the Waialua district. This district also includes the northwest end of the island out to Kaena Point, the end of the paved roads. Most of the homes in this district are single-family.

Appendix D Calculations

Composition Calculations

The composition estimates represent the **ratio of the components' weight to the total waste** for each noted substream. They are derived by summing each component's weight across all of the selected records and dividing by the sum of the total weight of waste, as shown in the following equation:

$$r_j = \frac{\sum_i c_{ij}}{\sum_i w_i}$$

where:

c = weight of particular component
w = *sum of all component weights*
for i 1 to n
where n = number of selected samples
for j 1 to m
where m = number of components

The confidence interval for this estimate is derived in two steps. First, the variance around the estimate is calculated, accounting for the fact that the ratio includes two random variables (the component and total sample weights). The **variance of the ratio estimator** equation follows:

$$\hat{V}_{r_j} = \left(\frac{1}{n}\right) \cdot \left(\frac{1}{\overline{w}^2}\right) \cdot \left(\frac{\sum_i \left(c_{ij} - r_j w_i\right)^2}{n-1}\right)$$

where:

$$\overline{w} = \frac{\sum_i w_i}{n}$$

Second, **precision levels** at the 90% confidence interval are calculated for a component's mean as follows:

$$r_j \pm \left(t \cdot \sqrt{\hat{V}_{r_j}}\right)$$

where:

t = the value of the t-statistic (1.645) corresponding to a 90% confidence level

For more detail, please refer to Chapter 6 "Ratio, Regression and Difference Estimation" of *Elementary Survey Sampling* by R.L. Scheaffer, W. Mendenhall and L. Ott (PWS Publishers, 1986).

Weighted Averages

The **weighted average for an overall composition estimate** is performed as follows:

$$O_j = \left(p_1 * r_{j1}\right) + (p_2 * r_{j2}) + (p_3 * r_{j3}) + \ldots$$

where:

p = the proportion of tonnage contributed by the noted substream
r = ratio of component weight to total waste weight in the noted substream

for j 1 to m
where m = number of components

The **variance of the weighted average** is calculated:

$$VarO_j = (p_1^2 * \hat{V}_{r_{j1}}) + (p_2^2 * \hat{V}_{r_{j2}}) + (p_3^2 * \hat{V}_{r_{j3}}) + \ldots$$

Comparison Calculations

Identifying statistically significant differences requires a two-step calculation. First, assuming that the two groups to be compared have the same variance, a **pooled sample variance** is calculated:

$$S_{pool}^2 = \frac{\left[(n1-1)\cdot\left(n1\cdot\hat{V}_{r_j1}\right)\right]+\left[(n2-1)\cdot\left(n2\cdot\hat{V}_{r_j2}\right)\right]}{n1+n2-2}$$

Next, the **t-statistic** is constructed:

$$t = \frac{(r1-r2)}{\sqrt{\frac{S_{pool}^2}{n1}+\frac{S_{pool}^2}{n2}}}$$

The **p-value** of the t-statistic is calculated based on (n1+n2 -2) degrees of freedom.

Appendix E Field Forms

PAPER				
Newspaper				
Cardboard				
High Grade				
Low Grade				
Compostable				
NR Paper				
PLASTIC				
#1 PET Bottles				
#2 HDPE Bottles				
Other Bottles				
Other Rigid Plastic				
Film Plastic				
Mixed Plas/Mat				
METAL				
Aluminum Cans				
Tin Cans				
Ferrous				
NonFerrous				
Mixed Met/Mat				
GLASS				
Containers				
Other Glass				
OTHER INORGANICS				
Gypsum Wallboard				
Asphalt Roofing				
Asphalt Paving				
Concrete				
Sand/Soil/Dirt				
Ceramic Products				
Misc. Inorganics				
OTHER WASTES				
Hazardous/Chemical				
Furniture/Mattresses				
Brown Goods				

WOOD				
Untreated Lumber				
Untreated Plywood				
Pallets/Crates				
Treated Wood				
Stumps				
YARD WASTE				
Yard Waste				
OTHER ORGANICS				
Food				
Textiles				
Carpet				
Tires				
Misc. Organics				

DATE:

SITE:

SAMPLE NO:

HAULER:

ROUTE:

TRUCK NO.:

LIC. NO.:

NET WEIGHT:

DISTRIC ORIGIN:
1W WEST HON
1E EAST HON
2 KOOLAUPOKO
3 EWA
4 WAHIAWA
5 WAIANAE

VEHICLE TYPE:
1 FRONT LOADER
2 REAR LOADER
3 SIDE LOADER
4 RO COMPACTOR
5 RO DROP BOX
6 PICK UP
7 LARGE OTHER

APPENDIX B

New Systems Research for Refuse Disposal
Oahu Municipal Refuse Disposal Alternatives Study

April 2000

City and County of Honolulu
Department of Public Works

August 1977

OAHU MUNICIPAL REFUSE DISPOSAL ALTERNATIVES STUDY

NEW SYSTEMS RESEARCH FOR REFUSE DISPOSAL

APRIL 2000

PREPARED FOR:

CITY & COUNTY OF HONOLULU
Department of Environmental Services
Refuse Division
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Honolulu, Hawaii 96813

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EXECUTIVE SUMMARY

1. BACKGROUND

The New Systems Research (NSR) task evaluated the feasibility of various alternatives to divert refuse currently being sent to the Waimanalo Gulch Landfill. The City and County established the following objectives for this study.

- The technology must process waste materials being disposed in the Waimanalo Gulch Landfill.

- The technology must be operating at full scale and processing the amount of material expected at Waimanalo Gulch.

- The net cost of the technology (after credits for the revenue from the products of the operation) must be no greater than the fee paid for disposal.

The task is performed by first gathering data on the City and County of Honolulu (City) refuse management system, its requirements and its objectives. Next, a model of the City's management system is developed to aid the technology evaluation and screening process.

The evaluation of the technologies was initiated by conducting an extensive survey of the available systems. Next a two-tier screening process is used to first narrow down the survey results to seven and then from seven to a set of short-listed technologies. In order to allow a more detailed evaluation, a pre-conceptual plan was developed for each of the three short listed technologies as an integrated refuse diversion facility with all of the ancillary systems needed. The integrated facilities that passed the second tier technical screening are:

- Oahu Municipal Refuse
- Disposal Alternatives Study

Information on a third technology is also included, although it did not meet the past operating and economic performance criteria. This technology is the Plasma Generating Station. It was included due to its advantages and apparent potential to qualify under the City's criteria in the future.

Pre-conceptual designs for each of the integrated facilities are presented later in this report. Each of the pre-conceptual designs include a system integration block diagram, a facility functional block flow diagram, and a facility plot plan. The pre-conceptual characterization of the options also included the functional, operational and performance aspects of the overall facility and its key unit operations. Based on the pre-conceptual characterization of the facilities, rough order of magnitude (ROM) capital and operating costs for each of the alternatives are developed.

2. CONCLUSIONS

Although they do not achieve all of the City's objectives (they all fail the cost objective), the alternatives considered are highly effective in diverting refuse stream from the Waimanalo Gulch landfill. Preliminary study results show that these alternatives can be implemented without requiring major changes to the existing City refuse management system. The most promising alternative, plasma-generating station, could potentially divert as much as 90% of the estimated 278,000 tons refuse being sent to the landfill. If this alternative were implemented, the only major waste stream requiring disposal would be the H-POWER ash, which is estimated to be approximately 108,000 tons per year. The other two alternatives, the metal and gypsum recycling plants, have a potential of diverting 11% and 7%, respectively.

One of the most "problematic" materials in the waste stream to the landfill is treated wood. This waste contains potentially toxic materials that limit the options for volume reduction or recycling. Hence, any thermal technology employed to process the wood must contend with the toxic metals emissions. The plasma gasification/vitrification technology offers the most advantageous solution in dealing with the toxic contamination in the treated wood stream due to its high operating temperatures, embedding the contaminants into a vitrified glass material, and ease of capturing emissions.

The plasma generating station and gypsum recycling plant will convert refuse to products that could be sold in the Hawaii region market place. It is estimated that the plasma generating station will produce approximately 900 kwh of electricity per ton of refuse processed, with 300 kwh available to be sold. The gypsum produced can be sold as an agriculture soil additive, animal bedding, and an oil absorbent product. The product from the third alternative, metal recycling plant, must be shipped offshore for recycling.

Currently there are no large capacity municipal gasification/vitrification installations based on direct current (DC) arc plasma systems. The largest operational DC arc plasma system is approximately 10 tons/day. These systems have been used in (or proposed for) mostly hazardous and medical waste applications in the U.S.

Metal recycling is a common technology that is employed by all industrial facilities generating scrap metal and most municipal refuse systems. A literature survey indicates there are a minimum of two gypsum recycling plants operating in the U.S.

The plasma generating station would require both air emissions and water discharge permits. The metal recycling and gypsum recycling plants are expected to require only air emissions permits for their baghouse dust collection exhaust streams. Environmental impact assessments would also be required for the three alternatives.

We estimate that it will require 70 months to acquire the plasma generating station and 32 months for the metal and gypsum recycling plants. Assuming a privatized ownership of the facilities, the estimated net revenue (including sale of all products and payment of the full disposal tip fee) per ton of waste processed at plants using the three technologies are:

- negative $28 per ton for the plasma generating station
- negative $29 per ton for the metal recycling plant, and
- negative $39 per ton for the gypsum recycling plant.

Using the estimated price for electricity, these technologies are between 22 and 54 percent more costly than the current disposal fee. Using the actual price now paid to H-POWER for sale of electricity, the increased cost is between 30 and 54 percent greater.

The City required that a technology have a proven track record in all aspects of implementation, including technical, permitting and cost-effectiveness and be less costly than the disposal fee. The study concludes that none of the three technologies meet the City's criterion.

The Plasma Generating Station alternative based on a DC arc plasma technology has not been used in municipal refuse applications and has a net cost of operation greater than the fee for disposal. Hence, it does not meet the City's criterion. Both the Metal Recycling Plant and the Gypsum Recycling Plant have a net cost of operation greater than the fee for disposal.

In the interest of providing information to assist the City should it review alternatives to the current disposal methods in the future, we have included our technical analyses in this report. The details provided here should enable the City to narrow the focus of future evaluations.

3. RECOMMENDATIONS

The primary conclusion of this evaluation is that there are no technologies now available that provide an alternative to the current disposal system and achieve the City's three objectives.

If the City decides to proceed despite none of the technologies meeting its criteria, the next milestone should be a "go/no-go" decision on a "focused feasibility study" aimed at better understanding the nature of the three candidate technologies. It is believed that the diversion and recycling capabilities of the candidate technologies are highly promising and, hence, a "go" decision is warranted.

The focused feasibility study should further develop the concepts proposed herein. The focused study should emphasize the salient features of the alternatives, including issues that attract private investors. For example, the technical, permitting and economic risks associated with the selected technologies and the availability of a market for the recycled product must be thoroughly investigated so that an interested private investor is able to make an informed decision on potential investment.

In conjunction with the focused feasibility study, it is recommended that a survey be conducted to identify alternative sites for locating the plants. Furthermore, public and business relations efforts are needed to solicit private sector investors and companies.

One of the alternatives considered by this study, the plasma generating station is uniquely compatible with the City's refuse diversion needs. The limited availability of land space, the highly protected environment, and limited energy resources are the three reasons that lead to recommending the plasma gasification/vitrification technology as the ultimate solution for the future refuse disposal space problem. This innovative and first-of-a-kind technology promises to be environmentally friendly, produce the much-needed electricity for the region, and significantly reduce the City's landfill space requirements. After this alternative has been proven in a full scale plant operating on municipal solid waste, it is recommended that further feasibility studies be conducted to provide a better understanding of the technology's reliability, operability and cost-effectiveness.

Gypsum recycling is an innovative and new use of commonly available machinery for pulverizing gypsum and separating the facing paper. The major barrier for implementing this option is the market for the gypsum. Therefore, it is recommended that market research be conducted to ensure that recycled gypsum can be sold on the island.

SECTION 1
INTRODUCTION

1.1 PROJECT OVERVIEW

This report was prepared for the City & County of Honolulu (City), Department of Environmental Services, Refuse Division. This evaluation was conducted as part of an overall study addressing six key areas of the City's waste collection and diversion programs. This introduction provides a summary of the solid waste system when the evaluation was conducted.

The evaluations were conducted by R. M. Towill Corporation (RMTC) in association with Solid Waste Associates (SWA), which provided project management support and prepared two evaluations. Other companies that participated in the evaluation are listed below.

- A *Waste Composition Analysis* of the residential, commercial, and self-haul waste streams. Cascadia Consulting Group, Inc., Sky Valley Associates and SWA conducted this analysis.
- A *Study of Managed Competition* in waste collection services. HDR Engineering, Inc., prepared this study.
- An *Evaluation of Green Waste Collection, Processing, and Marketing* to address the infrastructure needed for expanded green waste collection. This evaluation was prepared by SWA in association with Total Compliance Management, Inc.
- An *Evaluation of Once-Per-Week Waste Collection* to assess the cost savings and operational impacts of collecting residential waste from single-family dwellings once per week rather than twice per week. Franklin Associates prepared the evaluation.
- An *Evaluation of Curbside Recyclable Collection* from single-family dwellings. This evaluation, conducted by Franklin Associates, was to determine the cost of implementing a curbside program compared to the existing drop-off system.
- *New Systems Research for Refuse Disposal* to identify new and innovative technologies that might be appropriate for the City to investigate further. ATG, Inc., prepared this evaluation.
- An *Evaluation of Market Strategies for Recyclable Materials* prepared by Skumatz Economic Research Associates (SERA).

1.2 EXISTING SYSTEM

1.2.1 General

These reports are based on conditions that existed between January 1998 and September 1998. The data on the waste collection, diversion, and disposal systems were for 1997, the latest full year for which data were available. The waste composition information was taken between April 1998 and September 1998. The waste sampling schedule for the waste composition study was based on 1997 disposal amounts and vehicle counts at the facilities sampled. The 1997 data used to prepare the sampling program were checked against the actual disposal in 1998 to confirm that the 1997 data were representative of the 1998 data.

While the data for 1997 were determined to be adequately representative of the 1998 disposal for waste composition sampling plan purposes, the amount of disposal at the City's disposal facilities has decreased in 1998. The amount of waste handled at the Waimanalo Gulch Landfill and at H-POWER in the last two fiscal years is shown in **Table 1–1**, Changes in Amount of Waste Disposal. The increase at H-POWER was due to increased availability of the plant, not an increase in waste generation, and would account for part of the decline at Waimanalo Gulch Landfill.

Table 1–1
Changes in Amount of Waste Disposal
(Tons)

	H-POWER	Waimanalo Gulch Landfill	Total
FY 96-97	588,939	385,248	974,187
FY 97-98	639,286	278,374	917,660
Difference	9%	-28%	-6%

1.2.2 Collection System

The City & County is divided into seven collection districts. Waste from the districts is either sent through one of three transfer stations or directly to the disposal site, depending on distance from the route to the disposal point.

The Refuse Division collects waste from single–family dwellings and from some apartment buildings and small commercial facilities. Waste from most large commercial facilities and apartments is collected by private waste haulers.

Residential waste is collected twice per week. In areas with automated collection services, green waste is collected separately once per month. On–call green waste collection is provided in some automated areas due to the large amount of green waste generated. In areas with manual collection, green waste is collected with the rubbish.

Both automated side–loaders and manual rear–loader trucks are used for waste collection. About 78 percent of the routes are automated. The Refuse Division staff anticipates converting a total of about 90 percent of the routes to automated collection over the next several years. In the automated areas, green waste is collected with manual trucks.

The City operates a system of six convenience centers where householders can drop off waste. The centers have bins designated for recycling, H–POWER, and landfill. The customer places the waste in the proper bin.

1.2.3 Diversion

The waste diversion program includes the following components:

- A drop–off system currently located at schools around the island. Materials collected include paper, plastic, aluminum cans, and glass. The drop–off system is being expanded to additional schools and some commercial facilities, such as grocery stores and supermarkets.

- Green waste processing is done at three locations, two private operations and one operated by the Refuse Division (located at the Kapaa Landfill). The private operations produce both mulch and compost. The finished product from private facilities is marketed in retail stores and in wholesale bulk. The Refuse Division operation produces mulch, which is provided free to the City Parks and Recreation Department and other departments and to the public.

- A statewide advance disposal fee of 1.5 cents that is collected for each glass container entering the state provides an incentive for recycling that material. The processor is paid six cents per pound by the State for recycling glass.

- The Partnership for the Environment is a City-supported organization comprised of businesses that have extensive commercial recycling activities. The Partnership acts as an information source for expanding commercial recycling on Oahu.

- The City requires recycling of glass containers from bars and restaurants. It also requires office buildings greater than 20,000 square feet in size to recycle office paper, newspaper, and cardboard.

- Restaurants and other facilities that generate food waste are required to recycle that material.

- The City has a program to recycle materials from its offices.

- While not City-sponsored, there are commercial programs to recycle construction and demolition waste, tires, and appliances.

1.2.4 Disposal

The City operates two disposal facilities, and a third is privately operated. The City facilities are the Waimanalo Gulch Landfill and H–POWER. H–POWER is a waste–to–energy plant that processes over 620,000 tons of waste per year (about 2,000 tons per day) and generates electricity. The facility is a refuse derived fuel plant that recycles ferrous metals from the front end processing equipment and ferrous and non–ferrous metals from the ash.

The Waimanalo Gulch Landfill accepts non–combustible waste, including the ash from H–POWER, and other materials, mostly from private waste haulers and commercial self-haulers. Householders do not pay for waste disposal. Commercial customers pay $65.75 per ton, which includes a state tax of $0.35 per ton. A six-percent City recycling surcharge is added on to each ton disposed. On July 1, 1999, the fee will become $72.25 per ton and the surcharge will increase to 12 percent.

PVT Land Company operates the private landfill. It accepts construction and demolition materials at a tip fee of $25 per ton.

1.2.5 Existing Compost Facilities

Today there are two existing green waste facilities processing approximately 115 tons per day of green material from both commercial and City sources. These existing sites can expand to handle up to 490 tons per day of material.

Hawaiian Earth Products is located in the Campbell Industrial Park and has been in operation since 1993. Kalaheo Green Waste Recycling Facility is located on top of the closed Kalaheo Landfill near the Kapaa Quarry and has been in operation since 1996.

SECTION 2
BACKGROUND

2.1 NSR PURPOSE AND SCOPE

New or innovative technologies may provide a high level of waste disposal efficiency with few residuals, reducing the dependence on landfilling and incineration. The NSR uses the available information on new and innovative technologies and assesses the applicability of such technologies for diverting refuse currently being sent to the Waimanalo Gulch Landfill for disposal.

2.2 EVALUATION METHODOLOGY

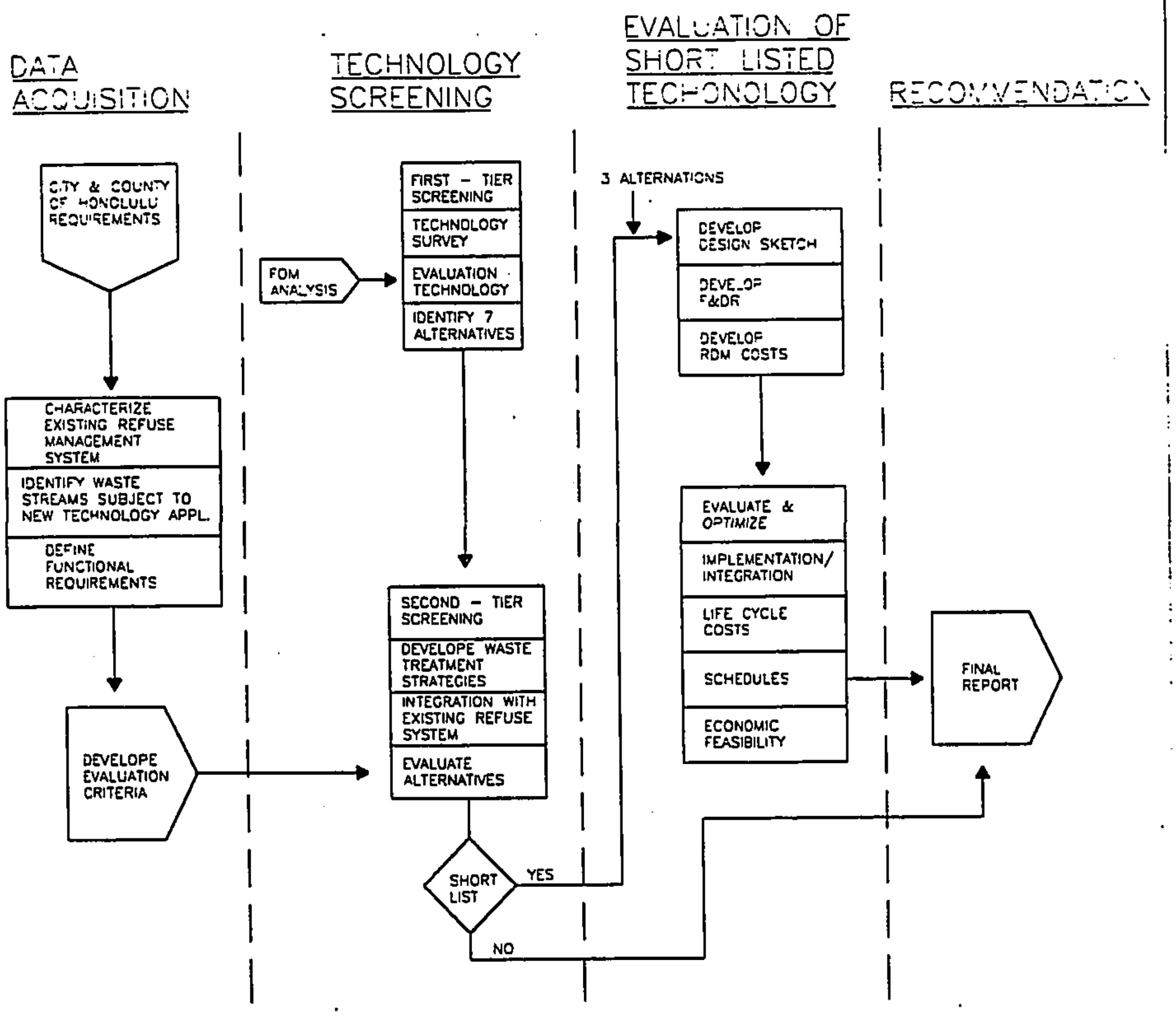
The step-by-step technology evaluation process in this study is shown in a block diagram, which is enclosed as Figure 2-1. As shown, the task is performed by first gathering the data on the City's refuse management system and its requirements and objectives. Next a model of the City's refuse management system is developed (see Section 3). This model includes the physical facilities, recycled (diverted) waste streams and material processing rates at key facilities. Using this model, the cost of the key system elements is obtained for use in the technology evaluation studies.

Evaluation of technologies is initiated by conducting a survey of the available systems. Next a first-tier screening process is used to narrow down technologies to seven most feasible options (see Section 4). These options are subjected to a second-tier screening and are evaluated against the City's requirements and objectives (see Section 5). The second-tier screening produced a set of three short-listed technologies for detailed evaluation.

Each of the short-listed technologies is incorporated into an integrated waste management facility (see Section 6). Each facility uses one or more of the short-listed technologies as its main component, but the facility also includes other unit operations that would be needed for a total and complete integration of the technology within the existing City refuse management system. A pre-conceptual design package is developed and presented for each of the integrated facilities. This includes a system integration block diagram, a facility functional block flow diagram, and a facility plot plan. The pre-conceptual characterization of the options also includes the functional, operational and performance aspects of the overall facility and its key unit operations. Based on the pre-conceptual characterization of the facilities, rough order of magnitude (ROM) capital and operating costs for each of the alternatives are developed.

The last step of the study encompassed a technical and economic review of the facilities that were based on the short-listed technologies. The review covered the following aspects:

- Application to the existing system
- Existing system changes required
- Project development activities and estimated duration
- Milestones
- Prior experience
- Permitting
- Operational reliability
- Implementation barriers and incentives
- Diversion capability
- Economic feasibility



FOM = FIGURE OF MERIT.

FIGURE 2-1 NEW SYSTEMS RESEARCH EVALUATION DIAGRAM

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NEW SYSTEMS RESEARCH

UNLESS SPECIFIED OTHERWISE, THE GIVEN SCALE IS VALID WHEN DRAWING IS 11"x17"

SECTION 3
STUDY ASSUMPTIONS AND BASIS

3.1 GENERAL

The City's refuse management system is summarized in this section.

3.2 REFUSE MANAGEMENT SYSTEM

The refuse system model presented below is based on conditions that existed as of September 1998. The model covers the existing system only to the extent that it is related to the performance of the NSR task. A more detailed presentation of the overall refuse system is included in other reports produced for the Oahu Municipal Refuse Disposal Alternatives Study. A conceptual diagram of the model is shown in Figure 3-1.

3.2.1 Collection System

The City is divided into seven collection districts. Waste from the districts is either sent through one of three transfer stations or hauled directly to the disposal site, depending on distance from the route to the disposal point.

The City's Refuse Division collects waste from single-family dwellings and from some apartment buildings and small commercial facilities. Refuse from most commercial facilities and apartments are collected by private waste haulers.

Refuse from residential units is collected twice per week. Green waste is collected separately twice per month in areas with automated refuse collection. In areas with manual collection, green waste is collected with the rubbish.

Both automated side-loading and manual rear-loading trucks are used for waste collection. The Refuse Division staff anticipates converting a total of about 89 percent of the routes to automated collection over the next several years. In the automated areas, green waste is collected with manual rear-loading trucks.

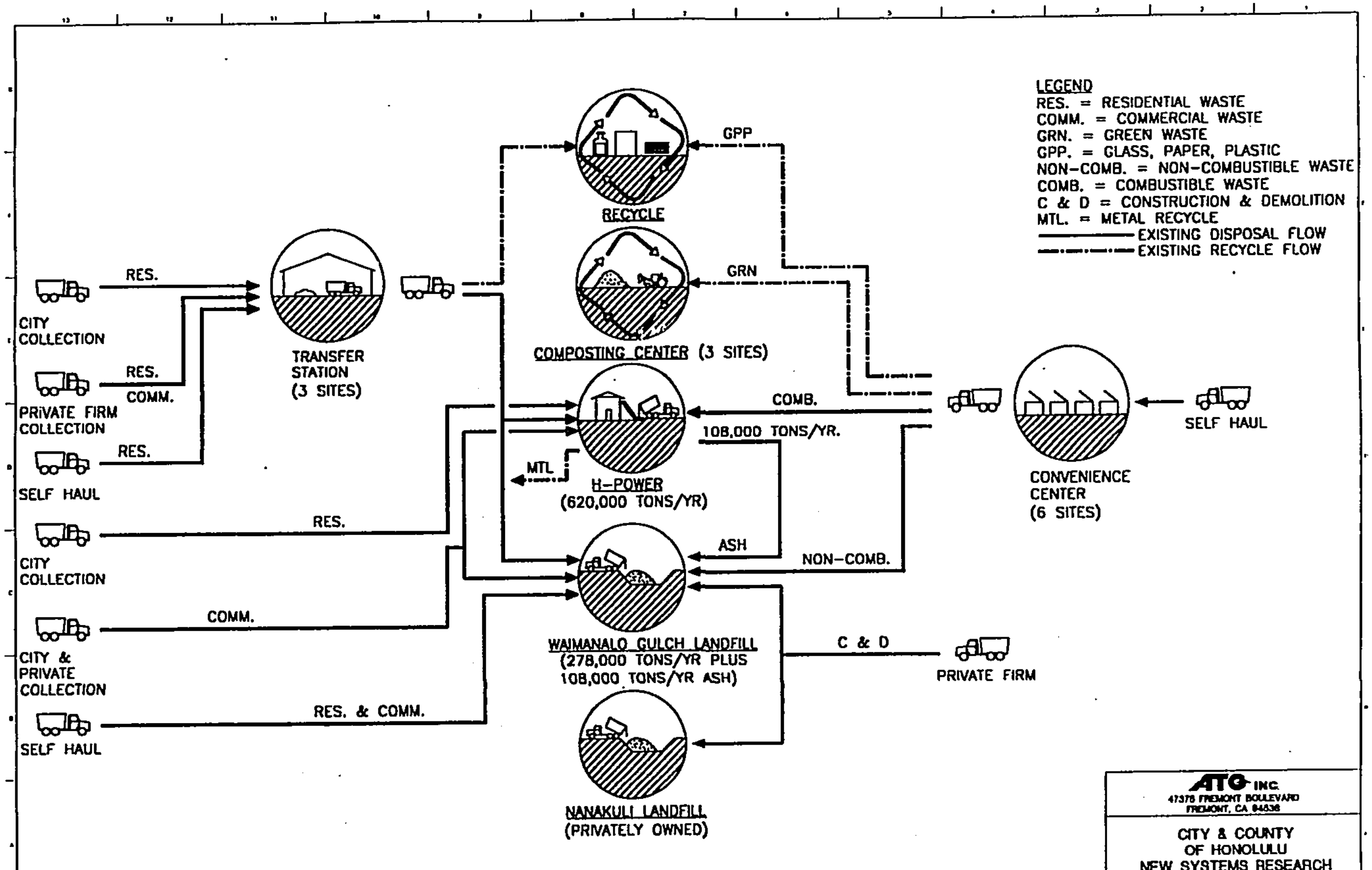

FIGURE 3-1 BLOCK DIAGRAM OF EXISTING REFUSE MANAGEMENT SYSTEM MODEL

3.2.2 Convenience Centers

The City operates a system of six convenience centers where householders can drop off waste. The centers have bins designated for recycling, H-POWER, and landfill. The customer places the waste in the proper bin.

3.2.3 Transfer Stations

The City owns and operates three transfer stations to optimize the transport of collected refuse to the disposal facilities.

- **Keehi Refuse Transfer Station.** The Keehi Refuse Transfer Station is located on a 5-acre site in Honolulu. The facility serves the most populous area of Oahu and has been operational since 1977. The facility contains a 12-bay depressed tipping floor with a 1,000-ton storage capacity, four compactors and a maintenance shop. Operating equipment includes wheel loaders, backhoes, sweepers, truck tractors, transfer trailers and pickup trucks.

- **Kapaa Refuse Transfer Station.** Kapaa Refuse Transfer Station is located on a site formerly mined as a rock quarry by Ameron HC&D. This transfer station began operation in 1989. The facility contains an 8-bay depressed tipping floor with an 800-ton storage capacity, two trailer load-out bays and maintenance and storage rooms. Operating equipment includes wheel loaders, knuckle-boom loaders, backhoes, sweepers, truck tractors, transfer trailers and pickup trucks.

- **Kawailoa Refuse Transfer Station.** Kawailoa Refuse Transfer Station is located next to the closed Kawailoa Sanitary Landfill. This transfer station began operation in 1987. The facility is an open-air facility in which smaller collection trucks dump directly into a transfer trailer, after which the refuse is redistributed and tamped with a knuckle-boom loader. The station also serves as a convenience center. Operating equipment includes open top transfer trailers, truck tractors, one knuckle-boom loader, one backhoe and one pickup truck.

3.2.4 Waste Recycling

The City's waste recycling programs include the following components:

- **Recycling Drop-Off Centers**: A drop-off system is currently located at schools around the island. Materials collected include paper, plastic, aluminum and steel cans, and glass. The drop-off system is being expanded to some commercial facilities, such as shopping centers.

- **Green Waste Drop-Off Centers**: Green waste processing is done at three locations, two private operations and one operated by the Refuse Division (located at the former Kapaa Landfill). The private operations produce both mulch and compost. The finished products are marketed in retail stores and in wholesale bulk. The Refuse Division operation produces mulch, which is provided to the City parks and other departments and to the public.

- **Citizen Sponsored Recycling**. The Partnership for the Environment is a City-coordinated organization comprised of representatives of companies that have extensive commercial recycling activities. The Partnership acts as an information source for expanding commercial recycling.

- **Restaurant Glass Recycling**. The City requires recycling of glass containers from larger bars and restaurants.

- **Restaurant Food Waste Recycling**. Restaurants and other facilities that generate pre-consumer food waste are required to recycle that material.

- **Office Paper Waste Recycling**. The City has a program to recycle materials from its offices. It also requires office buildings greater than 20,000 square feet in size to recycle office paper, newspaper, and cardboard.

- **Construction Debris Recycling**. While not City sponsored, there are programs to recycle construction and demolition waste.

- **Incentive-Induced Glass Recycling**. A statewide advance disposal fee for glass provides an incentive for recycling that material. A fee of 1.5 cents is collected for each glass container entering the state. The processor is paid six cents per pound for the recycled glass.

- **Ferrous and Non-Ferrous Metal Recycling**. The City's H-POWER, which is a waste-to-energy plant, recycles ferrous metals from the front end processing equipment and ferrous and nonferrous metals from the ash.

3.2.5 Disposal

The City operates two disposal facilities, and a third is privately operated. These facilities are:

- **Waimanalo Gulch Landfill**. This landfill is located at Waimanalo Gulch in Kapolei, Oahu. It is owned by the City and operated by a private contractor.

- **Waste-to-Energy Plant (H-POWER).** The City's H-POWER facility located in Campbell Industrial Park is a refuse-derived fuel plant that produces energy from combusted solid waste.

- **PVT Landfill.** The PVT Landfill is located in Nanakuli, Oahu. It is owned and operated by the PVT Land Company and accepts refuse from construction and demolition activities.

3.3 REFUSE COMPOSITION AND DISPOSAL RATES

Table 3-1 provides 1998 waste composition data for the Waimanalo Gulch Landfill waste stream. These data were obtained from the Waste Composition Study, conducted as part of the overall project.

- **H-POWER.** The most recent data indicate that the City's H-POWER facility processes over 620,000 tons of waste per year (about 2,000 tons per day).

- **Waimanalo Gulch Landfill.** The amount of waste disposed of at the Waimanalo Gulch Landfill in 1998 was 192,099 tons. For the NSR study, it is assumed that this waste is processible.

Table 3-1. Composition of Refuse Received at Waimanalo Gulch Landfill in 1998.

MATERIAL	COMPOSITION (mean %)	TONS
Paper	**8.9%**	**17,097**
Newspaper	0.2%	384
Cardboard	5.2%	9,989
High Grade	0.5%	960
Low Grade	2.2%	4,226
Compostable	0.3%	576
Non-Recyclable Paper	0.5%	960
Plastics	**5.0%**	**9,605**
PET #1	0.0%	0
HDPE #2	0.0%	0
Other Bottles	0.0%	0
Rigid Plastic	1.4%	2,689
Film Plastic	2.5%	4,802
Other Plastic	1.0%	1,921
Wood	**31.2%**	**59,935**
Treated Wood	13.9%	26,702
Pallets/Crates	7.6%	14,600
Untreated Lumber	5.8%	11,142
Untreated Plywood	2.6%	4,995
Stumps	1.3%	2,497
Metal	**12.3%**	**23,628**
Aluminum Cans	0.2%	384
Tin Cans	0.2%	384
Ferrous	6.7%	12,871
Non-ferrous	0.4%	768
Mixed/Other	4.8%	9,221
Glass	**0.5%**	**960**
Yard Waste	**6.0%**	**11,526**
Other Inorganics	**20.0%**	**38,420**
Wallboard	7.0%	13,447
Asphalt Roofing	1.4%	2,689
Asphalt Paving	1.9%	3,650
Concrete	2.9%	5,571
Other	6.8%	13,063
Other Wastes	**16.0%**	**30,736**
Furniture/Mattresses	5.1%	9,797
Carpet	4.5%	8,644
Other	6.4%	12,294
TOTAL	**100%**	**192,099**

Note: Composition data are calculated at 90% confidence interval

- **Private Landfill.** PVT Land Company accepts approximately 355,000 tons per year of refuse from construction and demolition activities.

3.4 REFUSE MANAGEMENT COSTS

Refuse management costs for the system are presented below. The data are for system operations in 1996, 1997 and 1998.

- **Collection.** City's average collection cost is $88.11 per ton. The cost is based on 1996-97 fiscal year when approximately 302,000 tons of refuse was collected .

- **Convenience Centers.** The operating cost at the City's convenience centers is approximately $57 per ton of refuse handled. This cost is based on 1996-97 fiscal year when approximately 33,500 tons of refuse was handled.

- ***Transfer Stations.*** The operating cost at the City's transfer stations is approximately $31 per ton of refuse handled. This cost is based on 1996-97 fiscal year when approximately 227,000 tons of refuse was handled.

- **H-POWER.** The H-POWER income and expense for the year 1996-97 were as follows:

Income		
Material Sales		$112,000
Electricity Sales		$27,300,000
Equity		$25,000,000
	Total Income	**$52,412,000**
Expense		
Operating and Maintenance		$55,140,000
Annualized Capital Costs		$18,700,000
	Total Expense	**$73,840,000**
Net Cost		21,428,000
Refuse Processed		588,940
Net Cost Per Ton		**$31.36**

- **Waimanalo Gulch Landfill.** The Waimanalo Gulch Landfill accepts noncombustible waste, including the ash from H-POWER, and other materials, mostly from private waste haulers and self-haulers. Householders do not pay for waste disposal. Commercial customers pay $72.25 per ton, which includes a state tax of $0.35 per ton and a 12 percent City recycling surcharge.

- **PVT Landfill.** The PVT landfill has a tip fee of $25 per ton.

- **General Recycling.** City recycled approximately 17,000 tons of material in the fiscal year 1996-97. Recycling operations cost was approximately $1,400,000. Revenue from the sale of material was $25,179. The net cost of recycling was approximately $80.42 per ton.

- **Glass Recycling.** City recycled approximately 10,200 tons of glass in the fiscal year 1996-97. Recycling operations cost was approximately $1,374,000. Revenue from the sale of glass was $10,200. The net cost of recycling was approximately $134.83 per ton. Glass recycling is completely supported by the Advance Disposal Fee (ADF) system.

SECTION 4
FIRST-TIER SCREENING OF TECHNOLOGIES

4.1 TECHNOLOGY SURVEY

A survey of refuse recycling technologies was conducted to identify state-of-the-art and innovative ideas for volume reduction and recycling of refuse currently being sent to Waimanalo Gulch Landfill. The survey, which identified over 50 different recycling methods, included the following sources:

- **Municipal Solid Waste Programs.** A survey of the various municipal solid waste systems was conducted to obtain information on new technologies that have been considered by municipalities in the United States.

- **Literature Survey.** A literature survey (EPA, state and municipalities) was conducted to identify existing, new and emerging technologies implemented or proposed for municipal waste reduction.

- **Vendor Survey.** Various vendors were contacted to obtain data on their proposed waste management technologies.

Information on the technologies obtained during the survey was reviewed and each technology was grouped according to the waste stream application. Information gathered during the survey is included in the Appendix (bound separately).

4.2 CRITERIA USED FOR FIRST-TIER SCREENING OF TECHNOLOGIES

The purpose of the first-tier screening process was to reduce the number of technologies identified during the survey to approximately seven technologies. This screening process was performed through a figure-of-merit (FOM) evaluation method. This method involves first defining a set of screening criteria and then scoring each option against the given criteria. The total score developed during the FOM process is used to rank the technologies. The highest scoring technologies are selected for further evaluation.

The criteria used for FOM screening are listed below.

- **Volume Reduction.** The ability of the system to reduce the volume of waste to be placed in the municipal landfills.

- **Recycling.** The ability of the system to recover resources for recycling and reuse.

- **Disposal Site Impact.** The ability of the system to minimize impact on the disposal media. For example, a desirable system would maximize long-term disposal site stability and reduce: 1) dispersion of material at the disposal site areas; 2) toxicity of waste and minimize leakage into the groundwater; 3) subsidence; and, 4) generation of gas.

- **Adaptability.** Ease of adoption within the existing City refuse management system. Alternatives requiring an immediate drastic change could be cost prohibitive or impractical.

- **Worker Safety.** The ability of the system to be operated by the City or contract workers within acceptable safety standards.

- **Availability.** The level of maturity of the system and degree by which the system can be immediately applied are evaluated under by this criterion. Systems that are fully developed, operational, time proven, and commercially available would rate a higher score than emerging, unproven technologies. A system with technology elements that have only lab scale or prototype application histories would not qualify under this criterion.

- **Protection of the Public Health and Safety.** The degree by which the system is able to ensure public health and safety is evaluated under by this criterion.

- **Complexity.** The degree of complexity of the system and its ease of operation and maintenance. Simpler systems are desirable because of less possibility of failure, higher operational availability, and higher level of efficiency.

- **Versatility.** The ability of the system to handle the expected waste stream. The physical characteristics of typical waste streams could vary widely. Systems that are versatile enough to accept a wide range of waste would rate a higher score than one that has limitations and requires extensive sorting and segregation.

- **Environmental Friendliness.** The measurement of environmental friendliness will depend on the impact of the technology on human health and the environment. Technologies that minimize air emissions, discharges to surface waters, and risk of releasing toxic material to the groundwater are generally defined as "environmentally friendly" technologies.

- **Technical Risk.** Technical risk addresses the probability of the technology to produce the expected results and performance. For example, a technology may appear to be technically sound for some waste streams, but adoption to another waste stream being considered by the study may require a major redesign that could bring additional complexities and, hence, uncertainties.

- **Regulatory/ Permitting Risks.** The degree of uncertainty involved with the ability to obtain a construction and operating permit for the technology. The extent and complexity of permitting will depend on air emissions and any discharge to the surface wasters. Systems that have minimal air emissions and zero liquid discharge are the most desirable approach. Technologies that minimize potential leakage into the groundwater will receive a high score. Also, proven past permitting will be considered as a positive point.

- **Economic Risks.** The lifecycle cost performance for the technology will be defined. The economic risk criteria address the degree of confidence regarding the system's ability to perform within the estimated life-cycle costs. For example, if a technology has already been commercialized and has had previous operating experience, it is reasonable to assume that its cost can be quantified within a reasonable level of certainty. If the system is too complex and there are lots of unknown factors relative to its capital, operating, and maintenance costs, then the risk associated with cost overruns would be high and the system would receive a low score.

- **Schedule Risks.** This criterion evaluates the degree of uncertainty associated with acquiring and implementing a given technology. For example, if a system is still in the research and development stage, the probability of commercializing such system within the given time-frame might be lower than a system that is commercially available through a vendor.

4.3 FIRST-TIER SCREENING OF TECHNOLOGIES

Using the FOM method, the technologies were compared, assessed and ranked against the evaluation criteria. Additional data, including a summary of functional and operational requirements, were developed as necessary to allow a more thorough evaluation.

Each of the technologies was rated as low, medium or high. A corresponding score of one (1) was assigned to a low level of compliance with a given criterion, a score of two (2) was assigned to a medium level of compliance and a score of three (3) was assigned to a high level of compliance.

The technologies were then ranked based on the total score for each technology. The seven (7) technologies with the highest total scores were selected for further consideration.

A brief description of the selected technologies is presented below. Conceptual flowcharts are attached as **Figures 4-1 through 4-7**. Selected articles on the seven technologies are included in Appendix A of this report.

The seven technologies can be used in numerous system variations. Some of these variations are discussed below.

4.3.1 Alternative 1, Plasma Oxidation/Vitrification Followed by Conversion of Heat to Electricity in a Boiler

Alternative 1 uses thermal oxidation of waste materials in plasma and joule heated process chambers. The combined electrical heating destroys all of the organic compounds contained in the refuse and vitrifies the inert material into a glass or rock-like matrix. The thermal reactor is stationary (fixed-hearth), uses conventional technologies and accessories and can process a wide variety of materials to produce a totally inert residue that can be beneficially employed as an aggregate or filler. A steam boiler is included for energy recovery.

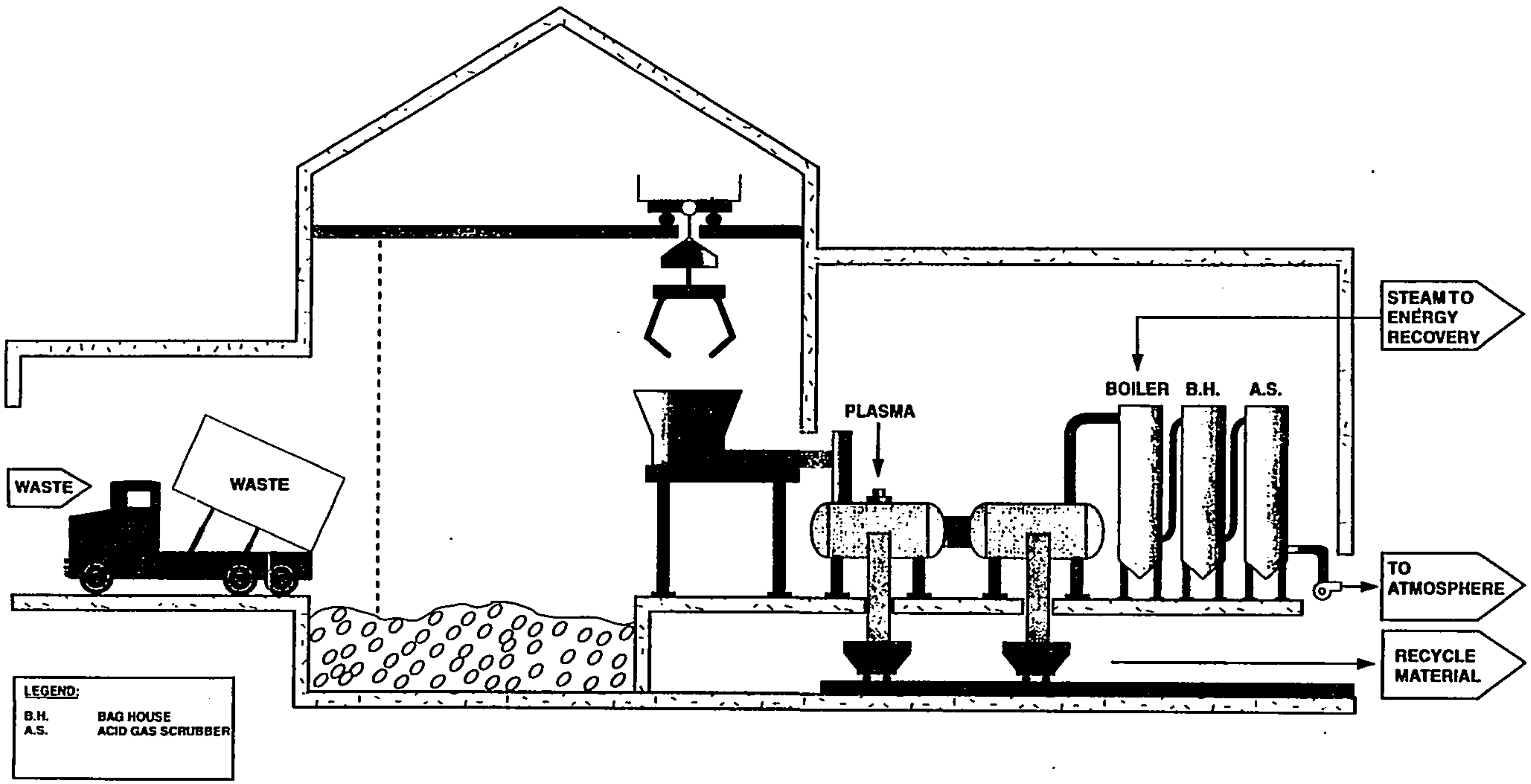

FIGURE 4-1

ALT 1. PLASMA OXIDATION/VITRIFICATION

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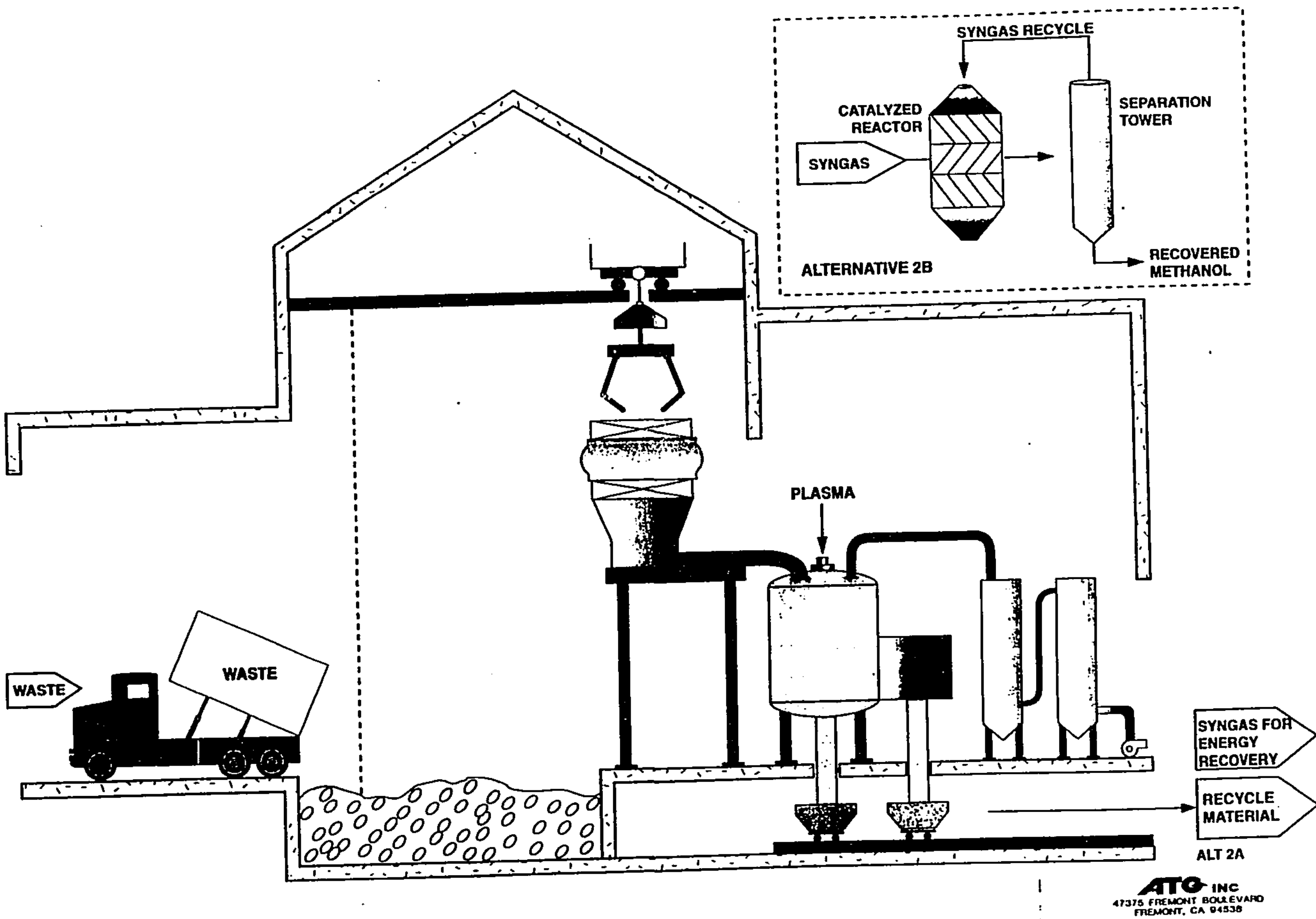

FIGURE 4-2

ALT 2. PLASMA GASIFICATION/VITRIFICATION

199/FF/PROPOSAL DEPT

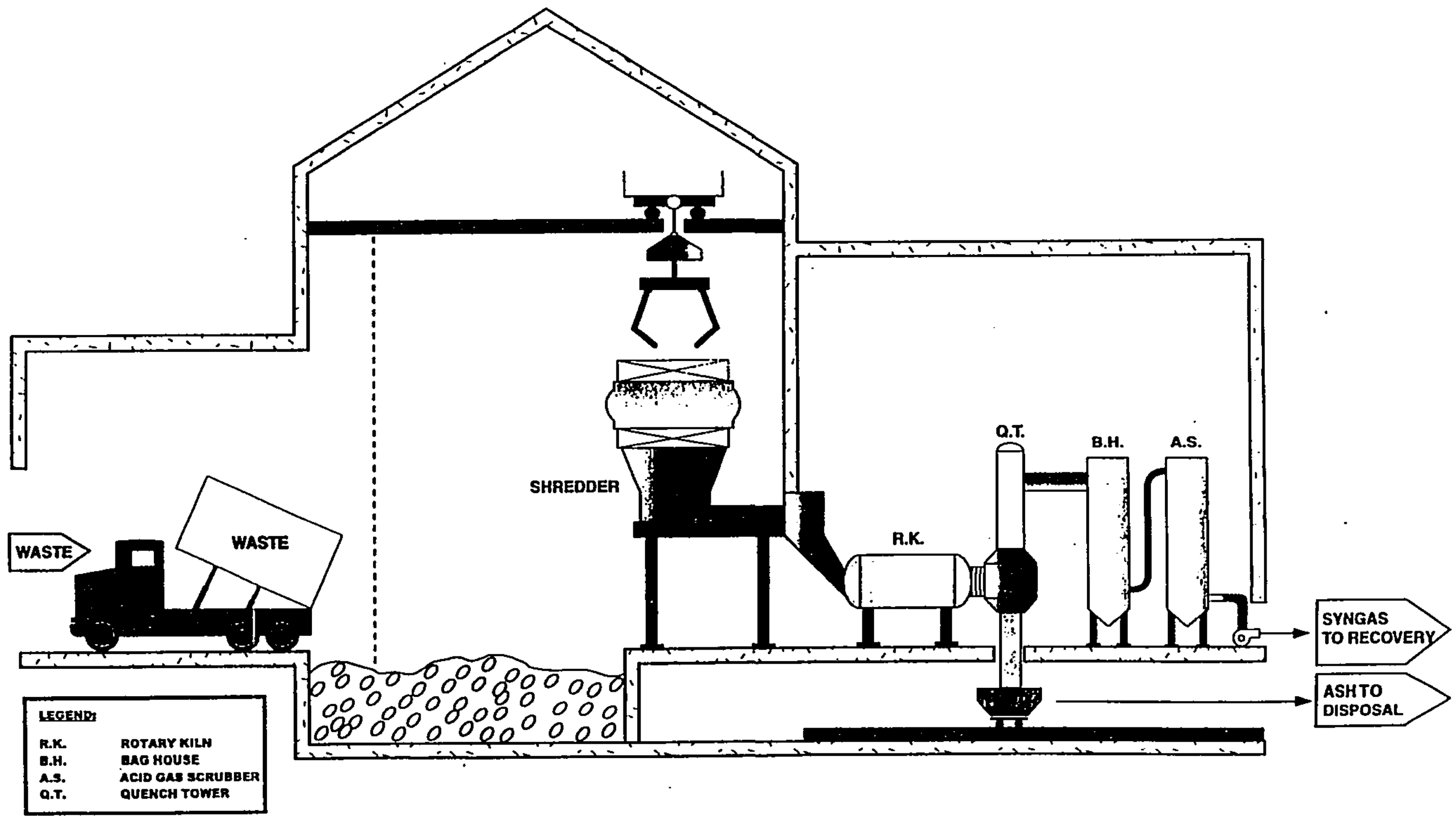

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FIGURE 4-3

ALT 3. ROTARY KILN GASIFICATION SLAGGING FOLLOWED BY METHANOL RECOVERY

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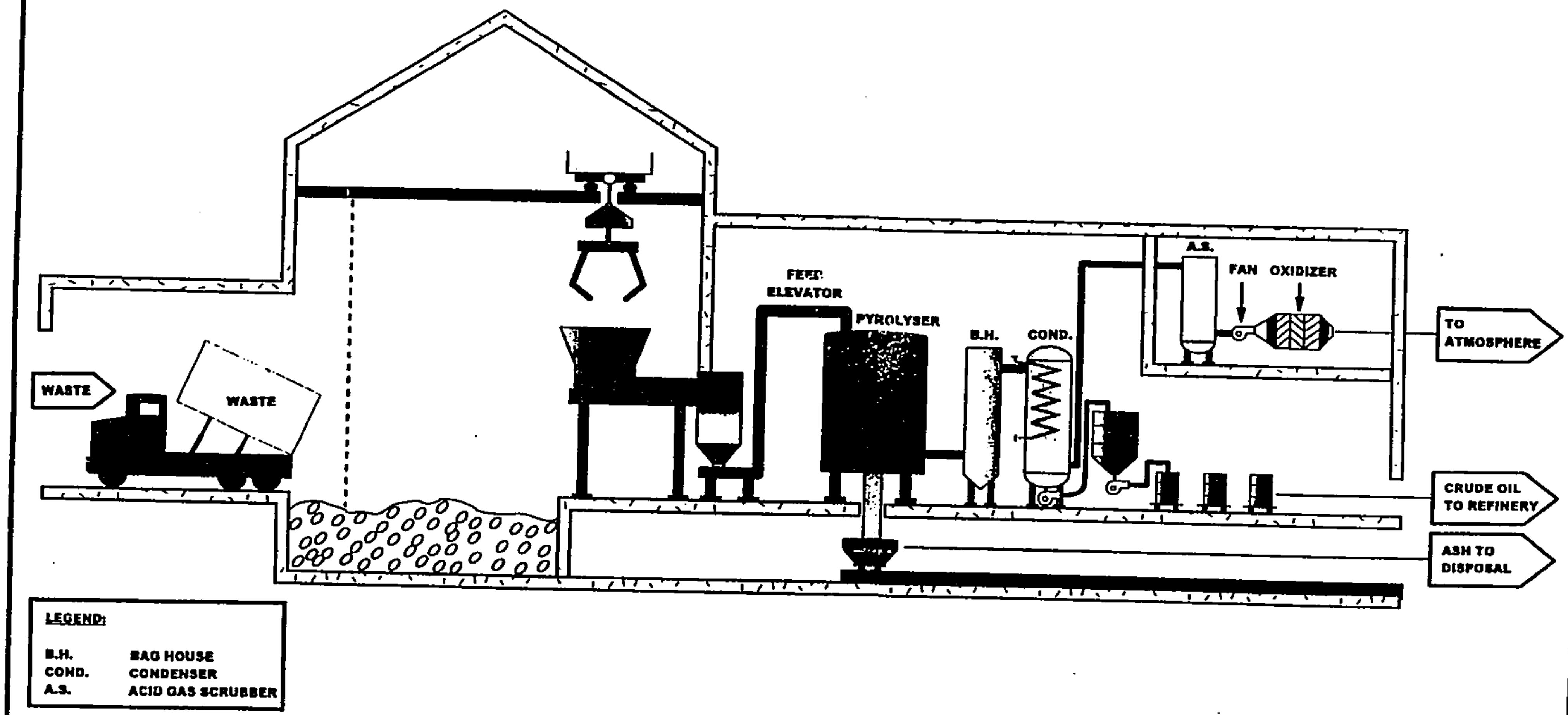

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FIGURE 4–4

ALT 4. LOW-TEMP PYROLYSIS/OIL RECOVERY

199/FF/PROPOSAL DEPT

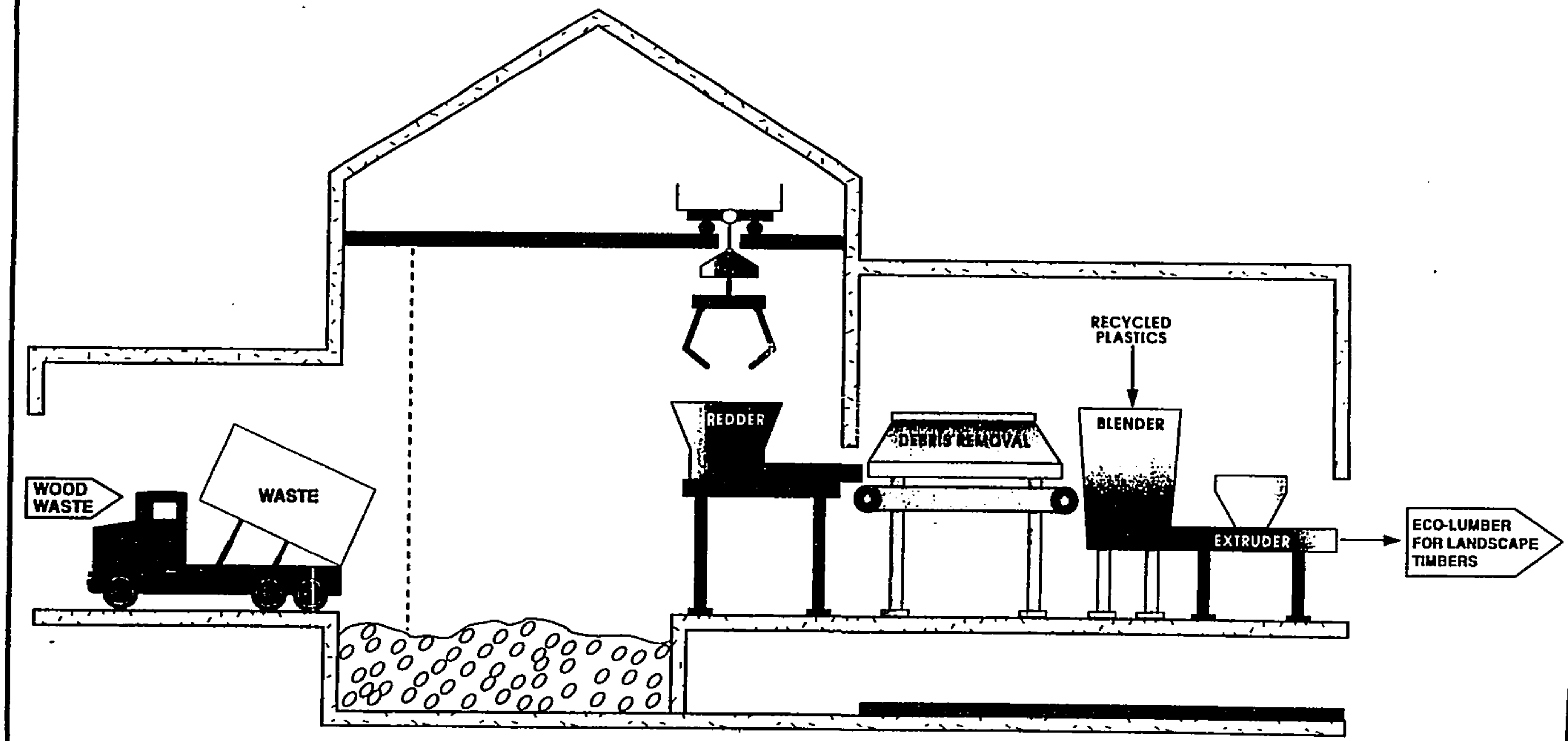

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FIGURE 4-5

ALT 5. CONVERSION OF WOOD/PLASTIC WASTES TO ECO-TIMBERS

199/FF/PROPOSAL DEPT

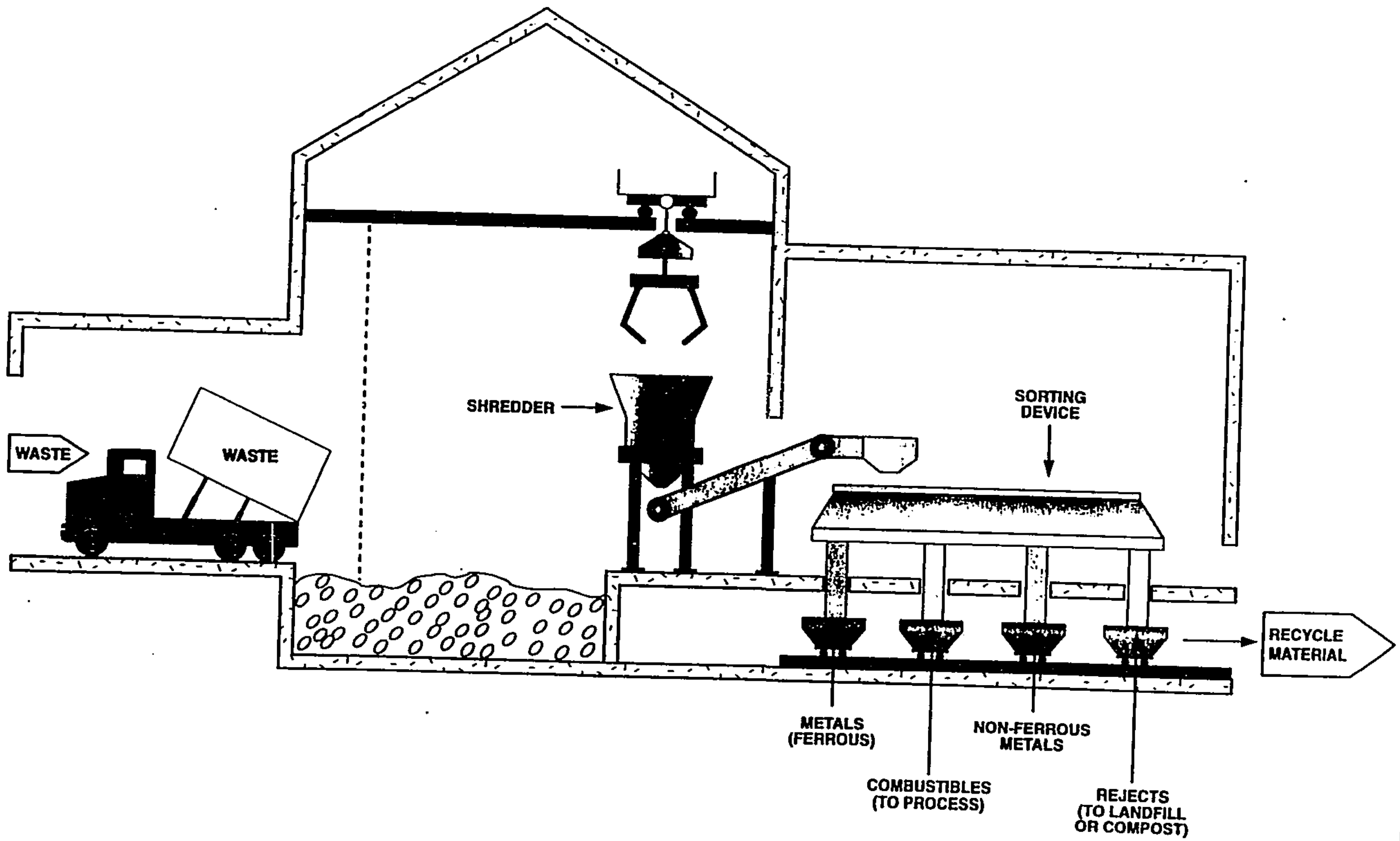

FIGURE 4-6

ALT 6. METALS RECOVERY

199/FF/PROPOSAL DEPT

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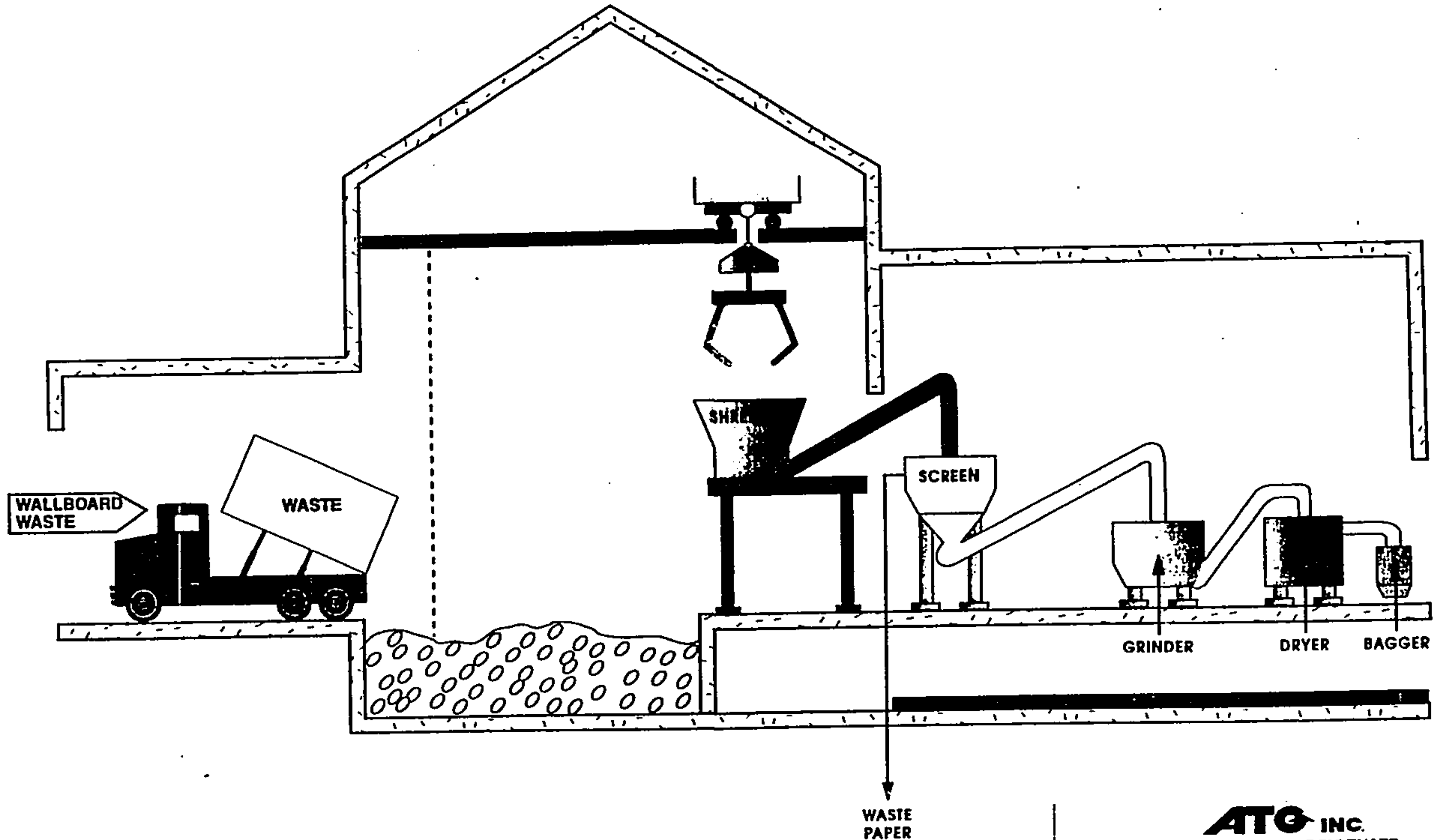

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FIGURE 4-7

ALT 7. GYPSUM RECYCLE FROM WALLBOARD

Advantages include a relatively simple operation, proven technology, multiple supplier sources, waste-heat recovery and product recovery in the form of a glass-like material. Disadvantages are low thermal efficiency and potential high risk in permitting.

4.3.2 Alternative 2, Plasma Gasification/Vitrification

Alternative 2 uses thermal gasification/vitrification of refuse materials in plasma and joule heated process chambers. A series of high-temperature plasma torches are used to decompose all organic components and melt inorganic residues into a rock-like glass material. It employs a combined-cycle gas turbine to generate power from the synthesis gas formed by the gasification of organic materials. Plasma temperatures reach 3,000-5,000° F so most organic compounds break down into their elemental components. Any water present reacts with elemental carbon to form carbon monoxide, resulting in a synthesis gas (syngas) that is primarily composed of hydrogen and carbon monoxide.

Alternative 2 can be implemented by using many different energy recovery methods. Two different methods, designated as alternatives 2A and 2B are described below:

- **Alternative 2A, Syngas Conversion to Electricity in a Turbine Generator.** In this alternative, the syngas is used to fuel a turbine power generator. A combined-cycle gas turbine generator is reputed to have as much as twice the energy efficiency of typical waste-to-energy thermal boilers. Advantages of this approach include size efficiency, energy recovery efficiency and revenue from the sale of electricity. A disadvantage is that this technology is relatively immature.

- **Alternative 2B, Syngas Conversion to Methanol.** In this alternative, the syngas is used to produce methanol. Methanol is easily produced from syngas in a high-pressure catalyzed reactor. It is a potentially useful transportation fuel, possibly more of a benefit to the Islands than production of electricity. Advantages of alternative 2B are the same as for alternative 2A, except that there may be a particular advantage to producing some product that is now being imported at a high price, transport fuel for example. Disadvantage is higher capital cost than alternative 2A.

4.3.3 Alternative 3, Rotary Kiln Gasification/Slagging Followed by Methanol Recovery

Alternative 3 uses a more conventional process chamber for converting refuse to methanol. Rotary-kiln gasifiers are designed much like cement kilns, consisting of a long, slowly revolving reaction chamber where heat decomposes organics in refuse into syngas. They have a longer history of operation and have been operated in much larger sizes than plasma vitrification units. Operating temperature is about 2000°F, compared to possibly 3000-5000°F for plasma. Rotary kiln gasifiers can be operated to produce either ash or slag (glass) as the residual. Experience with hazardous waste processing has developed reliable gas-scrubbing systems and cost information in similar-size operations. Like plasma gasifiers, the syngas could be converted to electricity, methanol, or other products.

An advantage is that this technology is more mature than the process used in Alternative 2. Disadvantages are that the unit would use natural gas or oil burners to heat the waste and the operation is anticipated to be more complex.

4.3.4 Alternative 4, Low-Temperature Pyrolysis Followed by Oil Recovery

Low-temperature pyrolysis, also called destructive distillation, operates at lower temperatures than gasification and produces a heavy oil product and a "char" residue that may be burned to heat the reaction chamber. This technology can recover black-carbon. The technology has received significant development during the 1970s as a method for recovering oil from shale deposits. The apparatus is an anaerobic heated reaction chamber, usually a batch reactor, and a condenser to recover the oil. Gas phase byproducts are usually fired in the reactor-heating unit.

Advantages are that capital and operating costs are projected to be lower than for gasification and that the technology is highly regarded by the environmental community. Pilot-scale operations have produced a usable fuel oil. There are specific processes developed in Europe for recycling treated wood. Disadvantages include the undeveloped state of this technology relative to municipal waste and the consequent lack of data on performance and cost.

4.3.5 Alternative 5, Conversion of Wood and Plastic Waste to ECO-Lumber

Alternative 5 is a method of grinding waste wood into fibers, blending the fibers with powdered or melted plastic and extruding the mixture as a monolithic composite material. It was included primarily as a low-cost way to process treated wood, but it also could be used as a method of transforming a majority of the waste stream into a useful product. There are commercially available composites of wood fiber and plastic, but so far, none of the identified products uses recycled plastic or post-consumer waste wood (except clean sawdust from milling operations).

Wood, paper and plastic together comprise 54.7% of the waste stream (see Table 3-1), if furniture and carpet are included. The ratio of plastic materials to wood (including paper) is about 1:4, roughly the ratio of plastic to wood in commercial composites. There is little chance of producing a high-quality aesthetic product for home flooring or decorative use from an uncertain and varying feedstock. However, there are many possible uses, such as culvert piping, landscape timbers, parking lot dividers and sea wall timbers, that would tolerate greater variation in product characteristics than the "architectural" products that are currently produced.

The NSR study envisions this as a more risky "development opportunity" rather than a fully commercial opportunity. Although an operation of this size has not been proven, if successful, it has the potential, based on the vendors' cost and revenue estimates, to save significantly more dollars per year compared to other options. ROM capital cost and claimed "production" costs for commercial materials are far below other options. Sale of the product is the key to success, and vendors' claims of product value have been greatly discounted due to the decidedly different nature of a product made from variable materials.

Advantages are a projected low cost, use of well-developed commercial process machinery, the ability to recycle treated wood and a projected valuable product. Disadvantages are the early state of development, uncertainties about the product and lack of operating data.

4.3.6 Alternative 6, Metals Recycling

Metals recovery and recycling alternative uses magnetic fields and eddy currents to remove metals from a stream of shredded waste that passes by on a belt conveyor or similar device. Typically, magnets recover ferrous metals and eddy-current devices remove non-ferrous metals.

There are other ways to separate the metals from the waste at the landfill. Loads with large amounts of metal can be tipped in a separate area of the working face and a magnet used to remove the ferrous metal. After the metal is removed, the waste is covered as usual. This method will not work with non-ferrous metals.

Advantages are that alternative six is a relatively low-cost, low-risk operation that is already common in the industry. It addresses a relatively small portion of the waste stream, but at low cost. There is some potential for direct profit from recycled materials. Numerous vendors are available for metal-recovery operations, and most of such operations are profitable. Metals comprise 12.3% of the waste stream and possibly a significant portion of the "furniture/mattresses" stream (5.1%) as well. Metal recovery is beneficial to the other technologies being considered by reducing potential handling difficulties and abrasion, as well as by reducing the volume of the waste stream. Disadvantage is that metals recovery addresses only a small portion of the waste stream and therefore diverts little from the landfill.

4.3.7 Alternative 7, Gypsum Recycling

Recovering gypsum from wallboard is simple and represents approximately 7% of the volume of the refuse stream being sent to the Waimanalo Gulch Landfill. Some of the gypsum waste identified as being disposed at the Waimanalo Gulch Landfill is mixed with other materials and some is painted or wall papered. If mixed with other materials, it may not be useable as described in this alternative. If coated with paint or wallpaper, it may not be useable due to the difficulty of removing the coatings.

Gypsum is widely used as a soil amendment, and the projected volume of 15,000 tons per year would justify a dedicated operation, either by a contractor or directly by the City. Gypsum is recovered by grinding the wallboard, often in two stages, removing any metals, screening out the paper, drying and bagging the gypsum powder. Advantages are low cost, proven technology, simple operation. Disadvantage is that gypsum recovery addresses only a small portion of the waste stream.

4.4 TECHNICAL DISCUSSIONS

Following is a discussion of some of the issues that must be considered in the selection of the technologies.

4.4.1 Sorting

The review found that the level of sorting required before processing is an important consideration in the system complexities and the capital and operating costs. The technologies listed above all require some level of sorting. Alternatives 1, 2 and 3 include removing metals through an automated sorting process, consisting of shredding and magnetic removal of the ferrous metals. Additional sorting, such as removing and recycling wallboard, would be helpful and probably cost effective. Alternative 4 benefits strongly from removal of additional inorganic materials besides the metals and wallboard since the "char" left after distilling the organic liquids will be fuel for heating the reactor. This is likely to be a hand-sort operation.

Alternative 5 is likely to include much additional sorting to improve the uniformity of the "product." Some washing of the plastics might be included, and treated wood might be processed separately from untreated. Provision would be included for "backhaul" of materials judged to be unsuitable for including in the "product."

4.4.2 Treated Wood

One of the most "problematic" materials in the specified stream is the treated wood refuse. This waste contains potentially toxic materials that limit the options for its diversion or volume reduction. Hence, any thermal technology employed to process the wood must contend with the toxic metals emissions. The plasma gasification/vitrification technology offers the most advantageous solution in dealing with the toxic contamination in the treated wood stream. This advantage stems from the following three factors:

- **Destruction of Organics in Wood Preservers.** The high temperature environment in the plasma process chamber ensures nearly total destruction of toxic organic compounds in the wood.

- **Capture of Solid Phase Metals in Wood Preservers.** The molten bath in the bottom of the plasma process chamber captures solid phase toxic metals, embedding them into a vitrified glass product.

- **Capture of Gaseous Phase Metals in Wood Preservers.** The plasma system's relatively small offgas stream (about 10% of the standard oxidation processes) makes it economical to use a multi-stage gas treatment unit for efficient capture of the gaseous phase toxic metals.

4.4.3 Dirt and Yard Waste

Dirt and yard waste are already addressed by existing composting programs. They and the food waste can be processed by the selected technologies but may be better addressed by composting. Any possible diversion of these materials to existing compost operations is a significant process benefit and probably a cost saving measure. However, separating these materials is expected to be more costly than disposal.

4.4.4 Fuels

Alternatives 2 and 3 include a gas production option for applications that can replace oil fuel with synthesis gas. Generating gas instead of electricity significantly lowers the facility cost. Converting the gas to methanol would add to the facility cost but produce a valuable product that could be used to power the City's vehicles, for example.

Alternative 5 includes the selective removal of wood, paper and plastics from the waste stream. The wood, paper and plastics would be processed separately and then blended into an extruded composite, suitable for landscape timbers, parking lot dividers and similar applications. The end product could also be pelletized to form a high Btu/ low ash "RDF," but the presence of a significant percentage of treated wood would limit the type of facility that could burn it while controlling metals emissions. Manual sort could be extended to separate treated from untreated wood, with the treated wood processed separately as landscape material and the untreated wood processed as RDF. Value of the RDF would depend on having a suitable use for the fuel, possibly to supplement H-POWER or as a home-heating product. Home wood-burning stoves are more common in colder climates, so the RDF might be an "export" product.

4.4.5 Electric Power

Alternatives 1, 2, and 3 have the potential to use and/or produce significant amounts of electrical power. A suitable location with full access to the electrical grid has been assumed. If fuels from the processes were to be useful in H-POWER, they would benefit from being located nearby. The demand for electric power has been assumed to be modest in selecting fuels instead of power as possible products from gasification processes.

SECTION 5
SECOND-TIER SCREENING OF TECHNOLOGIES

5.1 GENERAL

The purpose of second-tier screening was to short-list the number of technologies being considered for further evaluation. This section contains a description of this second-tier screening process.

5.2 SCREENING CRITERIA FOR SHORT-LISTING TECHNOLOGIES

In order to develop second-tier screening criteria, a review of the reports from previous studies done for the City was conducted. Information was also obtained on the current waste management conditions and requirements on Oahu. The resultant screening criteria included the following:

- **Waste Stream Application.** The waste stream application criterion requires that the selected technology be capable of diverting the waste streams selected for the study. The waste streams selected for inclusion in the NSR study are all wastes that are currently being disposed of at the Waimanalo Gulch Landfill. Waste being sent to H-POWER and ash from H-POWER are excluded from the NSR study. The composition of the Waimanalo Gulch Landfill waste (see Table 3-1) is 31.2 % wood (13.9% treated wood), 8.9% paper, 12.3% metal (6.7% ferrous), 5.0% plastics, 5.1% furniture, 4.5% carpet and 20.0% inorganics (7.0% wallboard). Other listed materials are largely wastes with existing treatment programs, such as composting. This waste composition, particularly the high percentage of treated wood, strongly influenced the selection of technologies.

- **Volume Reduction Performance.** The volume reduction performance screening criterion requires that the selected technology should provide capability for diverting or reducing the volume requiring disposal for a major portion of the waste stream.

- **Past Operating Performance.** The proven past operating performance screening criterion requires that the selected technology have a successful operating record in a municipality that has a similar material processing need as the City. It may be innovative but not experimental.

- **Past Economic Performance.** The proven past economic performance screening criterion requires that the selected technology should be cost effective when compared to the City's existing landfill costs.

- **Environmental Risk.** The environmental risk screening criterion requires that the selected technology should be "Environmentally Friendly," that is, not damage or degrade the environment, be "Island Friendly," readily adapted to the climate, geography, economy, culture and lifestyle of Oahu. The technology must be readily permitted, involving no difficult regulatory hurdles or delays.

5.3 RANKING THE SEVEN TECHNOLOGY ALTERNATIVES

The seven technologies were evaluated against each of the criteria and scored as low, medium or high. A score of one (1) was assigned to a low level of compliance; a score of two (2) was assigned to a medium level of compliance, and a score of three (3) was assigned to a high level of compliance.

The technologies were ranked based on the total score for each. The technologies that had the highest composite score and met the City's selection criteria were selected for further final evaluation in NSR study.

A technical panel reviewed the seven technologies in light of the screening criteria and scored each technology on its advantages and disadvantages relative to each criterion

5.4 TECHNOLOGY ALTERNATIVES REJECTED

Alternatives 1, 2B, 3, 4 and 5 were not short-listed for further evaluation. Key reasons for this are explained below. Evaluations conducted by the NSR staff indicated that even though these technologies were not short-listed, they may be worthy of further consideration in the future.

- **Alternative 1, Plasma Oxidation/Vitrification Followed by Conversion of Heat to Electricity in a Boiler.** This alternative was not short-listed for further evaluation because it uses an oxidation process. Oxidation processes would have a large gaseous waste stream and would need state-of-the-art and expensive air pollution control systems to eliminate the reformation of toxic organic gases (such as dioxins and furans) in their gaseous waste stream. Energy recovery in an oxidation system must be accomplished in steam boilers that have very low heat-to-electricity conversion efficiency.

- **Alternative 2B, Plasma Gasification Followed by Syngas Conversion to Methanol.** This alternative was not short-listed for further evaluation because, while converting syngas to methanol is a common process in refinery plants, it is a novice application in a refuse management system and its economics are not proven at this time.

- **Alternative 3, Rotary Kiln Gasification/Slagging Followed by Syngas Conversion to Methanol.** This alternative was not short-listed for further evaluation because it would require the use of natural gas or oil for converting refuse to syngas. Also, converting syngas to methanol is a novice application in a refuse management system and its economics are not proven at this time.

- **Alternative 4, Low Temperature Pyrolysis and Conversion of Refuse to Oil.** This alternative was not short-listed for further evaluation because it does not meet the past performance criterion and its technical, environmental and economic risks are unknown at this time.

- **Alternative 5, Conversion of Wood and Plastic Waste to ECO-Lumber.** This alternative was not short-listed for further evaluation because of the following key reasons: 1) extensive front-end sorting of the refuse would make the operations impractical and costly; 2) liabilities associated with converting a preservative-containing wood waste to a useful product was unknown; 3) the size of the market for selling eco-lumber was unknown; and 4) the technical, environmental and economic risks are unknown at this time.

5.5 SHORT LISTED TECHNOLOGY ALTERNATIVES

The following alternatives received the highest scores and are recommended for further evaluation.

- **Alternative 2, Plasma Gasification/Vitrification Followed by Converting Syngas to Electricity.** Alternative 2 uses a series of high-temperature plasma torches to decompose all organic components of the bulk waste stream and to melt inorganic residues into a glass-like slag. This alternative was ranked in the top three because of several advantages, including environmentally safe treatment of preservative contaminated wood wastes, environmental friendliness, production of the much needed electricity for the region, and significant reduction in the City's landfill space requirements

- **Alternative 6, Metal Recycling.** Metals recovery and recycling alternative uses magnetic fields and eddy currents to remove metals from a stream of shredded waste that passes by on a belt conveyor or similar device. Typically, magnets recover ferrous metals and eddy-current devices remove non-ferrous metals. This alternative was short-listed for further evaluation because ferrous metal recovery is a proven recycling method and there is no need for further R&D on this technology. City is already practicing metal recovery at the H-POWER facility and metal recycling application to the Waimanalo Gulch Landfill refuse stream could also be implemented without major difficulty.

- **Alternative 7, Gypsum Recycling**. The scrap gypsum wallboard recycling technology was short-listed for further evaluation because the technology is a proven recycling method and there is a likely market for its product in Hawaii.

Table 5-1. Evaluation and Scoring of Technologies

Alternative	Waste Stream Application	VR Performance	Past Operating Performance	Past Economic Performance	Environ-mental Risk	Total Score
Alt 1 – Plasma Oxidation./ Vitrification	3	2	2	1	1	9
Alt 2A – Plasma Gasification./ Vitrification / Electricity	3	3	1	1	3	11
Alt 2B – Plasma Gasification./ Vitrification / Methanol	3	3	1	1	2	10
Alt 3 – Rot. Kiln Gasification./ Slagging / Methanol	3	3	1	1	2	10
Alt 4 – Low Temp. Pyrolysis	2	2	1	1	2	8
Alt 5 – Wood/Plastic to eco-lumber	1	3	1	1	3	9
Alt 6 – Metals Recycling	2	3	3	2	3	13
Alt 7 -Gypsum Recycling	2	3	3	2	3	13

Scores:
1 = Low level of compliance with evaluation criteria.
2 = Medium level of compliance with evaluation criteria.
3 = High level of compliance with evaluation criteria.

SECTION 6

FACILITY CONCEPTS FOR SHORT LISTED TECHNOLOGIES

6.1 GENERAL

In order to allow a more detailed evaluation, pre-conceptual designs were done for the three short-listed technologies in Section 5. The designs include the basic ancillary systems needed to implement the given technology. The three integrated facilities are given the following names:

- Plasma Generating Station
- Metal Recycling Plant
- Gypsum Recycling Plant

The integrated facilities pre-conceptual design includes a block diagram, a facility functional block flow diagram and a facility plot plan. The pre-conceptual characterization of the options also identifies the functional, operational and performance aspects of the overall system and the key unit operations. Based on the pre-conceptual characterization of the facilities, rough order of magnitude (ROM) capital and operating costs for each of the alternatives are presented herein.

6.2 PLASMA GENERATING STATION

The integration of a plasma generating facility into the existing City refuse management system is shown on **Figure 6-1. Figure 6-2** shows a functional flow diagram for the station. **Figure 6-3** shows a footprint of the major unit operations and the overall land requirements for the Plasma Generating Station.

6.2.1 Facility Description

The Plasma Generating Station will use a plasma gasification and vitrification system and other ancillary equipment to convert the incoming trash into electricity, which can be fed to the Hawaiian Electric Company (HECo).

The station will be located on a 15-acre site and will have an incoming truck receiving, staging and dumping area. An area in the station will be provided for accumulating the incoming waste as needed for surge storage.

3-9

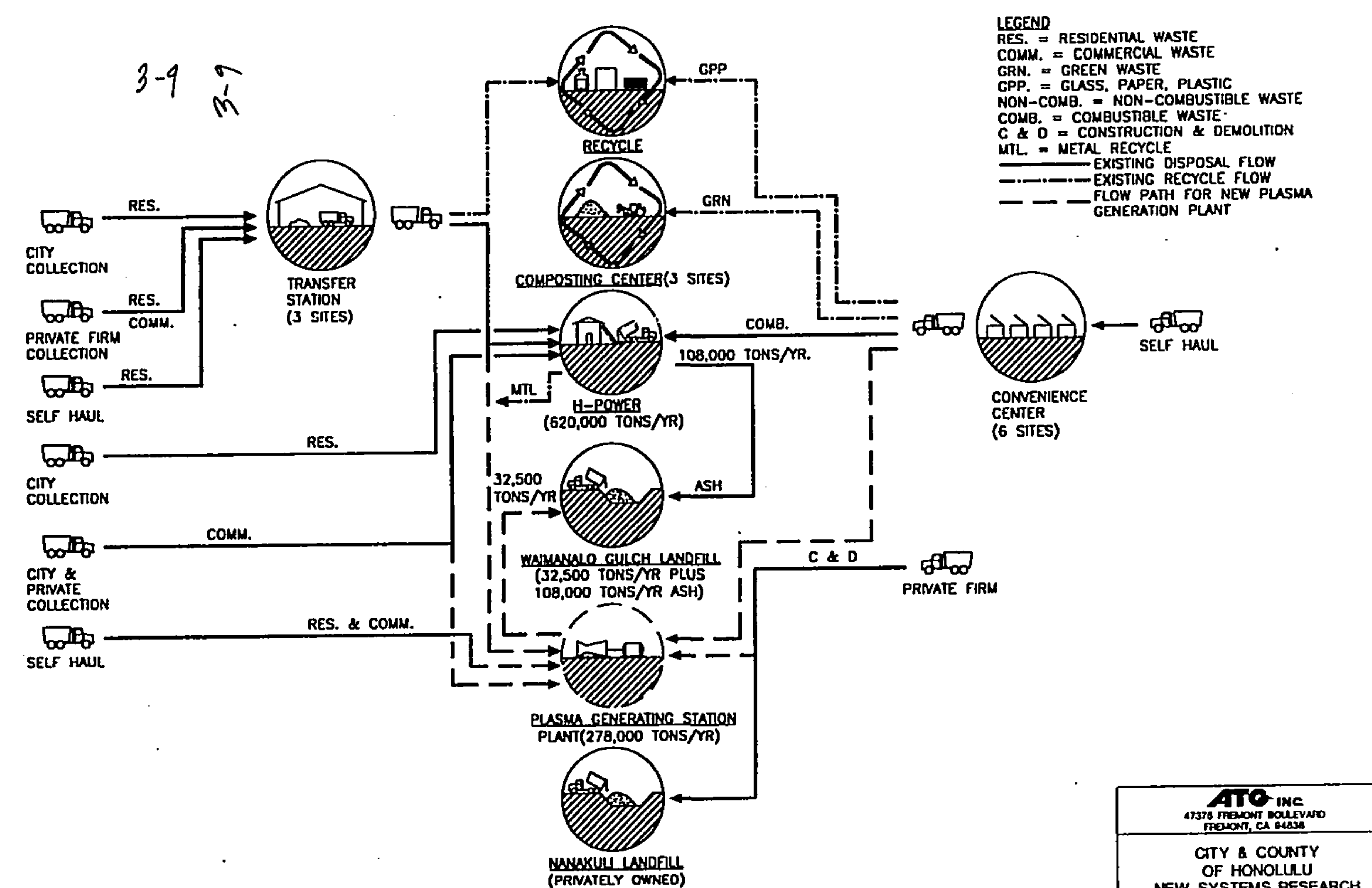

FIGURE 6-1 BLOCK DIAGRAM FOR INTEGRATING PLASMA GENERATING STATION INTO EXISTING SYSTEM

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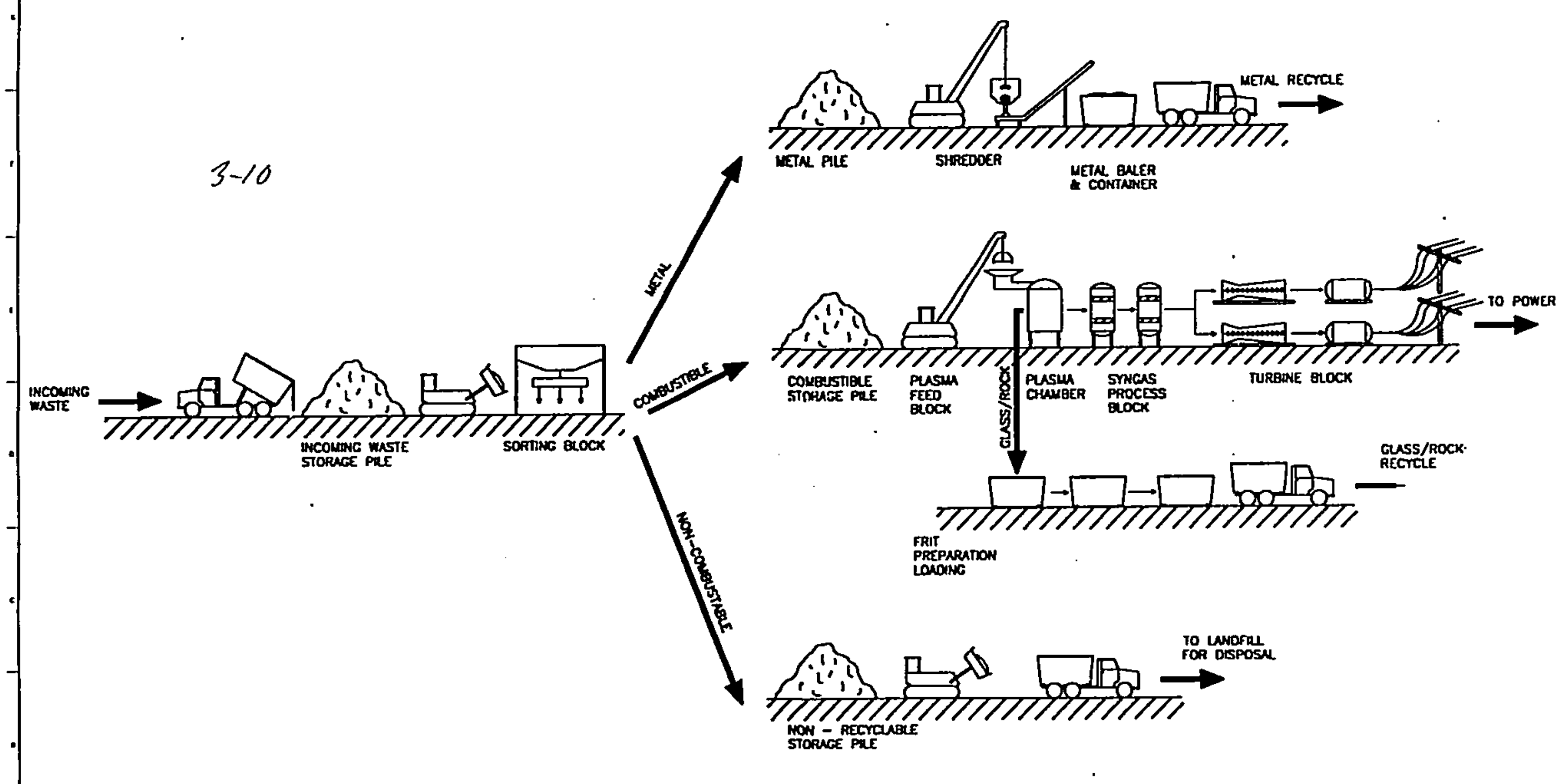

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FIGURE 6-2 BLOCK DIAGRAM FOR PLASMA GENERATING STATION

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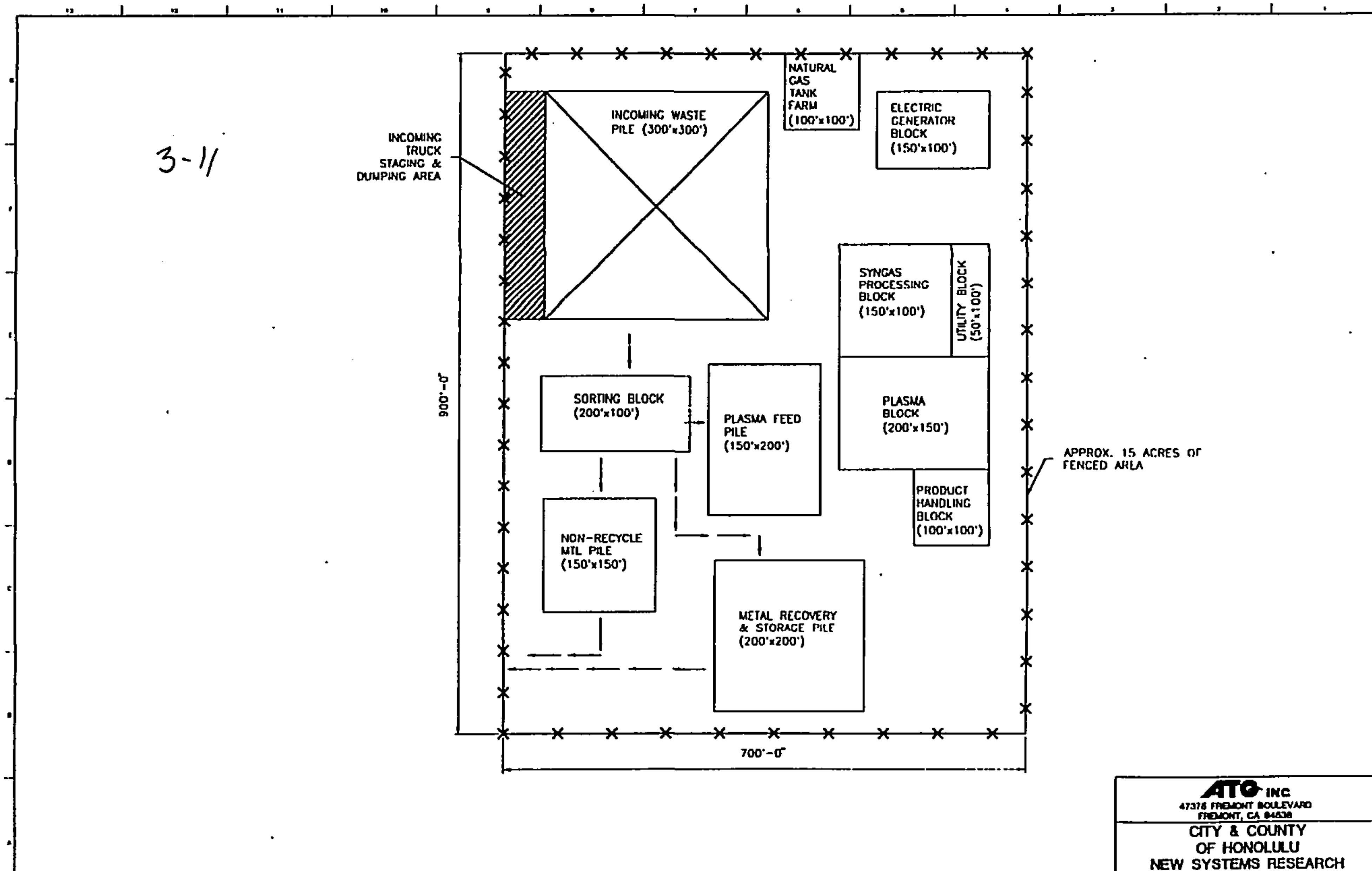

FIGURE 8-3 LAND SIZE REQUIREMENTS FOR PLASMA GENERATING STATION

As shown in **Figure 6-1**, almost all of the City, private firm and self-hauling refuse trucks going to the Waimanalo Gulch Landfill will be diverted to the Plasma Generating Station. Construction and demolition waste haulers will be encouraged to segregate wood-containing debris waste at its source and transport it directly to the Plasma Generating Station.

The material in the incoming waste storage pile will be transferred to a sorting unit. The sorting unit considered in this study is based on an integrated system being marketed by Lube-USA. The unit will have capability to segregate the waste into three categories: combustible, metals and non-recyclable refuse. The sorting unit will transfer each of the three refuse streams to a storage pile. These include storage piles for the refuse to be fed to the plasma unit, metal recycling and the non-recyclable material that must be shipped offsite.

The plasma unit considered in this study is based on the technology being marketed by Integrated Environmental Technology (IET) of Richland, Washington. The unit will have a feed system that will prepare and feed the incoming refuse to the plasma chamber. The IET plasma chamber will have both a direct current (DC) plasma arc system and a Joule heating system. The plasma chamber will be designed for operation in a gasification mode. A treatment train will be provided to treat the gaseous product to produce a synthesis gas (or syngas). The inert product, metal, glass/rock will be converted into re-usable material by a product handling subsystem.

A set of turbine generators, including all of the associated electrical and mechanical support units, will be provided to convert the plasma system syngas into electricity. The gas turbine considered in this study is based on industrial gas turbine technology being marketed in the US by TUMA Turbinematch, SA, of Switzerland.

The turbine block will also have a natural gas tank farm. The turbine will use natural gas during the station start-up, maintenance down times, and idle periods. During normal operation, it is anticipated that approximately 60% to 80% of the electricity will be used internally. The remaining power produced by the station will be sold.

The sorting system at the Plasma Generating Station will be upgraded to include metal recovery, since this feature can be added with only minor capital cost. The metal sorting part of the station will include magnetic separation devices at the sorting station, bulk size reduction units, and metal shredding units.

The station will consist of the following unit operations:

- **Incoming Truck Staging & Dumping.** Incoming waste will be brought to the station by refuse trucks and unloaded in the incoming truck staging area. A loader will be provided to pile up the incoming waste.

- **Sorting.** The sorting unit will have material transport conveyors, receiving hoppers and a primary and secondary crushing, sorting, and separation mechanisms. The unit reduces the size of the input feedstock and sorts the output into three waste streams: combustible, metals, and non-recyclable refuse. The metal sorting unit has a crane loader with a magnetic lifting rig. The loader transfers the material from the sorting and metal pile to various unit operations.

- **Metal Recycle.** The metal recycle unit will have a crane loader with a magnetic lifting rig. The loader transfers the material from the pile and places it into a shredder. The shredder reduces the size of the metals.

- **Non-Recyclable Waste Loading.** The non-recyclable waste loading unit has a surge storage pile, loaders and dump trucks. The trucks transport the waste to the Waimanalo Gulch Landfill.

- **Plasma Feeder.** The plasma feed unit has a surge storage pile, loaders and a feed conveyor.

- **Plasma Chamber**. The plasma chamber unit will consist of a refractory-lined plasma chamber, an air-lock feeder, a metal product discharge port, a glass/rock product discharge port, a DC arc plasma system, a joule heating electrode system, and the associated controls.

- **Syngas Processing Unit.** The syngas processing unit consists of an acid gas and particulate filtration train, induced draft fans and final particulate filters.

- **Turbine Generator.** Two sets of turbine generators convert the syngas to electricity. The generators will use either natural gas or syngas or both. The unit also includes a switchyard that will integrate the power from the station with the outside electrical transmission grid.

- **Natural Gas Tank Farm.** The tank farm stores natural gas as needed for the operation of the turbine generators during the initial start-up of the facility and to subsidize the generation of the syngas whenever the plasma unit is down for maintenance and during idle period.

- **Product Handling.** The product handling unit converts molten glass/rock from the plasma chamber into a grit of gravel size so that it can be used for road construction or other applications.

6.2.2 Functional and Operational Requirements

It is envisaged that the facility will meet the following functional and operational requirements.

- **Function.** The Plasma Generating Station will receive, sort and process for recycling and energy recovery in the form of electrical power, a major portion of the City refuse that is currently being sent to Waimanalo Gulch. The station will segregate combustible material and metals from the incoming wastes and return any non-recyclable refuse to Waimanalo Gulch for landfill disposal. Metals will be size-reduced and packaged in containers ready for shipment to offshore recycling steel mills. The station will use the segregated combustible refuse as a feedstock to the plasma gasification/vitrification system. This plasma system will convert the organic content of the feedstock into a synthesis gas, which will be cleaned and used in a turbine generator to produce electricity. The inert material, including metals, contained in the station will be converted into a material that is recyclable.

- **Operations.** Almost all of the refuse trucks currently transporting refuse to Waimanalo Gulch will be diverted to the Plasma Generating Station. It is estimated that the refuse received by the Plasma Generating Station will be approximately 278,000 tons per year. The plasma system will process approximately 70% (or 195,000 tons per year) of the incoming refuse. The composition of this waste is anticipated to be as follows:

8.9% paper + 5% plastic + 31.2% wood + 16% furniture and carpet + 10% inorganic composite = 70%

It is estimated that the remaining 30% (or 30% X 278,000 tons/yr = 83,000 tons/yr) of the incoming refuse will be either scrap metal or a non-recyclable material (such as concrete and soils). The scrap metal can be processed by the metal recycling portion of the station. Non-recyclables (such as concrete and soils) are not economical for vitrification and must be sent to the landfill for disposal. The metal recycling portion of the station will recover approximately 90% of the available scrap metal (i.e., 0.9 x 12.3% x 278,000 = 31,000 tons per year from the refuse currently being sent to the Waimanalo Gulch Landfill. The remaining refuse, approximately 52,000 tons/year will be sent to the landfill. Also, it is estimated that approximately 10% of the waste processed by the plasma system (or 70% X 278,000 tons/yr. X 10% = 19,500 tons per year) will be a glass-like material which will be recycled for use as road or construction concrete aggregate. The station will operate 24 hours per day and 330 days per year. To calculate the operating cost, we have assumed that the waste receiving and dumping operations will operate approximately 7 hours per day and 355 days per year. The metal recycling receiving operations will operate approximately 7 hours per day, 22 days per month and 12 months per year.

- **Performance**. Metal recovery efficiency will be approximately 90% of the total incoming ferrous metals. Waste segregated for plasma feed operations will have approximately 70% combustible material. The station will be self-powered and will produce approximately 300 kwh of excess power per ton of waste processed by the plasma unit.

- **Permitting**. The station will require an NPDES permit for liquid discharges. Clean air permit will be required for turbine generator units. Fugitive emissions will be minimized through design. A State of Hawaii, Department of Health, solid waste permit will be required for construction and operation of the facility.

- **Design, Installation and Construction**. The station will be designed, installed and constructed to meet the national and local codes and standards. All equipment and systems will be designed for outdoor installation. Equipment will be pre-assembled and tested at the factory to minimize delays due to field start-up problems.

6.3 METAL RECYCLING PLANT

The integration of a metal recovery plant into the existing City refuse management system is shown on **Figure 6-4. Figure 6-5** shows a functional flow diagram for the plant. **Figure 6-6** shows the footprint for the major unit operations and the overall land requirements for the metal recycling plant.

6.3.1 Facility Description

The metal recycling plant will use sorting and shredding technologies to recover ferrous metals from the incoming refuse. The recovered metals will be sent to the existing recycling companies.

Special containers (e.g., roll-off bins) for metal recycling will be placed at the Waimanalo Gulch Landfill. The operating personnel will remove metal containing objects from the incoming refuse and place them on the recycling containers. Trucks, provided by the metal recycling plant, will transport the containers to the metal recycling plant. Private C&D waste haulers will be encouraged to segregate metal-containing refuse at its source and transport it directly to the recycling plant.

The plant will be located in an approximately 8-acre site and will have an incoming truck receiving, staging and dumping area. An area in the station will be provided for accumulating the incoming waste as needed for surge storage.

The material in the incoming waste storage pile will be transferred to a sorting unit. The sorting unit considered in this study is based on an integrated system being marketed by Innovative Recycling Systems, Inc., of Solon, Ohio. The unit will have capability to segregate the waste into two categories: metals and non-recyclable refuse. The sorting unit will transfer each of the two refuse streams to a surge storage pile.

The metal recycling unit will include magnetic loading devices that will transfer the metals to various unit operations. First the material will be sent to an area for bulk size reduction using large hydraulic shears and balers. The size-reduced material will be placed on a conveyor that leads to a shredder. The metals will be shredded and made ready for shipment to markets.

3-12

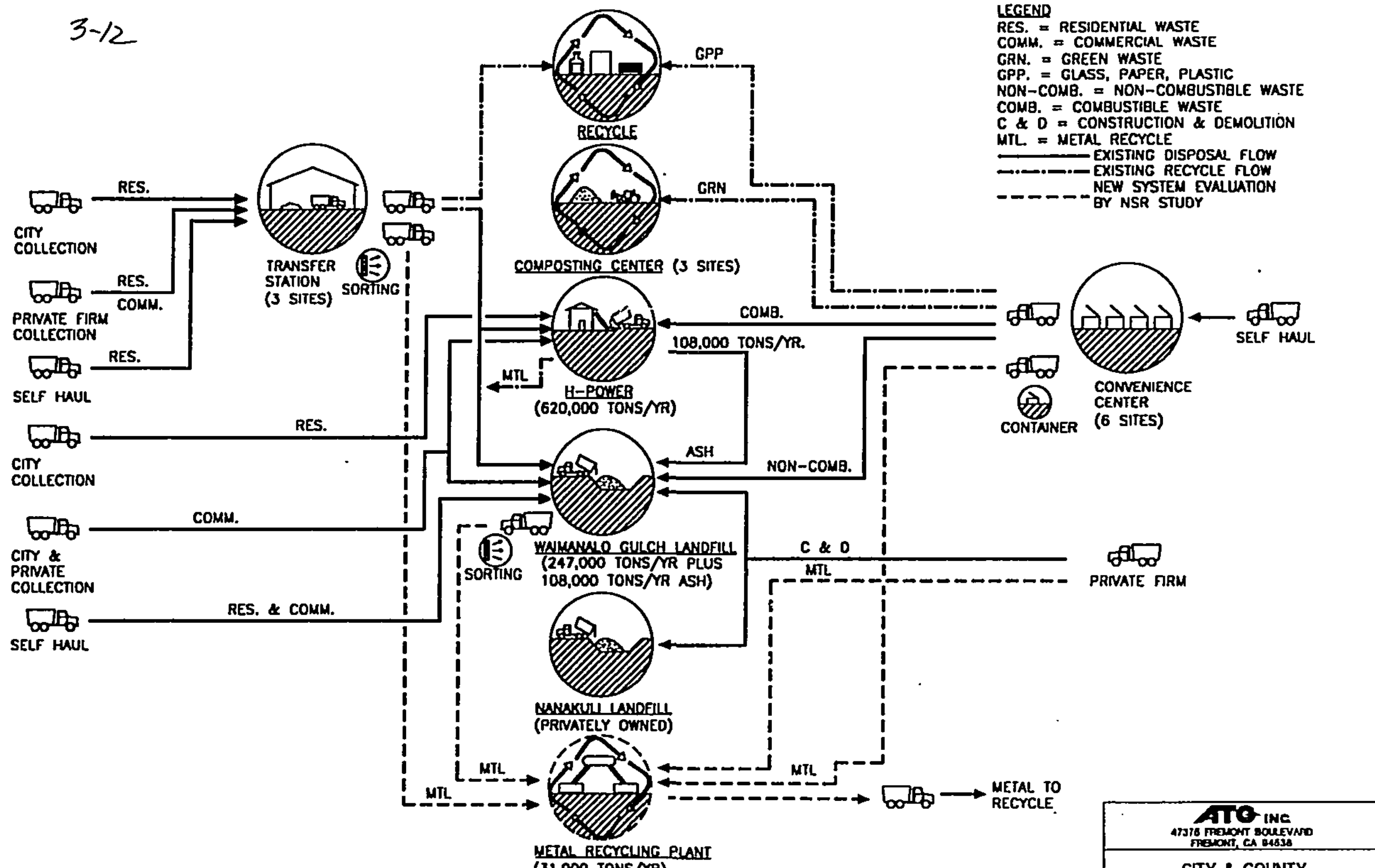

FIGURE 6-4 BLOCK DIAGRAM FOR INTEGRATION OF METAL RECYCLING PLANT INTO EXISTING SOLID WASTE

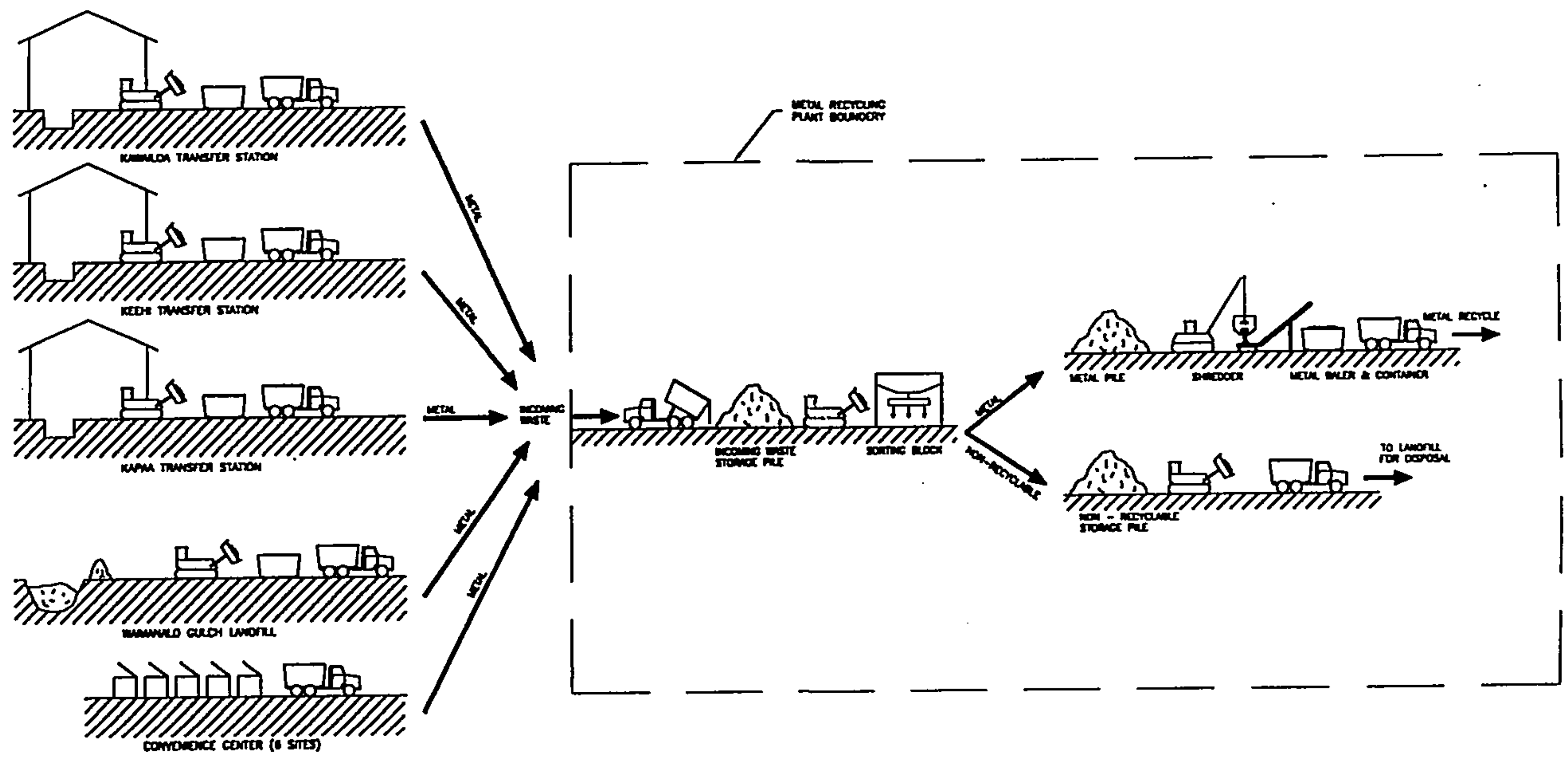

FIGURE 6-5 BLOCK DIAGRAM FOR METAL RECYCLING PLANT

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FREMONT, CA 94538

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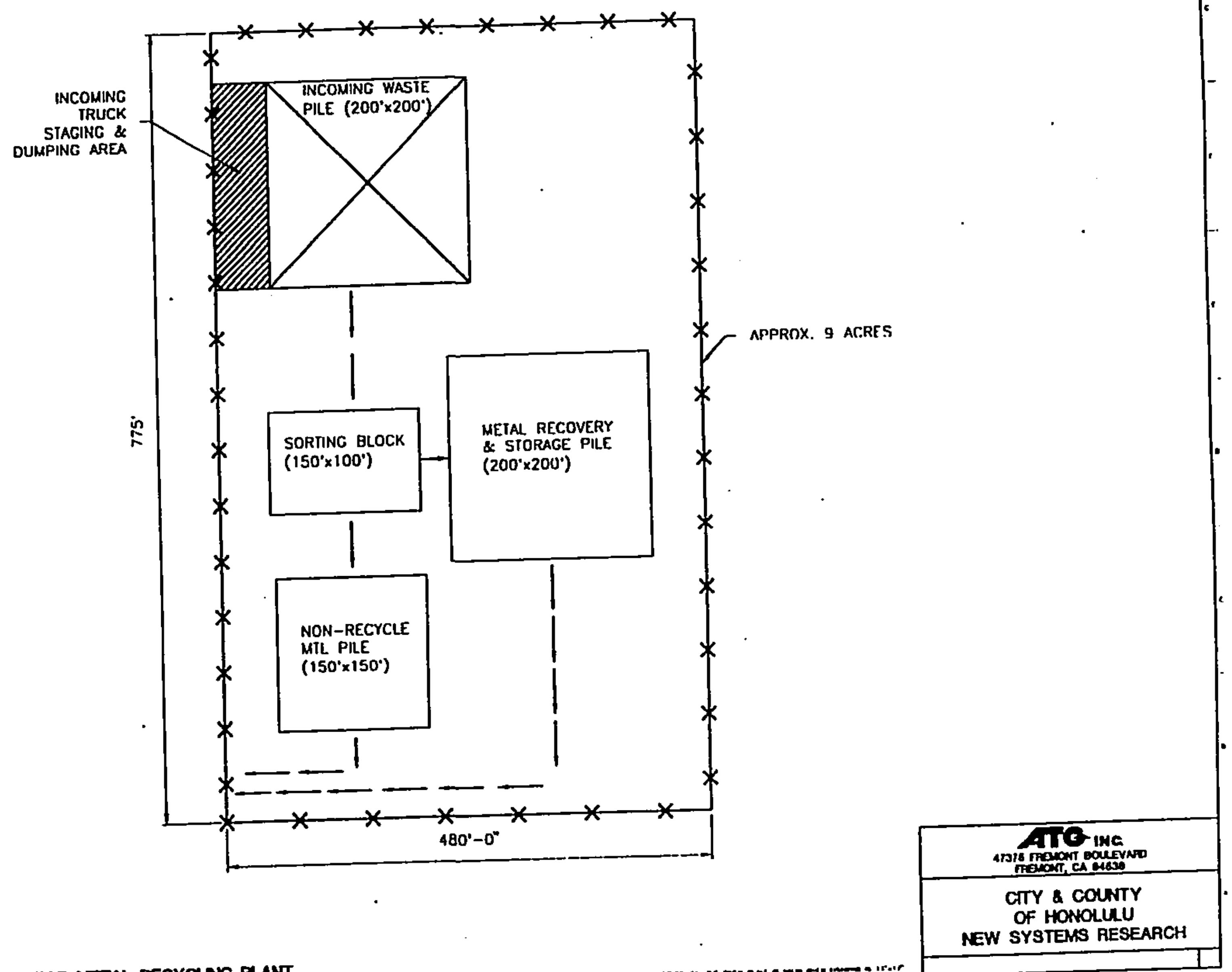

FIGURE 6-6 LAND SIZE REQUIREMENTS FOR METAL RECYCLING PLANT

The plant will consist of the following unit operations:

- Incoming Truck Staging & Dumping. Incoming waste will be brought to the facility by trucks and unloaded in the incoming truck staging area. A loader will be provided to pile up the incoming waste.

- **Sorting.** The sorting unit will have material transport conveyors, size reducing devices, and magnetic separation mechanisms. Large structural steel members will not be fed to the sorting unit. Only bulk composite material will be processed by the sorting device. The unit reduces the size of the input feedstock and sorts the output into two waste streams: metals, and non-recyclable refuse.

- **Bulk Size Reduction.** The bulk size reduction area will have large hydraulic sheer and plasma torches that will be used to reduce large metal objects and structural members to a size that can be fed to the shredding devices.

- **Shredders.** The shredder reduces the size of the metals.

- **Non-Recyclable Waste Loading.** The non-recyclable waste loading unit has a surge storage pile, loaders and dump trucks.

6.3.2 Functional and Operational Requirements

It is envisaged that the metal recycling plant will meet the following functional and operational requirements.

- **Function.** The metal recycling plant will receive, sort and process for recycling bulk and composite material containing ferrous metal. The plant will segregate metals from the incoming wastes and return any non-recyclable refuse to the Waimanalo Gulch Landfill for disposal. Metals will be size reduced and delivered to the recycling companies.

- **Operations.** It is estimated that the metal recycling plant will receive approximately 11.5% (6.7% ferrous metals and the 4.8% mixed/other material) of the 195,000 tons of refuse currently being sent to the Waimanalo Gulch Landfill. This is approximately 22,500 tons per year. The plant will recover approximately 90% of the incoming metal, which is roughly 20,200 tons of metal per year. The remaining amount, approximately 2,300 tons/year, will be sent to the landfill. The metal recycling plant will operate approximately 7 hours per day, 22 days per month and 12 months per year.

- **Performance.** The metal recovery efficiency will be approximately 90% of the total incoming ferrous metals.

- **Environmental Permitting.** The plant will require a Clean Air Act permit for the dust collector. No other major environmental permits are anticipated. Fugitive emissions will be minimized through design, and will also be subject to permitting. A State of Hawaii, Department of Health, solid waste permit will be required for construction and operation of the facility.

- **Design, Installation and Construction**. The plant will be designed, installed and constructed to meet the national and local codes and standards. All equipment and system will be designed for outdoor installation. Equipment will be pre-assembled and tested at the factory to minimize delays due to field start-up problems.

6.4 GYPSUM RECYCLING PLANT

The integration of a gypsum recycling plant into the existing City refuse management system is shown on **Figure 6-7. Figure 6-8** shows a functional flow diagram for the plant. **Figure 6-9** shows the footprint for the major unit operations and the overall land requirements for the gypsum recycling plant.

6.4.1 Facility Description

The gypsum recycling plant will use pulverizing and screening technologies to recover gypsum from gypsum wallboard. The descriptions contained in this report are based on systems being marketed by Andela Tool and Machine, Inc., of Richfield Springs, NY, and Gyp-Pack Container, Inc., of Tonowanda, NY.

Roll-off bins for gypsum recycling will be placed at the Waimanalo Gulch Landfill. The site operator will remove the discarded gypsum wall boards from the incoming refuse and place them in the recycling containers. Trucks, provided by the gypsum recycling plant, will transport the containers to the gypsum recycling plant. Private C&D waste haulers will be encouraged to segregate gypsum-containing refuse at the source and transport it directly to the recycling plant.

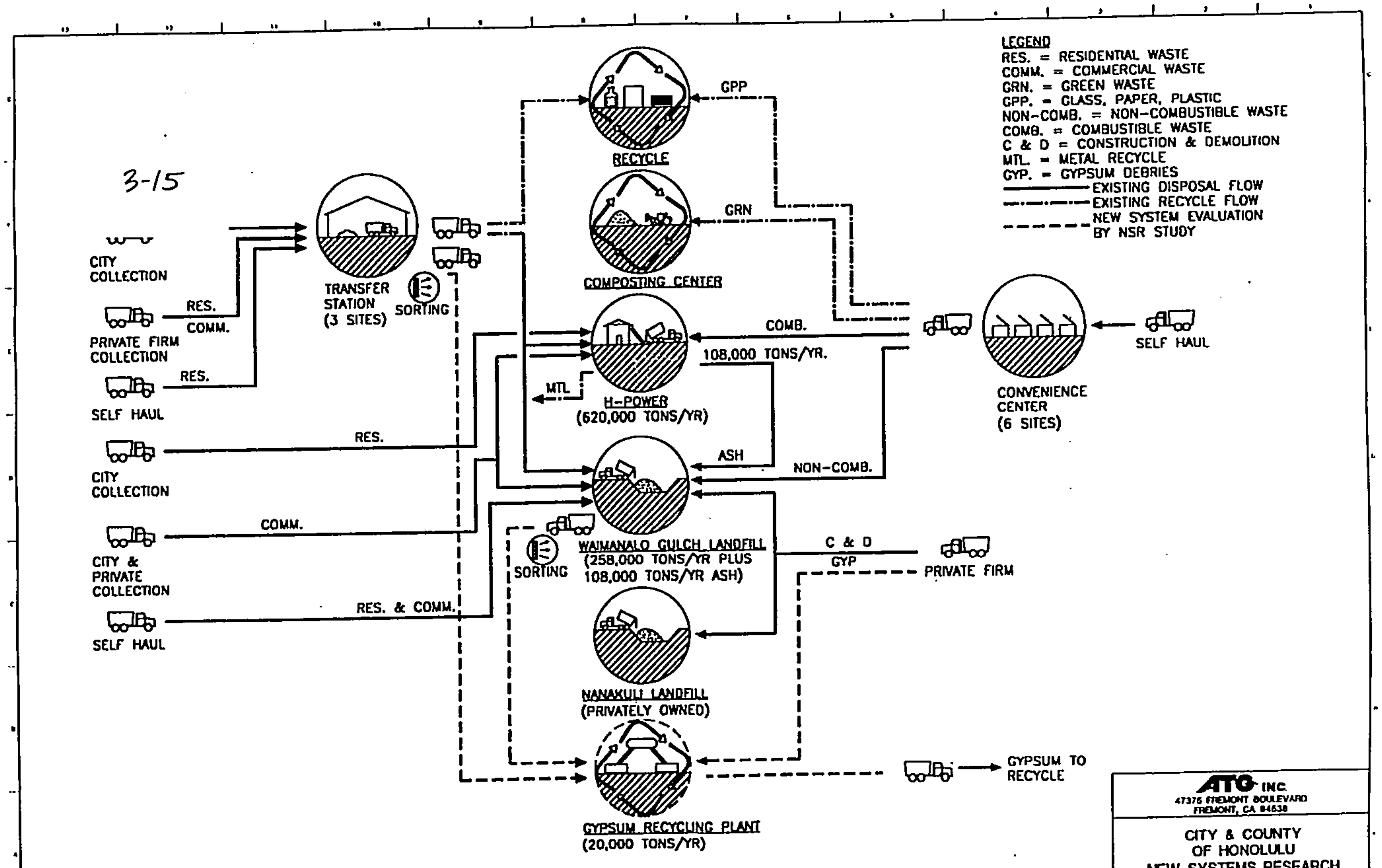

FIGURE 6-7 BLOCK DIAGRAM FOR INTEGRATION OF GYPSUM RECYCLING PLANT INTO EXISTING SOLID WASTE

3-16

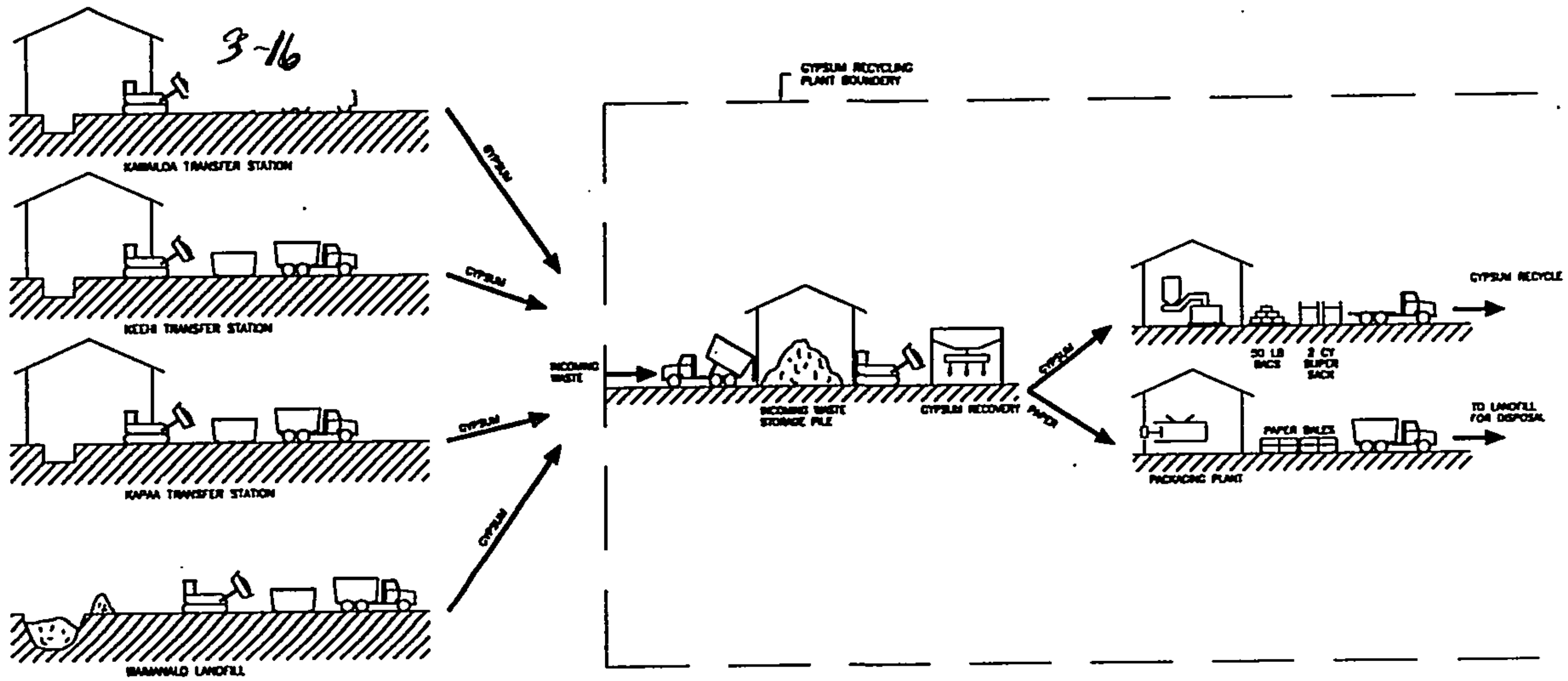

FIGURE 6-8 BLOCK DIAGRAM FOR GYPSUM RECYCLING PLANT

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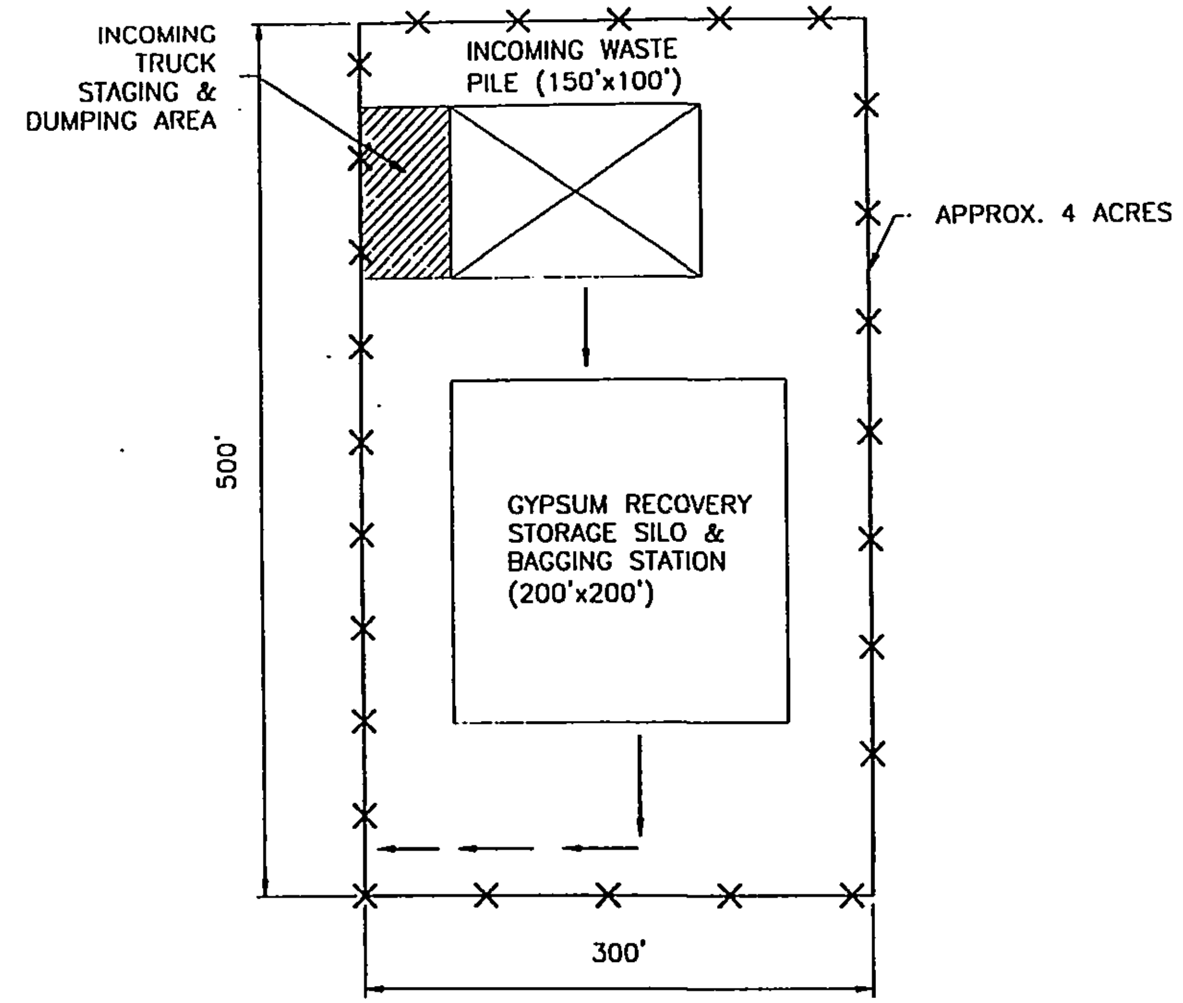

3-17

FIGURE 6-9

LAND SIZE REQUIREMENTS FOR GYPSUM RECYCLING PLANT

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The gypsum recycling plant will receive the incoming gypsum, crush and separate the non-recyclable material and package the recyclable gypsum. The packing unit operation will bag gypsum in either 50-pound bags or 2-cubic yard plastic sacks (super-sack). The packaged products will be sold as a soil additive in bags at retail markets or in bulk to the agricultural industry. Sale of recycled gypsum product to other markets, such as oil absorbents in the environmental industry, will also be pursued.

The plant will be located on a 4-acre site and will have an incoming truck receiving, staging and dumping area. An area in the station will be provided for surge storage of the incoming gypsum wallboard. The storage area will be covered to keep rainwater away from the scrap wallboard storage area.

The scrap wallboard will be spread on a flat area in the storage building. A loader equipped with a wheel crusher/roller will be performing an initial bulk size reduction. The crushed scrap wallboards will then be moved by belt conveyor to the infeed hopper. The hopper delivers a metered quantity of gypsum to a separator. The separator will remove the paper facing from the gypsum wallboard and break down the gypsum core into powder. The output from the separator is delivered to a trommel separator.

The trommel screens the paper from gypsum and deposits each product on a separate conveyor beneath the trommel. The gypsum conveyor delivers the gypsum to the bagging station silos. At the bagging station, gypsum will be filled into special bags and containers designed for each market.

The paper waste will be sent to H-POWER for use as fuel and for energy recovery.

- **Incoming Truck Staging & Dumping.** Incoming roll-off bins will be brought to the facility by trucks. This unit operation will also accept dump trucks. A loader will be provided to assist in the gypsum unloading, piling and transfer operations. Before feeding the gypsum to the separator unit, the loader will spread the pile into a flat layer. A wheeled crusher will perform initial bulk size reduction.

- **Separator** The separator unit will have infeed conveyors, hoppers, pulverizers, trommels, and product output conveyors. The unit receives dry gypsum wall board, crushes the boards, separates the facing paper from gypsum, grinds the gypsum to a powder consistency and deposits the gypsum and paper output on discharge conveyors.

- **Bagging Station.** This unit operation will have receiving silos, transfer conveyors, load cell weight platforms and bag and container filling stations. The unit will surge store recyclable gypsum and produces various sizes of bagged gypsum ready for transportation to outside markets.

6.4.2 Functional and Operational Requirements

The gypsum recycling plant will meet the following functional and operational requirements.

- **Function.** The gypsum recycling plant will receive pre-sorted scrap gypsum wallboards. The plant will remove the facing paper from scrap wallboard, grind gypsum to a powder, and bag the powdered gypsum ready for sale in various markets. The paper waste will be taken to H-POWER for use in energy recovery.

- **Operations.** It is estimated that the gypsum recycling plant will receive approximately 7% of the City's refuse that is currently being sent to Waimanalo Gulch. This is equal to 20,000 tons per year. The plant will recover approximately 90% of the incoming gypsum, which is roughly 18,000 tons per year. The remaining amount, approximately 2,000 tons/year, is waste paper that will be sent to H-POWER. The gypsum recycling plant will operate approximately 7 hours per day, 22 days per month and 12 months per year.

- **Performance.** The gypsum recovery efficiency will be approximately 90% of the total incoming scrap gypsum.

- **Environmental Permitting.** The plant will require a Clean Air Act permit for the dust collector. No other major environmental permits are anticipated. Fugitive emissions will be minimized through design. A State of Hawaii, Department of Health, solid waste management permit will be required for construction and operation of the facility.

- **Design, Installation and Construction.** The plant will be designed, installed and constructed to meet the national and local codes and standards. All equipment and systems will be designed for outdoor installation. Equipment will be pre-assembled and tested at the factory to minimize delays due to field start-up problems.

6.5 ROM LIFE-CYCLE COSTS

6.5.1 ROM Capital Cost Estimate

ROM capital cost estimates for the three alternatives are shown on **Tables 6-1, 6-2 and 6-3**. Due to the pre-conceptual nature of the estimate, a 25% contingency has been added to the total estimated cost for each alternative. The cost is based on prices in effect in the third quarter, 1999. The estimates assume that a private sector firm will design, construct and operate the facilities. Furthermore, it is assumed that all equipment will be pre-assembled, skid mounted and tested to the extent practical in manufacturer's facility before it is shipped to the site.

6.5.2 ROM Operating Estimate

ROM operating costs for the three alternatives are on **Table 6-1, 6-2 and 6-3.** The O&M labor costs are based on an average labor salary of $40,000 per year and a supervisory personnel salary of $55,000 per year. The direct salary is multiplied by a factor of 1.3 to allow for employment tax, social security and fringe benefits.

Due to the conceptual level of the estimate, a 25% contingency has been included to the total estimated annual O&M costs. As mentioned above, it is assumed that the facility will be owed and operated by a private sector firm.

Table 6-1. ROM Capital and O&M Cost Estimates for Plasma Generating Station

Line No.	Activity Description	Estimated Cost ($ x 1000)
100	**Engineering and Home Office**	
101	Home Office Engineering (3% of Equipment & Construction)	$3,003
102	Architect Engineering (6% of Equipment & Construction)	$6,006
103	Environmental/Permits (3% of Equipment & Construction)	$3,136
104	**Subtotal**	**$12,146**
200	**Process, Non-Process and Auxiliary Equipment**	
201	Incoming Truck Staging & Dumping	$1,800
202	Sorting	$2,000
203	Metal Recycle	$1,400
204	Non-recyclable Refuse Loading.	$600
205	Feed	$4,000
206	Plasma System	$45,000
207	Turbine Generator	$8,500
208	Natural Gas Tank Farm	$1,200
209	Product Handling	$800
210	Utilities.	$1,100
211	**Subtotal**	**$66,400**
300	**Construction**	
301	Site Development (Grading, Roads & Paving, etc.)	$2,250
302	Process and Auxiliary Buildings	$2,750
303	Mechanical (10% of equipment)	$6,640
304	Electrical/Instrumentation (15% of equipment)	$9,960
305	Yard Utilities (1.2% of equipment)	$797
306	Super-structures (1.5% of equipment)	$996
307	Substructures (Equipment Pads, etc.)	$1,400
308	Painting (1.5% of equipment)	$996
309	Subtotal Direct Costs	$25,789
310	Contractor Overhead and G&A (21% of Directs)	$5,416
311	Contractor Fee (8% of Direct & Indirects)	$2,496
312	**Subtotal**	**$33,701**
400	**Misc.**	
401	Freight, Taxes and Insurance (12% of Equipment and Construction)	$12,012
402	Subtotal Project	$124,258
403	Contingency (25% of Project Subtotal)	$31,065
500	**ROM Capital Cost Estimate**	**$155,323**

Line No.	Activity Description	Estimated Cost ($ x 1000)
600	**Annual Operating and Maintenance**	
601	Operating Labor (7 crews)	$2,685
602	Maintenance Labor (2 crew)	$767
603	Maintenance Parts & Equip Replacement Cost (10% of Equipment Capital)	$6,640
604	Fuel/Electricity/Water. Etc.	$749
605	Consumables	$403
606	Tax Insurance & License Fees	$600
607	**Subtotal**	**$11,843**
608	Contingency (25% of O&M Subtotal)	$2,961
700	**ROM Annual O&M Cost Estimate**	**$14,804**

Table 6-2. ROM Capital and O&M Cost Estimates for Metal Recycling Plant

Line No.	Activity Description	Estimated Cost ($ x 1000)
100	**Engineering and Home Office**	
101	Home Office Engineering (3% of Equipment & Construction)	$220
102	Architect Engineering (6% of Equipment & Construction)	$440
103	Environmental/Permits (3% of Equipment & Construction)	$181
104	**Subtotal**	**$841**
200	**Process, Non-Process and Auxiliary Equipment**	
201	Incoming Truck Staging & Dumping	$800
202	Sorting	$850
203	Metal Recycle	$1,200
204	Non-recyclable Refuse Loading.	$600
205	Utilities.	$200
206	**Subtotal**	**$3,650**
300	**Construction**	
301	Site Development (Grading, Roads & Paving, etc.)	$1,200
302	Process and Auxiliary Buildings	$200
303	Mechanical (10% of equipment)	$365
304	Electrical/Instrumentation (15% of equipment)	$548
305	Yard Utilities (1.2% of equipment)	$44
306	Super-structures (1.5% of equipment)	$55
307	Substructures (Equipment Pads, etc.)	$350
308	Painting (1.5% of equipment)	$55
309	Subtotal Direct Costs	$2,816
310	Contractor Overhead and G&A (21% of Directs)	$591
311	Contractor Fee (8% of Directs and Indirects)	$273
312	**Subtotal**	**$3,680**
400	**Misc.**	
401	Freight, Taxes and Insurance (12% of Equipment & Construction)	$880
402	Subtotal Project	$9,050
403	Contingency (25% of Project Subtotal)	$2,715
500	**ROM Capital Cost Estimate**	**$11,765**
600	**Annual Operating and Maintenance**	
601	Operating Labor (2 crews)	$767
602	Maintenance Labor (1 crew)	$384
603	Maintenance Parts Material Replacement Cost (10% of Equipment Capital)	$365
604	Fuel/Electricity/Water, Etc.	$374
605	Consumables	$115
606	Tax, Insurance & License Fees	$250

Line No.	Activity Description	Estimated Cost ($ x 1000)
607	Subtotal	$2,255
608	Contingency (25% of O&M Subtotal)	$564
700	ROM Annual O&M Estimate)	$2,819

Table 6-3. ROM Capital and O&M Cost Estimates for Gypsum Recycling Plant ($ X 1,000).

Line No.	Activity Description	Estimated Cost ($ x 1000)
100	**Engineering and Home Office**	
101	Home Office Engineering (3% of Equipment & Construction)	$147
102	Architect Engineering (6% of Equipment & Construction)	$294
103	Environmental/Permits (3% of Equipment & Construction)	$118
104	**Subtotal**	**$558**
200	**Process, Non-Process and Auxiliary Equipment**	
201	Incoming Truck Staging & Dumping	$450
202	Sorting	$400
203	Gypsum Recycle	$900
204	Bagging Station	$210
205	Non-recyclable Refuse Loading.	$250
206	Utilities.	$150
207	**Subtotal**	**$2,360**
300	**Construction**	
301	Site Development (Grading, Roads & Paving, etc.)	$600
302	Process and Auxiliary Buildings	$250
303	Mechanical (10% of equipment)	$236
304	Electrical/Instrumentation (15% of equipment)	$354
305	Yard Utilities (1.2% of equipment)	$28
306	Super-structures (1.5% of equipment)	$35
307	Substructures (Equipment Pads, etc.)	$400
308	Painting (1.5% of equipment)	$35
309	Subtotal Direct Costs	$1,939
310	Contractor Overhead and G&A (21% of Directs)	$407
311	Contractor Fee (8% of Directs & Indirects)	$188
312	**Subtotal**	**$2,534**
400	**Misc.**	
401	Freight, Taxes and Insurance (12% of Equipment & Construction)	$587
402	Subtotal Project	$6,040
403	Contingency (25% of Project Subtotal)	$1,509.92
501	**ROM Capital Cost Estimate**	**$7,550**
600	**Annual Operating and Maintenance**	
601	Operating Labor (1 crews)	$384
602	Maintenance Labor (0.5 crew)	$192
603	Maintenance Parts Material Replacement Cost (10% of Equipment Capital)	$236
604	Fuel/Electricity/Water, Etc.	$262
605	Consumables	$58
606	Tax, Insurance & License Fees	$200
607	**Subtotal**	**$1,331**

Line No.	Activity Description	Estimated Cost (\$ x 1000)
608	Contingency (25% of O&M Subtotal)	\$333
700	**Total Project O&M Estimate)**	**\$1,664**

SECTION 7
EVALUATION OF SHORT-LISTED TECHNOLOGIES

7.1 GENERAL
This section contains a technical and economic evaluation of the short-listed alternatives described in Section 6.

7.2 APPLICATION TO THE EXISTING SYSTEM
Application of the new system within the existing City refuse management system is shown in **Figures 6-1, 6-4 and 6-7**. A brief discussion of the impact of each alternative is presented below:

7.2.1 Plasma Generating Station
Implementation of the plasma generating station alternative will impact the current operations at the City's transfer stations and the convenience centers only to the extent that more effort may be needed to prevent disposal of scrap metal. The refuse trucks from these centers and other sources would be diverted to the site where the generation station is located. Landfill operations at Waimanalo Gulch would be reduced significantly.

7.2.2 Metal Recycling Plant
The size of the operations at the transfer stations and the Waimanalo Gulch Landfill would have to be increased to separate scrap metal.

7.2.3 Gypsum Recycling Plant
The impact of the gypsum-recycling alternative on existing operations are the same as the metal recycling plant. The only difference is that the gypsum recycling plant alternative will not require placing containers at the convenience centers.

7.3 EXISTING SYSTEM CHANGES REQUIRED
The changes that would be needed to the existing City refuse management system to use the new system alternatives are as follows:

7.3.1 Plasma Generating Station

Key changes required to implement the plasma generating station alternative are:

- Provide additional space and add scrap metals recycling containers at the transfer station. Increase operating staff and add magnetic lifting rigs to remove scrap metals from incoming refuse.

- Reduce the size of the landfill operations at Waimanalo Gulch to process only ash from H-POWER (approximately 108,000 tons per year) and the non-recyclable material from the plasma generating station (approximately 30,000 tons/yr).

7.3.2 Metal Recycling Plant

Key changes required to implement the metal recycling plant alternative are:

- Provide additional space and add scrap metals recycling containers at the Waimanalo Gulch Landfill. Increase landfill operating staff and add magnetic lifting rigs to remove scrap metal from incoming refuse.

- Provide additional space and add scrap metals recycling containers at the transfer station. Increase transfer station operating staff and add magnetic lifting rigs to remove scrap metals from incoming refuse.

7.3.3 Gypsum Recycling Plant

Key changes required to implement the gypsum recycling plant alternative are:

- Provide additional space and add scrap metals recycling containers at the transfer station. Increase transfer station operating staff and add magnetic lifting rigs to remove scrap metals from incoming refuse.

- Provide additional space and add scrap metals recycling containers at the Waimanalo Gulch Landfill. Increase landfill operating staff and add magnetic lifting rigs to remove scrap metals from incoming refuse.

7.4 PROJECT DEVELOPMENT ACTIVITIES AND ESTIMATED DURATION

The following key activities would be required if the options identified in this report are developed, financed and owned by the private sector.

- **Feasibility Study.** A feasibility study that is focused on the selected alternative. The feasibility study to include a conceptual design, cost estimate and economic data, detailed marketing research, and an overall strategy for implementing the option is needed for all considered alternatives. The study must clearly identify the salient features of the alternative to gain a wide interest from private sector investment groups.

- **Site Selection.** Based on the information provided by the feasibility study, a review must be conducted to identify locations for the proposed plant.

- **Soliciting Expression of Interest.** Soliciting expression of interest from the private sector is useful before issuing a detailed procurement package. This interim step would ensure that a procurement process takes into consideration the concerns of the potential investors.

- **Procurement.** If reliable and credible parties are identified during the expression-of-interest process, then a bid package can be prepared. The bid package would use the information gathered during the feasibility study and the expression-of-interest process. The procurement phase will also include proposal review and the project award.

- **Environmental Assessment.** The project would require an environmental assessment according to the State's Hawaii Revised Statutes, Chapter 343, process.

- **Facility Acquisition.** Facility acquisition activities include design, permitting, construction and start-up.

Estimated schedules for implementing each of the alternatives are shown in **Table 7-1.**

Table 7-1. Activities and Estimated Duration for Acquiring Alternative Refuse Diversion Facilities.

Activity	Activity Duration (Months)		
	Plasma Generating Station	**Metal Recycling Plant**	**Gypsum Recycling Plant**
Decision To Proceed	3	3	3
Focused Feasibility Study	9	6	6
Site Selection	6	3	3
Soliciting Expression of Interest	4	2	2
Procurement	6	3	3
Environmental Assessment	18	3	3
Facility Acquisition (design, permitting & construction)	24	12	12
Total	70	32	32

7.5 MILESTONES

There are two key milestones in the decision-making process the alternatives. These are described below.

- **Go/No-Go Decision.** The first milestone is the decision to pursue one or more of the alternatives considered by this study. This decision would entail funding allocation by the City for the feasibility study, site selection, and expression-of-interest solicitation. These activities are described above.

- **Funding Source.** The second milestone, to be pursued after the conclusion of the expression-of-interest phase, is the financing decision. If no interested private investor is found, the City must develop a strategy for public funding.

7.6 PRIOR EXPERIENCE

A discussion of the experience gained by the communities using the technologies embedded in the alternatives is presented below.

7.6.1 Plasma Generating Station

The heart of the process is a plasma arc gasification and vitrification system being marketed by Integrated Environmental Technologies, LLC (IET). Several other vendors also provide electric arc melters similar to that used in this alternative. A literature search by this study pointed to several municipal refuse thermal-processing units using melting and gasification technologies (1998 and 1999 IT3 Conference Proceedings). A majority of applications are in Japan and European countries. Detailed information on their operational experience and economical viability was not readily available. Acquisition of such information will require a first-hand examination of data from the operating facilities. A summary of three prior experiences in the US is presented below:

- **Integrated Environmental Technologies, LLC, (Contact Mr. Jeff Surma at 509/946-5700).** Battelle Memorial Institute developed this technology and tested it at the Department of Energy site in Hanford, Washington. Battelle licensed this technology to IET. A 10-ton per day engineering scale DC arc plasma system, referred to as PEM™, has been constructed and is available for demonstration. This unit has been used to process a variety of waste streams such as tires, solid waste, sludge, and hazardous wastes.

- **FMC Corporation, Pocatello, Idaho.** Three full-scale electrical arc melter systems that are generally similar to the IET's unit have been used by FMC since the mid-1970s. The units receive ores containing phosphorus compounds. They melt the ore to recover elemental phosphorous from the gaseous waste stream. The remaining soil in the ore is discharged from the furnace as a molten slag. The molten slag is cooled and is either sent to a storage pile or used as a granular media for road construction.

- **Allied Technology Group (ATG) GASVIT™ (Contact Bob Julian, Washington State Department of Ecology 509/736-5702).** IET has sold a 10-ton per day plasma arc gasification/vitrification unit to ATG. This unit is trademarked by ATG under the name of GASVIT™. This system has received an extensive risk assessment and evaluation by the Washington State Department of Ecology and the US-EPA Region 10 for processing toxic wastes. The unit has received a RCRA/TSCA Part B permit and the full-scale commercial operation is expected by early 2000.

7.6.2 Metal Recycling Plant

Metal recycling is a common technology and is employed by industrial facilities generating scrap metal and many municipal refuse systems. There is no technical risk in this technology as it has been in existence for several decades. The environmental aspects of this technology are also well known.

7.6.3 Gypsum Recycling Plant

Gypsum recycling is an innovative new use of commonly available machinery for pulverization of scrap gypsum and separation of the facing paper. The major barrier is that the market in which a recycled gypsum can be sold is new and in the developmental stage. In order to pursue a gypsum recycling option, the City must first undertake a market development program for recycled gypsum in the Hawaii Islands. A literature survey indicates that a minimum of two plants are practicing gypsum recycling in the US. Operational and economical experience at one of these firms is summarized below.

- **Construction Debris Recycling Inc. (Contact Ben Gordon, 518/271-4491).** The CDR facility opened in early 1999 near Albany, NY. The facility accepts drywall and roofing shingles. Gypsum is being processed into agricultural soil additives, construction material, manufacturing ingredients and odor and spill control material. It can be used to compensate for heavy clay soil and soil that is deficient in calcium and sulfur. When added to compost, gypsum can help the retention of nitrogen. Gypsum is also mixed with sand and used as animal bedding in horse stables. Gypsum absorbs urine odors and neutralizes and boosts nitrogen in the field. Paper separated from gypsum can also be used as animal bedding to absorb odor. C&D experience indicates that gypsum must be manually separated from other construction debris and that the current mechanical sorting technologies have not been effective in this application. CDRs primary revenue stream is from tipping fees. CDR experience indicates that a tipping fee of $45 to $50 would be needed to break even.

7.7 PERMITTING

Air emissions, water discharge and land disposal permitting requirements of the alternatives were reviewed. A State of Hawaii, Department of Health, solid waste permit will be required for all alternatives. Residual disposal of solid waste should be covered by existing permits.

The plasma generating station would require both air emissions and water discharge permits. The more significant of the two, the air emission permit, must be obtained for the turbine generators. Such a permit is expected to be routine and without any significant permitting issues. The plasma system would also need a water discharge permit for wastewater generated from the syngas cleaning scrubbers.

The metal recycling and gypsum recycling plants are expected to require only air emissions permit for the dust collector exhaust streams.

Environmental impact assessments would also be required for the alternatives. At this point, it is judged that the metal and gypsum recycling plants would require only an environmental assessment. However, due to its large size and potentially significant impact, the plasma generating station alternative is expected to require a full environmental impact statement.

7.8 OPERATIONAL RELIABILITY

7.8.1 Plasma Generating Station

The heart of this alternative is the plasma system. The durability and life of this system is comparable to a standard electrical arc furnace. This type of furnace is widely used in the mining and metal industry. For example, three large electrode arc furnaces have been operated at the FMC elemental phosphorous plant in Pocatello, Idaho, since the mid-1970s. The plasma process chamber is judged to have no reliability problem because it will use the latest refractory and product discharge mechanisms that have been tested at a smaller scale, but there is no operational experience at the project scale to support this. Some of the system auxiliary components, such as refuse feeders, process feed controls and syngas processing units, will require large scale application and long-term operational results so that their reliability in a refuse processing environment can be established.

7.8.2 Metal Recycling Plant

The heart of this plant is the separation and shredding equipment. These components are high maintenance but can be operated in a reliable manner by instituting a preventative maintenance program.

7.8.3 Gypsum Recycling Plant

The heart of this plant is the device that separates paper facing from wallboards. Proper operation of this equipment will require that the scrap gypsum be dried before it is fed to the crushers. As stated before, these components are high maintenance items that can be operated in a reliable manner by instituting a preventative maintenance program.

7.9 IMPLEMENTATION BARRIERS AND INCENTIVES

Factors that would provide significant incentives and barriers for implementing the alternatives are discussed below:

7.9.1 Plasma Generating Station

The incentives for implementing this alternative are: 1) Much of the refuse stream to Waimanalo Gulch is diverted; 2) the thermal process is environmentally friendly (i.e., nearly eliminates dioxin/furans in the thermal unit exhaust, the final residue is a vitrified rock/glass); 3) the process generates syngas which can be used in conjunction with a high efficiency (30%) turbine generator; and 4) the electricity produced by the facility is in high demand.

Impediments for this alternative are: 1) high economic risk because the viability has not been proven, and 2) high technical risk because the technology is first-of-a-kind.

7.9.2 Metal Recycling Plant

Incentives for this option are: 1) the technology and economics are well known; 2) scrap metal market is a well established; and 3) a relatively low level of capital investment, hence, attractive to private sector investment.

Impediments are: 1) The scrap metal price fluctuations increase the investment risk; 2) the costs for offshore shipment may be prohibitively high; and 3) the alternative addresses only a small portion (11%) of the Waimanalo Gulch refuse stream.

7.9.3 Gypsum Recycling Plant

Incentives for implementing this option are: 1) the technology has been used in the past and 2) the capital investment is relatively low, hence, attractive to private investors.

Impediments are: 1) the recycled gypsum market and prices are in a developmental stage and, hence, the economic risks are relatively high; 2) the alternative addresses only a small portion (7%) of the Waimanalo Gulch refuse stream; and 3) the experience with the technology is short-term (since early 1999).

7.10 DIVERSION CAPABILITY

The plasma generating station offers the highest diversion potential. The alternative could divert a major portion of the waste currently being sent to Waimanalo Gulch. It is expected that 10% of the waste would have to be sent to the landfill.

The metal and gypsum recycling plants will divert approximately 11% and 7%, respectively, of the material going to the Waimanalo Gulch Landfill.

7.11 ECONOMIC FEASIBILITY

The revenue and expense estimates for the alternatives are shown in **Table 7-2.** Expenses incurred are the annual facility cost of capital, O&M costs, if any, and the cost of disposing waste from the facilities. The revenues include tipping fees and the sale of any recyclable product produced by the facility.

The capital cost is amortized over a 20-year period assuming the required capital will be raised through a tax-free industrial revenue bond (IRB). The assumed interest rate for the IRB is 7% per annum. The resultant annuity incurred by the facility cost of capital is $94,390 for each one million dollar of facility capital cost.

For all options, the facility tipping fees are assumed to be equal to the current refuse disposal rate ($72.25 per ton of waste) at Waimanalo Gulch. The electricity is assumed to be sold at a price of $0.08 per kwh. The recycled scrap gypsum and scrap metal are assumed to be sold at $50 per ton.

The results of the economic analysis is presented below:

7.11.1 Plasma Generating Station

As shown in **Table 7-2,** the cost of facility operations is $119.50 per ton of refuse received at the facility. The income from the facility is $91.31 per ton of refuse received at the facility. The net result is a negative $28 per ton of waste processed at the facility. Hence, the facility is not anticipated to generate positive cash flow under the City's current economic evaluation conditions.

7.11.2 Metal Recycling Plant
As shown in **Table 7-2,** the facility annual expense is $115.76 per ton of refuse received at the facility. The annual income from the facility is $87.12 per ton of refuse received at the facility. The net result is a negative $29 per ton of waste processed at the facility. Hence, the facility is not anticipated to generate positive cash flow at the current City economic evaluation conditions.

7.11.3 Gypsum Recycling Plant
As shown in **Table 7-2,** the facility annual expense is $129.03 per ton of refuse received at the facility. The annual income from the facility is $90.25 per ton of refuse received at the facility. The net result is a negative $39 per ton of waste processed at the facility. As a result, this facility also is not anticipated to generate positive cash flow at the current economic criteria that are established for evaluating the alternatives.

Table 7-2. Estimated Expense and Income for the Alternatives.

Line No.	Description	Plasma Generating Station	Metal Recycling Plant	Gypsum Recycling Plant
	Refuse Processed (Tons/Yr)	278000	41700	20000
	Non Recyclable Refuse Returned for Landfill (Tons/Yr)	52000	10700	2000
	Recyclable Material For Sale (Tons/Yr)	31000	31000	18000
	Electricity For Sale (MWH/Yr)	58500	0	0
100	**Annual Expense**			
101	Facility O&M	$14,803,719	$2,818,688	$1,663,569
102	Facility Capital Cost (20 years @ 7% APR)	$14,660,945	$1,110,511	$712,607
103	Annual Cost for Disposal of Returned Refuse (@$72.25/Ton)	$3,757,000	$773,075	$144,500
104	Additional Cost Imposed on Existing Refuse System ($/Yr)	$0	$125,100	$60,000
105	**Subtotal**	$33,221,663	$4,827,374	$2,580,676
106	**Cost Per ton**	**$119.50**	**$115.76**	**$129.03**
200	**Annual Revenue**			
201	Tipping Fee (@$72.25 per ton)	$20,085,500	$3,012,825	$1,445,000
202	Sale of Recycled Product (@20/ton)	$620,000	$620,000	$360,000
203	Sale of Electricity (@ $0.08/kwh)	$4,680,000	$0	$0
205	**Subtotal**	**$25,385,500**	**$3,632,825**	**$1,805,000**
206	**Revenue Per Ton**	**$91.31**	**$87.12**	**$90.25**
301	**Gross Profit (Loss) Per Ton**	**($28)**	**($29)**	**($39)**

SECTION 8
LIST OF REFERENCES

1. 1998 IT3 Conference, International Conference on Incineration & Thermal Treatment Technologies Proceedings, May 11-15, 1998.

2. 1999 IT3 Conference, International Conference on Incineration & Thermal Treatment Technologies Proceedings, May 10-14, 1998.

APPENDIX C

Inventory Study of Potential Sanitary and Demolition Landfill Sites

City and County of Honolulu
Department of Public Works

August 1977

RECEIVED AS FOLLOWS

INVESTIGATION OF POTENTIAL SANITARY AND DEMOLITION LANDFILL SITES

city and county of honolulu
department of public works
division of refuse collection and disposal

INVENTORY OF POTENTIAL SANITARY AND DEMOLITION LANDFILL SITES ON THE ISLAND OF OAHU

PREPARED FOR THE
CITY AND COUNTY OF HONOLULU
DEPARTMENT OF PUBLIC WORKS
DIVISION OF REFUSE COLLECTION AND DISPOSAL

BY

STANLEY S. SHIMABUKURO AND ASSOCIATES, INC.
1126 - 12th Avenue
Honolulu, Hawaii 96816

August 1977

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PART I - GENERAL

A. PURPOSE

The objective of this study was to prepare an inventory of potential sanitary and demolition landfill sites on the island of Oahu, to rank each potential site, and make recommendations for landfill site selections.

After review of the site recommendations, the City selected five sites for which the Consultant prepared conceptual plans for landfill site development, cost estimates for development, operations and maintenance, and environmental assessments.

B. INTRODUCTION

Everyone, manufacturers and consumers, produces solid waste. Man has always been producing solid waste as a by-product of his existence. This waste must be properly disposed of to maintain the public health.

On Oahu the most economical method used to dispose of solid waste is the sanitary landfill. "Sanitary landfilling is an engineered method of disposing of solid wastes on land by spreading them in thin layers, compacting them to the smallest practical volume, and covering them with soil each working day in a manner that protects the environment. By definition, no burning of solid waste occurs at a sanitary landfill. A sanitary landfill is not only an acceptable and economic method of solid waste disposal, it is also an excellent way to make otherwise unsuitable or marginal land valuable."[1]

The availability of land for sanitary purposes is becoming a critical problem for the City and County of Honolulu. The City is rapidly running out of sanitary landfill space at its three sites: Kapaa, Kawailoa and Waianae. It is estimated by the Division of Refuse Collection and Disposal that at the current disposal rates, less than 1, 4 and 4 years of life remain at Kapaa, Kawailoa and Waianae, respectively. Thus, new sanitary landfill sites must be identified, selected, and developed. See Table I-1[3] at end of this section for refuse quantities.

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1 Sanitary Landfill Design and Operation, EPA, 1972, p. 1

Limited land space due to the City being a small island community, the restrictions imposed by the Board of Water Supply in the ground water supply areas, the scarcity of low cost, undeveloped suitable lands, the large volumes of solid waste generated by everyone, and community objections to landfills have, in general, created problems in selecting and developing landfill sites.

Many potential sites are located in inland areas, away from population centers, where huge gullies on this island offer great capacities for landfill. However, these sites are situated over the ground water aquifers which supply potable water to the population or are potential sources of water supply. Possible contamination of these aquifers by leachates, which can be generated in a landfill, is a threat to one of our most vital natural resources and must be a major consideration in the site selections.

There is no question that landfills will have a temporary adverse impact on the environment. This impact can be reduced by proper planning and operation. The final impact of a completed landfill can be managed in such a way that there is an enhancement of environmental values.

Sites should be selected with the utmost care. Work on technical and environmental problems related to development of the landfill site must be attended to properly.

The City has incorporated engineering technology into landfill operations to protect our natural resources, our environment, and our health. Without proper operational procedures and management, a landfill can become an open dump and will be both an economic and environmental liability. To prevent this, landfill personnel should be continually trained. Only small areas, two to four acres, should be opened at any one time within the site, if practicable.

Presently there is great interest in resource recovery. However, it should be noted that:[2]

1. With the full exploitation of all recovery techniques available or presently under study, about 50% by weight of all solid waste must still be disposed of in landfills.
2. This figure of 50% would rise to 80% if energy generation is not utilized.
3. The commonly expressed belief by landfill opponents that present technology today can utilize all waste and thereby eliminate the need for all landfills is a myth.

A new solid waste resource recovery plant, now under study by the City and State, may be designed to utilize solid waste for energy generation, but due to its high cost and risks involved in resource recovery, it will be difficult to predict when such a plant will be operational. In any event, no plant will be operational before 1981. The cost of hauling all refuse to such a plant may be prohibitive initially and it would be wise for the present to continue to rely on landfills

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2 Waste Age, January 1975, pp. 14-22

for disposal of solid wastes and to plan major landfills on both the Windward and Leeward areas for the reasons stated in Part II.

Planning, financing and constructing a resource recovery plant must be programmed over a period of years. Therefore, landfilling of solid waste on Oahu is the only method of disposal which can be implemented soon enough to maintain continuity of disposal capacity. It is not a question of whether there will be landfills, but rather, where, how many, and under what conditions they will be allowed.

Table I-1[3]

Projections of City/County Solid Waste Quantities

Population/Projections	FY75-76	1980	1985	1990	1995	2000
Resident Population	704,500	749,500	818,700	891,000	965,000	1,039,400
Defacto Population	759,700	819,900	908,600	1,005,800	1,111,500	1,226,300
Series A: Increasing Generation Rate*						
#/c/d-MSW	3.34-3.82	3.61-4.13	3.99-4.56	4.19-4.79	4.40-5.03	4.62-5.29
TPD MSW	1270-1450	1480-1695	1810-2070	2110-2410	2445-2795	2830-3245
TPD ISW	300	300	300	300	300	300
TOTAL TPD	1570-1750	1780-1995	2110-2370	2410-2710	2745-3095	3130-3545
TPY	489,800-546,000	555,360-622,400	658,300-739,400	751,900-845,500	856,400-965,600	976,600-1,106,000
Series B: Stable Generation Rate						
#/c/d-MSW	3.34-3.82	3.34-3.82	3.34-3.82	3.34-3.82	3.34-3.82	3.34-3.82
TPD MSW	1270-1450	1370-1565	1515-1735	1680-1920	1855-2120	2045-2340
TPD ISW	300	300	300	300	300	300
TOTAL TPD**	1570-1750	1670-1865	1815-2035	1980-2220	2155-2420	2345-2640
TPY	489,800-546,000	521,000-581,900	566,300-634,900	617,800-692,600	672,400-755,000	731,600-823,700

*Assuming rate increase of 2%/yr thru 1985; thereafter 1%/yr. MSW only.

**Based on a six day work week.

3 Mitre Corporation Report, Analysis of the Feasibility of Resource Recovery for Honolulu, April, 1977.

C. CONDUCT OF STUDY

In preparing the inventory of potential sanitary and demolition landfill sites on Oahu, existing data compiled and preliminary work done by the Division of Refuse Collection and Disposal were reviewed. A literature research was made, meetings and discussions with the Division of Refuse Collection and Disposal were held, and the following general guidelines, not necessarily characteristic to all of the sites, were established to make initial pre-site selections:

1. Adequate capacity, generally a five-year life, based on the following assumptions for this study:
    a. Theoretical refuse disposal rate:

        500 Tons/Day -- Leeward

        500 Tons/Day -- Windward

    b. Compacted refuse density -- 1,000 Lb./C.Y.
    c. Refuse to Earth Cover Ratio -- 3 : 1
2. Access available or easily constructed.
3. Within reasonable distance from the major refuse generation centers.
4. Land idle or under low use and could be put to a higher use or could be reverted back to its present use after use as a landfill.
5. Generally located away from areas with potable ground water sources.
6. Significant or direct major adverse effect on any urban or rural community could be minimized.

7. Environmental impact not significant, and final environmental impact can be controlled to be within tolerable limits.

The above guidelines served to define a potential landfill site for this study and precluded the investigation of every gully or depression on this island. They also served as a base to begin the study.

Sites on Oahu located within fairly easy access to an adequate highway, guideline 2, and away from ground water source areas, guideline 5, generally have climate, flora and fauna which are not of primary concern for pre-site selections. Fair weather predominates throughout the year and variations in rainfall quantities do not significantly affect the pre-site selection process. Natural vegetation and wildlife do not appear to include species which are rare or in immediate danger of extinction.

Therefore, climate, flora and fauna are discussed only briefly and were not of primary concern in pre-site selections. They will be investigated further during the preparation of the Environmental Impact Statement after sites are selected for actual development. Environmental Impact Statement Preparation Notices and Assessment are included in Appendix H.

The initial pre-site selection process was aided by using aerial photo and contour maps, U.S.G.S. maps, by aerial and ground reconnaissance, and by owners who did not object to the use of their lands for landfills.

After initial pre-site selections, each site selected which seemed to have adequate capacity, adequate protection of ground water supply, no apparent significant environmental damage to the land, air, ocean or population, and apparent economical feasibility was further evaluated by compiling the remaining data listed in Appendix A. This enabled the Study to make a more detailed analysis, and evaluate and rank each site according to its desirability as a potential landfill site. See Appendix D and Summary of Evaluations and Ranking of Sites, Windward Oahu and Leeward Oahu, pages II - 7 and II - 13, respectively.

D. ORGANIZATION OF REPORT

For ease of presentation and clarity, this report is divided into four parts.

Part I contains the Purpose, Introduction, Conduct of Study, Organization of Report, Conclusions and General Recommendations.

Part II contains the Key Map, Site Evaluations and Recommendations for Development of Windward and Leeward Sites.

Part III contains the Conceptual Plans for Sites Selected for Study, Aerial Views and Cost Estimates for the Development, Operation and Maintenance of the sites selected.

Part IV contains the Appendixes which provide the backup information for this report and the Environmental Impact Statement Preparation Notice and Assessment.

E. CONCLUSIONS

1. Disposal of solid waste by landfill methods is still a necessary part of the solid waste cycle for the City and County of Honolulu. Even with complete energy conversion and resource recovery, ash and demolition waste must still be disposed of by landfill methods. A landfill is also needed to serve as an emergency backup to the resource recovery plant, if constructed.
2. The Windward and Leeward areas each need one major site--the Leeward landfill to service the Leeward areas and Honolulu District, and the Windward landfill to service primarily the Windward area.
3. Separation of demolition and sanitary solid waste can extend the life of the sanitary landfill sites sufficiently to warrant its consideration.
4. The City can improve its landfilling operations. Landfill personnel need continual training. Detailed landfill plans should show operational phases and incremental development.
5. There is a need for a public relations effort to educate the general public in solid waste disposal technology. Through education, most citizens can become supporters of the City's solid waste disposal program.
6. Since landfilling is a temporary use of land, the City needs final utilization plans for all existing and proposed

landfill sites so that the landfill can be developed to accommodate the final usage.

7. Shredding can enhance the operation and extend the life of landfills. Shredding should be considered when the City contemplates selecting sites of marginal capacity, or cover material is not readily available, or near developed areas.

8. The total landfill life of the developable sites at a 500 tons/day disposal rate are:

   Leeward Area - 114 years (56,000,000 cubic yards - 28,000,000 tons)

   Windward Area - 53 years (26,000,000 cubic yards - 13,000,000 tons).

F. GENERAL RECOMMENDATIONS

1. The City should upgrade the appearance of the existing Kapaa, Kawailoa and Waianae Landfill Sites by landscaping completed areas as soon as practicable and not wait until the entire site is filled before beginning landscaping operations. Landfill personnel should receive formal training. The whole concept of a sanitary landfill and the Department of Health regulations covering landfill operations should be explained to all landfill personnel.
2. Secondary beneficial uses, such as parks, golf courses, farm lands, ranches or open space, should be determined prior to the land being used as landfill sites and plans for implementation of such uses should be prepared at least one year before the completion of the landfills.
3. The City should expand its public relations effort regarding sanitary landfills to gain public support. The prevailing "open dump" idea type of operation now in the minds of the public should be dispelled once and for all. The need for landfills should be explained. On resource recovery, the state of the art, market demand for recovered material, and economic feasibility should be discussed.
4. The City should adopt twenty years as the maximum planning period for solid waste disposal due to changing technology.

5. The City should evaluate refuse shredding to extend the life, provide a neater, more efficient operation, and to enhance the public acceptability of sanitary landfills.
6. After the City has made final selections of future landfill sites, the land should be acquired in fee or leased, and especially zoned for this purpose. Land use for landfills should also be added to the City General Plan and the State Land Use District Maps to minimize the problems of acquiring future landfill sites.
7. Even after the City acquires a sufficient number of sites to extend the refuse disposal capacity for years to come, it should continue to keep its interest in the state of the art of recycling and energy conversion and also seek other methods of disposal.

PART II

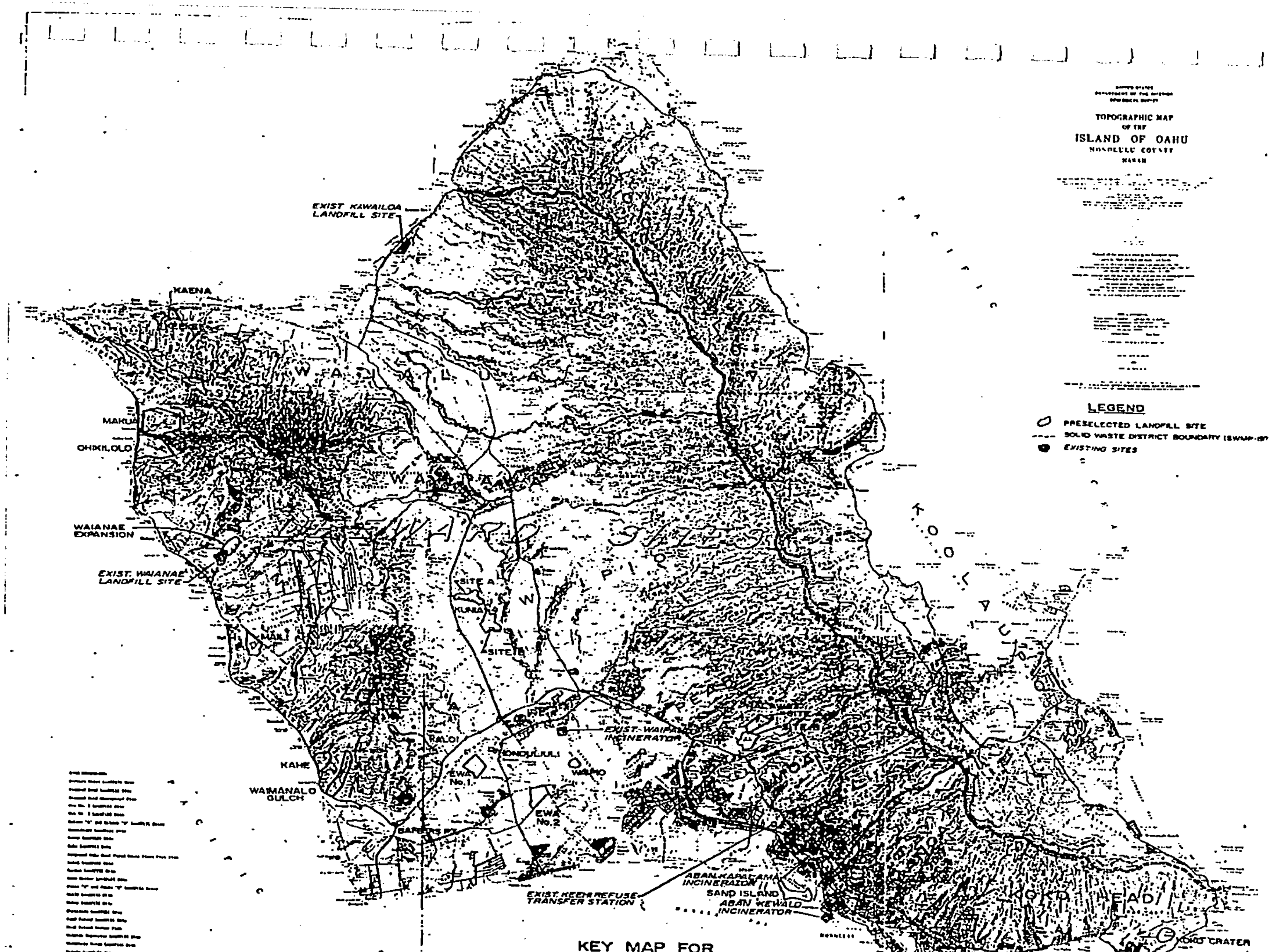
POTENTIAL LANDFILL SITES STUDY

POTENTIAL LANDFILL SITES STUDY

As noted earlier, everyone produces solid waste. A study of the map of Oahu shows quite readily that the population is spread out over the entire island and solid waste will be generated in all areas of the island.

The topography and separation of the urban areas make the selection for the location of a single major landfill on Oahu very difficult. Any single location would create hardships on the areas that are remote from the landfill. Hauling distances for these areas would be too great for the home owner, private hauler and the City. It became apparent that having two major landfills would greatly alleviate the problems associated with a single landfill and thus, for this study, it was established that there would be two major landfills. A sanitary landfill can have great environmental impact and only the minimum number should be constructed. The City should be able to serve all of Oahu economically and efficiently with the two major landfills that are recommended in this study.

The Koolau Mountains serve as a natural divide to the island and hence it was further established that each side of the Koolaus, the Windward and Leeward, would have one major landfill.



KEY MAP FOR
SUPPLEMENT TO
INVENTORY STUDY OF POTENTIAL
SANITARY & DEMOLITION

B. WINDWARD OAHU

1. GENERAL CHARACTERISTICS OF WINDWARD OAHU

Windward Oahu is generally known as the area that is northeast of the Koolau Mountain Range from Makapuu Point to Waimea Bay. This area represents about one-fifth of Oahu's land area. See Plate II-A-1.

Windward Oahu is essentially a narrow strip of land between the mountain and the sea with the communities separated by finger-like ridges that extend down from the Koolau ridge line.

Windward Oahu contains the Koolaupoko and Koolauloa Solid Waste District (Plate II-A-1). The communities are spread out along the entire length of the area, about 40 miles, and are served by Kamehameha and Kalanianaole Highways. The Pali and Likelike Highways serve as more direct links to the Leeward areas of the island via tunnels through the Koolau Mountains. Kailua and Kaneohe are the major urban centers.

Climate is generally fair with temperatures averaging from 70° to 75° throughout the year. Generally, rainfall varies from 20 to 40 inches at the shoreline to about 50 to 100 inches near the top of the Koolau Range.

The areas of existing and future ground water sources are shown in Plate IV-F-1, Appendix F. Location of sanitary landfills in these areas are restricted by the Board of Water Supply unless a positive means of protecting the ground water is provided in the landfill. See Appendix F.

Present population is approximately 110,000[4] and the 1995 population is estimated at 148,000[4]. These figures represent about one-seventh of the population of Oahu.

The average daily projected refuse generation rate, excluding the military and agriculture, is as follows:[5]

1975	1980	1985	1990	1995
167	221	272	323	388

Figures are in Tons/Day for 365 days a year. These figures would be increased if Honolulu refuse is disposed of on the Windward side.

4 Interpolated from Hawaii Regional Water Resources Study (1976) Population Projections table (from DPED Series E-2 Projections).

5 From Division of Refuse Collection and Disposal, City & County of Honolulu

2. RECOMMENDATIONS FOR WINDWARD OAHU

All sites preliminarily selected for sanitary landfill use were evaluated according to the criteria listed in Appendix A. Many criteria could not be measured objectively, and the evaluations were made subjectively. With the subjective evaluations, a ranking was established and the results are shown in the table on page II-7.

With the Kapaa Sites ranking first, it is recommended that the City continue its operation in the Kapaa area. This area is already being used as a landfill site and the Kapaa #1 and Kapaa #2 and #3 Sites (Plate IV-D-1) have additional life of 11.1 years (at 500 Tons/Day). Opening up a new site away from the Kapaa area will have a greater impact on the environment and will involve greater costs.

Kapaa #2 and #3, which are adjacent to the existing landfill site (Plate IV-D-1), can be used immediately as an extension of the existing landfill site. Kapaa #1 can be opened after Kapaa #2 and #3 are filled. Then the Kalaheo Site (Plate IV-D-2), which has a life of 11.5 years (at 500 Tons/Day), located north of the H-3 Freeway, can be utilized.

To extend the sanitary landfill life of the Kapaa area, demolition waste can be separated and used to create landmasses for the Kawainui Swamp Park development. Demolition waste accounts for 10% to 20% of the total solid waste,[6] and removal of this volume can provide a valuable extension of sanitary landfill life in the Kapaa area.

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6 Division of Refuse Collection & Disposal, C. & C. of Honolulu

This recommendation is made on the premise that the Department of Parks and Recreation develop a park plan requiring the creation of landmasses and also it is determined that such a development will not have any serious adverse environmental effects on the swamp.

The City's existing Kapaa Corporation Yard facilities can be used to provide maintenance support for landfill operations in Kapaa #1, #2 and #3.

The Heeia Uka site can be temporarily used as a demolition landfill site if Kawainui Swamp is not available. This should be done only if a resource recovery plant is not constructed and only when the Kapaa sites are reaching their capacities to preclude the possible unnecessary opening of this site.

The Kalaheo site may become a higher ranking site if the H-3 Highway project terminates. The major problem with this site is access, and termination of the H-3 project will eliminate this problem.

According to HC&D, Ltd., the quarry operations in Kapaa will remove at least 20 million cubic yards of material from the area, and this site can eventually be used for landfill purposes when quarry operations cease. Lease extends to the year 2012, but may be extended further. To await use of the HC&D quarry site, the City can construct a shredder to extend the life of the proposed sanitary landfill sites in this area by 25% or more.[7] Future quarry operations may change and the

7 Decision Makers Guide - Solid Waste Management, EPA 1976.

City may be able to coordinate earlier use of the depleted portions of the quarry with HC&D.

If a small portion of Kawainui Swamp is utilized for demolition landfill in conjunction with its development as a park and if a shredder is constructed, landfill operations in the vicinity of the Kapaa landfill area may be extended appreciably.

See Appendix C for more detailed evaluation of Windward Oahu Landfill Sites.

1. SUMMARY OF EVALUATIONS AND RANKING OF SITES*
WINDWARD OAHU

RATING

E = Excellent
G = Good
F = Fair
P = Poor

Max = Maximum
Mod = Moderate
Min = Minimum

POTENTIAL SITE	RANKING	1. Approximate Capacity, in million cu. yd.	2. Approximate Life as Sanitary Landfill, in yrs.**	3. Access to Adequate Roads	4. Availability of Utilities	5. Measures Required for Protection of Ground Water	6. Objection by Public, Community Groups, etc.***	7. Objection by Landowner and Adjacent Landowners	8. Impact on Nearby Land Uses	9. Site Location	10. Measures Required for Protection of Surface Water	11. Availability of Cover Material	12. General Nuisance (Litter, Dust, Noise, Odor, Traffic, etc.)	13. Land Cost	14. Drainage Improvements On and Off Site	15. Topography	16. Hazard to Public Health and Safety	REMARKS
Kapaa #2 and #3	1	2.38	4.9(F)	G	G	Min	Max	Min	Min	E	Mod	E	Min	Low	Min	F	Min	Sanitary Landfill Site
Kapaa #1	2	3.03	6.2(G)	G	G	Min	Max	Min	Min	E	Mod	E	Min	Low	Min	F	Min	" " "
Kalaheo	3	5.59	11.5(G)	P	F	Min	Mod	Min	Min	E	Mod	E	Min	Low	Min	G	Min	" " "
Heeia Uka	4	2.45	5.0(F)	G	F	Min	Mod	Min	Min	G	Mod	G	Mod	High	Mod	G	Mod	" " "
Waimanalo North	5	9.87	20.0(E)	P	F	Mod	Mod	Min	Mod	G	Mod	G	Mod	Low	Mod	G	Mod	" " "
Auloa	6	2.79	5.7(G)	G	F	Min	Max	Max	Mod	G	Mod	G	Mod	Mod	Mod	E	Mod	" " "
Waimanalo South																		
Kahaluu																		
Waihee																		
Waiahole																		
Waikane	UNRANKED -- SEE TEXT FOR COMMENTS ON THESE SITES																	
Kaaawa																		
Punaluu																		
Olomana																		
Bellows Field																		
Heeia Kai																		

References:
Appendix A — Site Selection and Evaluation Criteria
Appendix C — Site Maps
Appendix D — Detailed Site Data and Descriptions
Plate II-A-1 — Key Map

* Some of the evaluation criteria from Appendix "A" have been modified, revised or deleted for this tabulation.
** If demolition material is disposed of at another site, Sanitary Landfill life can be increased by approximately 10% to 20%. If site is used exclusively for Demolition Landfill, life can be increased approximately 5 to 10 times.
*** Anticipated reaction.

C. LEEWARD REPORT

1. GENERAL CHARACTERISTICS OF LEEWARD OAHU

For this report Leeward Oahu is considered all of that part of Oahu other than Windward Oahu. See Plate II-A-1. Leeward Oahu includes the western side of the Koolau Range, the Waianae Range, the Schofield Plateau in between, and the remainder of the coastal plains.

The coastal plains contain most of major urbanized areas including Honolulu, Aiea, Pearl City, Waipahu, Ewa, Nanakuli and Waianae.

The urbanized area on the Schofield Plateau are Wahiawa, Waipio and Mililani. This plateau is used primarily for sugar cane and pineapple.

The areas of existing and future ground water sources are shown in Plate IV-F-1, Appendix F. Location of sanitary landfills in these areas is restricted by the Board of Water Supply unless a positive means of protecting the ground water from contamination by leachates is provided in the landfill. See Appendix F.

The average annual rainfall in the Waianae Range generally varies from about 75 inches near the ridge to about 20 inches along the coast. The Schofield Plateau averages about 40 inches annually.

Fair weather predominates throughout the year, with temperature averaging 75 degrees.

Leeward Oahu contains approximately six-sevenths (6/7) of the population and four-fifths (4/5) of the land area. Present population is estimated to be 556,000.[8] The 1995 population is estimated to be 810,000.[8]

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8 Interpolated from Hawaii Water Resources Regional Study (1976)

The average daily projected refuse generation rate, excluding the military and agriculture is as follows:[9]

1975	1980	1985	1990	1995
1102	1354	1528	1727	1962

Figures are in tons/day for 365 days a year.

9 From the Division of Refuse Collection and Disposal, City and County of Honolulu

2. RECOMMENDATIONS FOR LEEWARD OAHU

After following the same procedure for ranking of the sites as the Windward side, the resulting rankings for the Leeward side, tabulated on Page II-13 was arrived at. The Makaiwa and Nanakuli sites rated approximately equally and either can be selected as the major sanitary landfill site for the Leeward Oahu area.

The Honouliuli site could be added to the already planned Kaukonahua site as demolition landfill site, and may be used in conjunction with the Makaiwa or Nanakuli site or any other major sanitary landfill site selected for the Leeward area. The Waipahu site is already planned as an extension of the ash disposal site for the Waipahu incinerator.

The Makaiwa site has a capacity of approximately 15,232,000 cubic yards and 31± years of life at 500 Tons/Day.

This land is leased from Campbell Estate by Hawaii Meat Co. and further subleased to Tongg Ranch. Present lease extends to 1987. Tongg Ranch has applied for extending their lease holdings in this area to 1996, but the Makaiwa site is not included in their lease extension plans.

This site is approximately 18 miles from the new Shafter Flats Transfer Station, but most of the travel is on a modern, high-speed highway.

Cover material is scarce along this Southern Waianae Range area. Some cover material is available on the site. The City could save on cover material by constructing shredding facilities.

Since the site is not over the potable ground water aquifer and extensive leachate control works are not required, the shredded waste can be used as the daily cover material for the refuse not processed through the shredder. Shredding will serve to minimize cover requirements from daily to possibly weekly or longer intervals, decreasing the need for cover material and also increasing the compactability of the refuse, and hence increase the life of landfill by about 25% or more.[10] Shredding will also enhance the operation of the landfill because the shredded waste will be a homogeneous mass and is easy to handle, and a neater, more efficient operation will result. Shredding of refuse should therefore be considered by the City if operating and maintenance costs and other economic factors are favorable. Another source of potential cover material can be the dredged material from the proposed deep draft harbor.

The life of this site would be further extended with demolition waste being disposed of separately at the Kaukonahua and Honouliuli sites. This combination of use of demolition landfill sites and shredding with the Makaiwa site will give the Leeward area a sanitary landfill life of about 50 years.

This site can be reverted back to its present open land use after landscaping. The owner may plan other uses in the future.

The Nanakuli site also appears to be a good potential site. It offers almost the same major features as the Makaiwa site except:

a. Capacity is approximately 27 years.

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10 Decision Makers Guide - Solid Waste Management, EPA, 1976

b. Approximately 4 miles farther from the proposed Shafter Transfer Station.

c. Immediately adjacent to a residential area.

This site has the potential of generating its own daily cover material.

The Nanakuli site has great potential for an active type park or golf course after its use as a landfill.

The Kaloi Gulch site offers great capacity, but this alternative has three major drawbacks:

a. Need for cover material even with shredding.

b. Requirement for lining to protect the ground water supply.

c. Poor access.

The Kaloi Gulch site is ranked as the third alternative site for Leeward Oahu because it offers a landfill capacity of approximately 50 years and is removed from residential areas. The James Campbell Trust Estate has reacted favorably at discussions to the City's use of this gulch for landfilling.

See Appendix C for more detailed evaluation of Leeward Oahu Landfill Sites.

3. SUMMARY OF EVALUATIONS AND RANKING OF SITES*
LEEWARD OAHU

RATING
E = Excellent
G = Good
F = Fair
P = Poor

Max = Maximum
Mod = Moderate
Min = Minimum

POTENTIAL SITE	RANKING	1. Approximate Capacity, in million cu. yd.	2. Approximate life as Sanitary Landfill, in yrs.**	3. Access to Adequate Roads	4. Availability of Utilities	5. Measures Required for Protection of Ground Water	6. Objection by Public, Community Groups, etc.***	7. Objection by Landowner and Adjacent Landowners	8. Impact on Nearby Land Uses	9. Site Location	10. Measures Required for Protection of Surface Water	11. Availability of Cover Material	12. General Nuisance (Litter, Dust, Noise, Odor, Traffic, etc.)	13. Land Cost	14. Drainage Improvements On and Off Site	15. Topography	16. Hazard to Public Health and Safety	REMARKS
Makaiwa	1	15.2	31 (E)	E	G	Min	Mod	Min	Mod	G	Min	P	Mod	Mod	Min	G	Mod	Sanitary Landfill Site
Nanakuli	1	13.4	27 (E)	E	G	Min	Max	Mod	Mod	F	Min	G	Mod	Mod	Mod	E	Mod	" " "
Kaloi	3	24.3	50 (E)	P	P	Max	Min	Min	Min	F	Mod	P	Min	Low	Max	G	Mod	" " "
Honouliuli	4	1.7	34 (P)	G	G	Mod	Mod	Min	Min	G	Mod	G	Min	Low	Min	G	Mod	Demolition Landfill Site
Kaukonahua	UNRANKED -- SEE TEXT FOR COMMENTS ON THESE SITES																	
Waipahu																		
Maili																		
Koko Crater																		
Waipio																		
Mililani																		
Poamoho																		
Keekee																		
Kaena Quarry																		
Makua																		
Ohikilolo																		
Waimanalo Gulch																		

References: Appendix A Site Selection and Evaluation Criteria
Appendix C Site Maps
Appendix D Detailed Site Data and Descriptions
Plate II-A-1 Key Map

* Some of the evaluation criteria from Appendix "A" have been modified, revised or deleted from this tabulation.

** If demolition material is disposed of at another site, Sanitary Landfill life can be increased by approximately 10% to 20%. If site is used exclusively for Demolition Landfill, life can be increased approximately 5 to 10 times.

*** Anticipated reaction.

PART III

CONCEPTUAL DEVELOPMENT STUDY

A. CONCEPTUAL PLANS FOR SITES SELECTED FOR STUDY --

WINDWARD AND LEEWARD

III. CONCEPTUAL DEVELOPMENT STUDY

After reviewing the recommendations and data presented in Part II, Potential Landfill Sites Study, the City and County selected the following five sites for further study:

Makaiwa Gulch	)	
Nanakuli A and B	)	Leeward Sites
Kaloi Gulch	)	
Kapaa #1, #2 and #3	)	Windward Sites
Kalaheo	)	

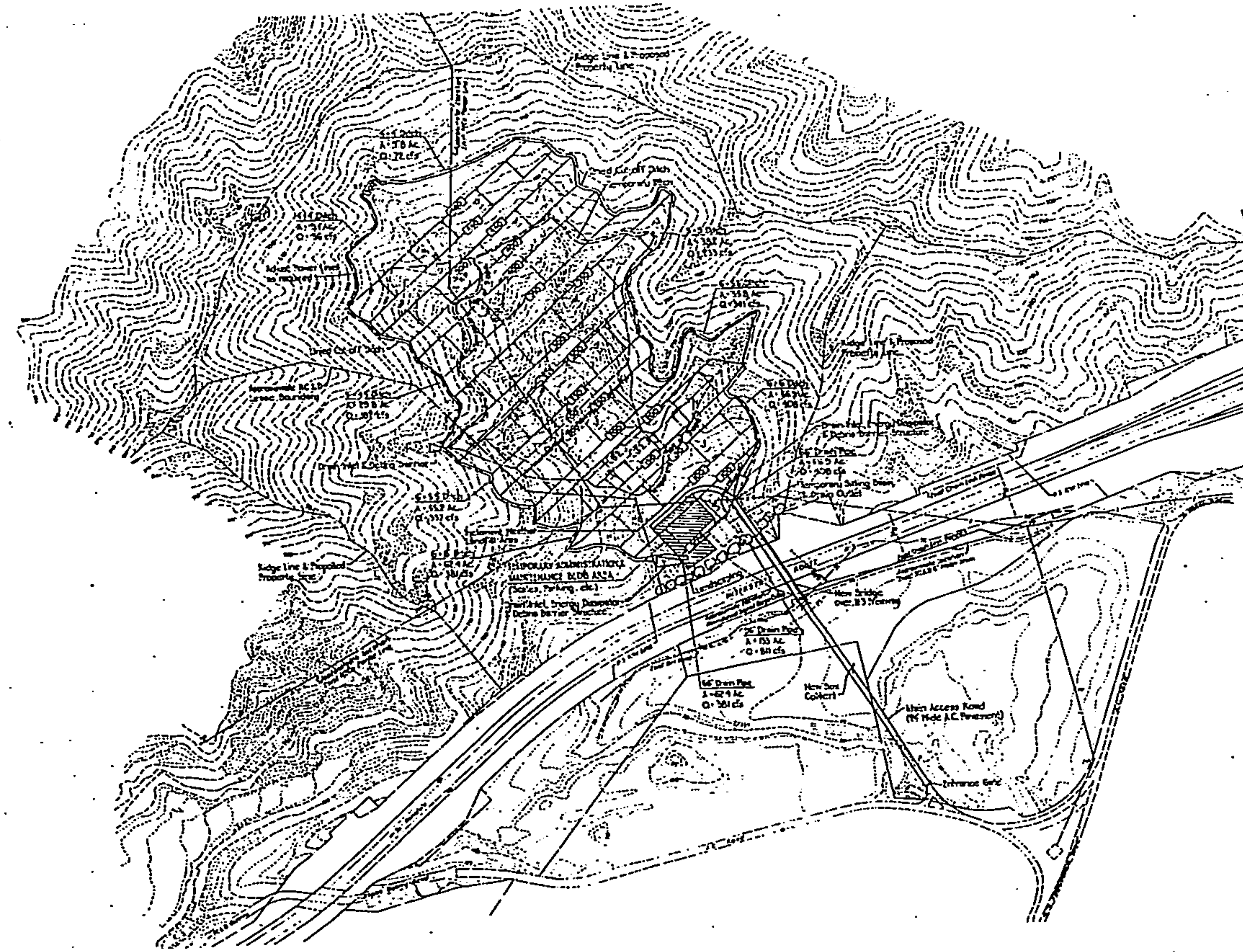
Each of the above sites provides a solution to the City's present landfill problem while keeping environmental damage at tolerable levels.

The conceptual development plans, aerial views, cost estimates and economic analysis of the sites are presented in this Part.

A. CONCEPTUAL PLANS FOR SITES SELECTED FOR STUDY -- WINDWARD AND LEEWARD

The conceptual site development plans show only essential features of the landfill requirements. They have been developed to provide sufficient data for preparation of preliminary cost estimates and for conducting economic analysis of the sites.

Details of the office building, maintenance building, scales, fencing, landfill landscaping and other site improvements will be accomplished in the design phase of the landfill development. Contouring for final use of the land, planning of roads and/or pathways, final landscaping, etc. will be done later, before completion of the landfill operations.



SUMMARY:

Landfill Area = 150± Acres
Landfill Volume = 3,585,000 Cu Yds
Landfill Life = 11.5± Years

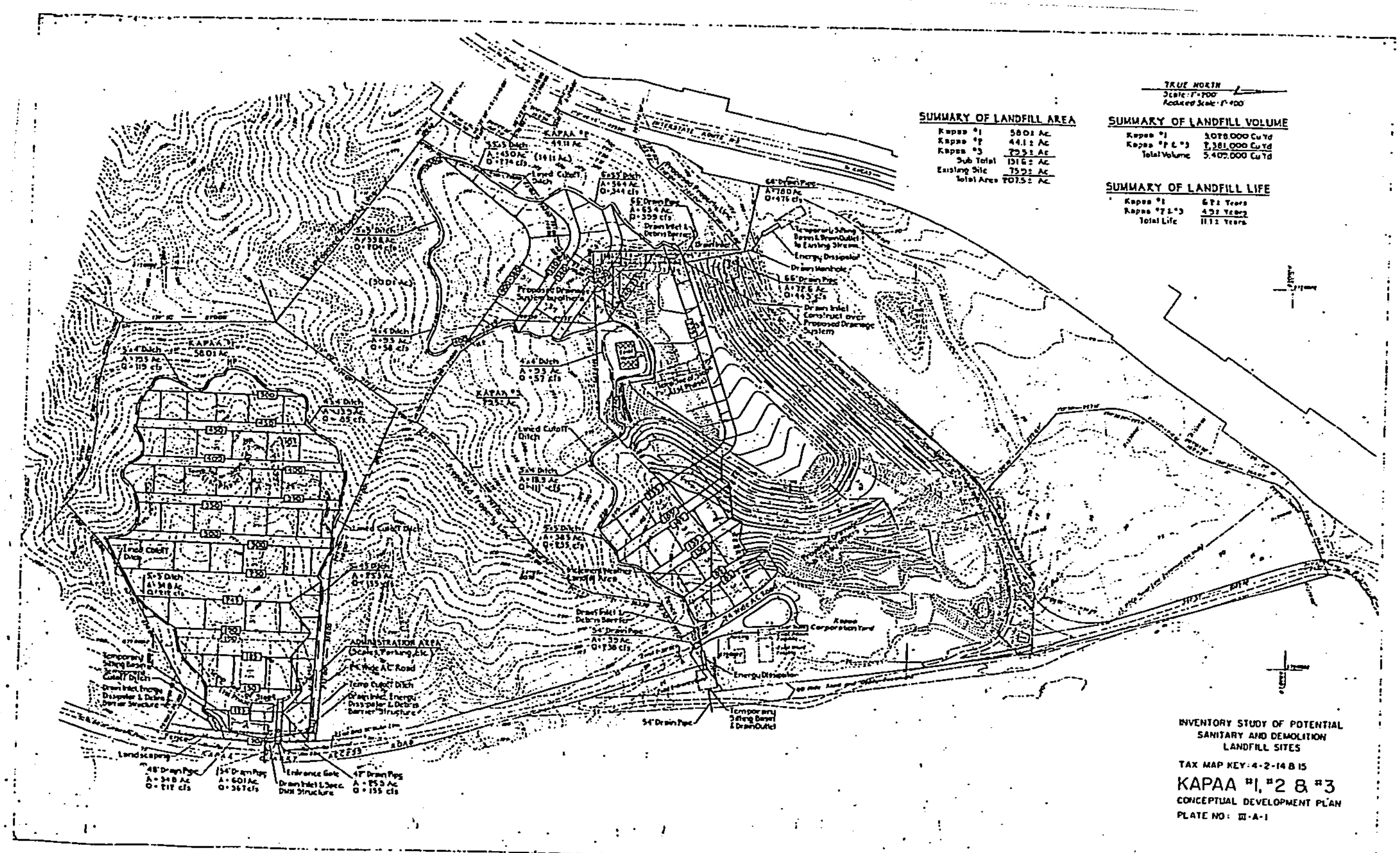
INVENTORY STUDY OF POTENTIAL
SANITARY AND DEMOLITION
LANDFILL SITES

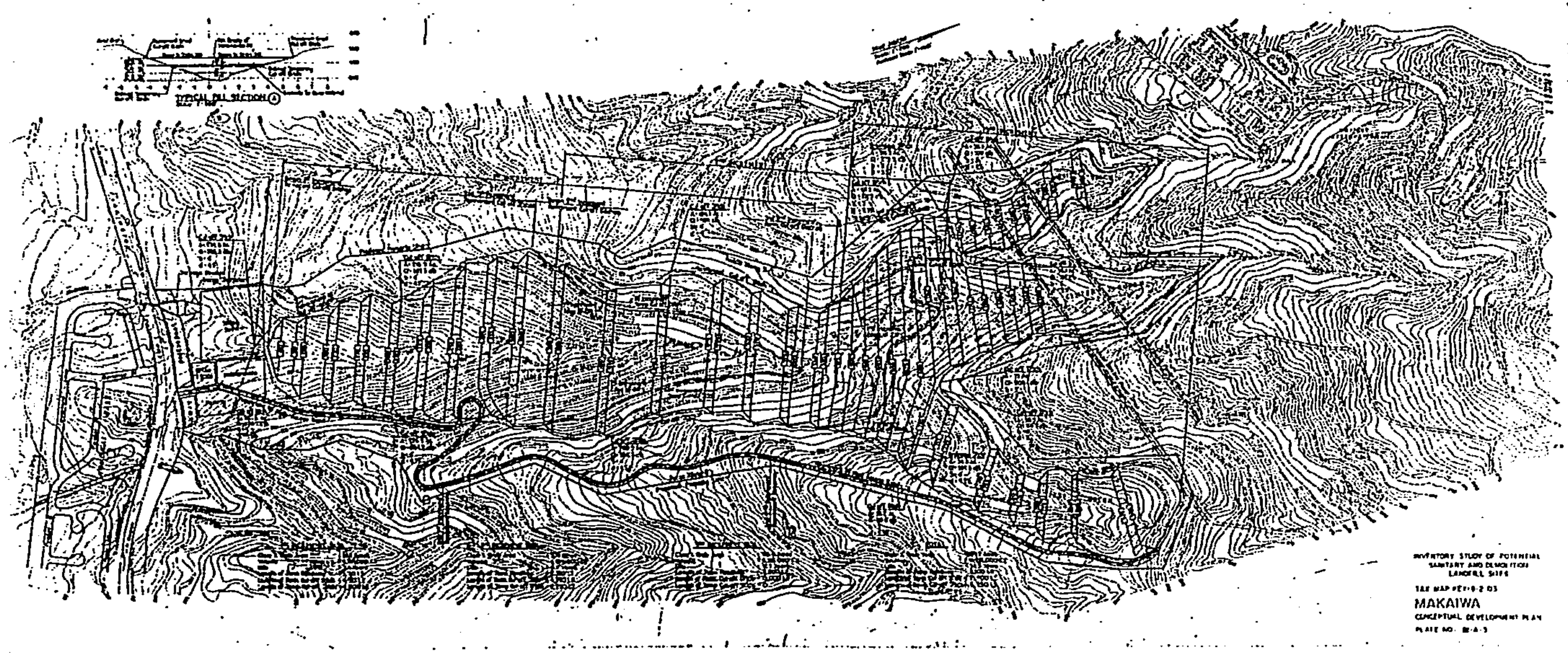
TAX MAP KEY: 4-2-15-POR 18 6

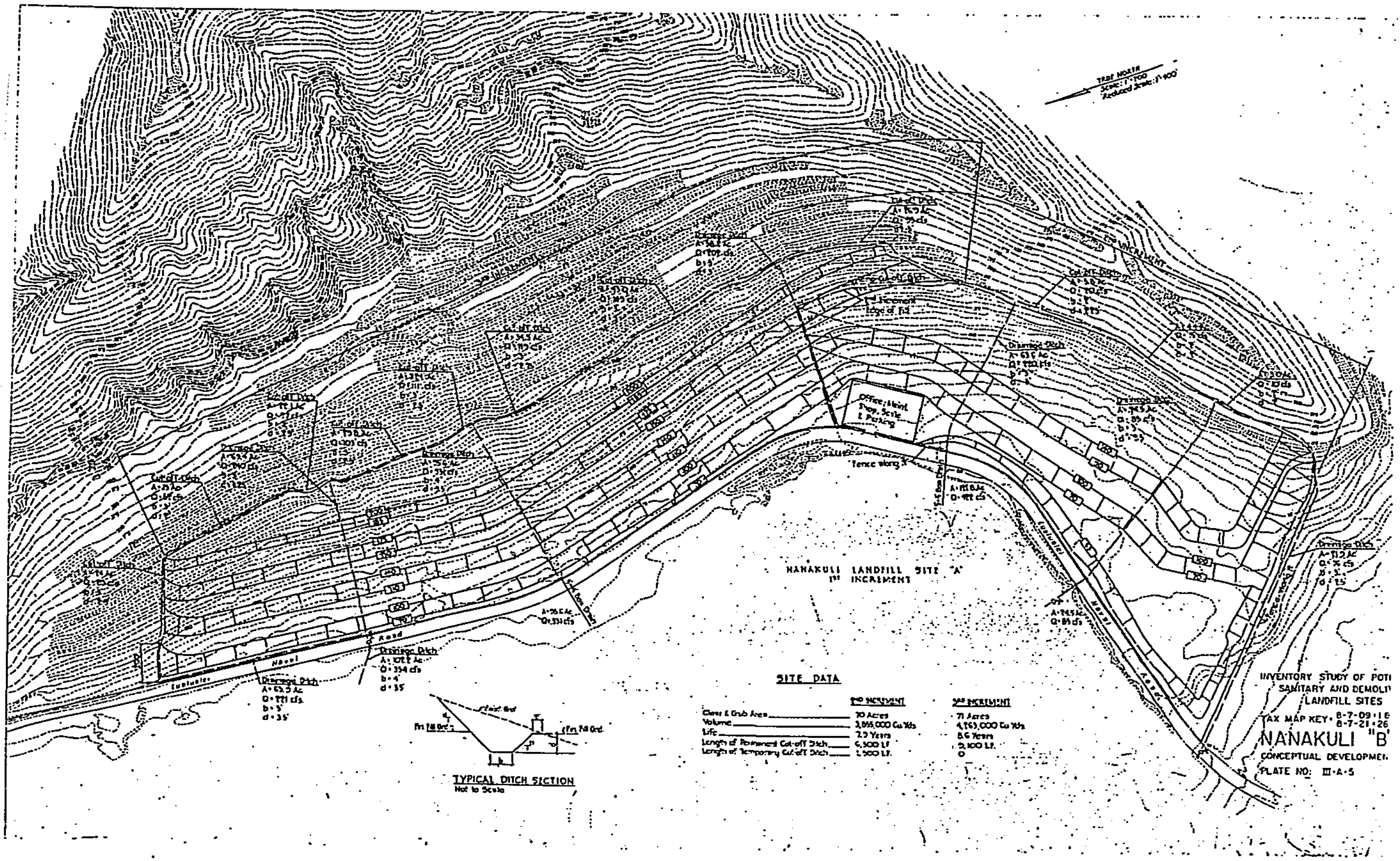
KALAHEO

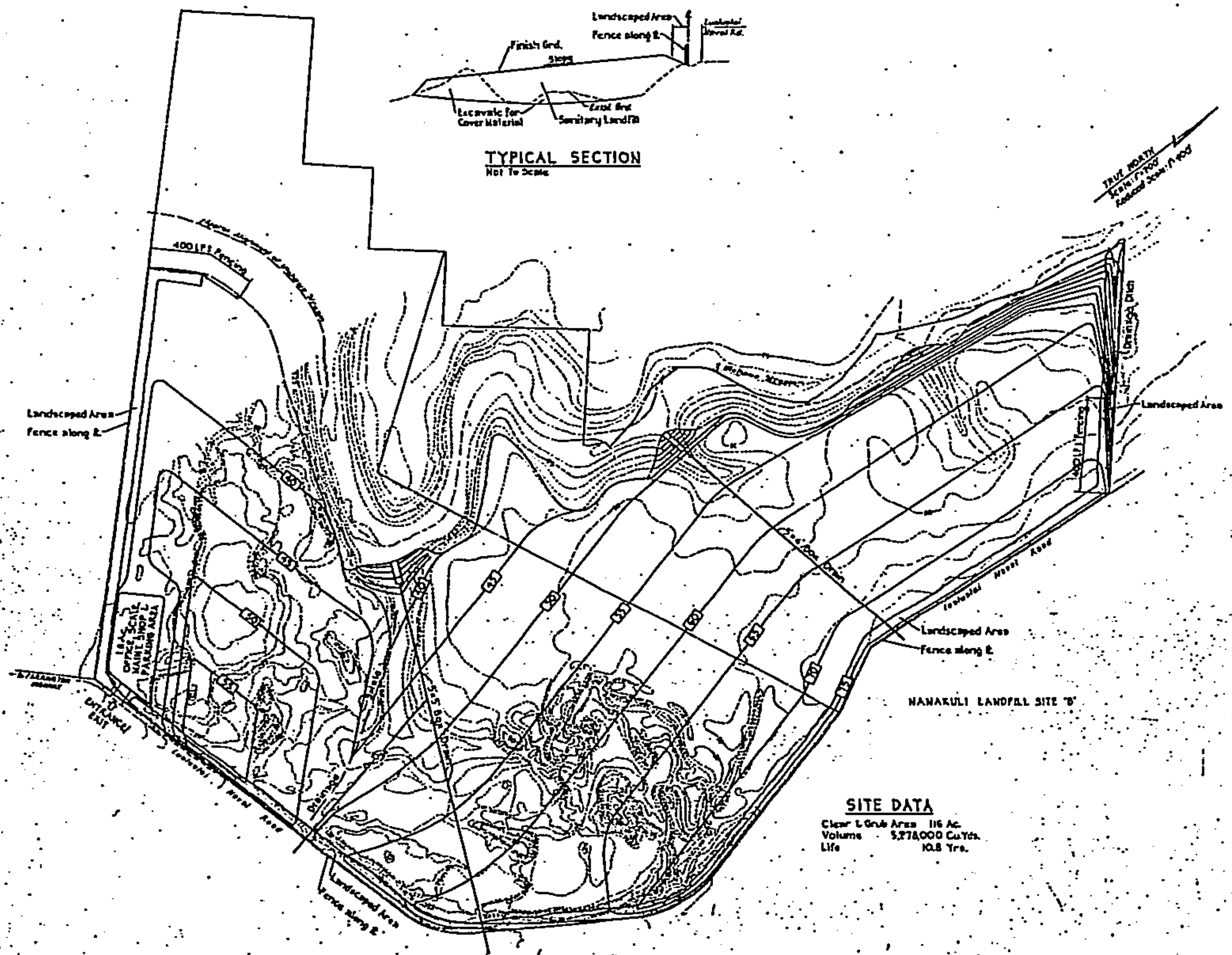
CONCEPTUAL DEVELOPMENT PLAN

PLATE NO: III-A-2


TRUE NORTH
Scale: 1"=200'
Reduced Scale: 1"=400'
SUMMARY OF LANDFILL AREA
Kapaa #1 58.0± Ac.
Kapaa #2 44.1± Ac.
Kapaa #3 29.5± Ac.
Sub Total 131.6± Ac.
Existing Site 75.9± Ac.
Total Area 207.5± Ac.
SUMMARY OF LANDFILL VOLUME
Kapaa #1 2,028,000 Cu Yd
Kapaa #2 & #3 3,381,000 Cu Yd
Total Volume 5,409,000 Cu Yd
SUMMARY OF LANDFILL LIFE
Kapaa #1 6.2± Years
Kapaa #2 & #3 4.9± Years
Total Life 11.1± Years
INVENTORY STUDY OF POTENTIAL
SANITARY AND DEMOLITION
LANDFILL SITES
TAX MAP KEY: 4-2-14 & 15
KAPAA #1, #2 & #3
CONCEPTUAL DEVELOPMENT PLAN
PLATE NO: III-A-1


TYPICAL FILL SECTION
INVENTORY STUDY OF POTENTIAL
SANITARY AND DEMOLITION
LANDFILL SITES
MAKAIWA
CONCEPTUAL DEVELOPMENT PLAN


NANAKULI LANDFILL SITE "A"
1ST INCREMENT
Office, Maint. Shop, Scale & Parking
SITE DATA
2ND INCREMENT
3RD INCREMENT
Clear & Grub Area 70 Acres 71 Acres
Volume 3,866,000 Cu Yds 4,163,000 Cu Yds
Life 7.3 Years 8.6 Years
Length of Permanent Cut-off Ditch 6,300 LF 9,100 LF
Length of Temporary Cut-off Ditch 1,500 LF 0
TYPICAL DITCH SECTION
Not to Scale
INVENTORY STUDY OF POT
SANITARY AND DEMOLI
LANDFILL SITES
TAX MAP KEY: 8-7-09:16
8-7-21:26
NANAKULI "B"
CONCEPTUAL DEVELOPMEN
PLATE NO: III-A-5



SITE DATA

Clear & Grub Area	116 Ac.
Volume	5,274,000 Cu.Yds.
Life	10.8 Yrs.

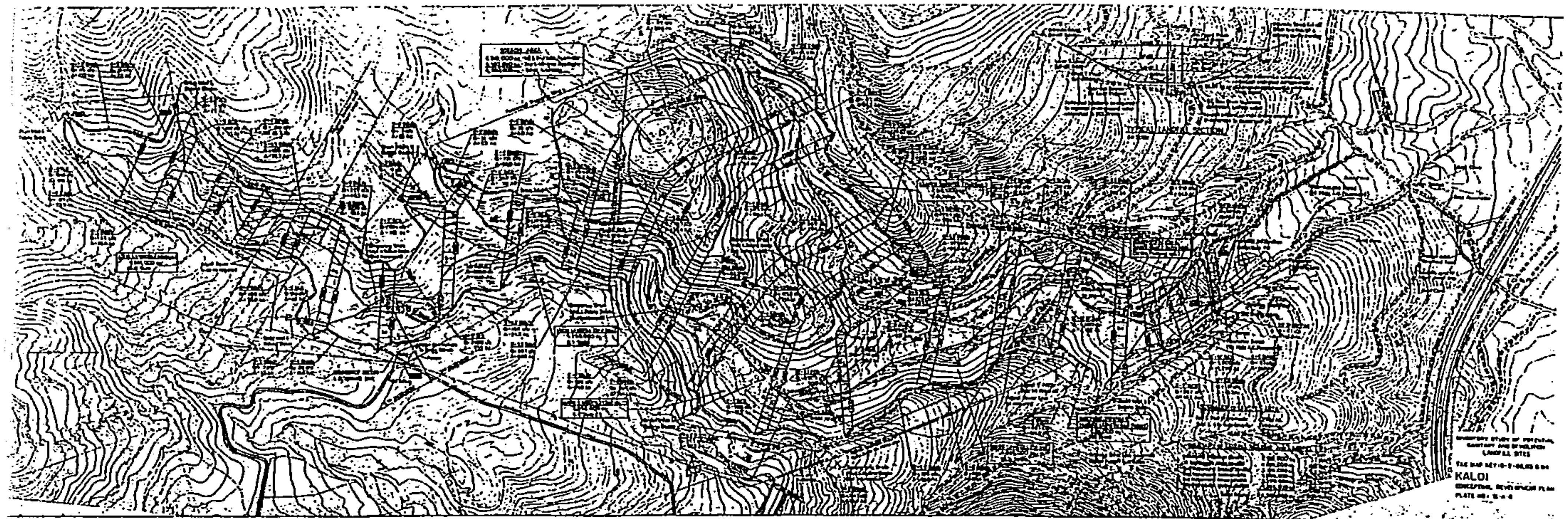
INVENTORY STUDY OF POTENTIAL SANITARY AND DEMOLITION LANDFILL SITES

TAX MAP KEY: 8-7-09:1 & 3, 8-7-21:26

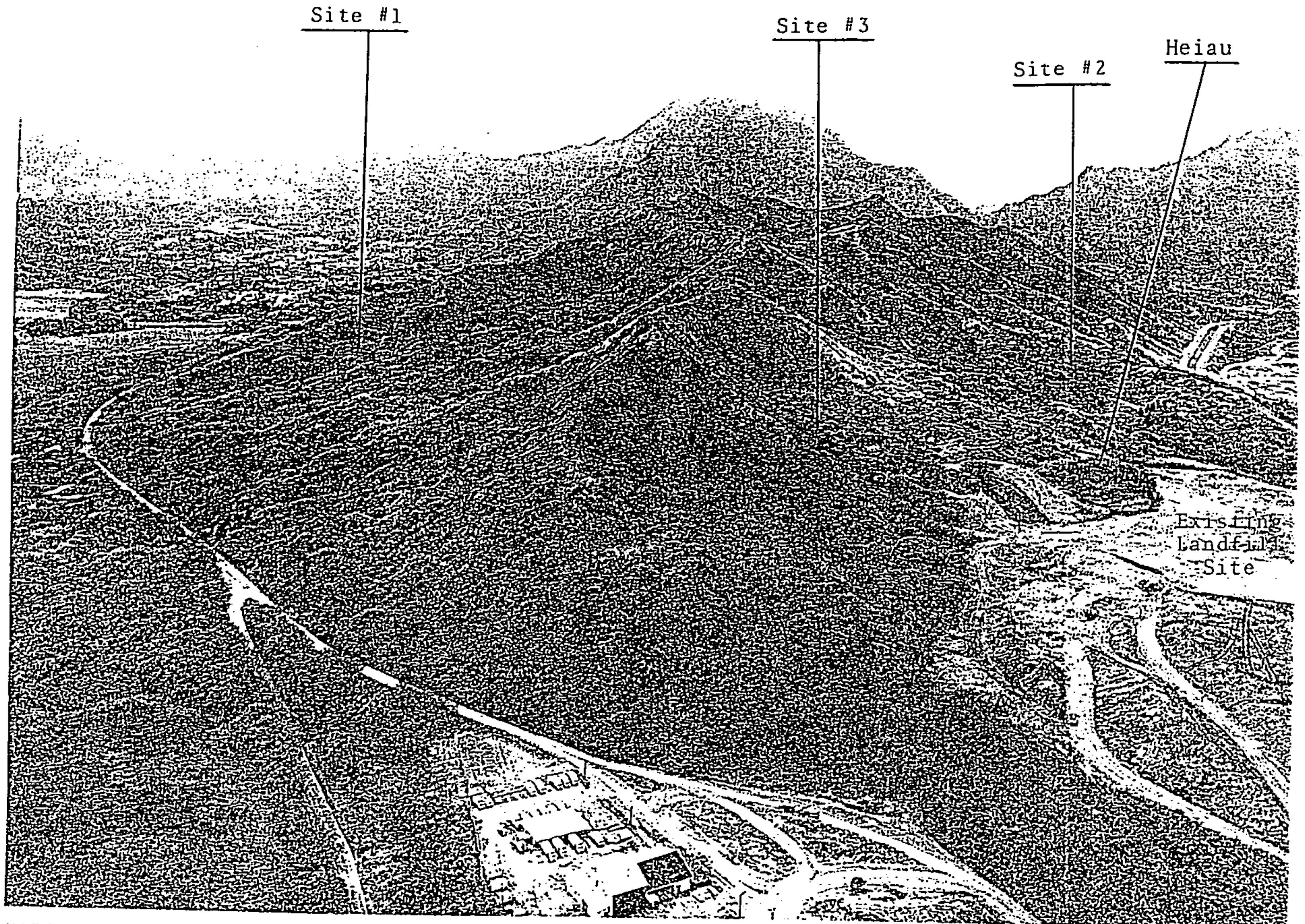
NANAKULI "A"

CONCEPTUAL DEVELOPMENT PLAN

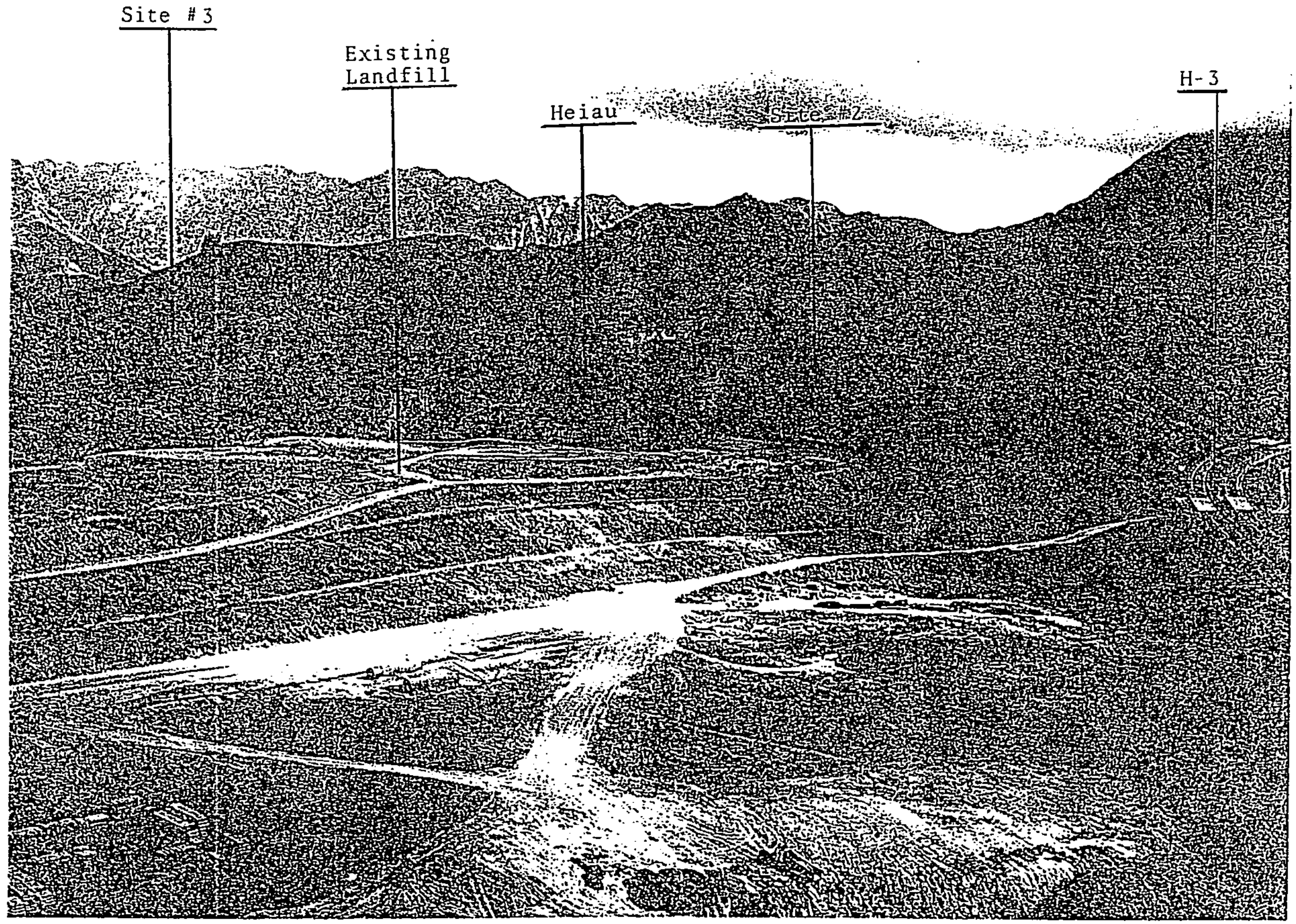
PLATE NO: III-A-4


KALOI

B. AERIAL VIEWS OF SITES SELECTED

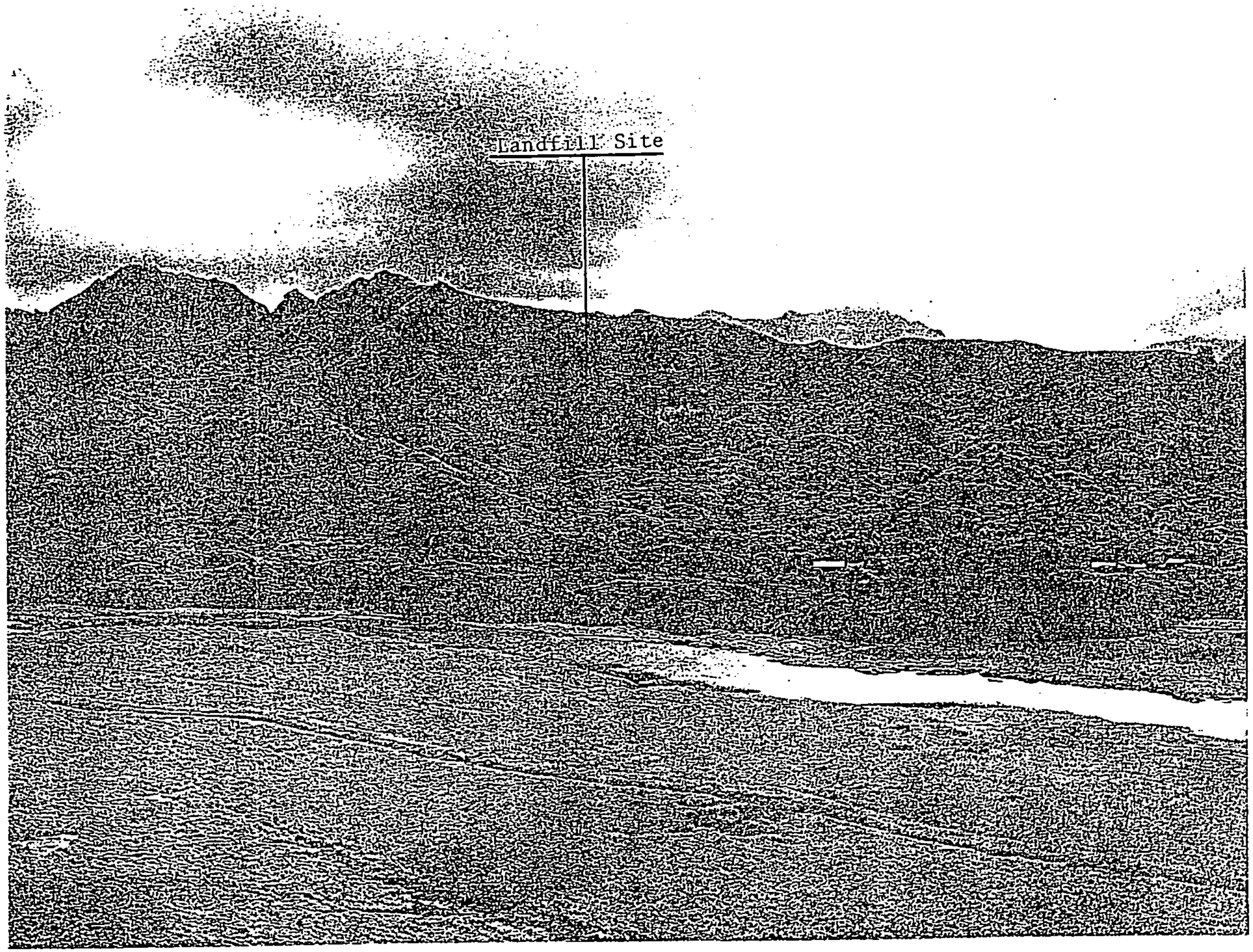


KAPAA SITES. City Kapaa Corporation Yard foreground.



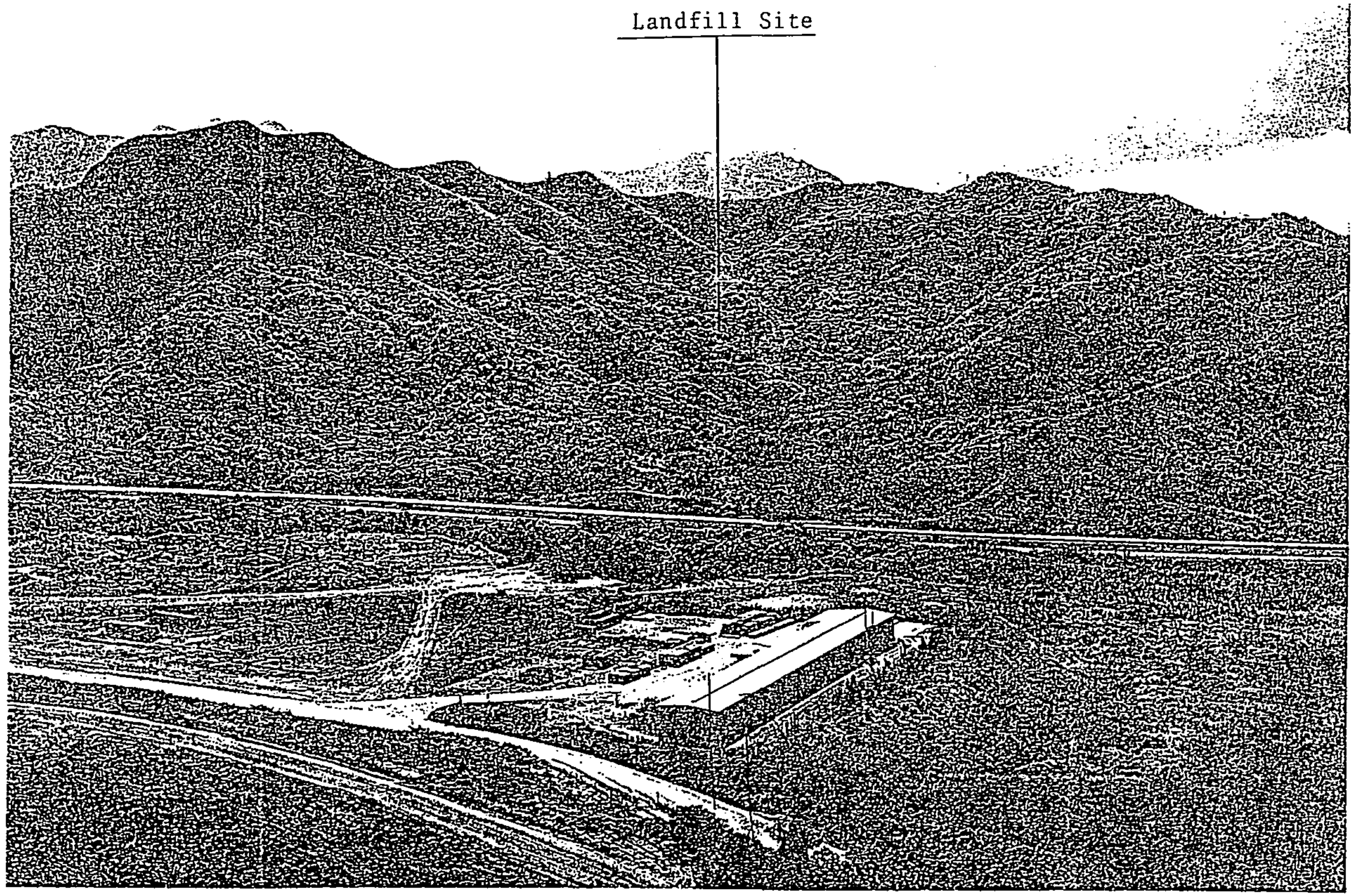
EXISTING KAPAA LANDFILL AND NEW KAPAA #2 AND #3

Plate No. III-B-2

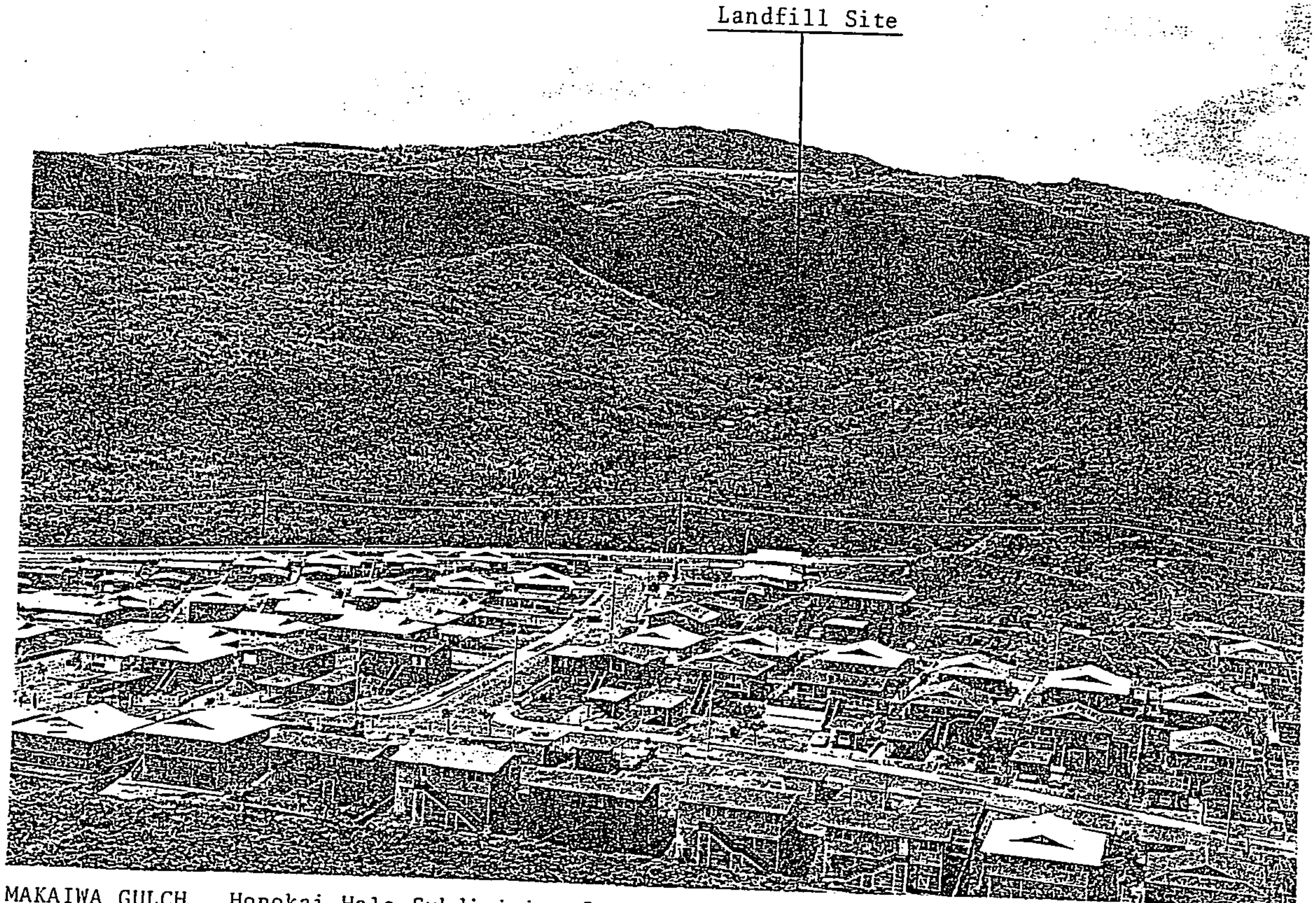


KAPAA #1. Kawainui Swamp foreground.

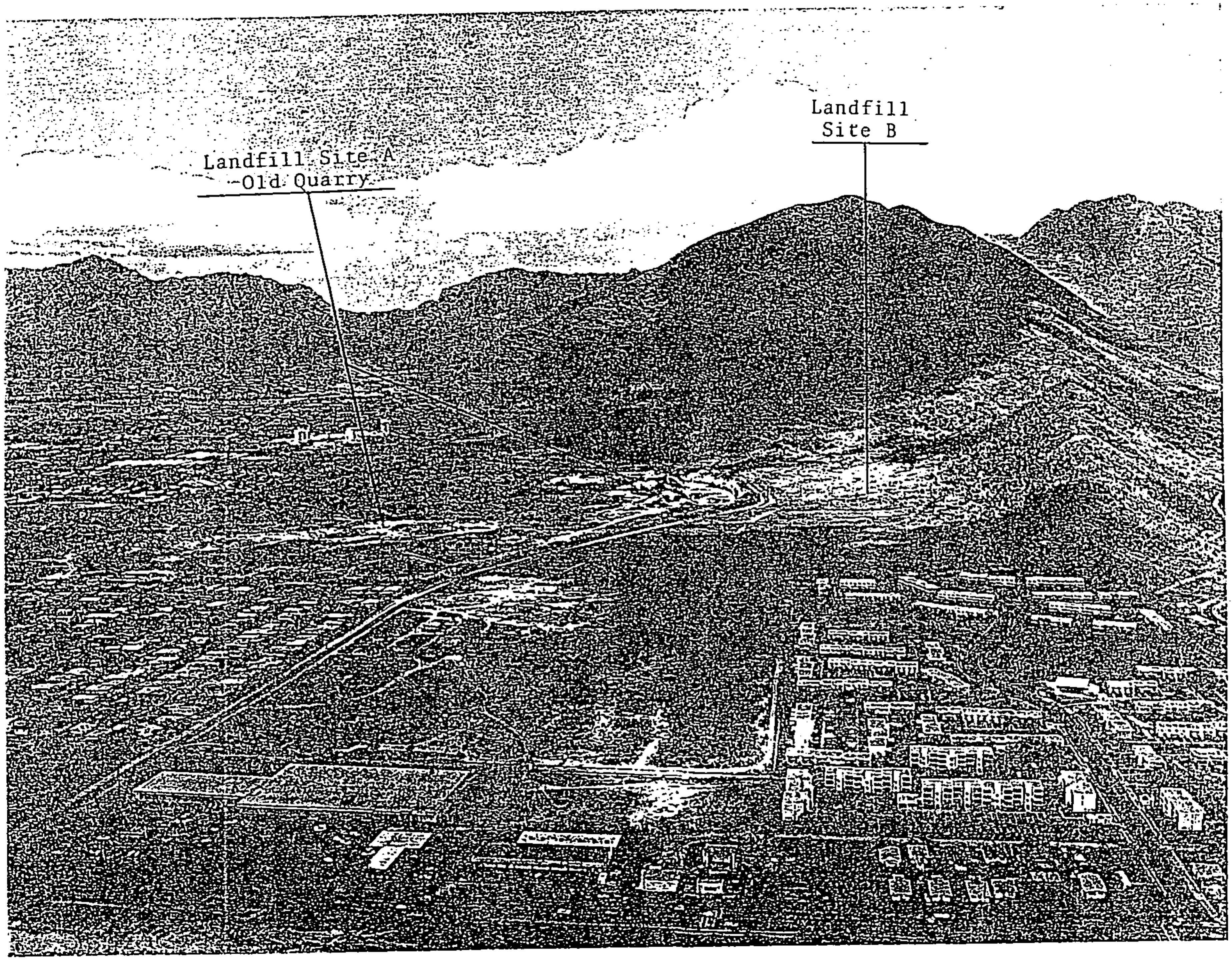
Plate No. III-B-3



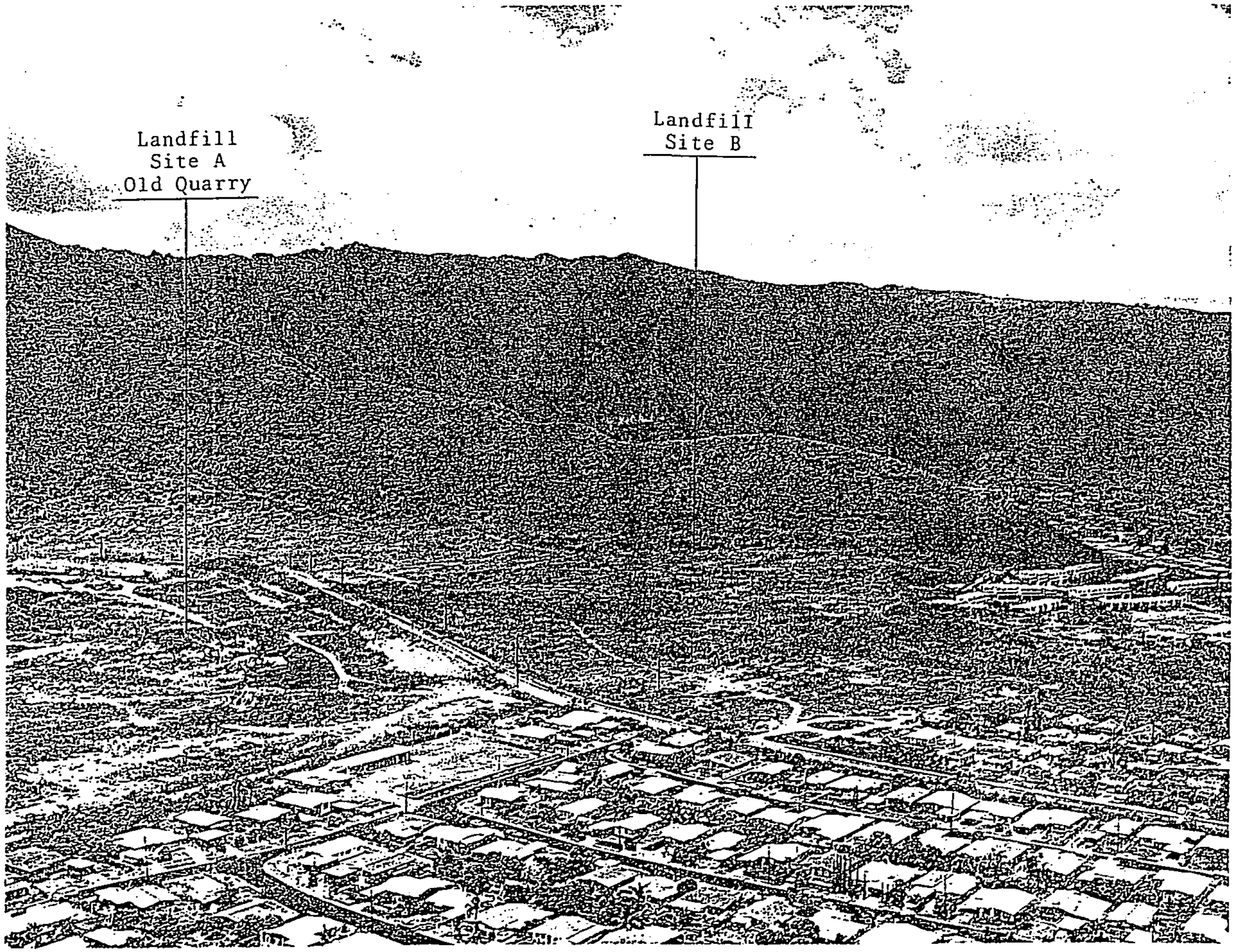
KALAHEO. H-3 center foreground.



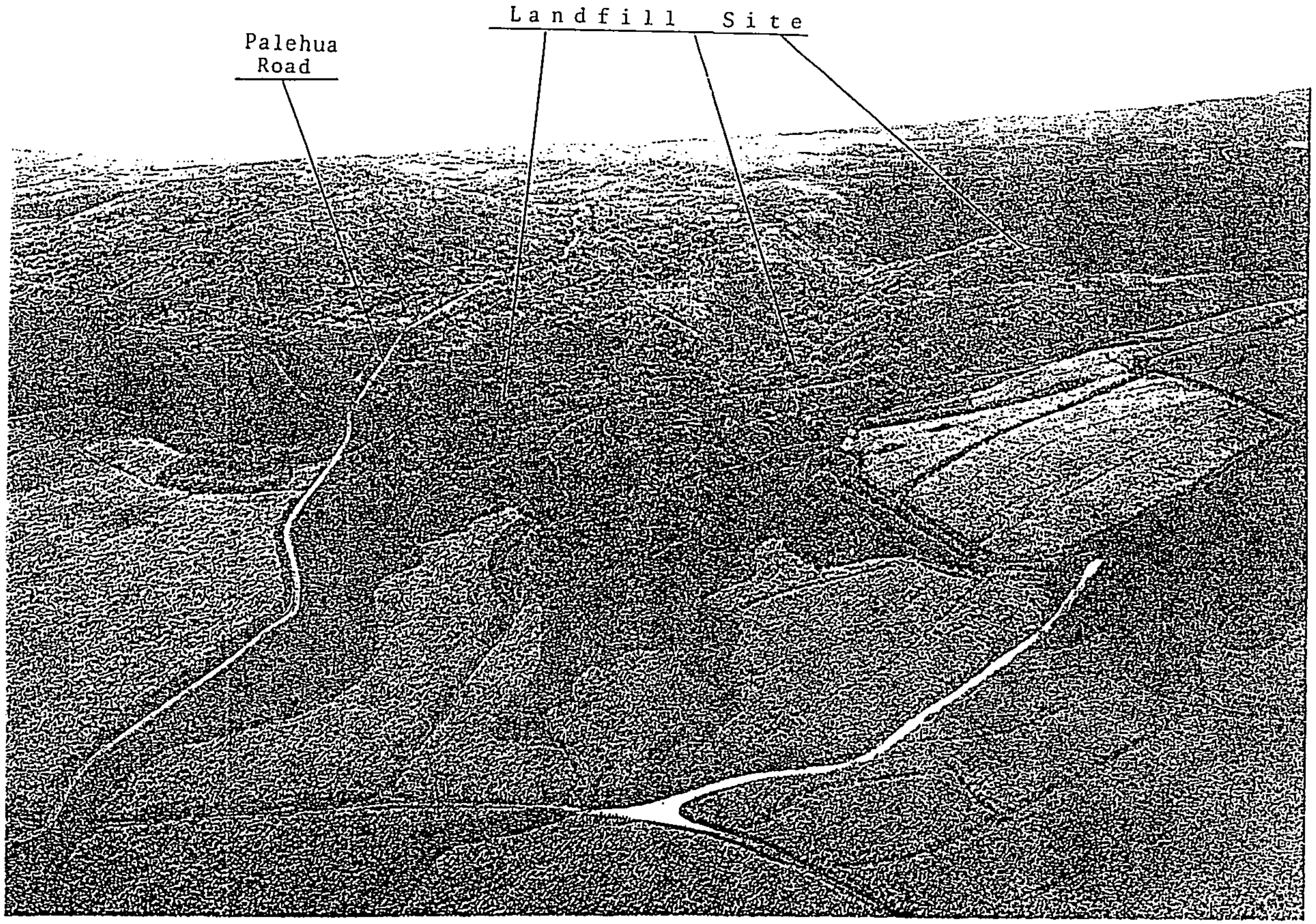
MAKAIWA GULCH. Honokai Hale Subdivision foreground.



NANAKULI A and B

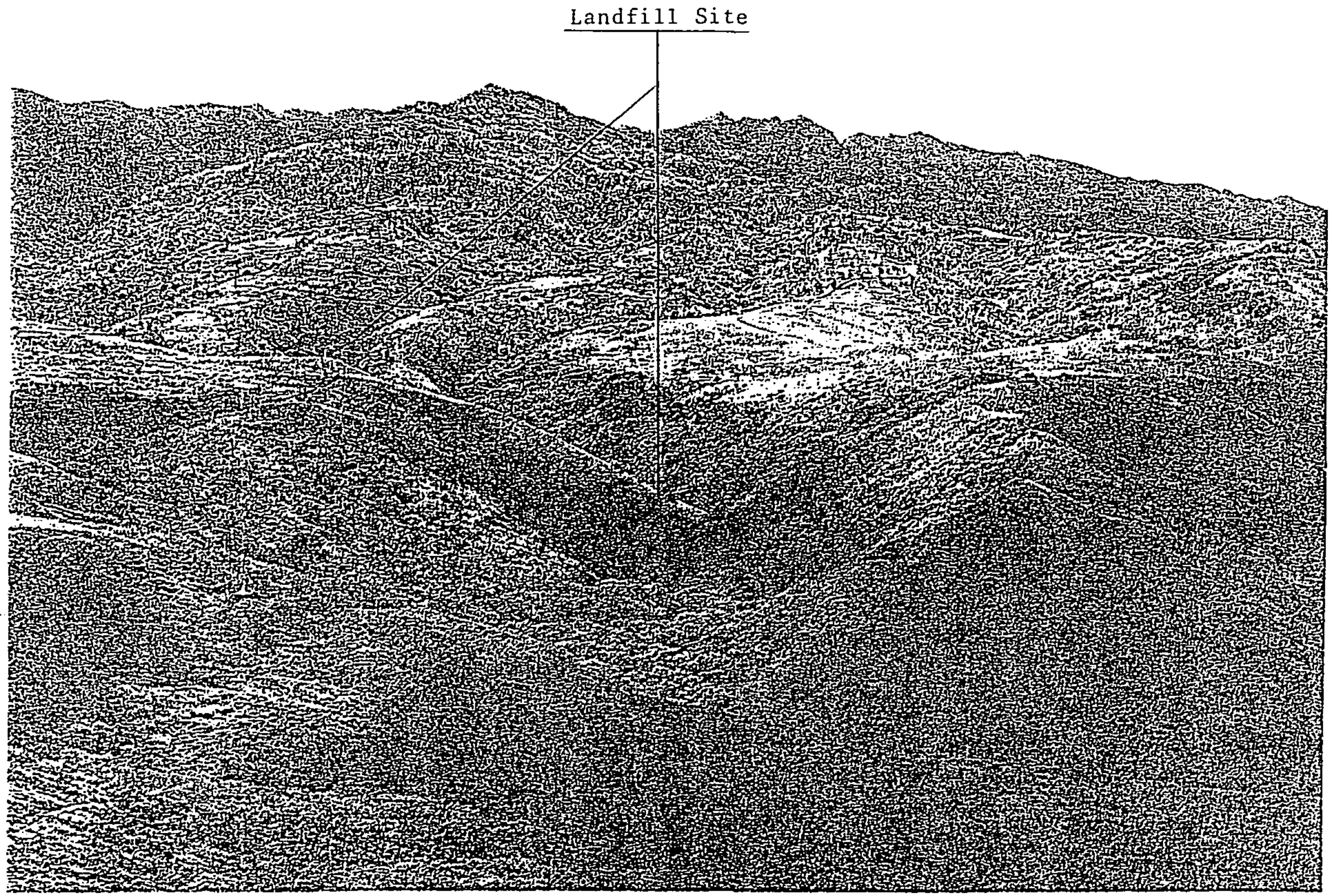


NANAKULI A and B



KALOI GULCH

Plate No. III-B-8



UPPER KALOI GULCH

Plate No. III-B-9

C. COST ESTIMATES AND ECONOMIC ANALYSIS

C. COST ESTIMATES AND ECONOMIC ANALYSIS

Of the many criteria used in the site selection process, economic feasibility is one of the most important. Summary of the estimated site development costs are shown in Table III-1. The cost per ton of disposal at a rate of 500 tons per day, 365 days a year is summarized in Table III-2. The costs are only for landfill development and operations, and do not include costs for collecting and hauling refuse to the site. The Nanakuli site on the Leeward side and the Kapaa site on the Windward side were the most economical.

A maximum life of 20 years was used for the economic study period in Table III-2. Where life of landfill was less than 20 years, the entire life of the landfill was used as the capital recovery period. Where life of landfill was greater than 20 years, cost for site development was interpolated to arrive at a 20-year cost. Life of the landfill equipment was assumed at 8 years. Interest rate used for capital recovery was 6%.

The major cost items for site development and landfill operations were:

1. Lining to protect ground water
2. Drainage System
3. Access Road
4. Land
5. Daily Cover Material
6. Equipment
7. Screening and fencing to protect nearby residences from landfill activities.

Land costs are not included in Table III-1 and III-2. It is expected that the City will lease or purchase the land when the landfill plan is implemented.

The cost of the land varies with location, time and other factors. The Division of Land Survey and Acquisition, Department of Public Works, will make appraisals when the negotiations for the land begin.

TABLE III-1

ESTIMATED SITE DEVELOPMENT COST*

Site	Phase	Capacity (CY)	Life (Yrs.)	Estimated Cost
Makaiwa Gulch	1st	4,580,000	9.4	$ 2,385,000
	2nd	4,484,000	9.2	1,405,000
	3rd	6,168,000	12.7	1,228,000
Total		15,232,000	31.3	5,018,000
Nanakuli A	1st	5,278,000	10.8	$ 2,589,000
Nanakuli B	2nd	3,855,000	7.9	1,204,000
	3rd	4,263,000	8.6	871,000
Total		13,396,000	27.3	$ 4,664,000
Kaloi Gulch	1st	7,631,000	15.7	$16,823,900
	2nd	6,414,000	13.2	9,483,000
	3rd	5,390,000	11.1	9,854,500
	4th	4,865,000	10.0	9,385,000
Total		24,300,000	50.0	$45,546,400
Kapaa 2 & 3		2,381,000	4.9	$ 1,814,800
Kapaa 1		3,028,000	6.2	1,467,850
Total		5,409,000	11.1	$ 3,282,650
Kalaheo Total		5,585,000	11.5	$ 3,494,000

*Costs are December, 1976 prices.
Land costs not included.

TABLE III-2

SUMMARY AND COST ANALYSIS

SITE (Yrs. of Life)	DEVELOPMENT COST	ANNUAL AMORTIZED DEVELOP. COST* (1)	ANNUAL EQUIPMENT COST (2)	ANNUAL ADMIN., OPER., MAINT. & SUPPLY COST (3)	TOTAL ANNUAL COST (1)+(2)+(3)	COST/TON**
LEEWARD						
Makaiwa (20)	$ 3,939,500	$ 343,400	$95,300	$514,100	$ 952,800	$ 5.22
Nanakuli (20)	$ 3,924,700	$ 343,200	$95,300	$377,100	$ 815,600	$ 4.47
Kaloi (20)	$19,912,000	$1,735,900	$95,300	$514,100	$2,345,300	$12.85
WINDWARD						
Kapaa (11.1)	$ 3,282,700	$ 416,200	$95,300	$377,100	$ 888,600	$ 4.87
Kalaheo (11.5)	$ 3,494,000	$ 443,000	$95,300	$377,100	$ 915,400	$ 5.02

* Capital cost of site development is amortized at 6% with CRF - 0.08718 (20 years) and CRF - 0.12679 (11 years).

** COST/TON based on disposal rate of 500 tons/day, 365 days/year (182,500 tons/year).

The following equipment and operational requirements were estimated, based on discussions with the Refuse Division and the operational requirements of each landfill site. Almost two complete shifts of personnel will be required per site, due to the long hours of operation (74 hrs. per week).

1. EQUIPMENT REQUIREMENTS:

1 - D-8 Size Landfill Dozer w/Acc.	$ 205,000
1 - Loader w/Acc.	97,000
1 - Compactor w/Acc.	123,000
1 - Water Tank Truck	35,000
1 - One-Half Ton Pickup	7,000
1 - Scraper - 20± C.Y.	125,000
Total Equipment Cost	$ 592,000 per site

Annual equipment cost amortized over 8-yr. period @ 6%, CRF - 0.16104 $ 95,300 per yr. per site

Due to each site handling the same volume of refuse, manpower and equipment requirements are assumed to be the same for all sites.

2. OPERATIONAL REQUIREMENTS:

a. Operation and maintenance cost of equipment (approximated from local contractor's costs) $ 58,400 per site

b. Annual Manpower Costs (overhead of 30.17% included):

2 - Supervisors	$ 36,400	
5 - Equipment Operators	69,000	
2 - Scale Operators	20,800	
5 - Laborers	45,500	
Total Annual Manpower Costs		$ 171,700 per site

c. Annual Cover Material Costs:

Makaiwa and Kaloi	$ 274,000 per site
Kapaa, Kalaheo and Nanakuli	$ 137,000 per site

Cover material costs are based on $2.25/cubic yard of imported fill. Cover material costs for the Kapaa and Kalaheo sites are estimated at one-half that of the Makaiwa and Kaloi sites due to availability. The Nanakuli site is grouped with Kapaa and Kalaheo due to the probability of this site also being able to generate most of its own cover material.

d. Annual Administration and Supply Costs -- allowance $ 10,000 per site

Total Annual Administration, Operation, Maintenance and Supply Costs:

Makaiwa and Kaloi	$ 514,100	per year per site
Nanakuli, Kapaa & Kalaheo	$ 377,100	per year per site

As stated earlier, collection and hauling costs were not included in Table III-2. Although hauling costs are not a part of landfill operations, they can become a significant factor in the site selection process and economic analysis.

Hauling costs to the Windward sites, Kalaheo and Kapaa, were assumed to be the same for both since there is no significant difference in distance between the two. Hauling costs to the Leeward sites were computed to compare differential cost. It was assumed that hauling from nearby communities to the landfill site by packer trucks was not significant. Further, the Waipahu Incinerator, after improvements, would increase its capacity and take in more refuse from the surrounding communities and further decrease the significane of refuse hauling to the landfill by packer trucks. Only hauling by transfer trailer truck from the Shafter Flats Transfer Station was considered in this analysis since the bulk of the refuse for the Leeward Landfill Site would be coming from the major refuse generation centers of Honolulu and environs.

Basic Data:

Travel Distance from Shafter Flats to:

Kaloi	15.5 mi.
Makaiwa	18.5 mi.
Nanakuli	22.5 mi.

Average Travel Speed:

Kaloi and Nanakuli	40 MPH
Makaiwa	45 MPH due to travel being mostly on H-1 Freeway

Cost per ton min. of hauling:

$0.024 from Mitre Corporation's report, Analysis of the Feasibility of Resource Recovery for Honolulu, April, 1977.

Differential Costs:

Kaloi $\frac{15.5}{40}$ x 60 x 2 x .024 = \$1.12/ton

Makaiwa $\frac{18.5}{45}$ x 60 x 2 x .024 = \$1.18/ton

Nanakuli $\frac{22.5}{40}$ x 60 x 2 x .024 = \$1.62/ton

Using Kaloi as the base, it costs \$.06/ton more to haul to Makaiwa and \$.50/ton more to haul to Nanakuli. Difference in hauling cost between Makaiwa and Nanakuli is \$.44/ton.

After considering the distance factor, the Nanakuli site is still more economical than the other sites.

PART IV

APPENDIXES

Appendix A

SITE SELECTION AND EVALUATION CRITERIA

In this study, the selection and evaluation of landfill sites were based primarily on the following criteria, not necessarily listed in order of importance:

1. Capacity - Each potential site must have sufficient volume to make it worthwhile, since opening a new landfill involves major capital cost. Capacity is a very important factor in landfill development economics. Desirable minimum capacity should provide for approximately 5 years life based on 500 tons/day of refuse.
2. Access to Adequate Roads - Any major landfill operation will attract additional traffic to the roadways in the area and an adequate, modern highway is needed to prevent excessive congestion and hazards. Site should be within 2,000 ft. of an adequate main highway.
3. Availability of Utilities - All major landfill sites will need power, communication, sanitary and water systems for proper operation. The immediate availability of these utilities can be a major factor in the evaluation of the site.
4. Proximity to Incompatible Land Uses - A landfill operation is a nuisance type activity, similar to heavy construction work, and most land uses would conflict with it. Generally, a buffer area with landscaping is needed to isolate the landfill if its location is not in low land use areas or is not remote.
5. Pollution of Ground and Surface Water - A landfill can produce leachates and silt. Our potable ground water supply sources must be protected from leachates and our surface water needs protection from siltation. The protection of our potable ground water supply is absolute.
6. Availability of Cover Material - Cover material is an important ingredient in a sanitary landfill. Without it, an ordinary dump exists. The economic availability of this cover material can be decisive. When cover material must be imported, the cost, depending on the location, of the landfill site can vary from $1.50 to $5.00 per ton.

7. Travel Distance - When conditions permit, landfill sites should be located close to the refuse generation centers. Hauling is an important factor in the economic operation of a landfill.

8. General Nuisance - A landfill operation will cause noise, dust, litter, odor and other nuisances. Unless these nuisances are properly provided for, the site should be remote. Wind direction is a factor. This item relates directly to 4 and 7.

9. Existing Land Use - The existing land use of sites should be low or open so as not to be objectionable to owners and interested groups.

10. Final Land Use of Landfill - The final land use after the landfill operation should be of equal or higher use than at present and should be compatible with the surrounding land uses. This item relates directly to item 9.

11. Zoning, City General Plan and State Land Use District - An active landfill may operate for an extended time and could affect the overall growth plan of the island. This item relates directly to land acquisition cost, the overall general plan of the island and items 9 and 10.

12. Geology - The geology of the site must be considered to protect the ground water supply and to determine the amount of cover material available. This item relates directly to items 5 and 6. It must be studied in greater detail in the EIS stage.

13. Drainage - On and off site drainage systems are required to minimize the generation of leachates and silt and for protection against floods. Gullies with large drainage basins behind them present major drainage problems and costs.

14. Topography - The topography of the site determines the capacity and a substantial portion of the development cost. It also determines the visual impact of the site. Generally, gullies, swamps and low lying areas are desirable sites.

15. Objection by Landowners, Adjacent Landowners, Public and Community Organizations, etc. - This item can be an important factor, as the City's need for additional landfill space is becoming critical. Protests by owners or interested groups can cause major delays and produce a crisis situation, but should not be the major consideration in the landfill site selection process.

16. Destruction of Natural Resources - Our natural resources must be protected from irreparable damages as much as possible while providing suitable landfill sites for the general welfare of the public.

17. Other Environmental Factors, Including Displacement, Historical and Archeological Sites, and Flora and Fauna - Historical and archeological significance and flora and fauna of the sites must be studied. Also visual pollution and displacement of persons and businesses must be considered. This item must be studied further in the EIS stage.

18. Safety - Site must have safe access and must not present any hazard to the public or to property. Site must be able to meet State Department of Health requirements. Public Health Regulations, Chapter 46, Solid Waste Management Control.

19. Major Development Costs - These costs are generally related to most of the items previously discussed. These costs can become prohibitive when:

    a. Leachate abatement measures are required.
    b. New access to site must be constructed to an adequate roadway.
    c. Utilities are not available nearby and must be brought in from remote sources.
    d. Cover material is not available on site or nearby and must be hauled in from afar and stored.
    e. Land is zoned for high uses such as residential or higher, or when land is in use.

Although this tabulation lists nineteen items as the criteria, each site was only required to have the following essential basic characteristics before being considered for further evaluation as a potential landfill site:

1. Adequate capacity.
2. Adequate protection of our ground water supply.
3. No apparent significant environmental damage to the land, air, ocean or population.
4. Apparent economical feasibility.

To rank the sites, all of the nineteen criteria were considered in total. Due to some of the criteria not lending themselves to measurement, an attempt to obtain objectivity was made by placing weighted subjective values on the criteria.

See Summary of Evaluations and Rankings of Site, Windward Oahu and Leeward Oahu, pages II-7 and II-13, respectively.

Appendix B

LANDFILL LIFE COMPUTATION CRITERIA

For this study, the computations for capacity and life of the landfill were based on the following:

1. Theoretical refuse disposal rate:

   500 Tons/Day -- Leeward

   500 Tons/Day -- Windward

2. Compacted refuse density -- 1,000 Lb./C.Y.
3. Refuse to Earth Cover Ratio -- 3 : 1

APPENDIX C

DETAILED SITE DATA AND DESCRIPTIONS

1. KAPAA #2 AND #3 LANDFILL SITES

A. BASIC DATA OF SITE

1. Location: West of Kapaa Quarry Road and Kawainui Swamp and northeast of Ulumawao Peak in Kailua. See Plate IV-D-1. Sites designated as Parcels 2 and 3 of Kapaa Landfill Sites by the City and County of Honolulu.

2. Tax Map Key: 4-2-15 : portions of 1, 3, 4 and 7.

3. Total Area: 74± acres

4. Owners: Michael C. Baldwin Trust, John C. Baldwin Trust, James C. Castle, Jr. Trust, James C. McIntosh Trust, (HC&D, Ltd., lessee of portion).

5. Present Use of Land: Open space

6. City Zone District: Preservation and Residential

7. City General Plan Land Uses: Industrial, Public Facilities and Utilities, and Agriculture.

8. State Land Use Districts: Urban and Conservation.

9. Adjacent Land Uses, Zones, etc.: Same as 5 thru 8 above.

10. Restrictions and Setbacks: Permit required from State for construction in Conservation District. Site is in the Kawainui Swamp Special Management Area and a Special Management permit must be obtained. An EIS may be required prior to obtaining a permit.

11. Historical and Archeological Significance: Historic Site #359, an existing heiau is on the existing Kapaa Landfill Site. Prior to use of Kawainui Swamp as a demolition fill site as recommended, the historical and archeological significance and the flora and fauna of the area must be studied and appropriate action taken.

12. Proximity to Population and Refuse Centers: Between Kaneohe and Kailua urban areas and approximately 4,000 ft. from residential developments.

B. DESCRIPTION OF SITE

1. Accessibility: Access from Kapaa Quarry Road and the existing Kapaa Landfill.

2. Topography: Kapaa #2 is moderately steep hillside ridge on the northern slopes of Ulumawao peak adjacent and south of Interstate Route H-3. The ridge begins at elevation 120' and rises to elevation 415' over a distance of 1700 ft.

Kapaa #3 and the future completed Kapaa Landfill will form a moderately steep depression on the northern slopes of Ulumawao Peak. One gully is located in the depression which begins at elevation 35' at the lower eastern end mauka of the Kapaa Corporation Yard and rises westward to elevation 270' over a distance of 1400'. The site is approximately 1200' wide at its widest point.

The longitudinal slope of the site varies from 10% to 15% at the lower end to 25% to 30% at the upper end with an average slope of about 18%. The transverse slope of the depression varies from 5% near the gully to over 50% at its upper reaches.

The depth of the depression from the top of the adjacent ridges and future completed Kapaa Landfill varies from 150' near the lower end to over 200' at the upper end. Kapaa #2 and #3 are buffered on the south by the slopes of Ulumawao Peak.

3. Soil Classification: Site consists of the following soils taken from the U.S. Soil Conservation Service Soil Survey of State of Hawaii, August, 1972:

   Rock land occurs in the upper reaches;
   Helemano silty clay, 30% to 90% slopes, and
   Alaeloa silty clay, 40% to 70% slopes
   occur along the upper sides of a major portion of the depression;
   Kawaihapai clay loam, 6% to 15% slopes
   occurs in the gully of a major portion of the depression and Alaeloa silty clay, 15% to 35% slopes, occurs in the lower end of the depression.

   See Appendix E.

4. Availability of Cover: Available on site or from HC&D quarry.

5. Surface Drainage: Storm runoff from 44± acre Kapaa #2 flows across ground by sheet flow. Storm runoff from 30± acre Kapaa #3 and future completed Kapaa Landfill depression is conveyed by one defined gully into and across the Kapaa Corporation Yard Site.

6. Ground Water Supply: None

7. Existing Utilities: None on Site. 36" Water main exists on Kapaa Quarry Road. Power available from adjacent Kapaa Corporation Yard.

C. SITE AS LANDFILL

1. Usable Area: 42± acres

2. Type of Operation: Trench, area and combination methods.

3. Capacity: 2,380,700± cubic yards

4. Life: 4.9± years

5. Land Use After Development: Can be park with recreational facilities according to Parks and Recreation Dept.

D. ENVIRONMENTAL CONCERNS OF SITE

1. General Landfill Nuisances: Noise, dust, odor, litter, pests, etc. associated with landfills will be generated. Because the site is removed from urban centers, nuisance to the public should be minimal.

2. Visual Pollution: Will occur and will be noticeable from the adjacent Interstate Route H-3. Existing landfill and quarry operations in the general area have scarred the landscape and should reduce the public's awareness of additional visual pollution. Landscaping prior to, during the progress and after completion of landfill operations should minimize visual pollution.

3. Ground Water Pollution: Area is not a source of ground water supply.

4. Surface Drainage Works: Moderate, although drainage area small, sensitive due to controls required.

5. Destruction of Natural Resources: Initially, land and vegetation will be committed to landfill. However, a green area will be developed after cessation of landfill activities to restore the land and vegetation.

6. Displacement: None

7. Other Environmental Concerns: Traffic should create no problems since the existing paved two-lane Kapaa Quarry Road is being utilized as access to the present Kapaa Landfill and the public is familiar with traffic patterns of this area. Impact on flora and fauna is not expected to be significant but these and other concerns will be addressed in more detail in an environmental impact statement if this site is selected for development.

8. Safety: Hazard to the public is minimal.

9. Objections by Owners and Adjacent Owners: Minimal, since land is not being utilized presently.

10. Objections by Public, Community Organizations, etc.: Landfill operations will be opposed by citizens who live in the vicinity of the proposed site and by the environmentally

oriented groups. The City must convince the public of the advantages of this landfill site.

E. SITE PREPARATION FOR LANDFILL

1. Access Road: None required since adjacent to existing Kapaa Landfill and the same roadway can be used.

2. Operations and Maintenance Facilities: Use existing facilities.

3. Utilities: Water, power and telephone service are available from adjacent site.

4. Drainage System: Nominal drainage works required.

5. Leachate Control System: Not required, but leachate generation should be minimized by incorporating proper design features in the landfill.

F. COMMENTARY OF SITE

1. Discussion: The Kapaa #2 and #3 Sites contain 74± acres, are located in vacant land, and owned by four trusts. The zoning permits landfill use. It is situated ideally between the urban and refuse generation centers of Kaneohe and Kailua in a hillside area scarred by existing landfill and quarry operations. A two-lane paved road runs adjacent to the site and cover material is available on or adjacent to the site. Ground water in this area is not a source of present or future water supply for the Board of Water Supply.

The capacity of the sites is approximately 2,380,700 cubic yards, and the estimated life is 4.9± years. No one will be displaced by the project, and because it is adjacent to the existing Kapaa Landfill, the general public and refuse collectors are familiar with the traffic patterns of the area. The site is well buffered from the urban centers of Kailua and Kaneohe by the mountains, Kawainui Swamp and distance. The prevailing trade winds are from the northeast and are favorable. Nearest residence downwind is about 3,000 ft. away behind the mountains.

Site preparations costs should be faborable since access roads, operation and maintenance facilities, and leachate control system will not be required. Utilities and drainage improvement costs will be nominal because water, power and telephone service are available from the adjacent Kapaa Corporation Yard, and required drainage works will be nominal.

2. Recommendation: The City should select this site as one of the Windward Oahu Sanitary landfill sites. Its capacity and economical location near the centers of Windward Oahu population and refuse generation makes it advantageous to use with the proposed Kapaa #1 and Kalaheo Sites for landfill operations prior to utilizing the new HC&D quarry for landfill. Environmental and economic impact are expected to be far less than that of opening a new site.

3. Ranking: 1

2. KAPAA #1 LANDFILL SITE

A. BASIC DATA OF SITE

1. Location: West of Kapaa Quarry Road and Kawainui Swamp and east of Ulumawao Peak in Kailua. See Plate IV-D-1. Site is approximately 1500 ft. southeast of the existing Kapaa Landfill site and is designated as Parcel 1 of Kapaa Landfill Sites by the City.

2. Tax Map Key: 4-2-14 : portion of 2.

3. Total Area: 60± acres.

4. Owner: Harold K.L. Castle (Kaneohe Ranch Co., Ltd., lessee)

5. Present Use of Land: Open space

6. City Zone District: Preservation and Residential

7. City General Plan Land Use: Agriculture

8. State Land Use District: Conservation

9. Adjacent Land Use, Zones, etc.: Same as 5 thru 8 above. In addition, City General Plan Land Use is Preservation east and west of the site and State Land Use District is Urban east of the site.

10. Restrictions and Setbacks: Permit required from State for construction in Conservation District. Site is in the Kawainui Swamp Special Management Area and a Special Management permit must be obtained. An EIS may be required prior to obtaining a permit.

11. Historical and Archeological Significance: No sites known to exist.

12. Proximity to Population and Refuse Centers: Between Kaneohe and Kailua urban areas and approximately 2500 ft. from residential development.

B. DESCRIPTION OF SITE

1. Accessibility: Access from Kapaa Quarry Road.

2. Topography: Moderately steep hillside depression on the eastern slopes of Ulumawao Peak. Three defined gullies are located in the depression which begins at elevation 70' at the lower eastern end mauka of the Kapaa Quarry Road and rises westward to elevation 500' over a distance of 2000 ft. The site is approximately 1200 ft. wide at its widest point.

The longitudinal slope of the site varies from 4% at the lower end to 60% at the upper end with an average slope of about 20%. The transverse slope of the depression varies from 0% to 5% near its gullies and from 30% to 70% at its upper reaches.

The depth of the depression from the top of the ridges to the gullies varies from 50' near the lower end to over 300' at the upper end.

3. Soil Classification: Site consists of the following soils taken from the S.C.S. Soil Survey:

   Rock land occurs in the upper reaches; Helemano silty clay, 30% to 90% slopes and Alaeloa silty clay, 40% to 70% slopes occur along the upper sides of a major portion of the depression; Kawaihapai clay loam, 6% to 15% slopes occurs in the gullies of a major portion of the depression, and Alaeloa silty clay, 15% to 35% slopes and Kawaihapai stony clay loam, 2% to 6% slopes occur in the lower end of the depression.

   See Appendix E.

4. Availability of Cover: Available on site or from HC&D quarry.

5. Surface Drainage: Storm runoff from 60± acres is conveyed by three defined gullies which converge into one and connects to an existing 54" drain pipe across Kapaa Quarry Road.

6. Ground Water Supply: None

7. Existing Utilities: None on site. 36 in. water main exists on Kapaa Quarry Road. Power available nearby.

C. SITE AS LANDFILL

1. Usable Area: 40± acres

2. Type of Operation: Trench, area and combination methods

3. Capacity: 3,028,000± cubic yards

4. Life: 6.2± years

5. Land Use After Development: Can be park with recreational facilities according to City Parks and Recreation Department.

D. ENVIRONMENTAL CONCERNS OF SITE: Because this site is in the same general area as Kapaa #2 and #3, the environmental concerns of the site are the same as that for Kapaa #2 and #3.

E. SITE PREPARATION FOR LANDFILL

Because this site is in the same general area as Kapaa #2 and #3, site preparation required for landfill is the same as that for Kapaa #2 and #3.

F. COMMENTARY OF SITE

1. Discussion: The Kapaa #1 site contains 60± acres, is located in vacant land owned by Harold K.L. Castle. The zoning permits landfill use. It is situated ideally between the urban and refuse generation centers of Kaneohe and Kailua in a hillside area scarred by existing landfill and quarry operations. A two-lane paved road runs adjacent to the site. Ground water in this area is not a source of present or future water supply for the Board of Water Supply.

The capacity of the site is approximately 3,028,000 cubic yards and the estimated life is 6.2± years. No one will be displaced by the project, and because it is in the vicinity of the existing Kapaa Landfill, the general public and refuse collectors are familiar with the traffic patterns of the area. The prevailing trade winds are from the northeast and are favorable. Nearest residence downwind is about 3,000 ft. away behind the mountains.

Site preparations costs should be favorable since access roads and leachate control system will not be required. Utilities and drainage improvement costs will be nominal because water is available from the adjacent Kapaa Quarry Road, power and telephone are available nearby and required drainage works will be nominal.

2. Recommendation: The City should select this site as one of the Windward Oahu sanitary landfill sites. Its capacity and economical location near the centers of Windward Oahu population and refuse generation makes it advantageous to use with the existing Kapaa Landfill and proposed Kapaa #2 and #3, and Kalaheo sites for landfill operations prior to utilizing the new HC&D quarry for landfill.

3. KALAHEO LANDFILL SITE

A. BASIC DATA OF SITE

1. Location: West of Interstate Route H-3 and Kawainui Swamp, north of the new HC&D Kapaa Quarry and south of the Mokapu Saddle Road in Kailua. See Plate IV-D-5. Site is approximately 2000 ft. northwest of the existing Kapaa landfill site.

2. Tax Map Key: 4-2-15 : portions of 1 and 6

3. Total Area: 130± acres

4. Owners: Michael C. Baldwin Trust, John C. Baldwin Trust, James C. Castle, Jr. Trust and James C. McIntosh Trust (small portion of site leased by HC&D, Ltd.)

5. Present Use of Land: Open space

6. City Zone District: Preservation and Residential

7. City General Plan Land Use: Agriculture

8. State Land Use District: Conservation

9. Adjacent Land Uses, Zones etc.: Same as 5 thru 8 above. In addition, City General Plan Land Use is Preservation west of the site and State Land Use District is Urban east of the Site.

10. Restrictions and Setbacks: Permit required from State for construction in Conservation District. Access not permitted from H-3. Site is outside Kawainui Swamp Special Management Area.

11. Historical and Archeological Significance: No sites known to exist.

12. Proximity to Population and Refuse Centers: Between Kailua and Kaneohe urban areas and approximately 1000 ft. from residential developments which are buffered from the site by the ridge separating Kaneohe from Kailua.

B. DESCRIPTION OF SITE

1. Accessibility: Not accessible to vehicular traffic. Access is not permitted from the adjacent H-3 Freeway. New access must be constructed from the Kapaa Quarry Road, which crosses the H-3 Freeway at the Kapaa Quarry Separation Structure, located 2500± ft. south of the site, or a grade separation structure over H-3 must be constructed.

2. Topography: Moderately deep hillside depression on the slopes of Kapaa Valley. Four defined gullies are located in the depression which begins at elevation 50' at the lower eastern end mauka to Interstate Route H-3 and rises westward to elevation 490' over a distance of 2300'. The site is approximately 1400 ft. wide at its widest point.

   The longitudinal slope of the site varies from 6% at the lower end to 45% at the upper end with an average slope of about 23%. The transverse slope of the depression varies from 0% to 10% near its gullies and from 20% to 60% at its upper ends.

   The depth of the depression from the top of the ridges to the gullies varies from 50' near the lower end to over 300' at the upper end.

3. Soil Classification: Site consists of the following soils taken from the S.C.S. Soil Survey:

   Helemano silty clay, 30% to 90% slopes
   occurs in the upper reaches;
   Alaeloa silty clay, 40% to 70% slopes
   occurs in the major portion of the depression and
   Kawaihapai stony clay loam, 2% to 6% slopes
   occurs in the lower gully.

   See Appendix E.

4. Availability of Cover: Available on site and from nearby HC&D quarry.

5. Surface Drainage: Storm runoff from 130± acres is conveyed by four defined gullies which converge into one and connects to an existing 120-in. drain pipe across H-3 Freeway.

6. Ground Water Supply: None

7. Existing Utilities: Power line crosses site. No other utilities available on or adjacent to site.

C. SITE AS LANDFILL

1. Usable Area: 55± acres

2. Type of Operation: Trench, area and combination methods.

3. Capacity: 5,585,000± cubic yards

4. Life: 11.5± years

5. Land Use After Development: Can be passive type park according to Parks and Recreation Department.

D. ENVIRONMENTAL ASSESSMENT OF SITE

1. General Landfill Nuisances: Noise, dust, odor, litter, pests, etc. associated with landfills will be generated. Because the site is removed from urban areas, nuisance to the public should be minimal.

2. Visual Pollution: Will occur and be noticeable because the site is adjacent to H3 Freeway. Existing landfill and quarry operations in the general area have scarred the landscape and should reduce the public's awareness of additional visual pollution. Landscaping prior to, during the progress and after completion of landfill operations should minimize visual pollution.

3. Ground Water Pollution: Area is not a source of ground water supply.

4. Surface Drainage Works: Minimal due to small drainage area. Drainage works will be required for access road.

5. Destruction of Natural Resources: Initially, land and vegetation will be committed to landfill. However, a green area will be developed after cessation of landfill activities to restore the land and vegetation.

6. Displacement: None

7. Other Environmental Concerns: Impact on flora and fauna is not expected to be significant, and these and other concerns will be addressed in more detail in an environmental impact statement if this site is selected for development.

8. Safety: Hazard to the public is minimal.

9. Objections by Owners and Adjacent Owners: Minimal, since land is not being utilized presently. HC&D, Ltd. will very likely object to the public usage of their road for access to the site and to the encroachment of the site and access road in their leased land.

10. Objections by Public, Community Organizations, etc.: Landfill operation will be opposed by citizens who live in the vicinity of the proposed site. The City must convince the public of the advantages of this landfill site.

E. SITE PREPARATION FOR LANDFILL

1. Access Road: 2,000± ft. required from existing Kapaa Quarry Road east of the H-3 Freeway, including an overpass structure over H-3.

2. Operations and Maintenance Facilities: Permanent facilities are recommended.

3. Utilities: Power lines across site must be relocated and telephone, electric and water services must be brought to site. Sanitary facilities must be installed.

4. Drainage System: Nominal drainage works required at site and for access road.

5. Leachate Control System: Not required, but leachate should be monitored.

F. COMMENTARY OF SITE

1. Discussion: The Kalaheo Site contains 130± acres, is located in vacant land owned by four trusts. The zoning permits landfill use. It is situated ideally between the urban and refuse generation centers of Kaneohe and Kailua in a hillside area of Kapaa Valley scarred by existing landfill and quarry operations. Cover material is available on or adjacent to the site. Ground water in this area is not a source of present or future water supply for the Board of Water Supply.

   The capacity of the site is approximately 5,585,000 cubic yards and the estimated life is 11.5± years. No one will be displaced by the project, and because it is in the vicinity of the existing Kapaa Landfill, the general public and refuse collectors are familiar with the traffic patterns of the area.

   The prevailing trade winds are from the northeast and are favorable. Nearest residence downwind is about 3,000 ft. away behind the mountains.

   Site preparations costs may be high even though a leachate control system will not be required. Access roads, utilities and drainage improvement costs will be higher than at other sites because 2,000± ft. of access road, including a grade separation structure is required, a power line must be relocated, electric, water and telephone services must be extended to the site and additional drainage works will be required for the access road.

2. Recommendation: The City should select this site as one of the Windward Oahu sanitary landfill sites to extend the landfill site capacity in the Kapaa area. Its capacity and location near the centers of Windward Oahu population and refuse generation makes it advantageous to use with the existing Kapaa Landfill and proposed Kapaa #1, Kapaa #2 and #3 sites for landfill operations prior to utilizing the new HC&D quarry for landfill.

3. Ranking: 3

4. HEEIA UKA LANDFILL SITE

A. BASIC DATA OF SITE

1. Location: Mauka on Kahekili Highway, approximately two miles north of Kahekili-Likelike Highways intersection and a mile south of Ahuimanu. See Plate IV-D-9.

2. Tax Map Key: 4-6-14

3. Total Area: 163± acres

4. Owner: Bernice P. Bishop Estate

5. Present Use of Land: Open

6. City Zone District: Lower elevations, R6, (approximately 20% of the land) and in the upper reaches, P1.

7. City General Plan Land Use: Preservation and Residential

8. State Land Use District: Conservation

9. Adjacent Land Uses, Zones, etc.: Residential and Conservation

10. Restrictions and Setbacks: State Highway Setback. Permit required from State for construction in Conservation District.

11. Historical and Archeological Significance: No sites known to exist.

12. Proximity to Population and Refuse Centers: Between Kaneohe and Kahaluu urban areas.

B. DESCRIPTION OF SITE

1. Accessibility: Access from Kahekili Highway

2. Topography: The lower section longitudinal slope varies from approximately 8% to 20% and the higher section slopes exceed 30%.

3. Soil Classification: Site consists of the following soils taken from the S.C.S. Soil Survey:

   25 to 40% slope, Waikane silty clay
   40 to 70% slope, Lolekaa silty clay

   See Appendix E.

4. Availability of Cover Material: Available on site.

5. Surface Drainage: Surface runoff flows down numerous defined gullies to a common low point and flows through a culvert crossing Kahekili Highway.

6. Ground Water Supply: None

7. Existing Utilities: None on site. Electric power, water and telephone services available on Kahekili Highway. Sanitary sewer connection not available.

C. SITE AS LANDFILL

1. Usable Area: 50± acres

2. Type of Operation: Combination of trench and area methods.

3. Capacity: 2,445,000± cubic yards

4. Life: 5.0± years

5. Land Use After Development: Can be passive natural recreational park according to Parks and Recreation Department.

D. ENVIRONMENTAL CONCERNS OF SITE

1. General Landfill Nuisances: On-site litter, noise, odor, pests, etc. associated with landfill operations will be present during operation.

2. Visual Pollution: Public exposure of the site from Kahekili Highway will require heavy landscaping for screening landfill operations to minimize visual pollution.

3. Ground Water Pollution: Site is not over present or future ground water sources. However, monitoring of leachate is recommended.

4. Surface Drainage Works: A drainage works for runoff flows from gullies, finish landfill surface and culvert crossing at Kahekili Highway must be installed.

5. Destruction of Natural Resources: Existing vegetation will be destroyed. Return to green area.

6. Displacement: None

7. Other Environmental Concerns: Impact on flora and fauna is not expected to be significant, and these and other concerns will be addressed in more detail in an environmental impact statement if this site is selected for development.

8. Safety: High speed traffic on Kahekili Highway will be interrupted. New intersection would add to traffic hazard.

9. Objections by Owner and Adjacent Owners: Some opposition by adjacent land owners.

10. Objections by Public, Community Organizations, etc.: Adjacent subdivision community organizations will probably object.

E. SITE PREPARATION FOR LANDFILL

1. Access Road: On and off ramps must be constructed on Kahekili Highway. Access normally required for a landfill site must be constructed.

2. Operations and Maintenance Facilities: Temporary facilities must be constructed.

3. Utilities: Electric power, water and telephone are available from Kahekili Highway. Sanitary facilities are required.

4. Drainage System: Runoff flowing in the gullies must be intercepted with a cutoff ditch or directed into an underground drainage system or a combination of both before crossing Kahekili Highway through the existing culvert.

5. Leachate Control System: None required.

F. COMMENTARY OF SITE:

1. Discussion: The Heeia Uka Landfill Site is situated approximately 2 miles from the Kaneohe urban area and 2.4 miles from Kahaluu. The land is owned by Bernice P. Bishop Estate and contains a total of 163± acres with usable area of 50± acres. The capacity is approximately 2,445,000 cubic yards and estimated life is 5.0 years. Site is heavily covered with vegetal growth. Access is from Kahekili Highway.

Prevailing trade wind direction is toward uninhabited areas and is favorable.

Site preparation costs will be nominal. Necessary utilities are nearby and no one will be displaced by this landfill.

2. Recommendation: This site should be selected by the City & County of Honolulu for a future sanitary landfill site. Cost of land will be slightly higher due to residential zoning of a portion of this site.

3. Ranking: 4

5. WAIMANALO NORTH LANDFILL SITE

A. BASIC DATA OF SITE

1. Location: South of Kailua urban areas, west of Olomana Golf Course and Bellows Air Force Station, northwest of Waimanalo urban areas, north of Waimanalo farm lands and approximately one mile southeast of Olomana Peak. See Plate IV-D-13.

2. Tax Map Key: 4-1-08:13

3. Total Area: 171± acres

4. Owner: State of Hawaii

5. Present Use of Land: Open

6. City Zone District: Agriculture

7. City General Plan Land Use: Agriculture

8. State Land Use District: Agricultural

9. Adjacent Land Uses, Zones, etc.: Agriculture and Residential

10. Restrictions and Setbacks: Special permit required from State for construction in Agricultural District.

11. Historical and Archeological Significance: No sites known to exist.

12. Proximity to Population and Refuse Centers: Between Waimanalo and Kailua urban areas (about 500 ft. from the closest residents of north Waimanalo community).

B. DESCRIPTION OF SITE

1. Accessibility: Access from Kalanianaole Highway.

2. Topography: The site consists of two defined gullies. Approximately a third of the lower area rises at 5 to 15% slope, half of the area lies between 15 to 30±% slope and the balance of the area greater than 30+% slope. The width at its widest point is 3000± ft. and is 2500± ft. from the lower limit to the ridge line.

3. Soil Classification: Site consists of the following soils taken from the SCS Soil Survey:

   0 to 6% slopes, Hanalei silty clay;
   15 to 35% slopes, Alaeloa silty clay;

40 to 70% slopes, Alaeloa silty clay;
30 to 90% slopes, Helemano silty clay.

See Appendix E.

4. Availability of Cover Material: Available on site.

5. Surface Drainage: Surface runoff is present only during and immediately after precipitation and drains directly into Waimanalo Stream.

6. Ground Water Supply: Site is not within the zone of potable water source. Abandoned Kailua Ditch runs under a portion of the site.

7. Existing Utilities: None on site. Electric power, water and telephone are available from Kalanianaole Highway or adjacent residential area south of the site.

C. SITE AS LANDFILL

1. Usable Area: 131± acres

2. Type of Operation: Combination of area and trench methods.

3. Capacity: 9,870,000± cubic yards

4. Life: 20.0± years

5. Land Use After Development: Farm land or can be active recreational area according to Parks and Recreation Department.

D. ENVIRONMENTAL CONCERNS OF SITE

1. General Landfill Nuisances: Litter, odor, dust, noise, pests, etc. associated with landfill sites will be generated.

2. Visual Pollution: Site will be visible from some residential areas. Landscaping during and after landfill operation will minimize this effect.

3. Ground Water Pollution: Site is not a source of ground water.

4. Surface Drainage Works: Minimum, since no major stream on site.

5. Destruction of Natural Resources: Land and its natural vegetation will be committed to landfill. However, the site will be returned to a green or higher use area.

6. Displacement: None

7. Other Environmental Concerns: Impact on flora and fauna is not expected to be significant, and these and other concerns will be addressed in an environmental impact statement if this site is selected for development.

8. Safety: Turn-off from Kalanianaole Highway will interrupt thru traffic and increase traffic hazard.

9. Objection by Owner and Adjacent Owners: Adjacent land is owned by the State. Site should be leased or purchased from the State by the City.

10. Objections by Public, Community Organizations, etc.: Citizens in the community will probably object to the use of this land as a landfill site.

E. SITE PREPARATION FOR LANDFILL

1. Access Road: Upgrading 1800± ft. of the old Kalanianaole Highway and construction of 1500± ft. of new access road entering the site from the north.

2. Operations and Maintenance Facilities: Permanent facilities are recommended.

3. Utilities: Electric power, water and telephone must be brought into the site. Sanitary facilities must be installed.

4. Drainage System: A nominal drainage system required.

5. Leachate Control System: None required, but any leachate generation and movement should be monitored.

F. COMMENTARY OF SITE

1. Discussion: The Waimanalo North Landfill Site is situated at the north end of Waimanalo community. Site is not over the ground water source. The total area is approximately 171 acres with usable area of 131± acres.

   The capacity of the site is approximately 9,870,000 cubic yards and life is 20 years. Cover material is available on or adjacent to the site.

   Temporary destruction of natural vegetation will be necessary. The site will be returned to a green area or farm area.

   Prevailing trade wind direction is toward uninhabited areas and is favorable.

Site preparation and improvement costs will be moderate and will include upgrading existing old road; new access to the site; drainage system; water, electric power and telephone connection; a sanitary waste disposal system; and operation and maintenance facilities.

2. Recommendation: The City should consider this site for a sanitary landfill if the higher ranking sites are not available.

3. Ranking: 5

6. AULOA LANDFILL SITE

A. BASIC DATA OF SITE

1. Location: South of Kalanianaole Highway, north of Auloa Road and east of their intersection at Castle Junction in Kailua. See Plate IV-D-17.

2. Tax Map Key: 4-2-14 : portion of 1

3. Total Area: 55± acres

4. Owners: Harold K.L. Castle (Kaneohe Ranch Co., Ltd., Olomana Farms, Lessees)

5. Present Use of Land: Open space at present. Olomana Farms plans to extend activities into this area.

6. City Zone District: Agriculture - 1

7. City General Plan Land Use: Agriculture

8. State Land Use District: Conservation

9. Adjacent Land Uses, Zones, etc.: Same as 5 thru 8 above. In addition, City General Plan Land Use is Residential southeast of the site and State Land Use District is Agricultural to the east and Urban to the southeast of the site.

10. Restrictions and Setbacks: Permit required from State for construction in Conservation District.

11. Historical and Archeological Significance: No site known to exist.

12. Proximity to Population and Refuse Centers: Between Kailua and Kaneohe urban areas and west and 500 ft. northwest of Maunawili residential area.

B. DESCRIPTION OF SITE

1. Accessibility: Accessible from Auloa Road.

2. Topography: Moderately deep depression between Kalanianaole Highway and Auloa Road. Five defined gullies traverse the site which begins at elevation 90' at the lower eastern end, 500 ft. from existing improvements. The site rises to elevation 330' at the upper western end over a distance of 2200' and is approximately 1600' wide at its widest point.

The longitudinal slope of the site varies from 3% at the lower end to 40% at the upper end with an average slope of about 10%. The transverse slope of the depression varies from 0% to 6% near its gullies and from 30% to 100% at its upper reaches.

The depth of the depression from the roadway grades of existing Kalanianaole Highway and Auloa Road varies from 110' to 220'. The depth of the depression from the top of interior ridges to the bottom of gullies varies from 50' near the lower end to over 240' near the middle of the site.

3. Soil Classification: Site consists of the following soils taken from the S.C.S. Soil Survey:

   Helemano silty clay, 30% to 90% slopes, and
   Alaeloa silty clay, 15% to 35% slopes
   occur in the upper reaches;
   Alaeloa silty clay, 40% to 70% slopes
   occurs in the major portion of the depression and
   Hañalei stony silty clay, 2% to 6% slopes
   occurs in the lower end of the gully.

   See Appendix E.

4. Availability of Cover Material: Available on site.

5. Surface Drainage: Storm runoff from 140± acres is conveyed by 5 defined gullies which cross the site and converge into one near the lower east end.

6. Ground Water Supply: None

7. Existing Utilities: Power lines on site. A proposed 10-ft. wide water pipeline easement crosses the site. Utilities are available from nearby subdivision.

C. SITE AS LANDFILL

1. Usable Area: 40± acres.

2. Type of Operation: Trench, area and combination methods.

3. Capacity: 2,785,000± cubic yards.

4. Life: 5.7± years

5. Land Use After Development: Ranch land or can be active and passive recreational park according to Parks and Recreation Dept.

D. ENVIRONMENTAL CONCERNS OF SITE

1. General Landfill Nuisances: Noise, dust, odor, litter, pests, etc. associated with landfills will be generated. With the site being relatively close to a residential area, every effort must be made to eliminate these nuisances.

2. Visual Pollution: Will occur. Existing highway and drive-in theater cuts in the general area have scarred the landscape and should reduce the public's awareness of additional visual pollution. Landscaping prior to, during the progress, and after completion of landfill operations should minimize visual pollution.

3. Ground Water Pollution: Area is not a source of ground water supply.

4. Surface Drainage Works: Minimal due to small drainage area.

5. Destruction of Natural Resources: Land and vegetation will be committed to landfill. However, a green area will be developed.

6. Displacement: None

7. Other Environmental Concerns: Traffic may create problems since the existing paved two-lane Auloa Road is narrow and traverses through residential areas east of the site. Traffic must be made to utilize Castle Junction for access to site and be restricted from traversing residential areas.

   Impact on flora and fauna is not expected to be significant, and these and other concerns will be addressed in an environmental impact statement if this site is selected for development.

8. Safety: Hazard to the public is minimal.

9. Objections by Owner and Adjacent Onwers: Strong. Owner will go to court.

10. Objections by Public, Community Organizations, etc.: Landfill operation will be opposed by citizens who live in the vicinity of the proposed site, the Kailua Community Council, Ad Hoc Committee for Kawainui Park and the community associations of the Maunawili area.

E. SITE PREPARATION FOR LANDFILL

1. Access Road: Widening of Auloa Road pavement and shoulders and improvements of curves will be required. An access road into site from Auloa Road must be constructed.

2. Operations and Maintenance Facilities: Temporary facilities are recommended.

3. Utilities: Water, power and telephone service must be brought to the site. Sanitary facilities must be installed.

4. Drainage System: Nominal drainage works required.

5. Leachate Control System: Not required but leachate generation should be minimized by incorporating proper design features in the landfill

F. COMMENTARY OF SITE

1. Discussion: The Auloa Site contains 55± acres, is located in vacant land owned by one owner, Harold K.L. Castle. The zoning permits landfill use. It is situated ideally between the urban and refuse generation centers of Kaneohe and Kailua in a moderately deep depression close to land scarred by highway and drive-in theater cuts. Paved roads run adjacent to the site and cover material is available on the site. Ground water in this area is not a source of present or future water supply for the Board of Water Supply.

   The capacity of the site is approximately 2,785,000 cubic yards and the estimated life is 5.7± years. The 500 feet of buffer at the lower end limits the capacity of this site.

   A lessee, Olomana Farms, plans to extend its existing operations into the area.

   Site preparations costs will be nominal since major access road improvements and leachate control system will not be required. Utilities and drainage improvement costs will also be nominal because water, power and telephone are available nearby.

2. Recommendation: This site offers great economic advantages and the City can use this site for development if all other higher selections fail to materialize.

3. Ranking: 6

7. WAIMANALO SOUTH LANDFILL SITE

The Waimanalo South Landfill Site is approximately 355 acres, owned by the State of Hawaii, and is located mauka (west) of Waimanalo Beach Park and south of University of Hawaii Experiment Station. See Plate II-A-1.

Cover material is available on or adjacent to the site. Ground water must be protected from leachates.

The capacity of the site is approximately 13,987,000 cubic yards and estimated life is 28.7± years.

Displacement of farm lands will be necessary.

Access is through residential area and is highly objectionable.

Site preparation costs will be moderate and will include improvement to access road; substantial drainage system; leachate control, collection and/or treatment as necessary; water, electric and telephone connections to nearby lines; sanitary sewer system; and other operations and maintenance facilities.

The requirement for leachate abatement measures to protect the ground water will result in high development cost.

This site is not recommended for development.

8. KAHALUU, WAIHEE, WAIAHOLE, WAIKANE, KAAAWA, AND PUNALUU LANDFILL SITES

Potential landfill sites exist in the above valleys in the Koolaupoko and Koolauloa District north of Heeia. See Plate II-A-1. However, they are handicapped for the following reasons:

A. The upper part of these valleys are used for recharging the ground water by rainfall and are the major sources of potable water for the Windward side of the island. To develop these valleys for landfills at this time with measures to protect the ground water from pollutants would be too costly. The lower parts of the valleys where minimum leachate control measures would be adequate are adjacent to or too close to existing residences. Also land is under higher use and acquisition costs would be high.

B. Sites are removed from the major refuse generation centers of Kaneohe and Kailua and hauling costs would be high.

C. Addition of substantial refuse truck traffic on substandard Kamehameha Highway would add to the danger of the already hazardous highway. The Highway is the only road serving these valleys and is considered to be substandard by modern criteria for highway design. Some of the substandard features that would increase traffic accidents due to increase in traffic are sight distance, roadside safety features, narrow roadway and shoulders, and horizontal and vertical alignments.

D. The quiet, serene atmosphere and life styles of the residents in the area would be grossly disrupted by activities of landfill operations.

Other sites recommended in this report would be more feasible. Therefore, it is recommended that these sites not be considered for landfill development at this time.

9. OLOMANA LANDFILL SITE

Site is adjacent to residential area and is ponding basin for flood control. See Plate II-A-1. This site is not recommended for landfill development.

10. BELLOWS FIELD LANDFILL SITE

The Bellows Field Landfill Site is situated at the north end of Waimanalo Community and Bellows Air Force Base. See Plate II-A-1. Keolu Hills Subdivision is adjacent but over a hill north of the site. Site is not over ground water source. The total area is approximately 173 acres, with usable area of 133± acres.

The site is approximately 2,500 ft. wide and 3,500 ft. long, capacity is 7,510,000± cubic yards and life is 15.4± years. Cover material is available on the site.

Temporary destruction of vegetation will be necessary. The site will be returned to a green area. A buffer strip with heavy landscaping will be required to screen the landfill activity from Bellows Field Air Base and the Olomana Golf Course.

Prevailing trade wind direction is away from the residential area and is favorable.

A drainage system must be constructed on and off site to control runoff and infiltration, soil erosion and flooding of lower areas.

Approximately 2,000 ft. of access road and utilities from Kalanianaole Highway to the site must be constructed.

Site preparation and improvement costs will be moderate and will include a new access road; drainage system; water, electric power and telephone connection; a sanitary waste disposal system; permanent operation and maintenance facilities.

With proper screening and buffer areas, this site can be a desirable site. However, according to the military, the site is needed to maintain military preparedness and is not available for sanitary landfill purposes.

11. HEEIA KAI LANDFILL SITE

This site is located immediately makai of the Heeia Uka site, Plate II-A-1. Access available from Kahekili and Kamehameha Highways. It has no ground water problem and offers a good capacity.

However, this site is planned for high use development and the present R-6 zoning would raise the cost of developing this site for landfill. This site is not recommended for development.

12. MAKAIWA LANDFILL SITE

A. BASIC DATA OF SITE

1. Location: 1.5± miles west-northwest of Puu Palailai, north/mauka of Farrington Highway, 1.6± miles south of Puu Manawahua and 1.3± miles east of Kahe Point. See Plate IV-D-21.

2. Tax Map Key: 9-2-03

3. Total Area: 338± acres

4. Owner: J. Campbell Trust Estate, Hawaii Meat Co. lessee, Tongg Ranch, sublessee.

5. Present Use of Land: Open

6. City Zone District: Agricultural

7. City General Plan Land Use: Agricultural

8. State Land Use District: Agricultural

9. Adjacent Land Uses, Zones, etc.: Agricultural and Military

10. Restrictions and Setbacks: Special permit required from State for construction in Agricultural District. Permit also required from State Highway for access. Present access agricultural.

11. Historical and Archeological Significance: No site known to exist.

12. Proximity to Population and Refuse Centers: Makakilo City 2.8± miles east; Nanakuli urban area 4.2± miles northwest; Maili urban area 7.0± miles northwest; and Waipahu urban area 8.3± miles east. The Honokai Hale subdivision development is immediately below and across Farrington Highway.

B. DESCRIPTION OF SITE

1. Accessibility: Access from Farrington Highway

2. Topography: The overall length of the site is 7600± feet and average width is 2000± feet. The lower 4500±feet is a well-defined gully 1700± feet wide and with an average slope of 13±%. The upper 3100±feet consists of three well-defined gullies 2600±feet wide with an average slope of 17±%.

3. Soil Classification: Site consists of the following soils taken from the S.C.S. Soil Survey:
   Stony Steep Land;
   Mahana Badland Complex;
   3 to 35% slopes, Lualualei extremely stony clay;
   30 to 90% slopes, Helemano silty clay.

   See Appendix E.

4. Availability of Cover Material: Some cover material is available on site. Shredding or imported cover required to make up deficiency.
5. Surface Drainage: The length of the drainage area is 12,000± ft. long and covers an area of 464± acres. The three gullies in the upper reaches drain into the lower gully and flows under a bridge on Farrington Highway.

6. Ground Water Supply: None

7. Existing Utilities: Power lines cross upper area. Electric power, telephone and water are available at Farrington Highway.

C. SITE AS LANDFILL

1. Usable Area: Approximately 75% of 338± acres or 254± acres.

2. Type of Operation: Combination area and trench methods.

3. Capacity: 15,232,000± cubic yards

4. Life: 31± years.

5. Land Use After Development: Can be a park according to Parks and Recreation Department.

D. ENVIRONMENTAL CONCERNS OF THE SITE

1. General Landfill Nuisances: Will be generated. Effective control measures must be in effect during the life of the site to minimize nuisances associated with landfill operations.

2. Visual Pollution: Site readily visible from Farrington Highway. Landscaping prior to, during and after landfill operations required to minimize visual pollution. Will also be visible from future West Beach resort development area.
3. Ground Water Pollution: Although site is not over a source of ground water supply, methods to minimize landfill pollutants from entering the ground water must be incorporated in the landfill design.

4. Surface Drainage Works: A major drainage system must be constructed.

5. Destruction of Natural Resources: Initially, land and vegetation will be committed to landfill. However, a green area will be developed after cessation of landfill activities to restore the land and vegetation.

6. Displacement: None

7. Other Environmental Concerns: Addition of intersection on Farrington Highway will increase hazards.

   Impact on flora and fauna is not expected to be significant, and these and other concerns will be addressed in more detail in an environmental impact statement is this site is selected for development.

8. Safety: Operational hazards are minimal.

9. Objections by Owner and Adjacent Owners: Objections by adjacent home owners below Farrington Highway will be voiced.

10. Objections by Public, Community Organizations, etc.: There will be objections by the public.

E. SITE PREPARATION FOR LANDFILL

1. Access Road: Improvements on Farrington Highway to provide safe turning movements must be constructed. Approximately 1000 ft. of new access road required.

2. Operation and Maintenance Facilities: Permanent facilities must be constructed.

3. Utilities: Electric power, telephone and water connections available on Farrington Highway. Sanitary sewer line must be constructed from subdivision across Farrington Highway.

4. Drainage System: A major drainage system must be constructed.

5. Leachate Control System: No special requirements.

F. COMMENTARY OF SITE

1. Discussion: The site is located in the Ewa district, mauka and off Farrington Highway, and adjacent to Waimanalo Gulch on the west and Palalai Gulch on the east.

   The lower portion is a single gulch and the upper portion divides into three gullies. The total area is 338± acres, of which 254± acres are usable. The capacity is 15,232,000± cubic yards, with a 31± year life.

   Power lines which cross site in the upper areas may have to be relocated if full life of site is utilized. Additional power lines are planned by Hawaiian Electric Co. on the floor of the gulch.

Site is presently open ranch land.

A drainage system must be constructed on and off site to control runoff, infiltration, soil erosion and flooding of lower areas.

A buffer strip with heavy landscaping will be required to screen the landfill activity.

The prevailing northeasterly wind is towards the residential development below Farrinton Highway and proposed Campbell Estate-Herbert Horita West Beach Development area. This may require odor abatement measures.

Site preparation and improvement costs will be moderate and include landscaping; drainage system, permanent operation and maintenance facilities; improvements to Farrington Highway, utilities; and site access road.

2. Recommendation: The site is recommended for a sanitary landfill. It has adequate capacity, access to a modern, 4-lane divided highway, no ground water problems for the Board of Water Supply, utilities can be brought in at nominal cost, and can be adequately buffered from the residential areas.

3. Ranking: 1

13. NANAKULI LANDFILL SITE

A. BASIC DATA OF SITE

1. Location: In Nanakuli, 2000± ft. mauka of Nanaikapono Beach Park, 4000± ft. west of Puu Heleakala, 4000± ft. east-southeast of Puu o Hulu Uka. See Plate IV-D-25.

2. Tax Map Key: 8-7-9 : 1 & 3
   8-7-21 : 26

3. Total Area: 611± acres

4. Owner: Shigeru Horita, et al; The Hawaii Corp.; U.S. Financial, Inc.

5. Present Use of Land: Open space

6. City Zone District: Agriculture & Planned Development Housing

7. City General Plan Land Use: Industrial, Residential, Agricultural and Preservation.

8. State Land Use District: Urban and Agricultural

9. Adjacent Land Uses, Zones, etc.: Agricultural, Residential, Industrial, Urban, Planned Development Housing and Preservation.

10. Restrictions and Setbacks: Major street or highway designated on City's General Plan traversing site. Special permit required from State for construction in Agricultural District.

11. Historical and Archeological Significance: No sites known to exist.

12. Proximity to Population and Refuse Centers: Adjacent to Nanakuli urban area. Other urban areas to the northwest are Maili 3.0± miles, Waianae 4.7± miles, and Makaha 7± miles. Waipahu is 12± miles and Makakilo is 5± miles southeast.

B. DESCRIPTION OF SITE

1. Accessibility: Access from Lualualei Naval Road.

2. Topography: The land west of Lualualei Naval Road (Site A - Plate IV-C-7) is an abandoned quarry site with depressions of 40± ft. and mounds of 30± ft. existing on the southern 60±% of the site. Northern 40±% is in its natural state with two defined shallow gullies meeting Ulehawa Stream. Slope varies in this area between 2±% and 10±%.

   The land east of Lualualei Naval Road (Site B - Plate IV-C-7) is relatively flat in the lower reaches along the Road and the slope gradually increases toward the ridge line.

3. Soil Classification: Site consists of the following soils taken from the S.C.S. Soil Survey:

   2 to 6% slopes, Lualualei clay;
   3 to 35% slopes, Lualualei extremely stony clay;
   0 to 12% slopes, Mamala stony silty clay loam;
   0 to 12% slopes, Pulehu very stony clay loam;
   Rock Land

   See Appendix E.

4. Availability of Cover Material: Has potential of generating cover material on site.

5. Surface Drainage: Portion of the site drains directly into Ulehawa Stream. Some surface runoff from Puu Heleakala is piped under Lualualei Naval Road and flows across the site into Ulehawa Stream.

6. Ground Water Supply: None

7. Existing Utilities: Power lines cross the site. Electric power, telephone and water are available from the adjacent residential area.

C. SITE AS LANDFILL

1. Usable Area: 288± acres

2. Type of Operation: Area method

3. Capacity: 13,396,000± cubic yards

4. Life: 27.3± years

5. Land Use After Development: Can be active recreational park according to Dept. of Parks and Recreation.

D. ENVIRONMENTAL CONCERNS OF SITE

1. General Landfill Nuisances: Litter, noise, dust, odor, pests, etc. associated with landfill operations will be generated. Effective control measures to minimize nuisances must be in effect during the life of the site. The residents of the nearby area must be protected from landfill nuisances. Buffer strip must be provided.

2. Visual Pollution: Landscaping prior to, during and after landfill operations will minimize visual pollution.

3. Ground Water Pollution: Area is not a source of ground water supply.

4. Surface Drainage Works: Drainage system must be constructed to minimize siltation of Ulehawa Stream.

5. Destruction of Natural Resources: Initially, land and vegetation will be committed to landfill. However, a green area will be developed after cessation of landfill activities to restore the land and vegetation.

6. Displacement: None

7. Other Environmental Concerns: Increased traffic on Lualualei Naval Road. Impact on flora and fauna is not expected to be significant, and these and other concerns will be addressed in more detail in an environmental impact statement if this site is selected for development.

8. Safety: Traffic hazards will increase on Farrington Highway and a portion of Lualualei Naval Road.

9. Objections by Owner and Adjacent Owners: Minimal objection by owner of Site A since 60% of site is unusable in present state. Adjacent residential, planned development housing owners and owners of lots east of road will object.

10. Objections by Public, Community Organizations, etc.: The residential community adjacent to the site will object.

E. SITE PREPARATION FOR LANDFILL

1. Access Road: Navy indicated receptiveness to City takeover of Lualualei Naval Road. Road needs widening.

2. Operations and Maintenance Facilities: Permanent facilities must be constructed.

3. Utilities: Electric power, telephone and water connections are available at the adjacent Lualualei Homestead Lots. Sanitary facilities must be constructed.

4. Drainage System: Surface runoff from off site and on site must be transmitted to Ulehawa Stream through a drainage system.

5. Leachate Control System: None required for ground water.

F. COMMENTARY

1. Discussion: The landfill site is located in Nanakuli, 2,000± ft. mauka of Farrington Highway, approximately 288± usable acres owned by Shigeru Horita, et al, The Hawaii Corporation, and U.S. Financial, Inc.

The capacity is 13,396,000± cubic yards with a 27.3± year life. Cover material is probably available on the site.

Approximately 127 acres of Site A was a quarry site. Therefore, depressions and mounds up to 40± ft. are present.

Prevailing wind is toward residential area and may present a problem. Odors may need masking and litter fences may have to be provided.

These sites have the proper State and City land use designations for urbanization, but economic development is severely restricted by the following major problems:

a. Extensive grading required for Site A (Imported Fill).

b. Access for Sites A & B - Roadway is a Navy right-of-way.

c. No drainage outlet for Site B.

Illegal dumping has started on the quarry portion of Site A, and this site is becoming an eyesore and a health hazard.

The upper portion of Site A (TMK:8-7-21 : 26, 75± acres) was placed on the 1976-77 C.I.P. Budget for community development. Should this project develop, the balance of Site A will have 8.1± years of life (3,962,000± cubic yards) left. The approximate total life of Site A is 10.8 years (5,278,000± cubic yards).

Site B (TMK: 8-7-09 : 1) then can be used to extend the life of the landfill to approximately 25 years. The approximate life of Site B is 16.5 years (8,118,000± cubic yards).

Ground water pollution is not a problem. However, monitoring of leachate movement is recommended.

Site preparation and improvement costs will be nominal and include landscaping; permanent operation and maintenance facilities; access road improvements; and utilities installation.

2. Recommendation: This site is recommended for a sanitary landfill. With proper planning and major emphasis placed on screening the adjacent community from the landfill, this site can be a desirable one.

3. Ranking: 1

14. KALOI LANDFILL SITE

A. BASIC DATA OF SITE

1. Location: South of Puu Kapuai and north of Puu Makakilo in Kaloi Gulch, Ewa. See location map, Plate IV-D-29. Site is approximately 2500 ft. northwest of Interstate Route H-1.

2. Tax Map Key: 9-2-02 : Portion of 1;
   9-2-03 : Portion of 2;
   9-2-04 : Portion of 5

3. Total Area: 400± Acres

4. Owner: James Campbell Trust Estate (Oahu Sugar Co. and Hawaii Meat Co. lessee, Tongg Ranch, sublessee)

5. Present Use of Land: Sugar cane, ranching and open space

6. City Zone Districts: Agricultural and Residential

7. City General Plan Land Uses: Agriculture and Residential

8. State Land Use District: Agriculture

9. Adjacent Land Uses, Zones, etc.: Same as 5 thru 8 above. In addition, State Land Use District is Urban to the south of the site.

10. Restrictions and Setbacks: Special permit required from State for construction in Agricultural District.

11. Historical and Archeological Significance: No sites known to exist.

12. Proximity to Population and Refuse Centers: Between Nanakuli and Waipahu, 1 mile north of Makakilo City, 18 miles west of downtown Honolulu, 4 miles west of Waipahu, and 5 miles east of Nanakuli.

B. DESCRIPTION OF SITE

1. Accessibility: Accessible from Palehua Road about 1800 ft. east of the site. Restricted by narrow underpass crossing H-1 Freeway, which is one lane for canehaul trucks.

2. Topography: Deep and long ravine between Puu Kapuai and Puu Makakilo in Kaloi Gulch. It begins at elevation 340' at the lower eastern end of the Gulch and rises to elevation 1360' at the upper western end over a distance of 10,500'. Approximately 2500' above the lower end of the site, the Gulch has a north branch which proceeds from elevation 500' at the junction with the Gulch to elevation 900' at the upper north end of the site. The site is approximately 3000' wide at its widest point from the north branch end to the south edge.

The Gulch has a longitudinal slope which varies from 5% at the lower end to 13% at the upper end with an average slope of about 10%. The transverse slope of the Gulch varies from 0° to 6% near the Gulch dry stream bed and flatlands and from 35% to 80% at the upper hilly and steep Gulch walls.

The depth of the Gulch, from the top of gulch to the dry stream bed varies from 85' at the lower end to over 300' at the upper end.

3. Soil Classification: Site consists of the following soils taken from the S.C.S. Soil Survey:

   Rock land occurs throughout a major portion of the gulch; Kawaihapai stony clay loam, 2% to 6% slopes, and Molokai silty clay loam, 15% to 25% slopes, occur in the lower end of the gulch; Helemano silty clay, 30% to 90% slopes, and Mahana Badland complex occur in the middle and upper ends of the gulch.

   See Appendix E.

4. Availability of Cover: Some cover available on site.

5. Surface Drainage: Storm runoff from 1,300± acres is conveyed by eight defined gullies which converge into one near the lower east end.

6. Ground Water Supply: Site located within source of irrigation water for Oahu Sugar Co. and potable supply for Barbers Point Naval Air Station and other military installations on ridge.

7. Existing Utilities: 4" water line, irrigation line and power lines cross site.

C. SITE AS LANDFILL

1. Usable Area: 265± acres

2. Type of Operation: Area method.

3. Capacity: 24,300,000± cubic yards

4. Life: 50± years

5. Land Use After Development: Green area or ranching lands

D. ENVIRONMENTAL CONCERNS OF SITE

1. General Landfill Nuisances: Noise, dust, odor, litter, pests, etc. associated with landfills will be generated. Because the site is removed from residences and improvements, nuisance to the public should be minimal.

2. Visual Pollution: Will occur but will not be noticeable. Landscaping prior to, during the progress, and after completion of landfill operations should minimize visual pollution.

3. Ground Water Pollution: Possible, since site is over ground water source. Leachate control system may have to be provided.

4. Surface Drainage Works: Substantial due to large drainage area runoff which must be conveyed through site.

5. Destruction of Natural Resources: Land and vegetation will be committed to landfill. However, a green area or ranching lands will be developed.

6. Displacement: Portion of ranch taken.

7. Other Environmental Concerns: Traffic will create problems since the existing two-lane Palehua Road is being utilized as access to the South Waianae mountains and as canehaul road by Oahu Sugar Co.

   Impact on flora and fauna is not expected to be significant, and these and other concerns will be addressed in more detail in an environmental impact statement if this site is selected for development.

8. Safety: Hazard to public will be moderate because the public is not familiar with traffic patterns of this area. Traffic study will be required to integrate canehaul truck traffic and public traffic. Underpass is only one-land width for canehaul trucks, which is very hazardous.

9. Objections by Owner and Adjacent Owners: Minimal, since land is being leased from Campbell Estate and the Estate has a right of withdrawal. Objections by Oahu Sugar Co. to the use of Palehua Road expected. They will ask for signalization on Palehua Road and pre-emptors to the signals for their canehaul trucks or some other positive means of giving their trucks the right-of-way at all times. Also, indemnification of Oahu Sugar Co. from liability will be requested.

10. Objections by Public, Community Organizations, etc.: There will be some opposition by citizens who live in the vicinity of the proposed site and by those concerned with Oahu's water supply.

E. SITE PREPARATION FOR LANDFILL

1. Access Road: Portions of Palehua Road must be upgraded for canehaul and refuse truck traffic, and a new bridge and a 2200' access road must be constructed. Requirements must be coordinated with Oahu Sugar Co. See paragraph D 9 above.

2. Operations and Maintenance Facilities: Permanent facilities are needed.

3. Utilities: Existing water, irrigation and power lines crossing the site will be relocated. Power is available. Water and telephone service must be brought to site. Sanitary facilities must be installed.

4. Drainage System: Major drainage works required.

5. Leachate Control System: Lining, collection and treatment system may have to be provided.

F. COMMENTARY OF SITE

1. Discussion: The Kaloi Site contains about 400 acres, is located in land owned by one owner, James Campbell Trust Estate. The zoning permits landfill use. It is situated near Makakilo in Kaloi Gulch between the urban and refuse generation centers of Nanakuli and Waipahu, and is 18 miles from downtown Honolulu. A two-lane canehaul road passes 1800' from the site. This road necks down to 33' at H-1 and provides only one lane at underpass for canehaul trucks. Integration of public traffic with canehaul truck traffic would be hazardous with the narrow underpass.

Some cover material is available on the site.

Ground water from this area is a source of water supply for Oahu Sugar Co. irrigation, and potable water for Barbers Point Naval Air Station and other small military installations on the ridge.

The capacity of the site is approximately 24,300,000 cubic yards and the estimated life is 50 years. Site is mostly obscured from view by its meandering alignment and because it is in a remote area, objections from the public should be minimal.

Site preparations costs would be substantial since access road improvements, traffic control measures, major drainage works and imported cover material will be required. A leachate control system may also have to be installed. Utilities costs will be higher than other sites because relocations of existing water, irrigation and power lines will be required. Water is available about one mile away.

Prevailing wind is toward the Makakilo community. This may create odor and litter problems.

About one acre of cane will be removed for realignment of canehaul road.

2. Recommendation: Although this site has great capacity and the owner is willing to offer the land, the City should select this site only if other sites are not available. The cost of on and off site improvements will be extremely high. The other sites can serve the Leeward area for over 20 years. Waste disposal technique will very likely change for the better in the future and this site may then become more feasible.

3. Ranking: 3

15. HONOULIULI LANDFILL SITE

A. BASIC DATA OF SITE

1. Location: 2.6± miles east of Puu Makakilo, 0.5± miles south of Farrington Highway, 2.4± miles east-southeast of Puu Kapuai and 4.5± miles north-northwest of Ewa Beach. See Plate IV-D-33.

2. Tax Map Key: 9-1-17

3. Total Area: 22± acres

4. Owner: James Campbell Trust Estate

5. Present Use of Land: 20±% Agricultural and 80±% Open

6. City Zone District: Agricultural

7. City General Plan Land Use: Agricultural

8. State Land Use District: Agricultural

9. Adjacent Land Uses, Zones, etc.: Agricultural, Residential and Commercial.

10. Restrictions and Setbacks: Special Permit required from State for construction in Agricultural District.

11. Historical and Archeological Significance: No sites known to exist.

12. Proximity to Population and Refuse Centers: Honouliuli residential and commercial area 1700± feet southeast, Waipahu business district 2.3± miles northeast, Fernandez Village 1.4± miles south, and Makakilo City 2.7± miles west-southwest of the site.

B. DESCRIPTION OF SITE

1. Accessibility: Access from Fort Weaver Road.

2. Topography: The site is a gully approximately 1400 ft. in length with the bottom sloped 3±%. The average width is 400± ft. and depth is 35± ft.

3. Soil Classification: Site consists of the following soils taken from the S.C.S. Soil Survey:

   0 to 8% slope, Waialua silty clay and
   30 to 90% slope, Helemano silty clay.

   See Appendix E.

4. Availability of Cover Material: Available on site.

5. Surface Drainage: Surface runoff drains toward Ft. Weaver Road.

6. Ground Water Supply: Outside of Board of Water Supply ground water zone.

7. Existing Utilities: None on site. Electric power, telephone, and water are available on Ft. Weaver Road.

C. SITE AS LANDFILL

1. Usable Area: 22± acres

2. Type of Operation: Combination of trench and area methods.

3. Capacity: 1,650,000± cubic yards

4. Life: 3.4± years (sanitary landfill), 20± years (demolition landfill)

5. Land Use After Development: Agriculture, or can be active and passive recreational park according to Parks and Recreation Dept.

D. ENVIRONMENTAL CONCERNS OF SITE

1. General Landfill Nuisances: Will be generated. Effective control measures must be in effect during the life of the site to minimize nuisances associated with landfill operations.

2. Visual Pollution: Landscaping prior to, during and after landfill operations will minimize visual pollution.

3. Ground Water Pollution: No protective measures required.

4. Surface Drainage Works: Drainage system must be constructed to minimize rainfall infiltration.

5. Destruction of Natural Resources: Land and vegetation will be committed to landfill. However, site can be planted in cane after landfill activities cease.

6. Displacement: Approximately 4.0 acres of cane land will be removed during the life of the landfill.

7. Other Environmental Concerns: Increase of traffic on Ft. Weaver Road will occur. Impact on flora and fauna is not expected to be significant, and these and other concerns will be addressed in more detail in an environmental impact statement if this site is selected for development.

8. Safety: Minimal

9. Objection by Owner and Adjacent Owners: Minimal since 10% of land is not being utilized at present and only 4.0 acres will be removed from cane production.

10. Objections by Public, Community Organizations, etc.: The community adjacent to the site will probably object.

E. SITE PREPARATION FOR LANDFILL

1. Access Road: 1200± ft. of access road must be constructed.

2. Operations and Maintenance Facilities: Temporary facilities must be constructed.

3. Utilities: Electric power, telephone and water connections must be made on Ft. Weaver Road.

4. Drainage System: Nominal surface drainage system on site and an underground pipe system to and across Ft. Weaver Road to Honouliuli Stream must be constructed.

5. Leachate Control System: None required but leachate movement should be monitored.

F. COMMENTARY OF SITE

1. Discussion: The site is a relatively small gully surrounded by cane fields located in Honouliuli, 1200± feet off Ft. Weaver Road and 3100± feet from Farrington Highway. About four acres of cane are being grown in the bottom of the gully. The total and usable area is 22± acres, 1,650,000± cubic yards capacity, estimated life of 3.4± years and is owned by James Campbell Trust Estate.

Immediately below the site, a plantation-owned deep water well is being used for irrigation of nearby cane fields.

Destruction of some cane land and natural vegetation will be necessary.

A drainage system must be constructed to minimize infiltration, soil erosion and property damage.

Site preparation and improvement costs will be moderate and include landscaping; temporary operation and maintenance facilities; drainage system; access road; and utilities.

2. Recommendation: The site is recommended for a demolition landfill site. Capacity too small for sanitary landfill.

3. Ranking: 4

16. KAUKONAHUA AND WAIPAHU LANDFILL SITES

The Kaukonahua and Waipahu Landfill Sites are already planned as demolition and ash landfill sites respectively by the City. See Plate II-A-1.

17. MAILI LANDFILL SITE

The Maili Landfill Site is located in Maili, 1200± feet from Farrington Highway. Site is owned by Permanente Cement Co. See Plate II-A-1.

The land contains approximately 200 acres, is presently being used as a quarry and the quarrying is expected to continue for 25 years.

It has an approximate landfill capacity of 9,200,000 cubic yards and life of 18.9± years.

The site is outside the Board of Water Supply ground water zone.

A drainage system must be constructed to minimize rainfall infiltration and soil erosion.

Site preparation and improvement costs will be moderate and include landscaping; operations and maintenance facilities; drainage system; upgrading of access road; and utilities.

This site has potential as a future sanitary landfill site. It is not recommended for development at this time since there are other more desirable sites.

18. KOKO CRATER LANDFILL SITE

The Koko Crater Site is located in the southeast portion of Oahu, contains 75± acres of usable landfill area, and is an open area owned by the City and County of Honolulu. Access is available through an existing paved road from both the Windward and Leeward sides of the island. Will pass through developed area in the future. See Plate II-A-1.

The site is outside the Board of Water Supply ground water zone. Location at the tip of the island adds to hauling costs from the Leeward areas.

Site preparation costs will be nominal. Utilities will have to be brought in from the subdivision road at the Hawaii Kai Golf Course about 3000± ft. away.

The capacity is approximately 4,537,500 cubic yards and estimated life is 12.4 years.

No one will be displaced by the project. A botanical garden of succulent plants occupies a small portion of the crater. Any landfill will have to be constructed around the garden with adequate buffer areas.

The site is well buffered from urbanized areas on all sides except the entrance, where a buffer with landscaping can easily be constructed.

New operational and maintenance facilities will be required.

The City should consider this site only for a future sanitary landfill site after the depletion of other sites since it is removed from refuse generation centers and hauling costs would be high. It also was deeded over to the City with the stipulation that the land be used as a park.

19. WAIPIO LANDFILL SITE

The entire lower Waipio Peninsula is a U.S. Naval Reservation, leased to Oahu Sugar Co. for agricultural purposes. The site, as shown on Plate II-A-1, is being used by Oahu Sugar Co. as their disposal site for cane wash water and bagasse.

As long as cultivation of sugar cane and operation of sugar mills continue, an area for mill waste disposal is necessary.

Should the City decide to acquire this land for demolition and/or sanitary landfill, the sugar company must find another area for mill waste disposal.

Therefore, it is recommended that the existing Oahu Sugar Co. bagasse and wash water disposal site remain as is, and the City & County of Honolulu consider other sites recommended in this report.

20. MILILANI LANDFILL SITE

The Mililani Landfill Site is one of the major gullies connected to Panakauahi Gulch. See Plate II-A-1. It is located adjacent to Mililani Memorial Park and pineapple fields, 1.5± miles from Kamehameha Highway, 4.6± miles from Waipahu, 3.2± miles from Pearl City and 2± miles from Mililani Town.

The total and usable area is 34± acres, with a capacity of 2,200,000± cubic yards, estimated life of 4.5± years, and owned by Castle & Cooke, Inc. (85±%) and B.P. Bishop Estate (15±%).

Destruction of natural vegetation will be necessary, but the site can be developed into productive agricultural land after landfill operations.

Ground water must be protected from sanitary landfill pollutants by construction of an impermeable lining and leachate collection, treatment and/or disposal system.

Construction of a surface drainage system to minimize rainfall infiltration and soil erosion and an underground conduit for runoff mauka of the east-northeast gully is required.

Site preparation and improvement costs will be substantial due to impermeable lining; collection, treatment and/or disposal of leachate; moderate drainage system; upgrading Mililani Memorial Park Access Road; and utilities.

This site is not recommended for a demolition or a sanitary landfill site.

21. POAMOHO LANDFILL SITE

The Poamoho Landfill site is located adjacent to cane and pineapple fields 2.6± miles north of Wahiawa urban area, off Kamehameha Highway. See Plate II-A-1.

Characteristics of this site are: Small capacity, short life of 1.5± years; upgrading required for existing 1200± ft. of cane dirt road; leachate control system must be provided; telephone and water service not available nearby; 1500± ft. drainage channel must be constructed to accommodate a 5±' x 20±' box culvert crossing Kamehameha Highway; and a cesspool must be constructed.

The site is not recommended for landfill development.

22. KEEKEE LANDFILL SITE

The Keekee Landfill Site is located in the western end of Oahu between Kaena Point and Waialua, adjacent to the west of Dillingham Field and east of Camps Erdman and Kaena. See Plate II-A-1.

The site is outside the Board of Water Supply ground water zone. Land is stony. Therefore, most of the cover material must be imported. Refuse generation centers of Waialua and Haleiwa urban areas are 6.7± miles away. Can be used for local landfill areas.

This site is not recommended for major landfill development.

23. KAENA QUARRY LANDFILL SITE

The Kaena Quarry Landfill site is located at the west mauka end of Dillingham Field and about 1,000 ft. mauka of Farrington Highway. The usable area is a pit created by the quarry operations and is approximately 14 acres. The State of Hawaii owns approximately 80 percent and Dillingham Corporation the remainder. See Plate II-A-1.

The capacity of the site is approximately 1,500,000± cubic yards and estimated life is 3.0± years at 500 tons per day disposal rate.

Cover material is scarce on site and must be imported or mined from the adjacent areas.

The site is not located over present or future ground water sources but an underground spring discharges into the pit. This water is pumped out and used as wash water for the aggregates produced at the quarry.

Site preparation would be nominal. The existing maintenance and operational facilities such as the scale and maintenance shops could be upgraded and retained for a landfill operation. Electric, telephone and potable water connections are available on the site.

The quarry operations ceased on April 4, 1977 and the quarry will be closed when the stockpile is sold. Stockpile is expected to be depleted in about a year.

This site can be used as a landfill site to replace Kawailoa. Life of this landfill when serving the same areas as the Kawailoa landfill is 15± years.

CORRECTION

THE PRECEDING DOCUMENT(S) HAS
BEEN REPHOTOGRAPHED TO ASSURE
LEGIBILITY
SEE FRAME(S)
IMMEDIATELY FOLLOWING

20. MILILANI LANDFILL SITE

The Mililani Landfill Site is one of the major gullies connected to Panakauahi Gulch. See Plate II-A-1. It is located adjacent to Mililani Memorial Park and pineapple fields, 1.5± miles from Kamehameha Highway, 4.6± miles from Waipahu, 3.2± miles from Pearl City and 2± miles from Mililani Town.

The total and usable area is 34± acres, with a capacity of 2,200,000± cubic yards, estimated life of 4.5± years, and owned by Castle & Cooke, Inc. (85±%) and B.P. Bishop Estate (15±%).

Destruction of natural vegetation will be necessary, but the site can be developed into productive agricultural land after landfill operations.

Ground water must be protected from sanitary landfill pollutants by construction of an impermeable lining and leachate collection, treatment and/or disposal system.

Construction of a surface drainage system to minimize rainfall infiltration and soil erosion and an underground conduit for runoff mauka of the east-northeast gully is required.

Site preparation and improvement costs will be substantial due to impermeable lining; collection, treatment and/or disposal of leachate; moderate drainage system; upgrading Mililani Memorial Park Access Road; and utilities.

This site is not recommended for a demolition or a sanitary landfill site.

21. POAMOHO LANDFILL SITE

The Poamoho Landfill site is located adjacent to cane and pineapple fields 2.6± miles north of Wahiawa urban area, off Kamehameha Highway. See Plate II-A-1.

Characteristics of this site are: Small capacity, short life of 1.5± years; upgrading required for existing 1200± ft. of cane dirt road; leachate control system must be provided; telephone and water service not available nearby; 1500± ft. drainage channel must be constructed to accommodate a 5±' x 20±' box culvert crossing Kamehameha Highway; and a cesspool must be constructed.

The site is not recommended for landfill development.

22. KEEKEE LANDFILL SITE

The Keekee Landfill Site is located in the western end of Oahu between Kaena Point and Waialua, adjacent to the west of Dillingham Field and east of Camps Erdman and Kaena. See Plate II-A-1.

The site is outside the Board of Water Supply ground water zone. Land is stony. Therefore, most of the cover material must be imported. Refuse generation centers of Waialua and Haleiwa urban areas are 6.7± miles away. Can be used for local landfill areas.

This site is not recommended for major landfill development.

23. KAENA QUARRY LANDFILL SITE

The Kaena Quarry Landfill site is located at the west mauka end of Dillingham Field and about 1,000 ft. mauka of Farrington Highway. The usable area is a pit created by the quarry operations and is approximately 14 acres. The State of Hawaii owns approximately 80 percent and Dillingham Corporation the remainder. See Plate II-A-1.

The capacity of the site is approximately 1,500,000± cubic yards and estimated life is 3.0± years at 500 tons per day disposal rate.

Cover material is scarce on site and must be imported or mined from the adjacent areas.

The site is not located over present or future ground water sources but an underground spring discharges into the pit. This water is pumped out and used as wash water for the aggregates produced at the quarry.

Site preparation would be nominal. The existing maintenance and operational facilities such as the scale and maintenance shops could be upgraded and retained for a landfill operation. Electric, telephone and potable water connections are available on the site.

The quarry operations ceased on April 4, 1977 and the quarry will be closed when the stockpile is sold. Stockpile is expected to be depleted in about a year.

This site can be used as a landfill site to replace Kawailoa. Life of this landfill when serving the same areas as the Kawailoa landfill is 15± years.

24. MAKUA LANDFILL SITE

Makua Valley is a Military Reservation used for military exercises. See Plate II-A-1.

This site is a practice range for military weapons and the possibility of existing duds makes this site very dangerous and hence undesirable.

This site is not recommended for landfill development.

25. OHIKILOLO LANDFILL SITE

The Ohikilolo Landfill Site is located north of Makaha Valley. It is remote from refuse generation centers and hauling costs would be high. See Plate II-A-1.

This site is not recommended for landfill development.

26. WAIMANALO GULCH SITE

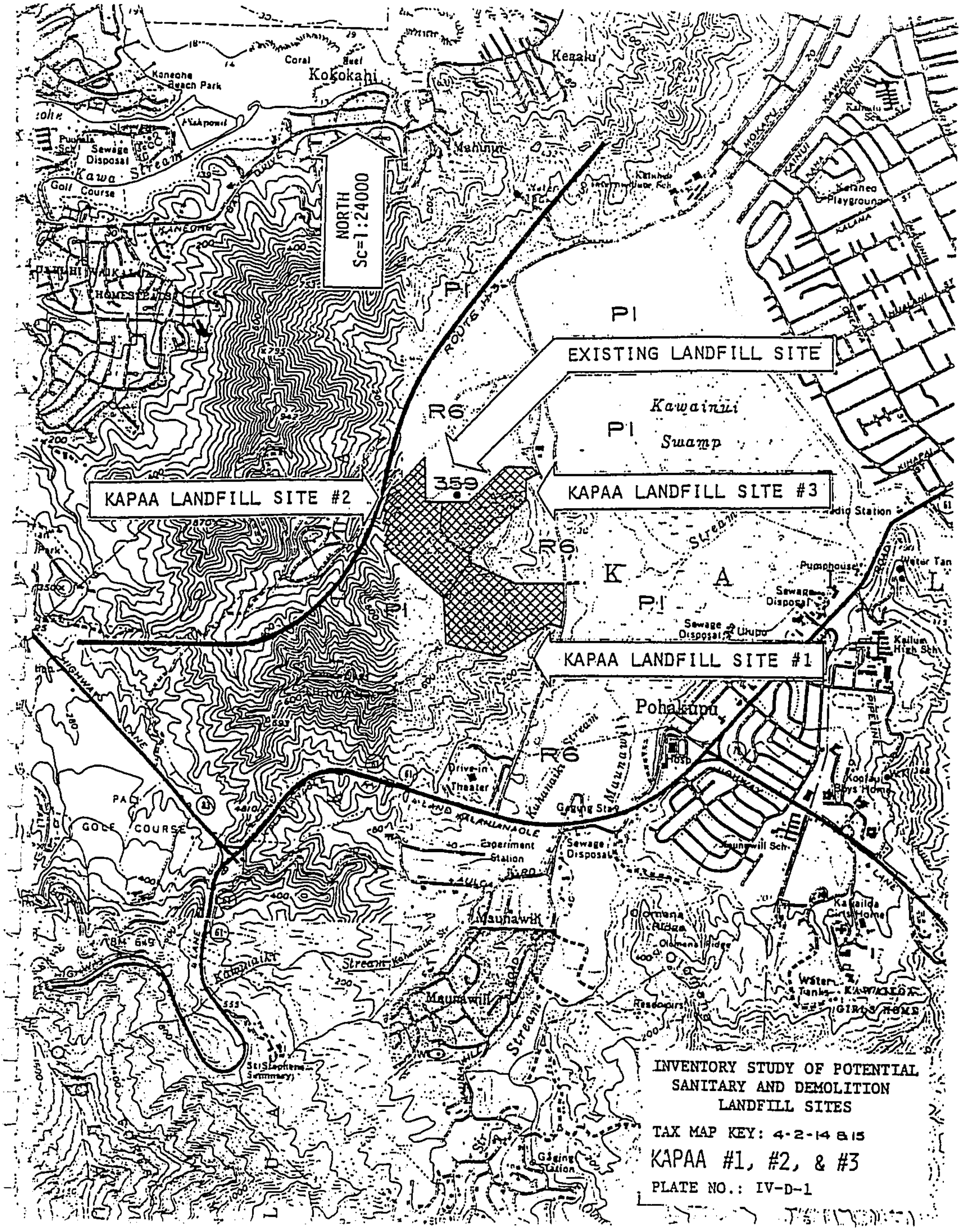
The Waimanalo Gulch Landfill Site is located between the Hawaiian Electric Co. Kahe Power Plant and the Makaiwa Landfill Site. See Plate II-A-1.

This site is presently being planned as a Disneyland-type park and hence land acquisition costs would be high.

This site is not recommended for landfill development.

APPENDIX D

SITE, STATE LAND USE, CITY GENERAL PLAN AND ZONING MAPS



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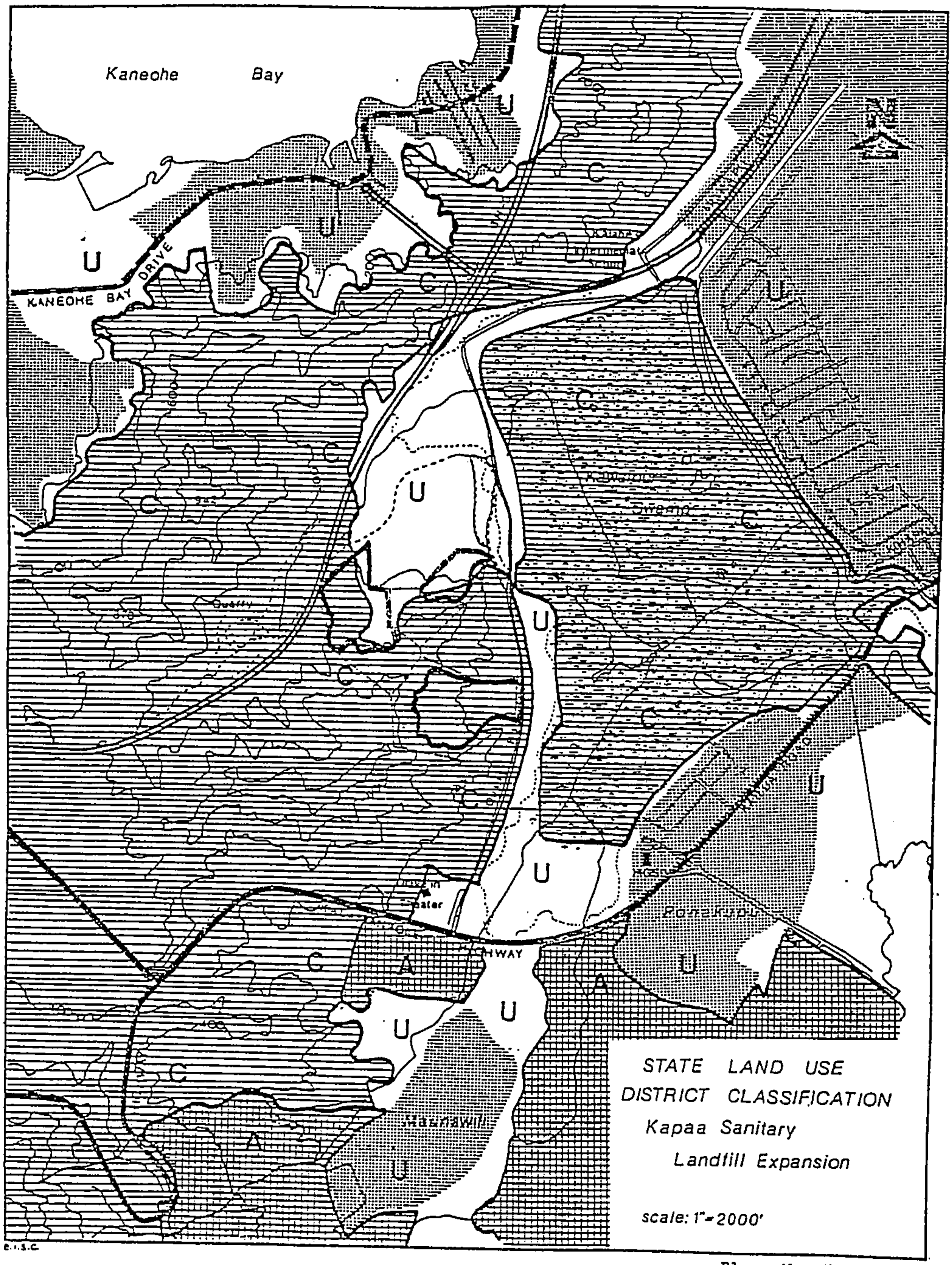
EXISTING LANDFILL SITE
KAPAA LANDFILL SITE #2
KAPAA LANDFILL SITE #3
KAPAA LANDFILL SITE #1
Kawainui
Swamp
P1
R6
Pohakupu
Kokokahi
Kealau
Drive-in Theater
Experiment Station
Maunawili
Olomana Ridge
INVENTORY STUDY OF POTENTIAL
SANITARY AND DEMOLITION
LANDFILL SITES
TAX MAP KEY: 4-2-14 & 15
KAPAA #1, #2, & #3
PLATE NO.: IV-D-1



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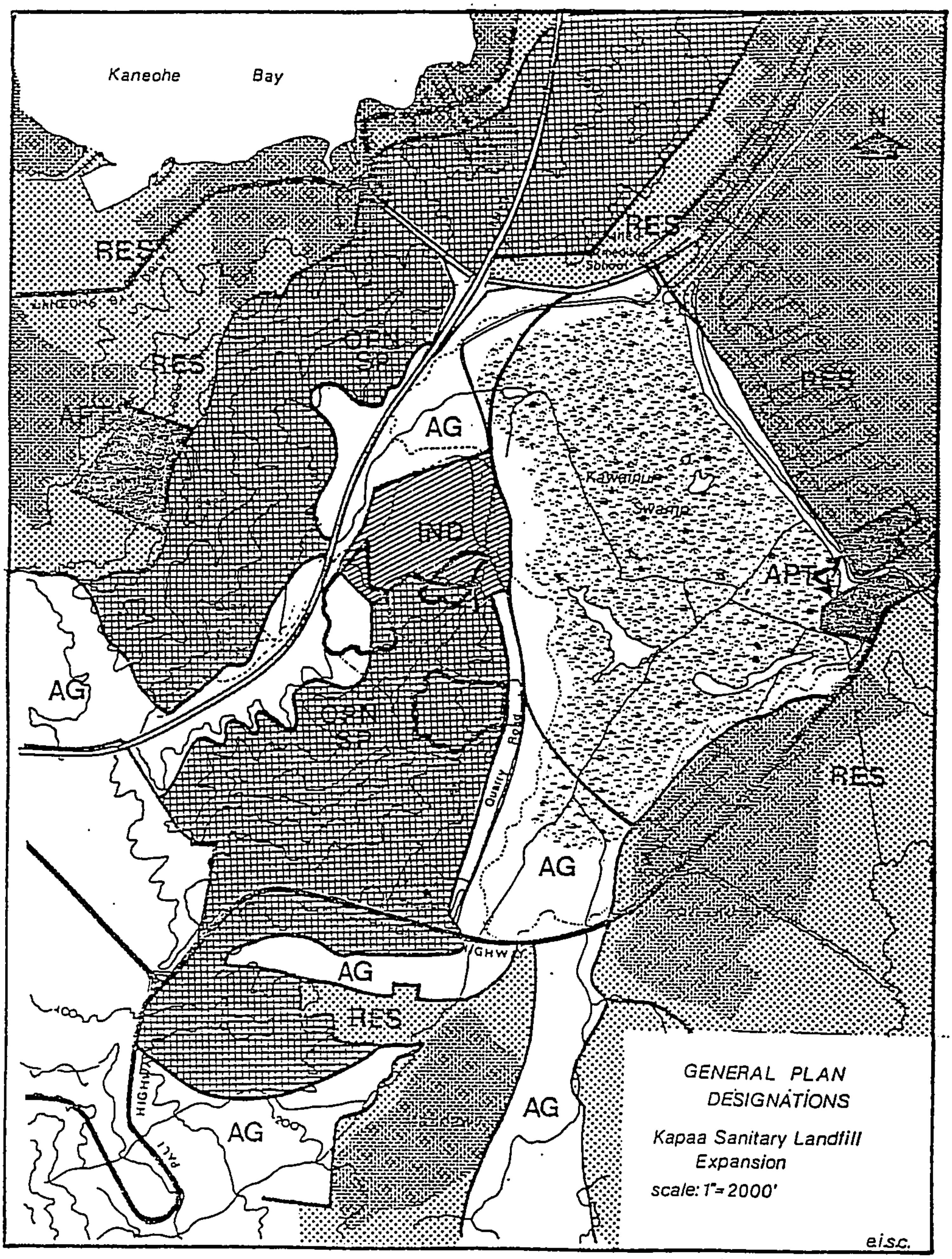

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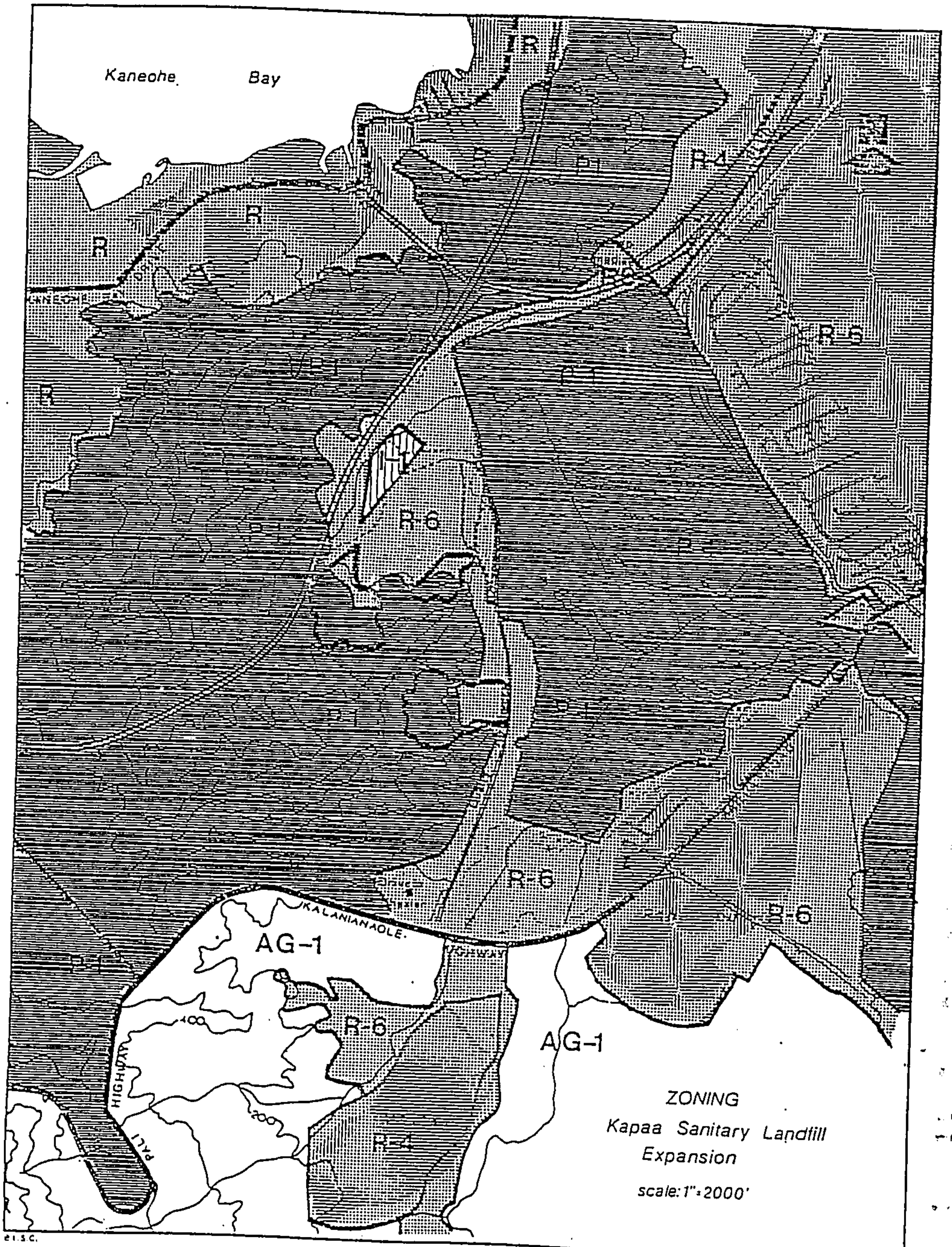

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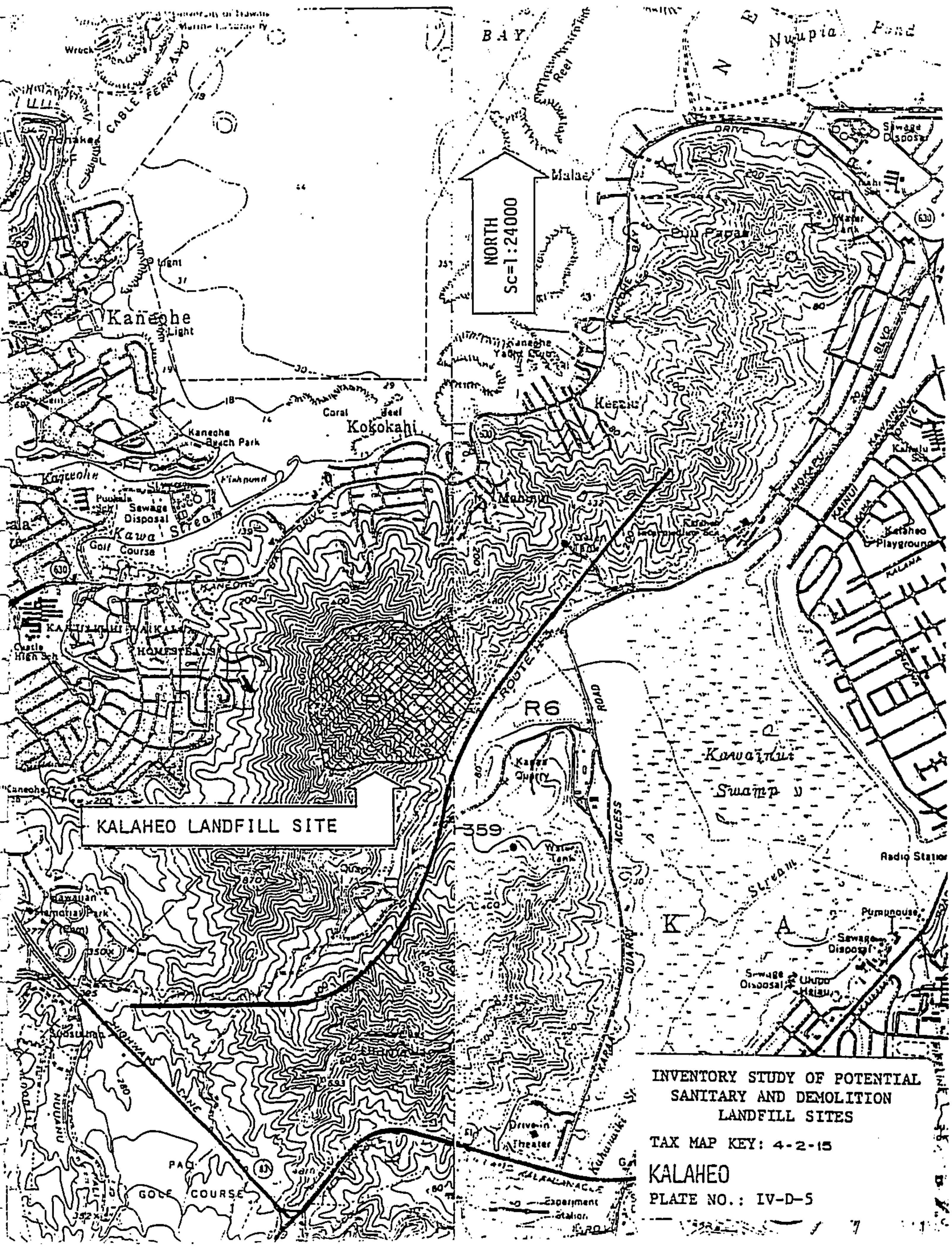
NORTH
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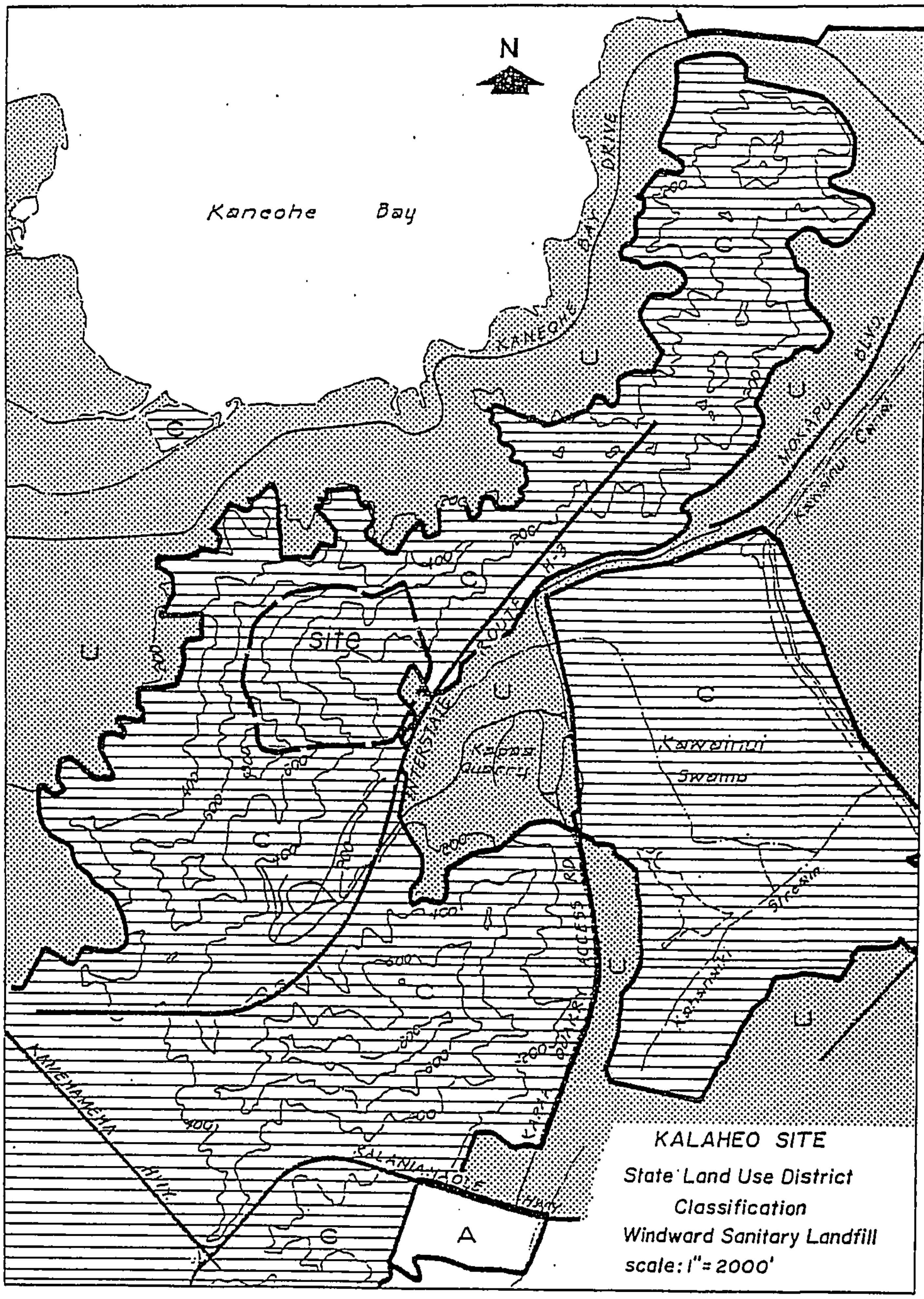
KALAHEO LANDFILL SITE
Kaneohe
Kaneohe Beach Park
Kokokahi
Coral Reef
BAY
Nuupia Pond
Malae
Sewage Disposal
Golf Course
Kawa Stream
Castle High Sch
R6
Kapaa Quarry
Kawainui Swamp
Radio Station
Pumpnouse
Kalaheo Playground
Drive-in Theater
Experiment Station
PALI GOLF COURSE
ROUTE 61
359
INVENTORY STUDY OF POTENTIAL
SANITARY AND DEMOLITION
LANDFILL SITES
TAX MAP KEY: 4-2-15
KALAHEO
PLATE NO.: IV-D-5



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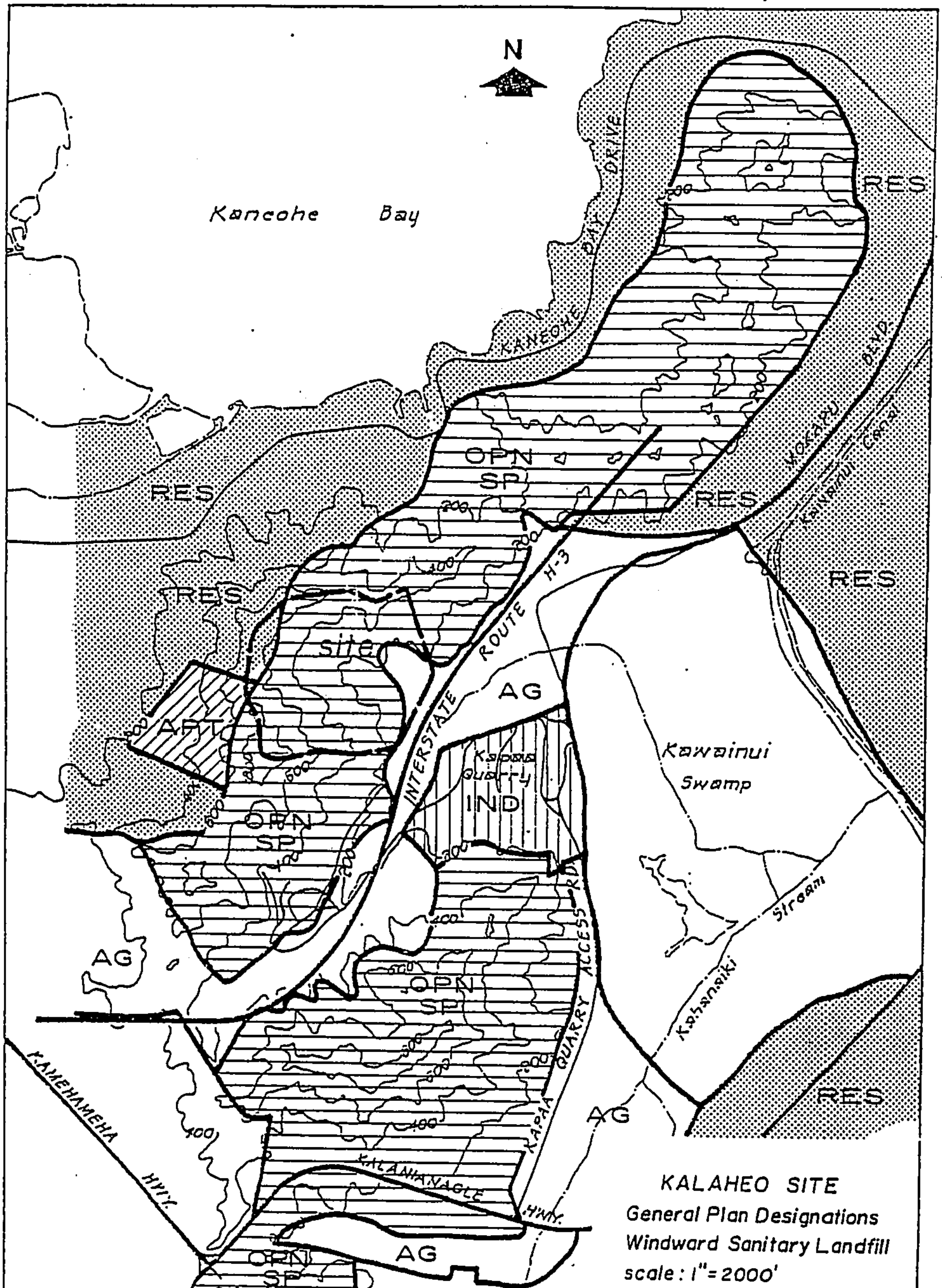

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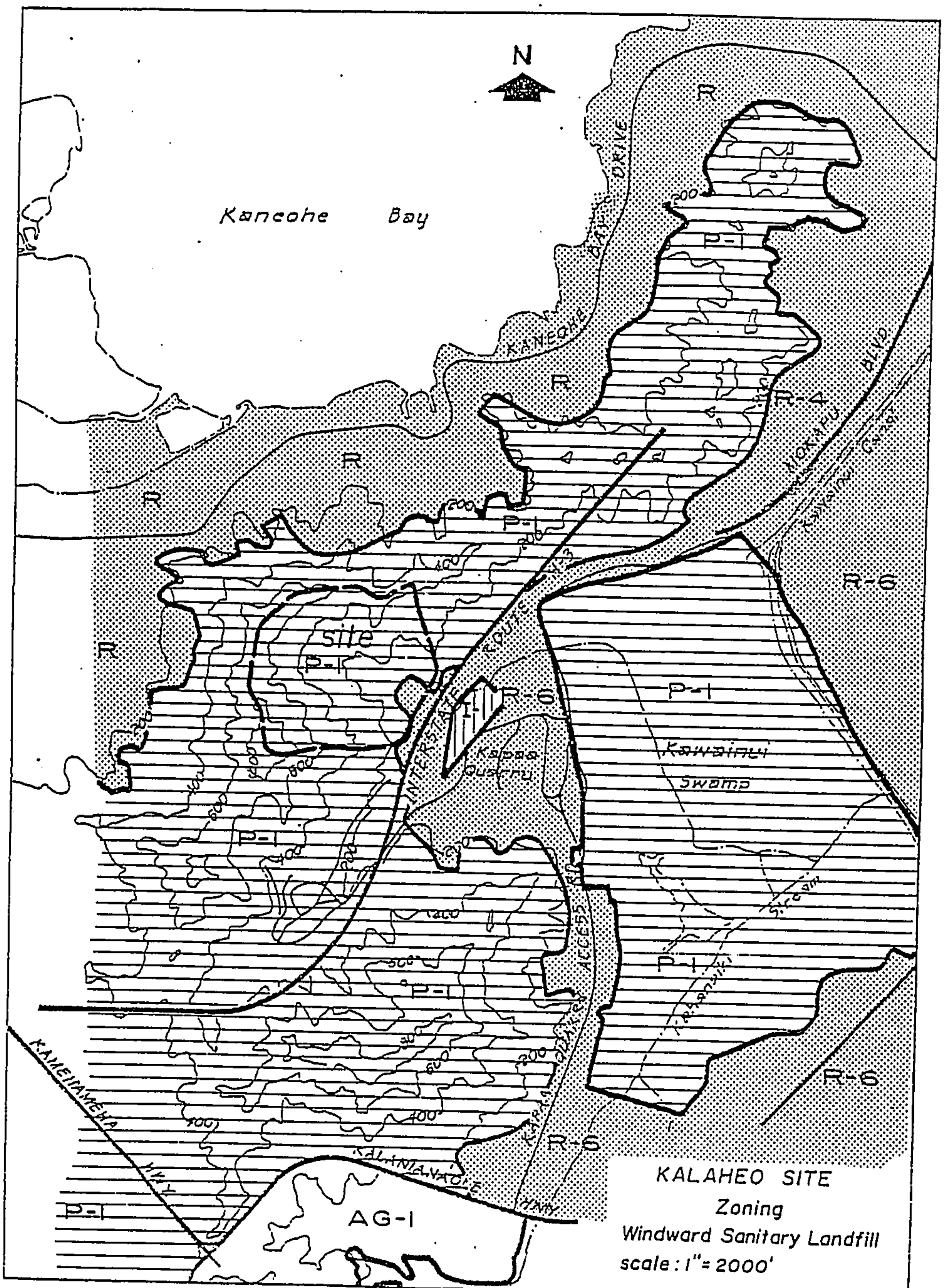

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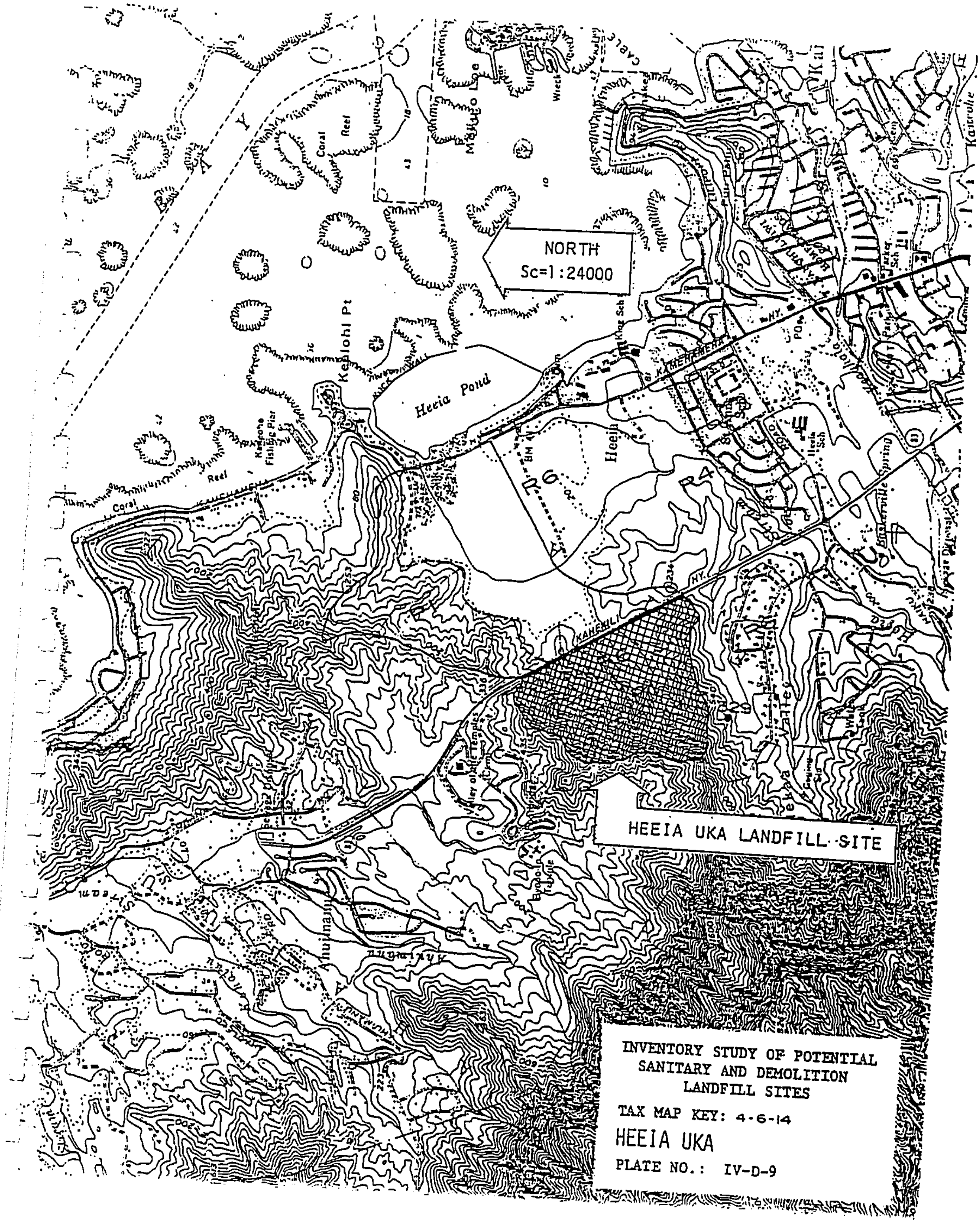

NORTH
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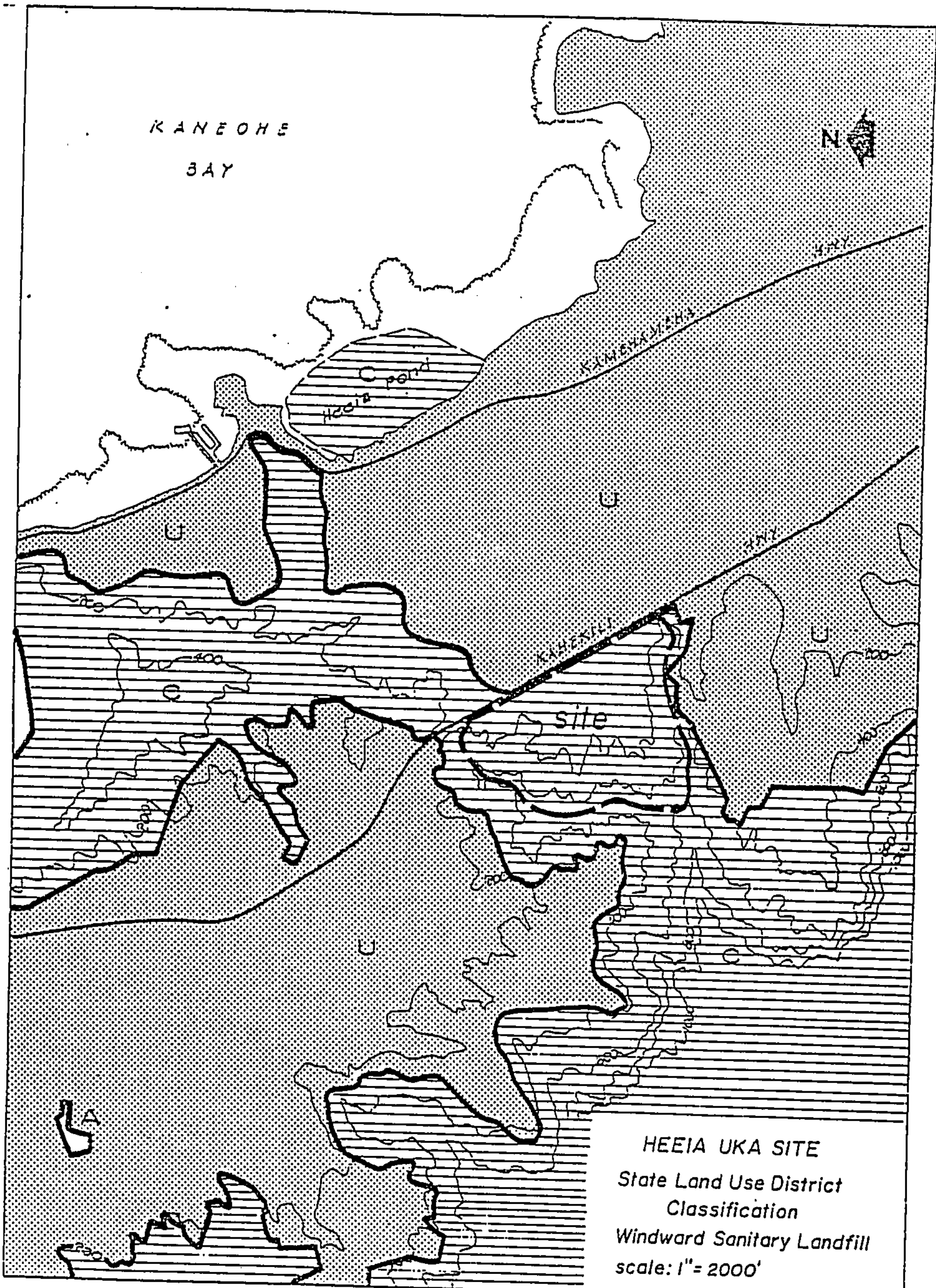
Heeia Pond
Kealohi Pt
Coral
Reef
HEEIA UKA LANDFILL SITE
INVENTORY STUDY OF POTENTIAL
SANITARY AND DEMOLITION
LANDFILL SITES
TAX MAP KEY: 4-6-14
HEEIA UKA
PLATE NO.: IV-D-9



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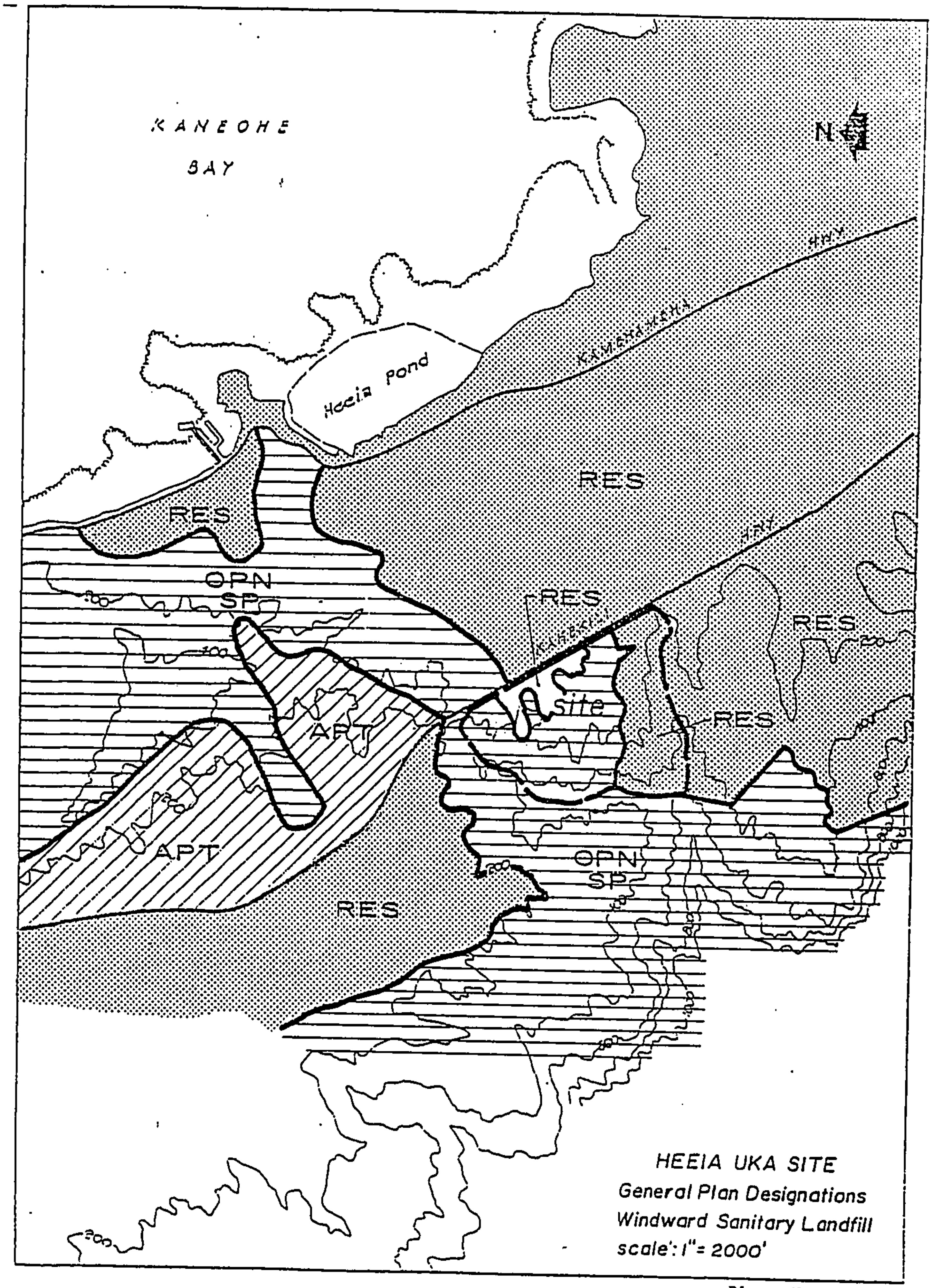

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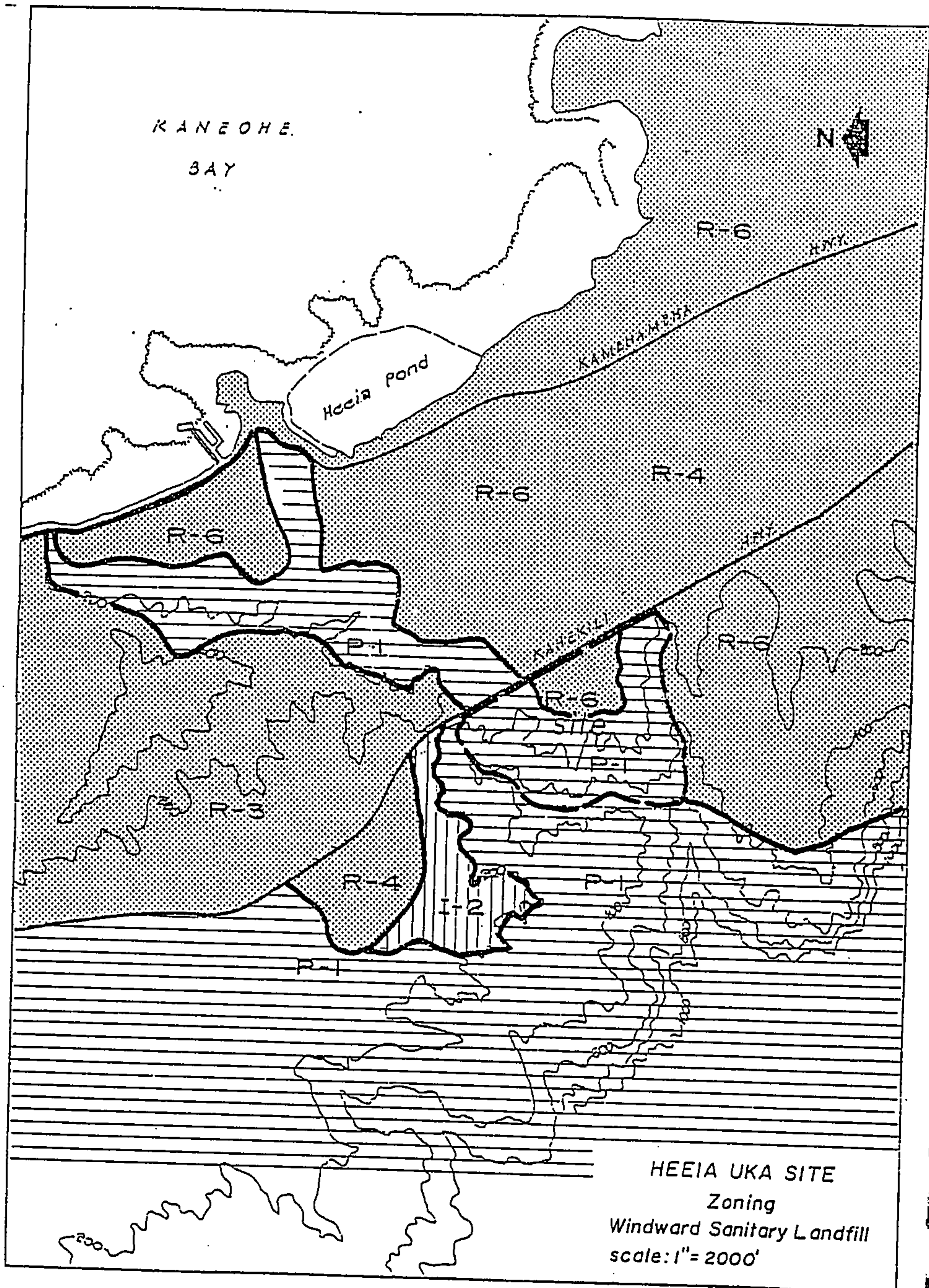
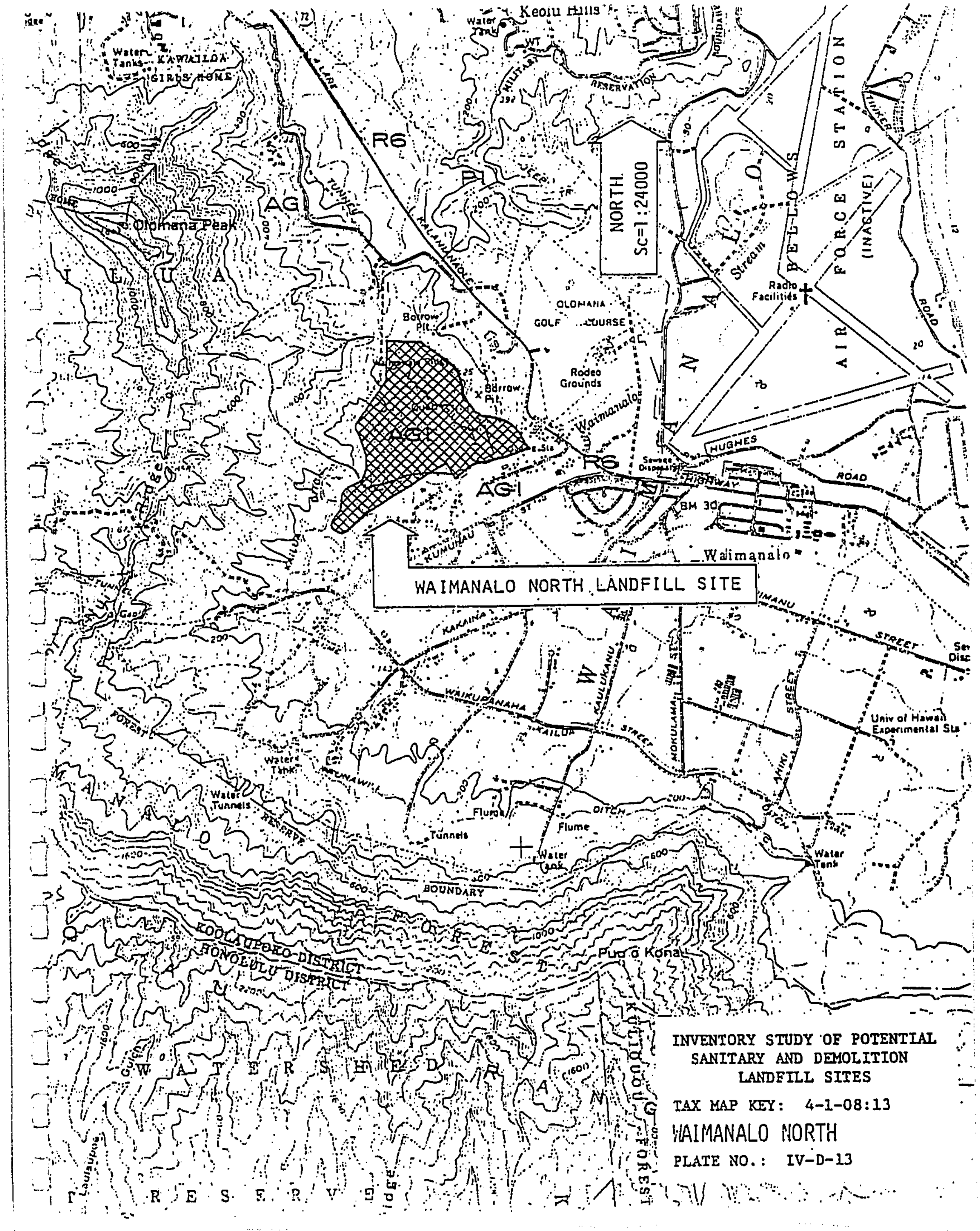

KANEOHE
BAY
N
R-6
HWY.
KAMEHAMEHA
Heeia Pond
R-4
R-6
R-6
HWY.
KAHEKILI
P-1
R-6
SITE
P-1
R-6
R-3
R-4
I-2
P-1
R-1
200
HEEIA UKA SITE
Zoning
Windward Sanitary Landfill
scale: 1" = 2000'

Plate IV-D-12

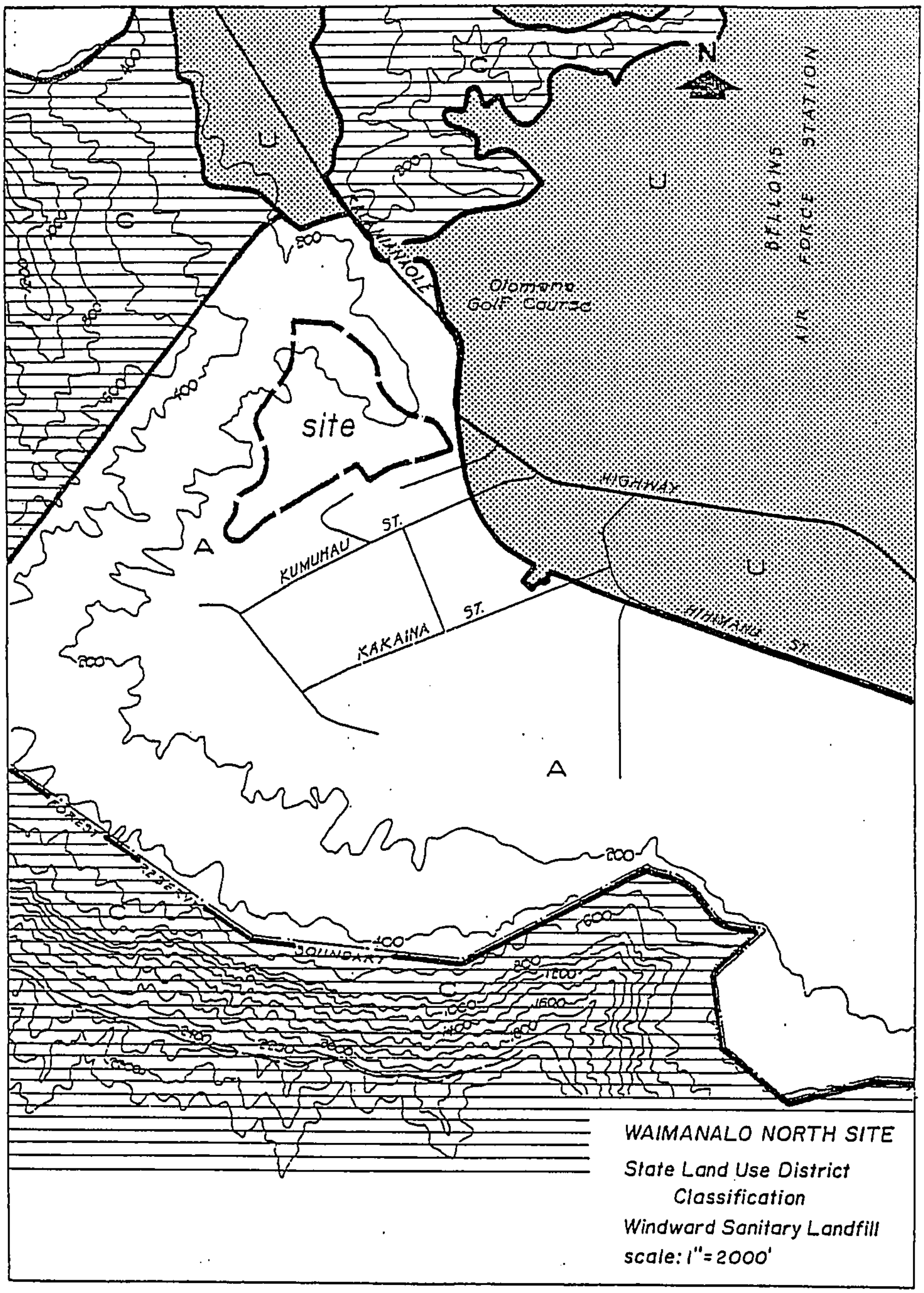


INVENTORY STUDY OF POTENTIAL SANITARY AND DEMOLITION LANDFILL SITES

TAX MAP KEY: 4-1-08:13

WAIMANALO NORTH

PLATE NO.: IV-D-13



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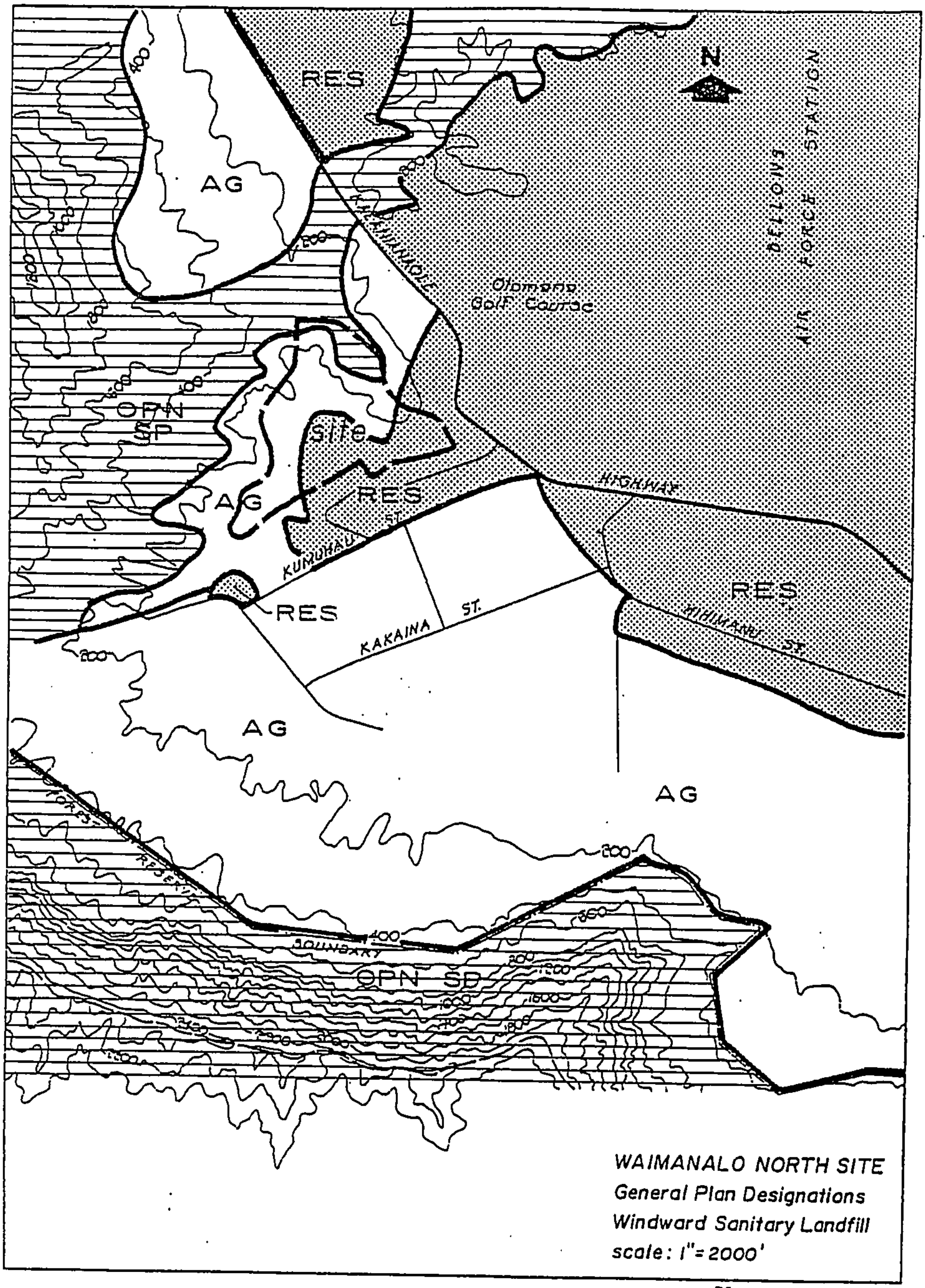

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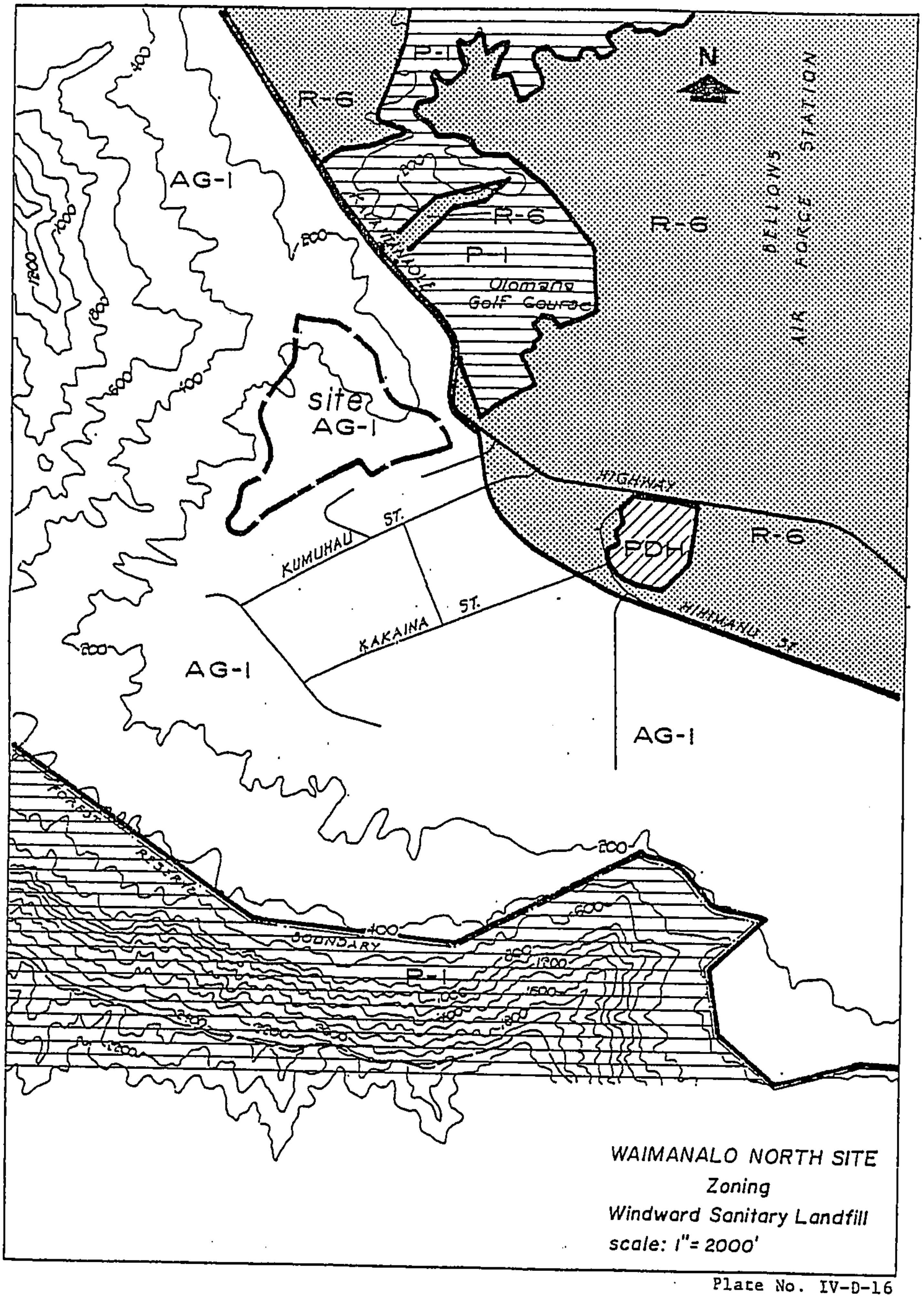
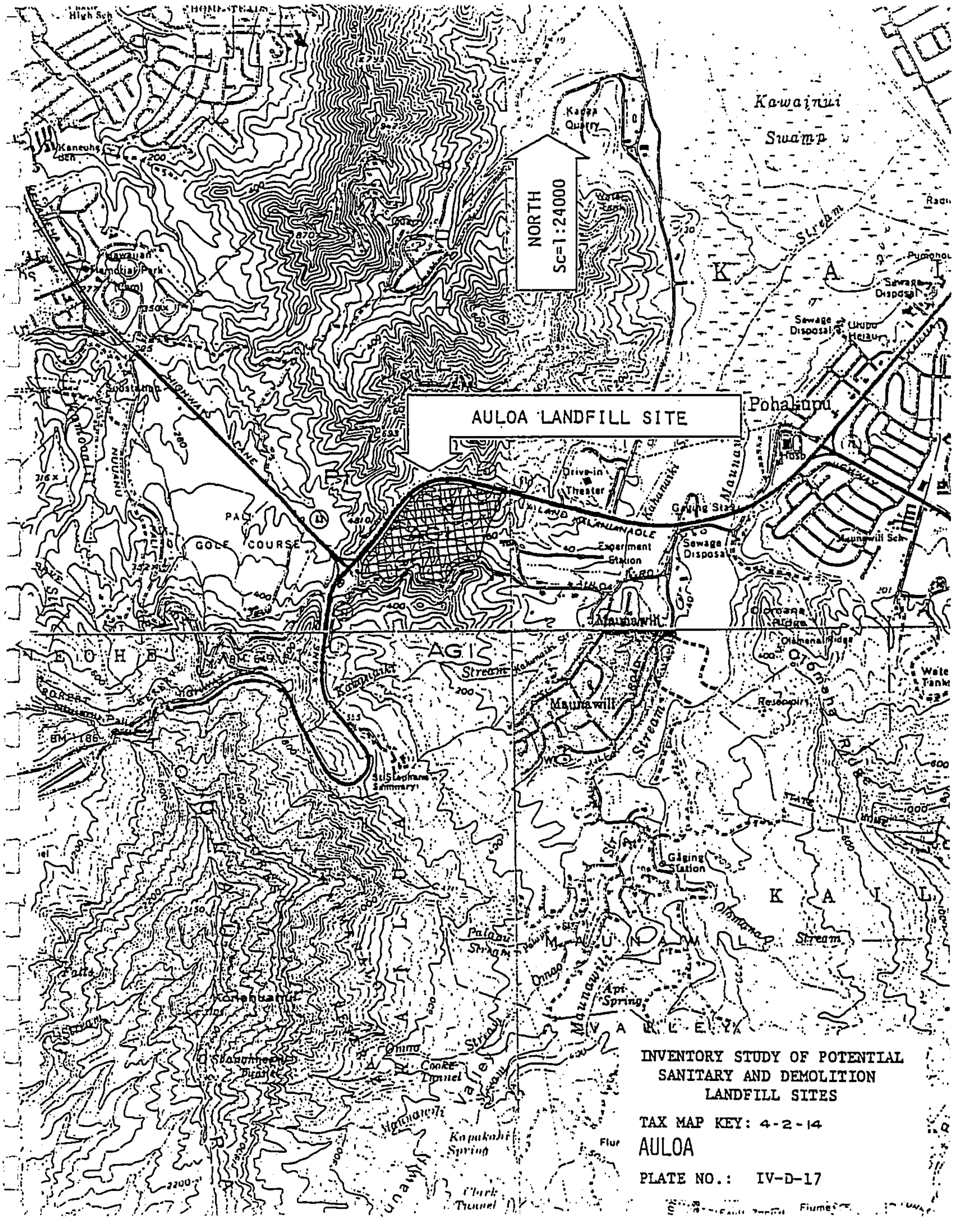


WAIMANALO NORTH SITE
Zoning
Windward Sanitary Landfill
scale: 1"= 2000'

Plate No. IV-D-16


NORTH
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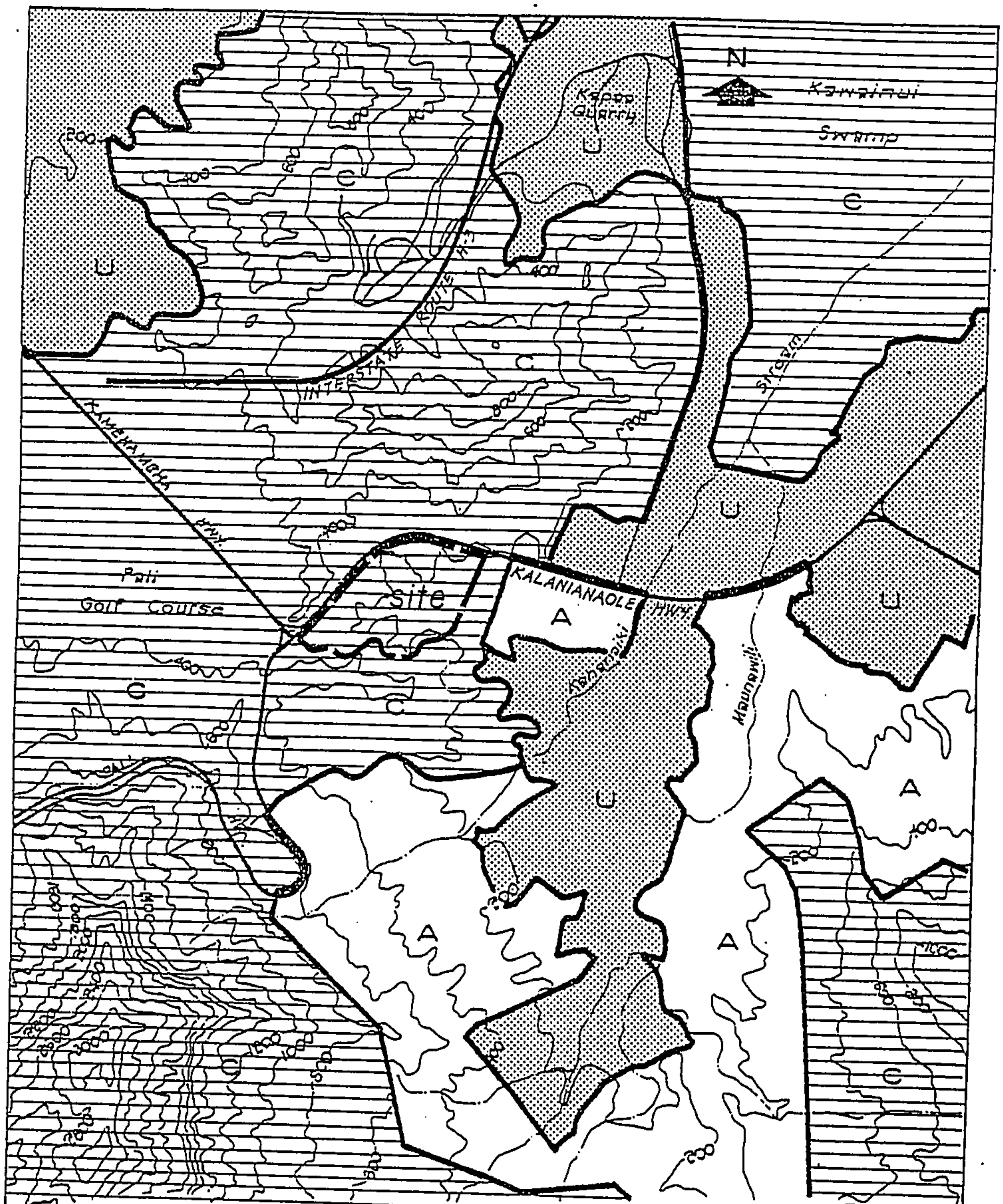
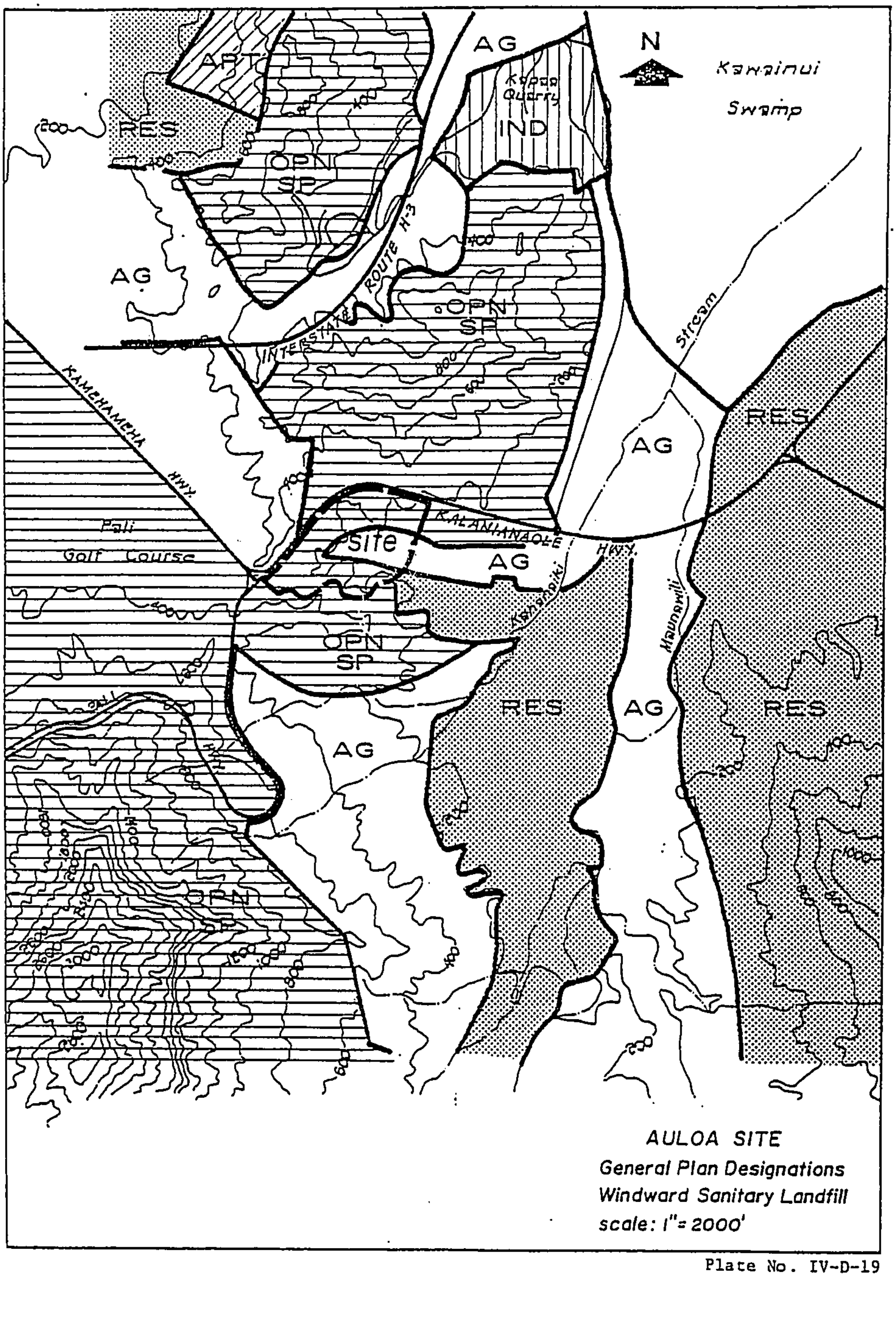
AULOA LANDFILL SITE
Kawainui
Swamp
Kapaa Quarry
Pohakupu
Drive-in Theater
Gaging Sta
Sewage Disposal
Experiment Station
Maunawili
PALI GOLF COURSE
Hawaiian Memorial Park
Maunawili Sch
Olomana Ridge
Reservoirs
Stream
Gaging Station
K A I L
Olomana Stream
Api Spring
Cooke Tunnel
Kapakahi Spring
Clark Tunnel
INVENTORY STUDY OF POTENTIAL
SANITARY AND DEMOLITION
LANDFILL SITES
TAX MAP KEY: 4-2-14
AULOA
PLATE NO.: IV-D-17



AULOA SITE

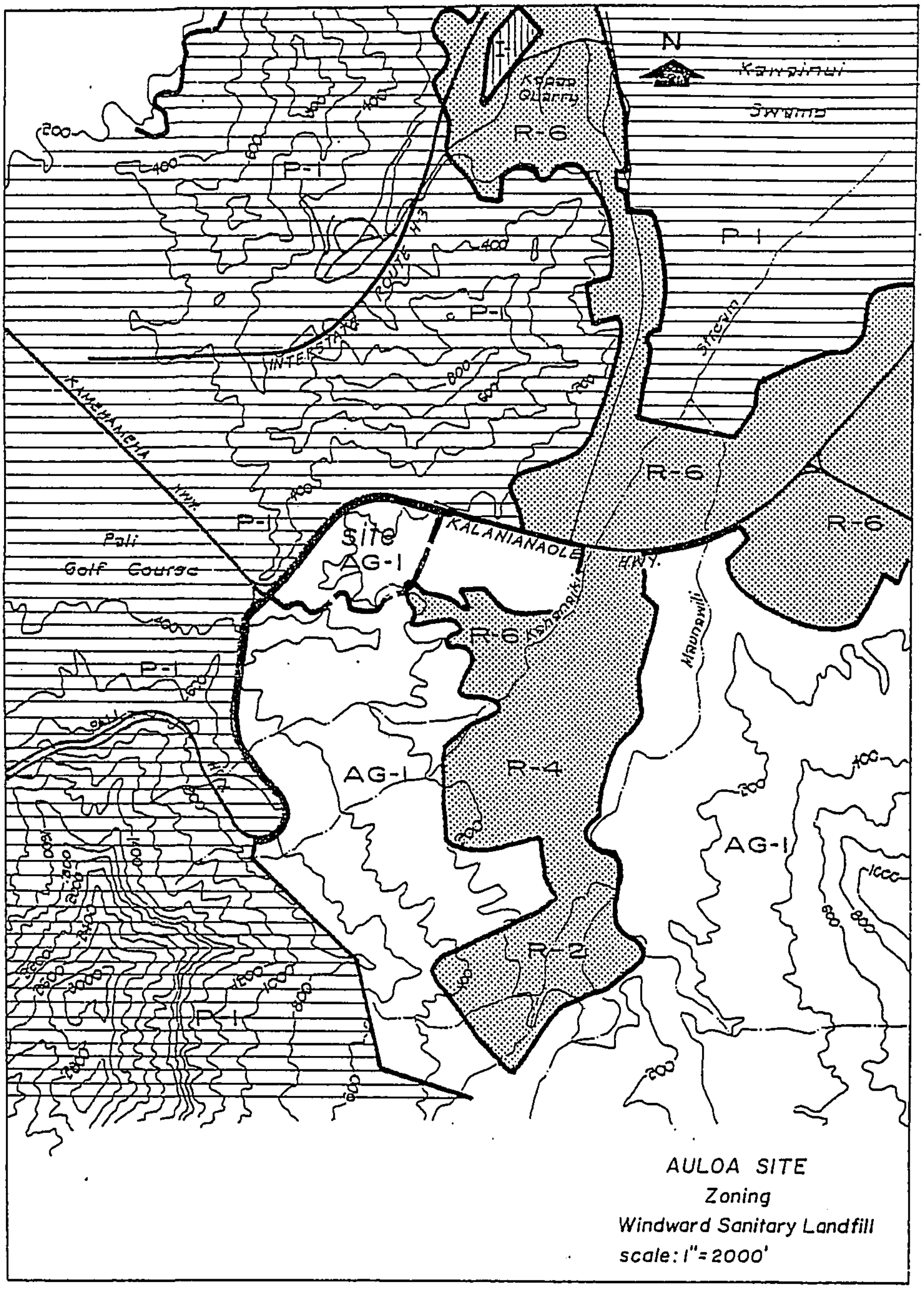
State Land Use District
Classification
Windward Sanitary Landfill
scale: 1" = 2000'

Plate No. IV-D-18



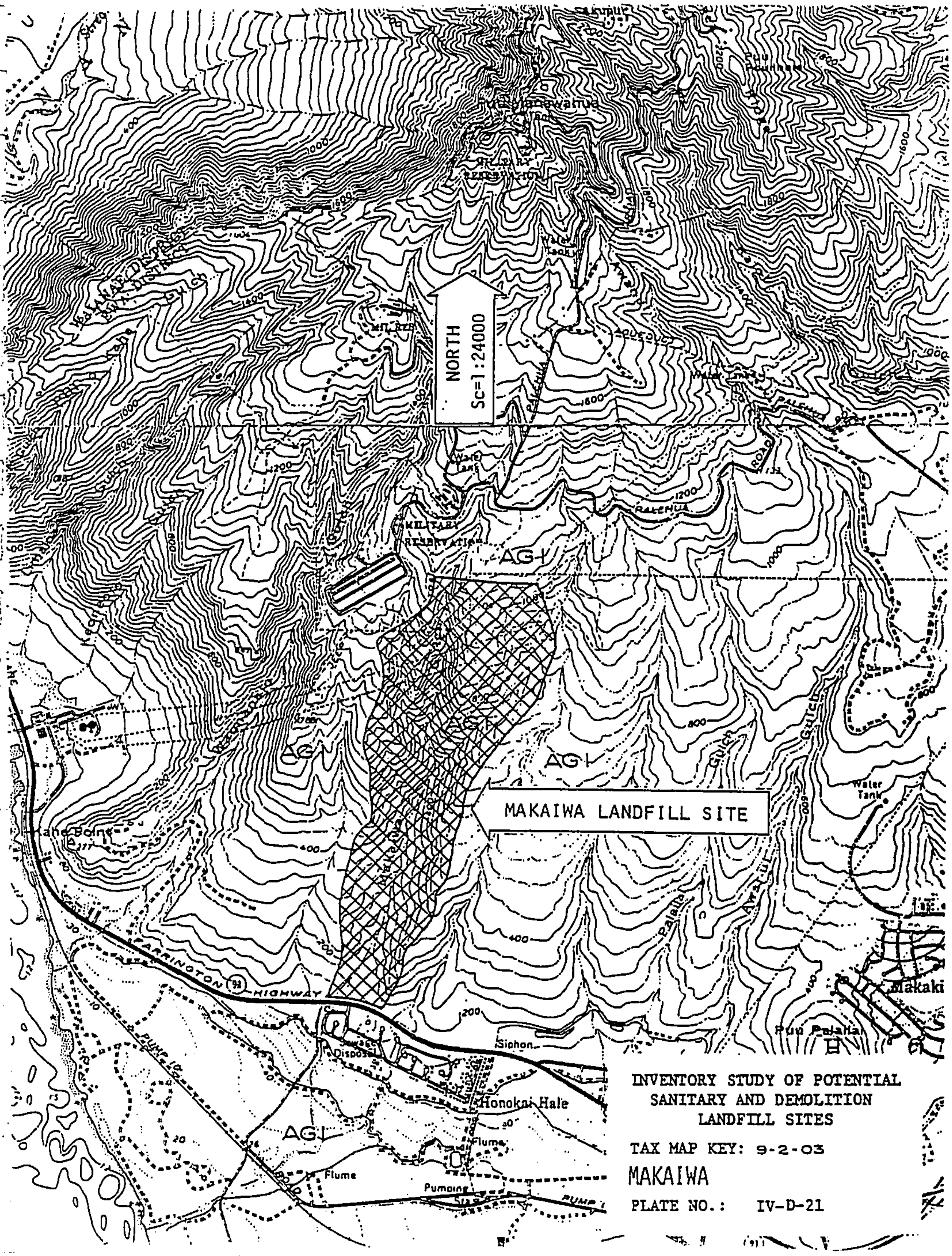
AULOA SITE
General Plan Designations
Windward Sanitary Landfill
scale: 1" = 2000'

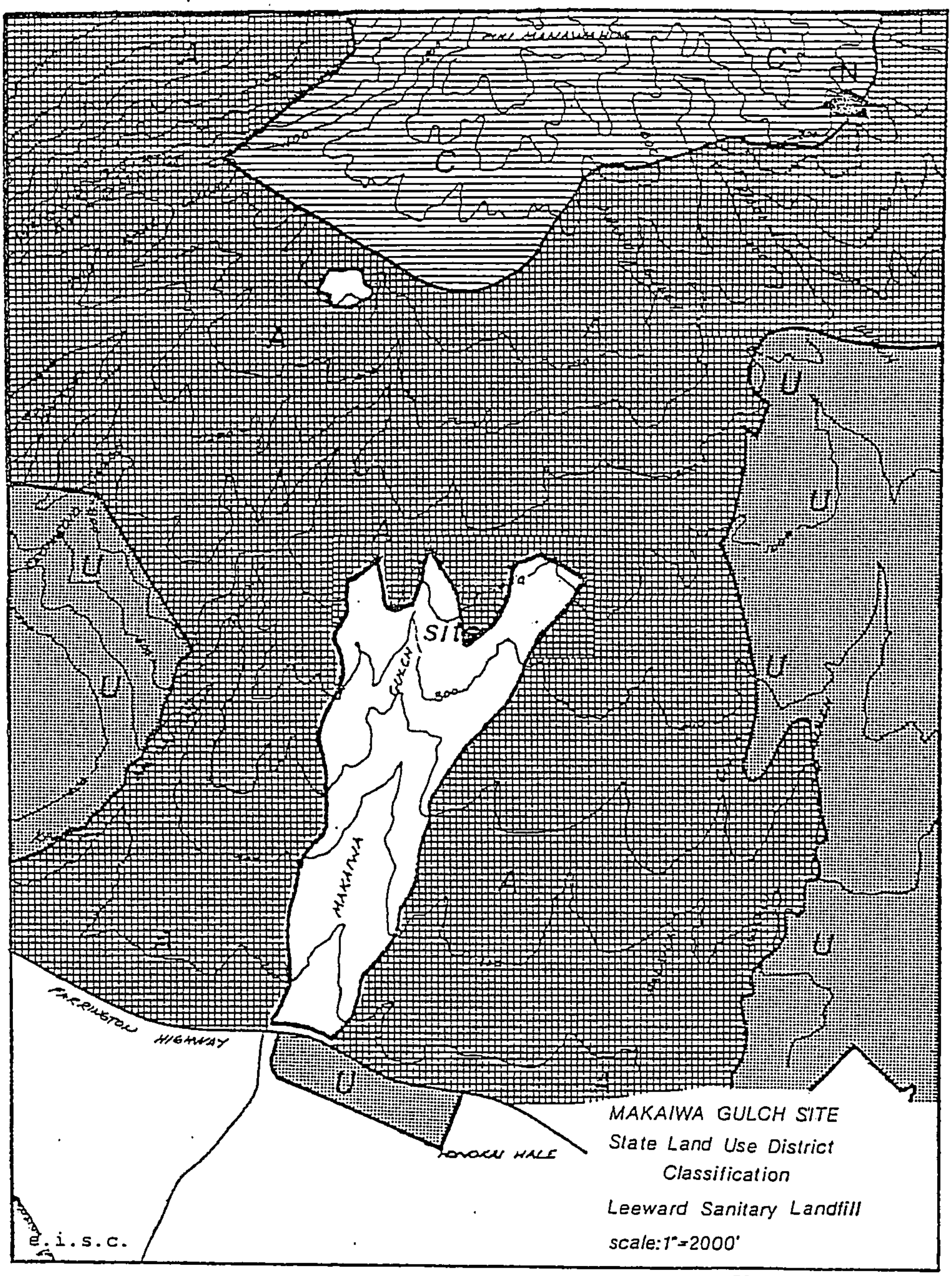
Plate No. IV-D-19



AULOA SITE
Zoning
Windward Sanitary Landfill
scale: 1" = 2000'

Place No. IV-D-20


NORTH
Sc=1:24000
MAKAIWA LANDFILL SITE
MILITARY RESERVATION
AG-I
Water Tank
PALEHUA ROAD
FARRINGTON HIGHWAY
Kahe Point
Honokai Hale
Flume
Pumping Sta
Siphon
Sewage Disposal
Puu Palailai
Makakilo
Gulch
INVENTORY STUDY OF POTENTIAL
SANITARY AND DEMOLITION
LANDFILL SITES
TAX MAP KEY: 9-2-03
MAKAIWA
PLATE NO.: IV-D-21



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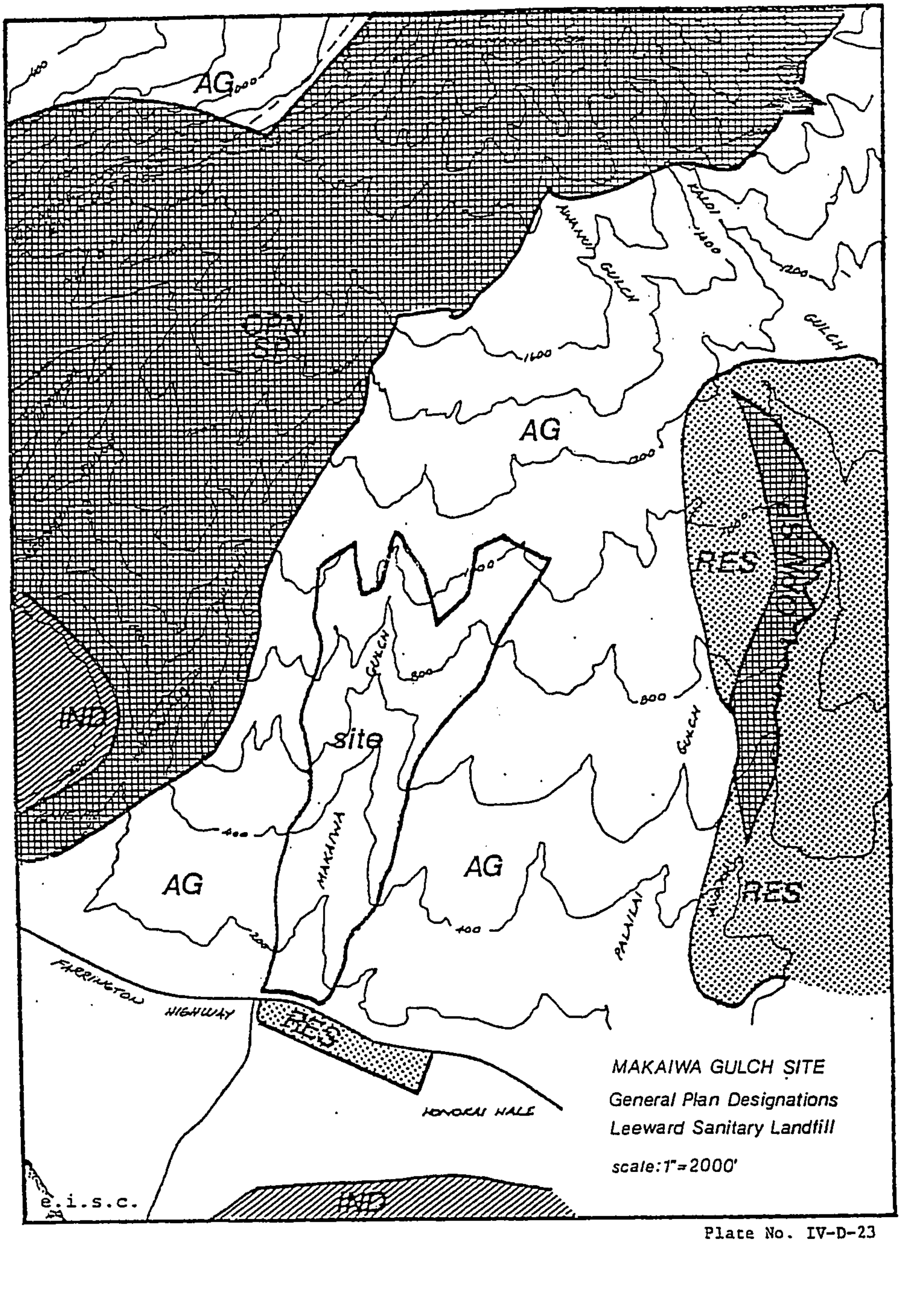

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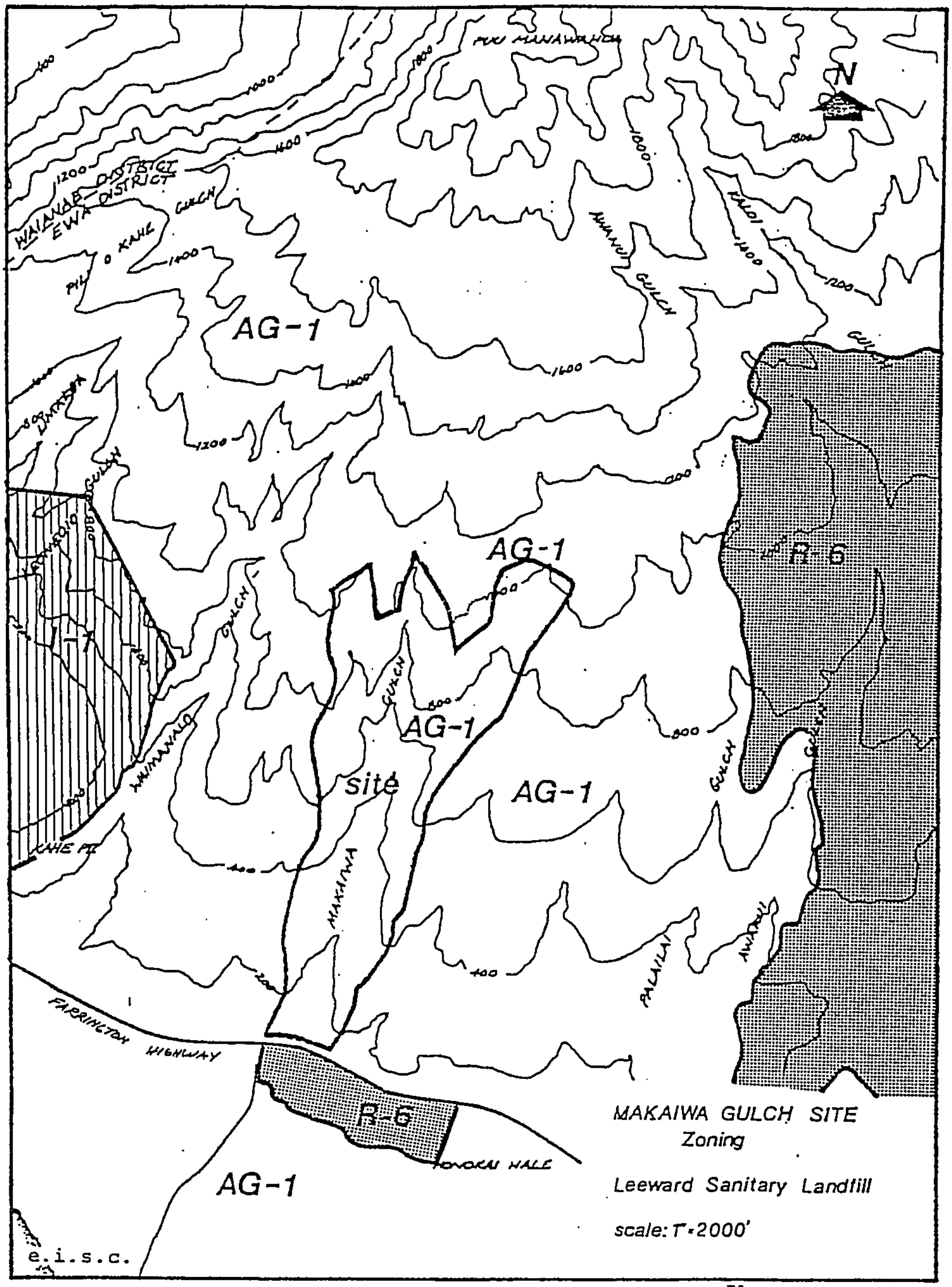
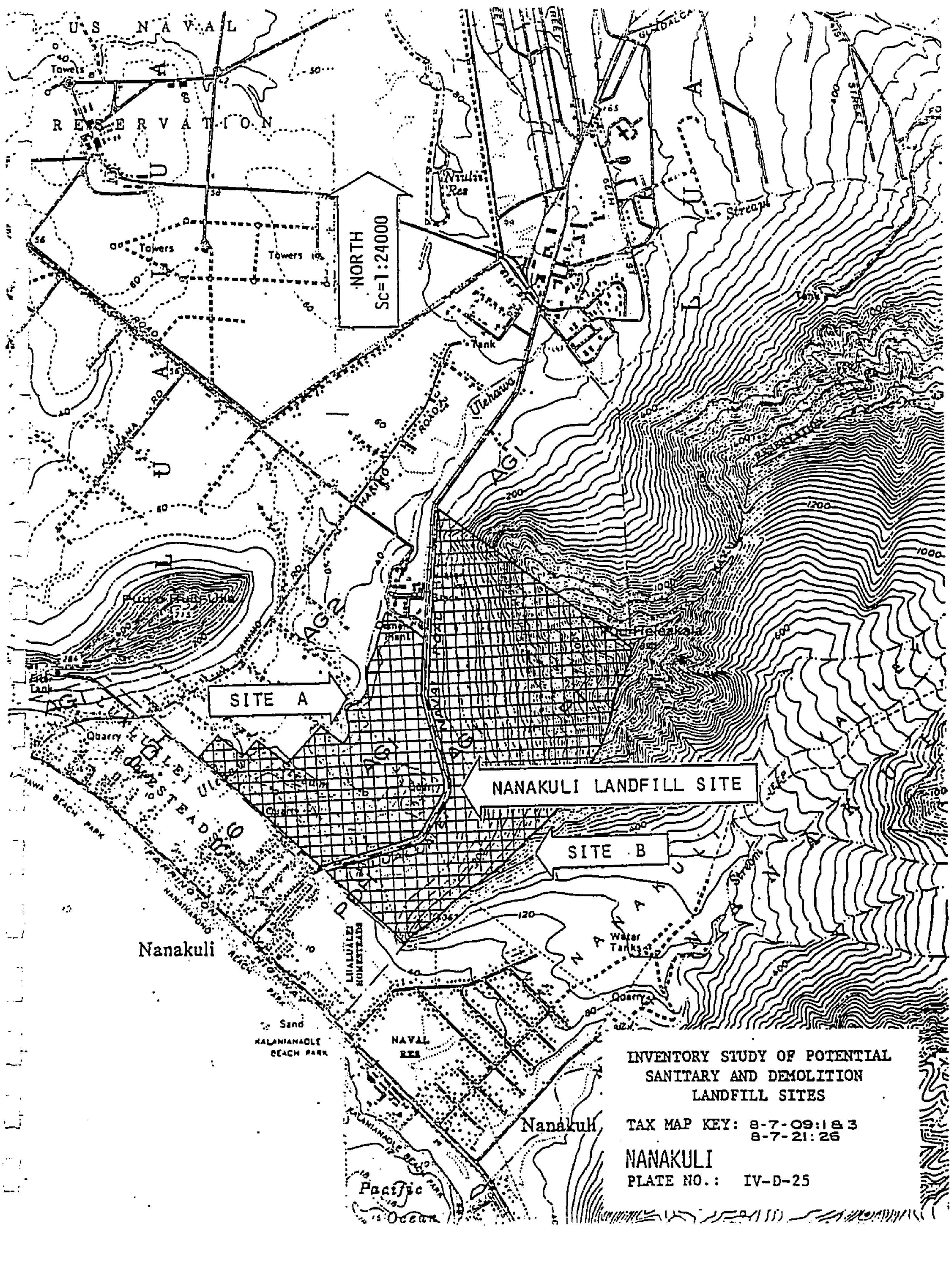
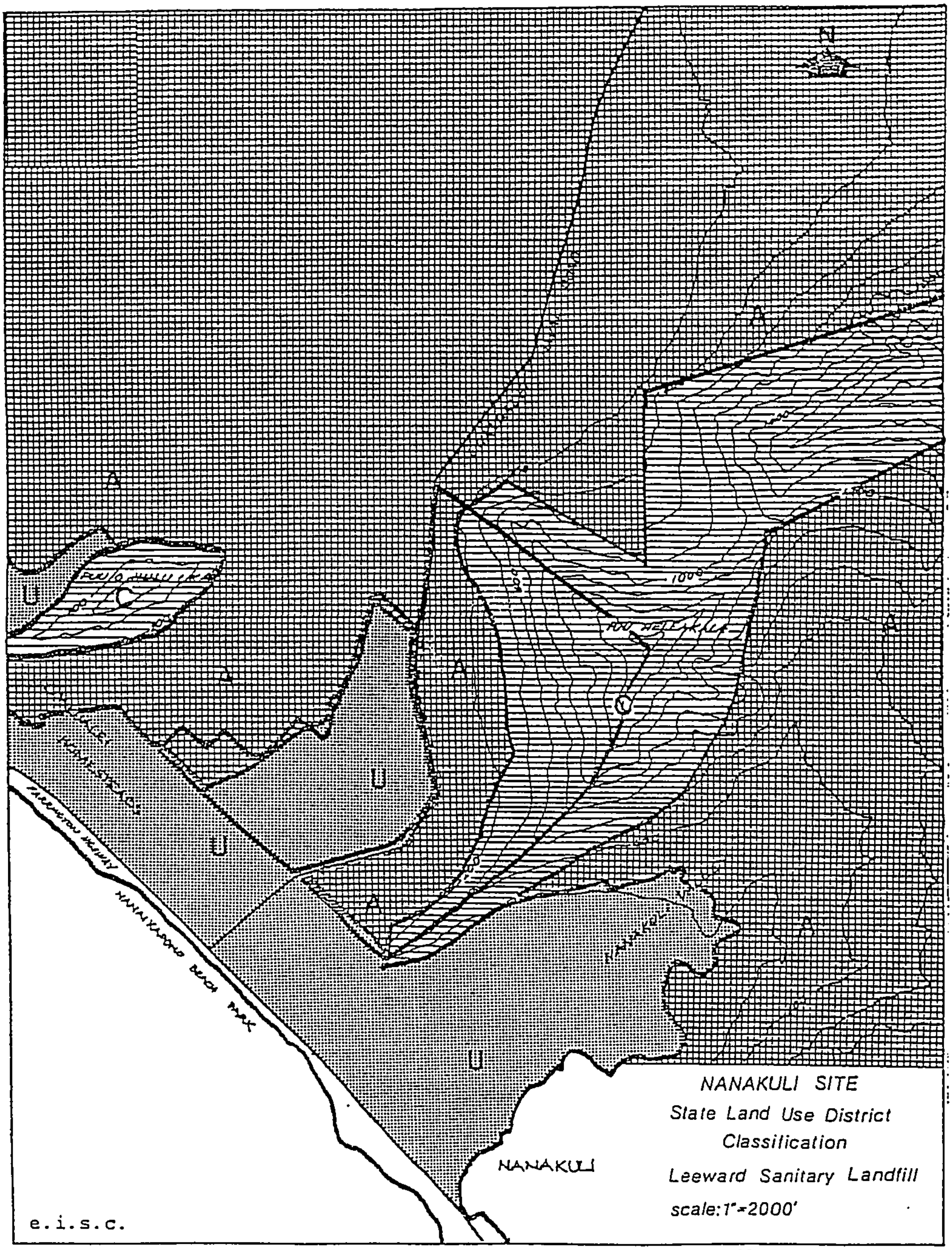


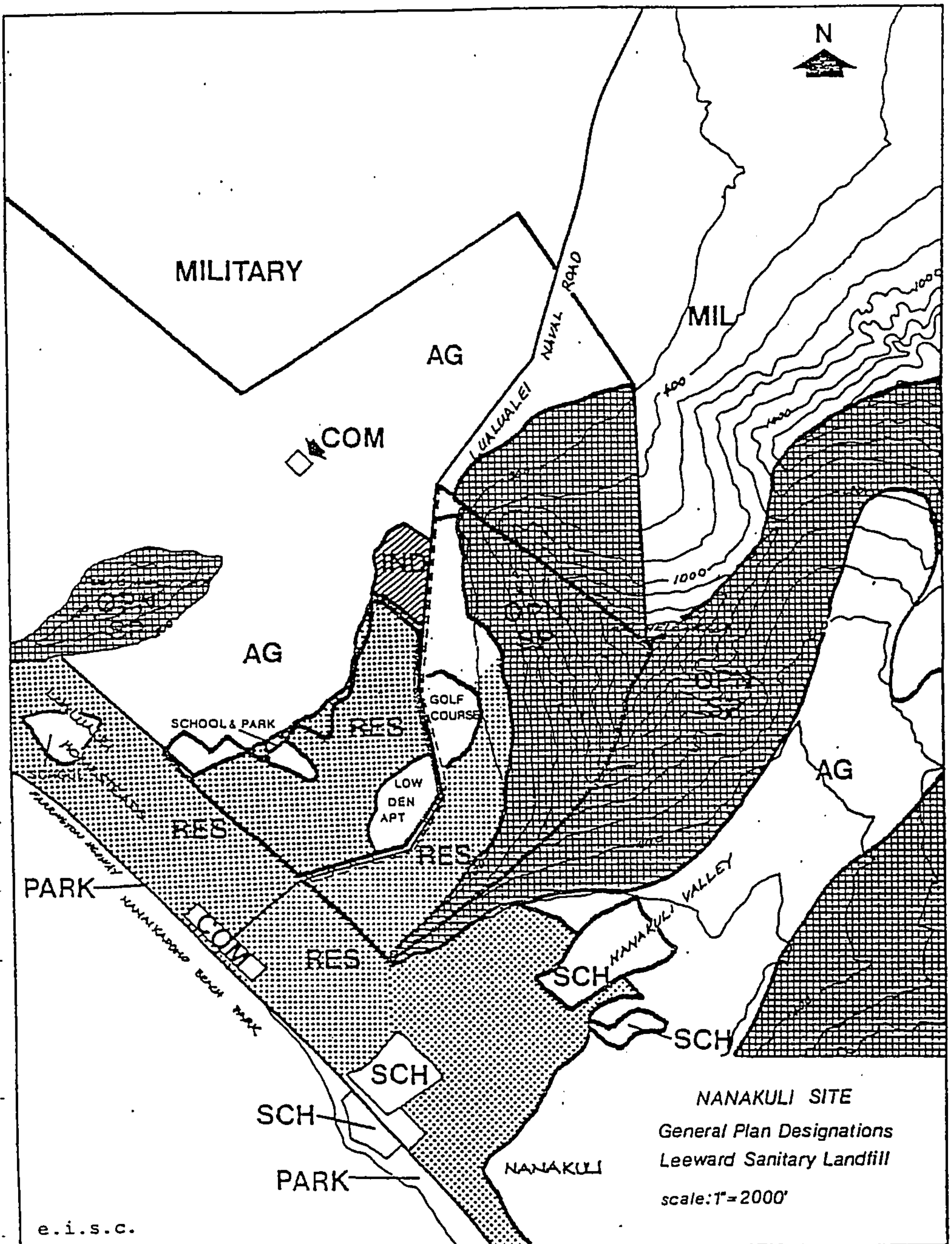
Plate No. IV-D-24



U S NAVAL
RESERVATION
Towers
NORTH
Sc=1:24000
SITE A
NANAKULI LANDFILL SITE
SITE B
Nanakuli
Pacific
Ocean
Water Tanks
Quarry
Sand
KALANIANAOLE BEACH PARK
NAVAL RES
Stream
Tank
INVENTORY STUDY OF POTENTIAL
SANITARY AND DEMOLITION
LANDFILL SITES
TAX MAP KEY: 8-7-09:183
8-7-21:26
NANAKULI
PLATE NO.: IV-D-25



Place No. IV-D-26



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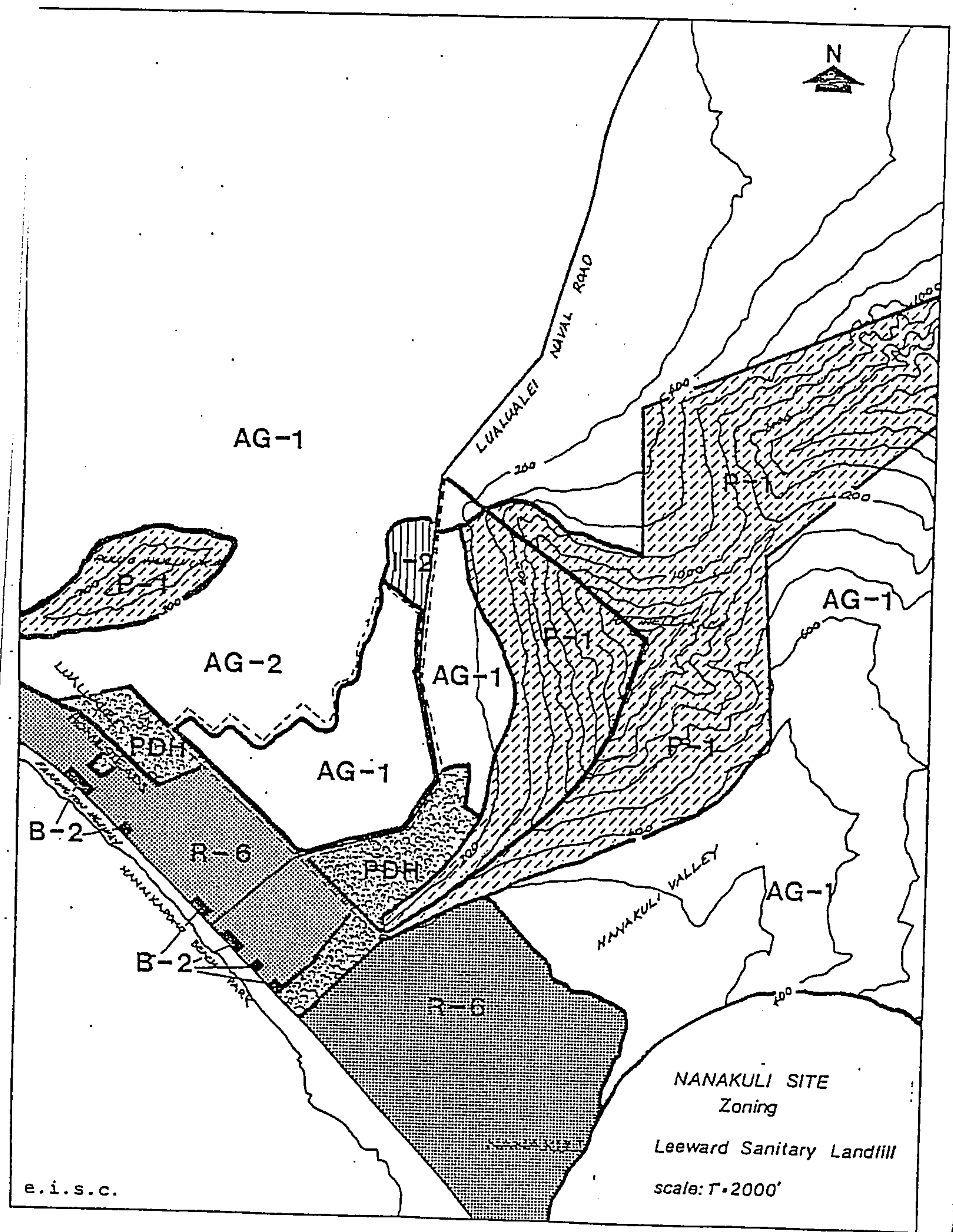

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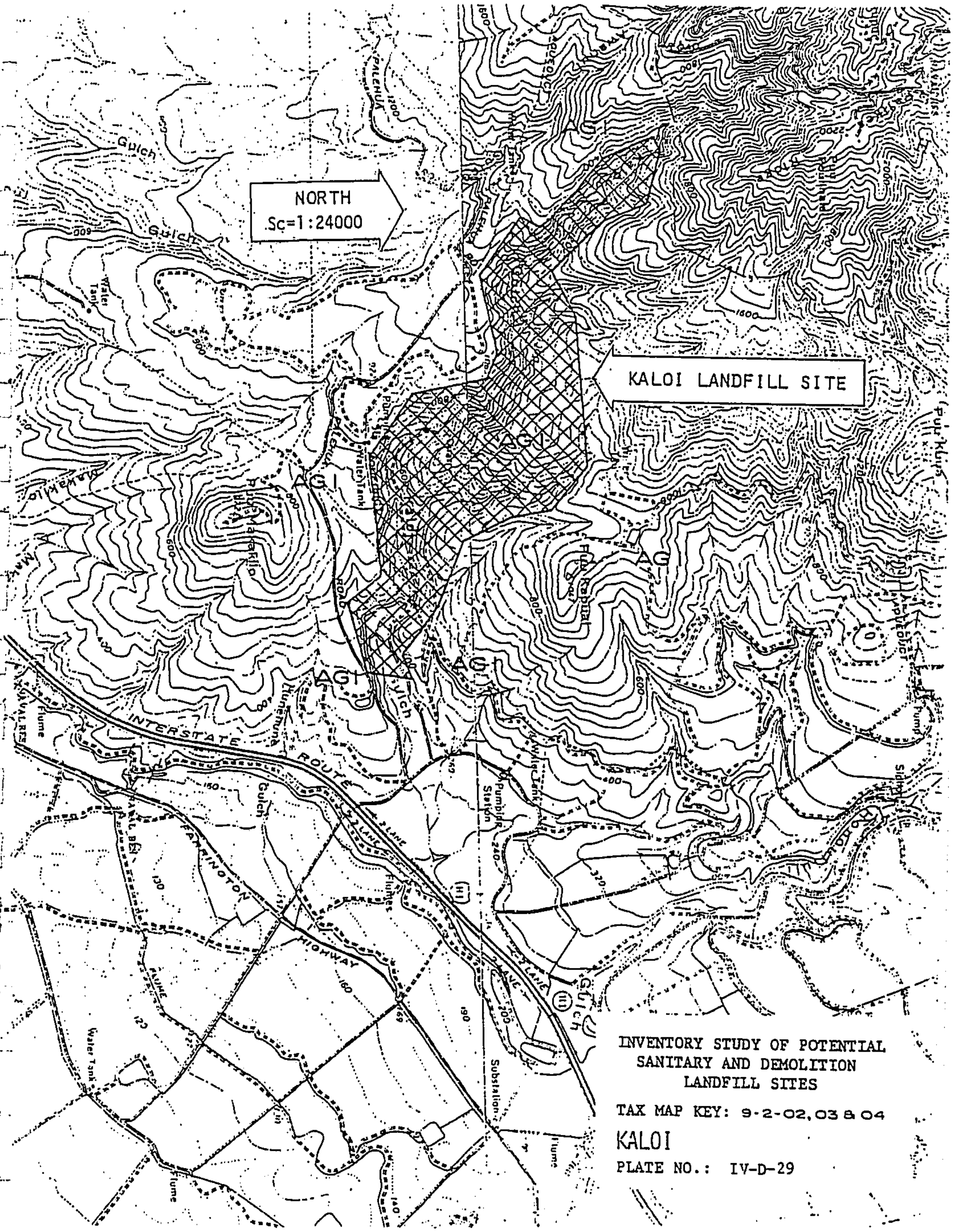
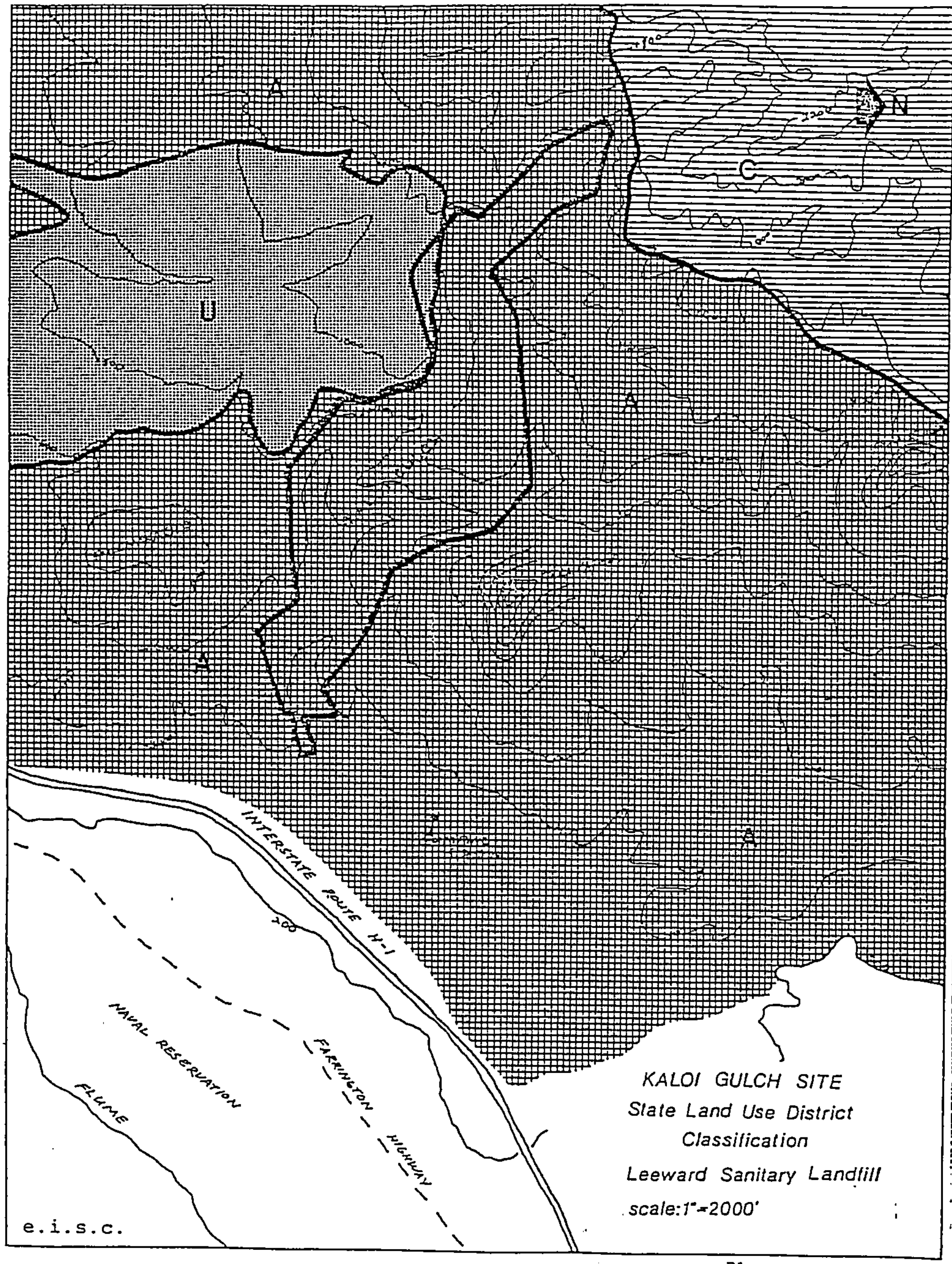


NORTH
Sc=1:24000
KALOI LANDFILL SITE
INTERSTATE ROUTE
HIGHWAY
FARRINGTON
INVENTORY STUDY OF POTENTIAL
SANITARY AND DEMOLITION
LANDFILL SITES
TAX MAP KEY: 9-2-02, 03 & 04
KALOI
PLATE NO.: IV-D-29



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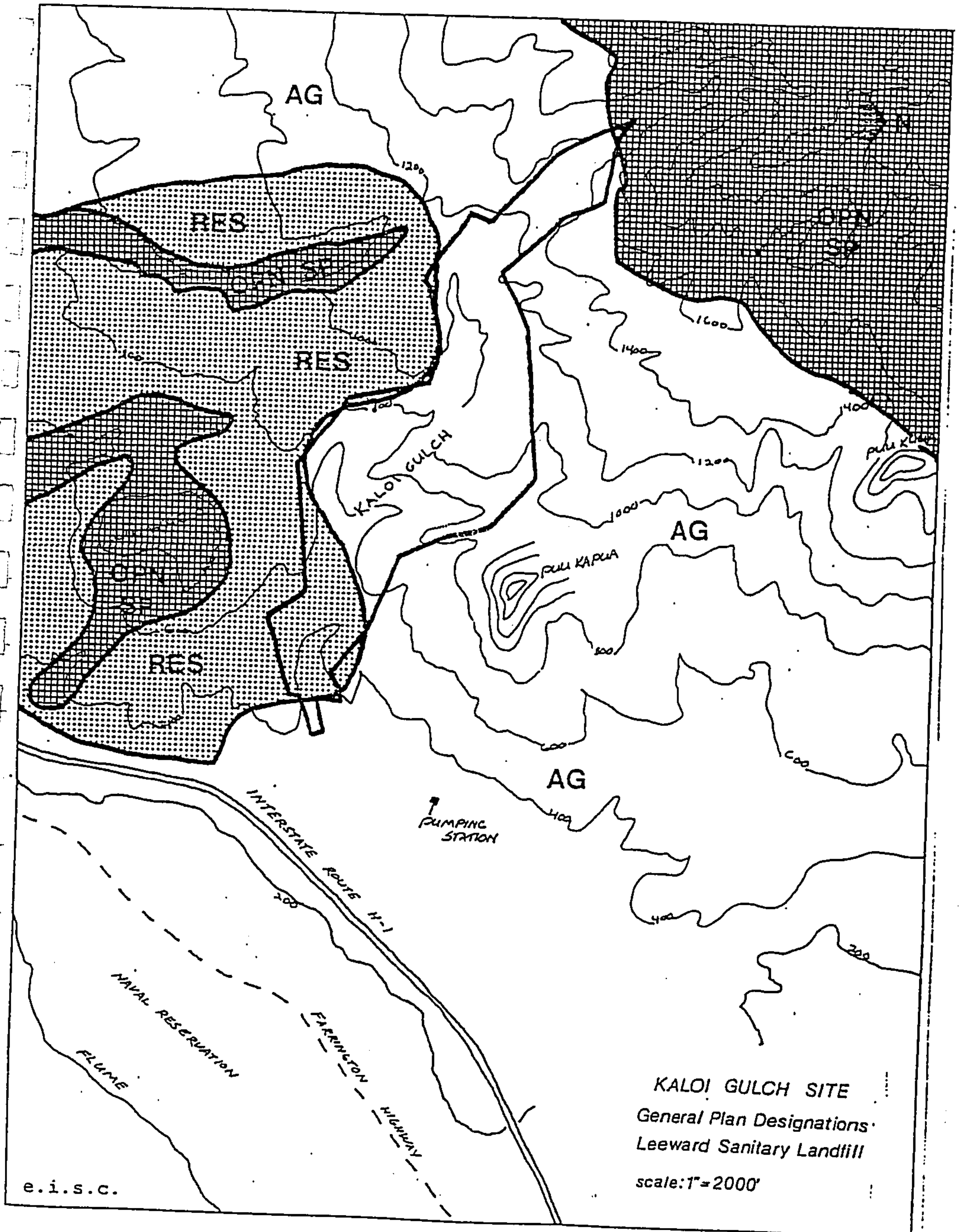


Plate No. IV-D-31

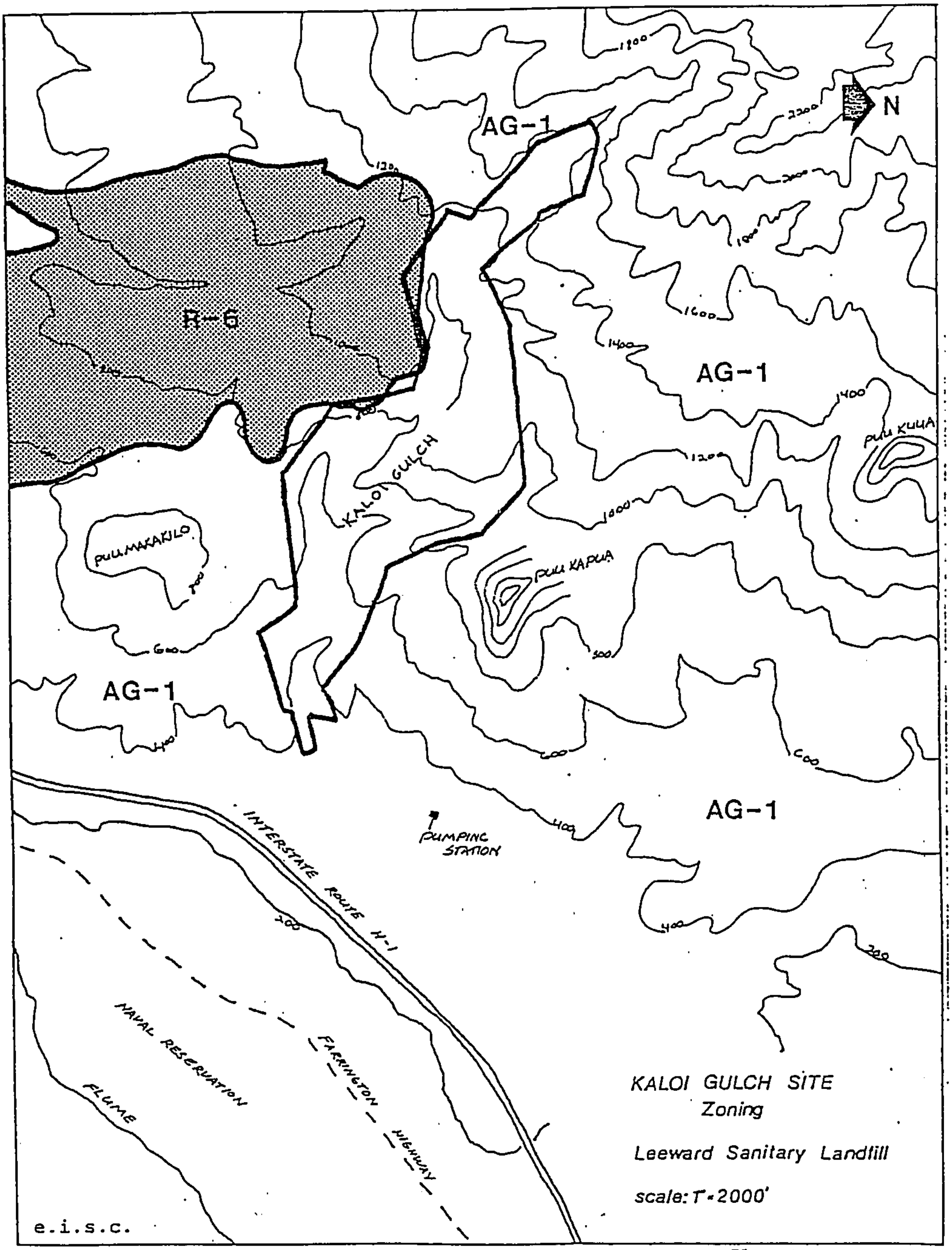
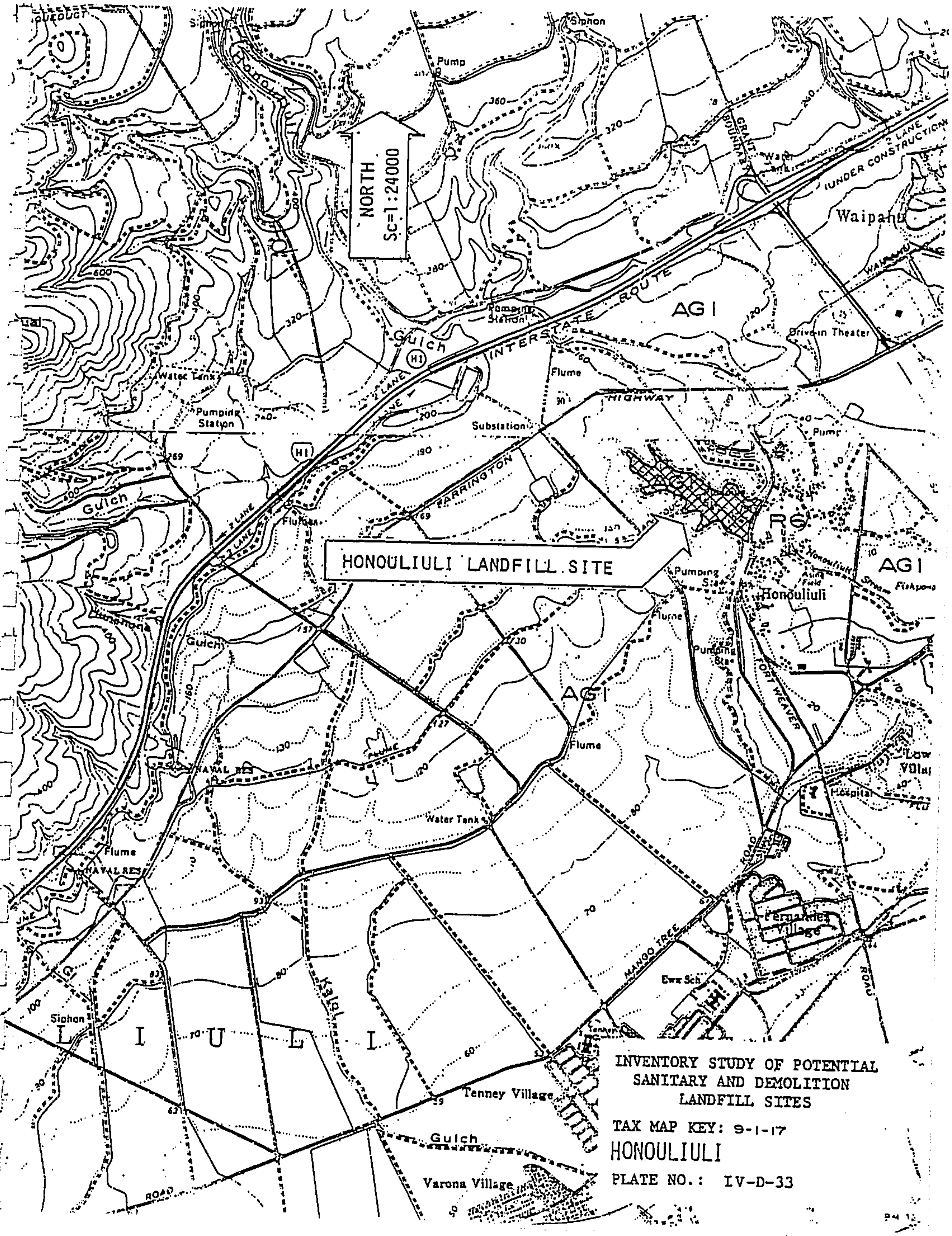


Plate No. IV-D-32



INVENTORY STUDY OF POTENTIAL
SANITARY AND DEMOLITION
LANDFILL SITES

TAX MAP KEY: 9-1-17

HONOULIULI

PLATE NO.: IV-D-33

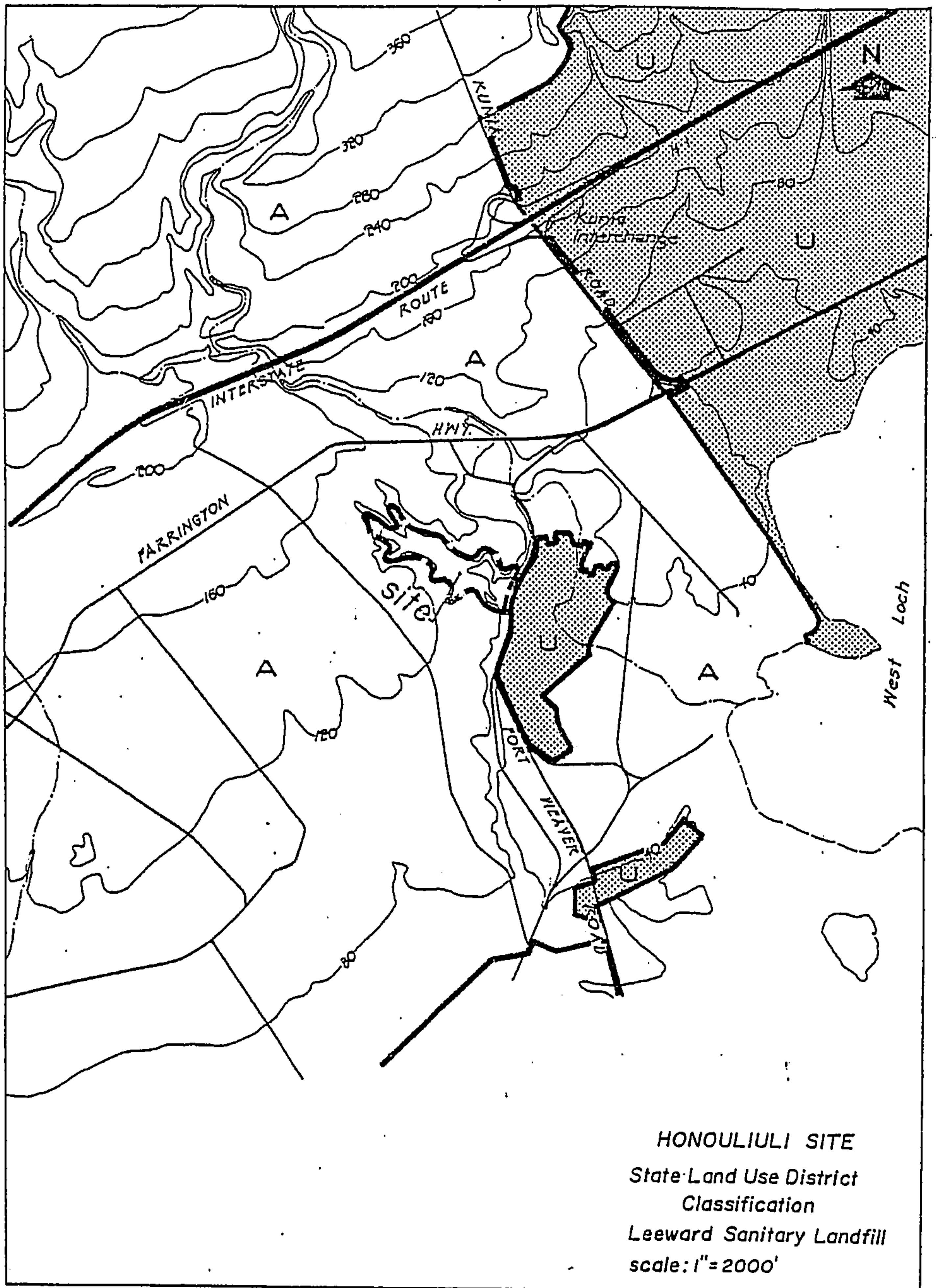


Plate No. IV-D-34

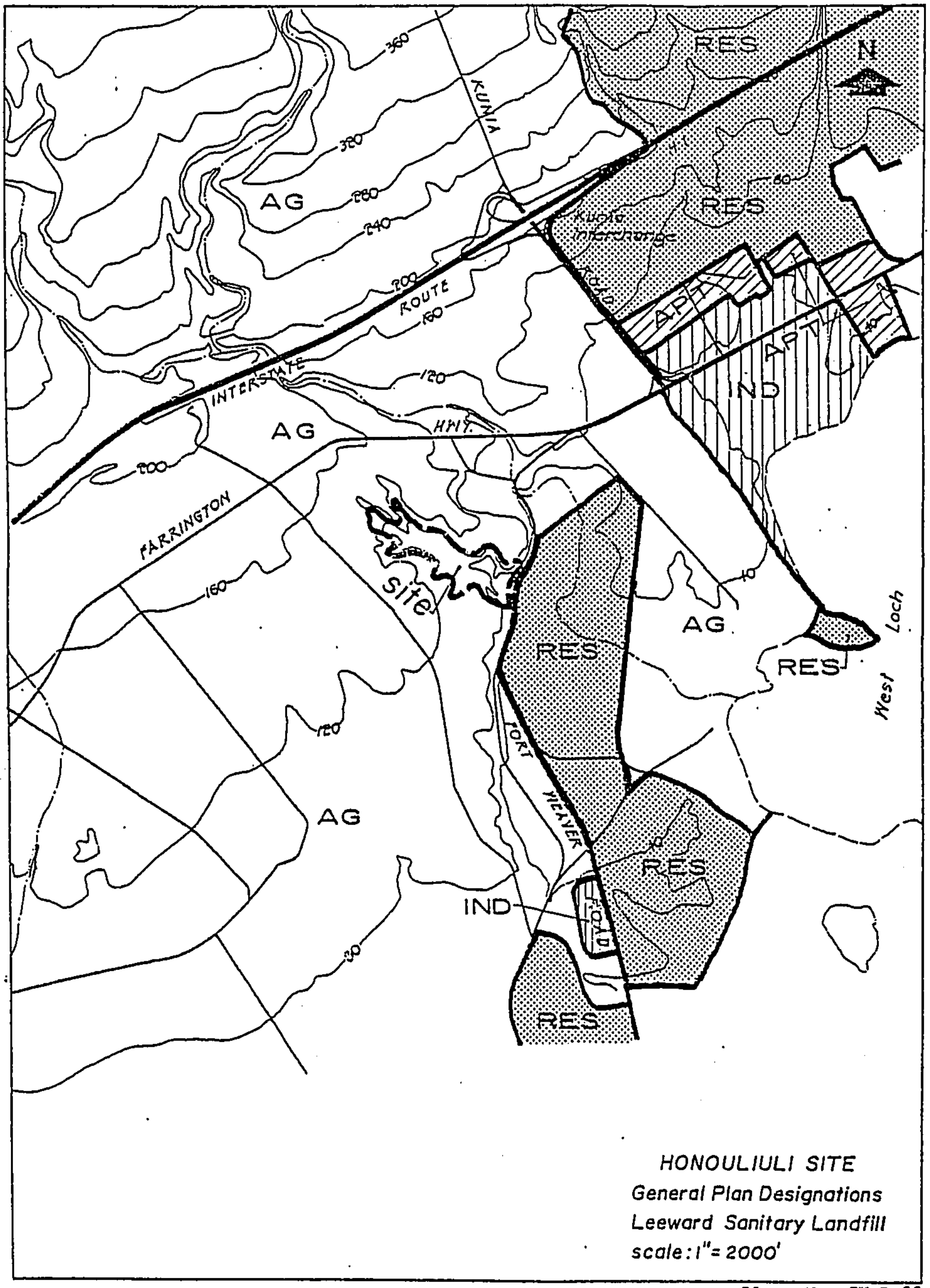


Plate No. IV-D-35

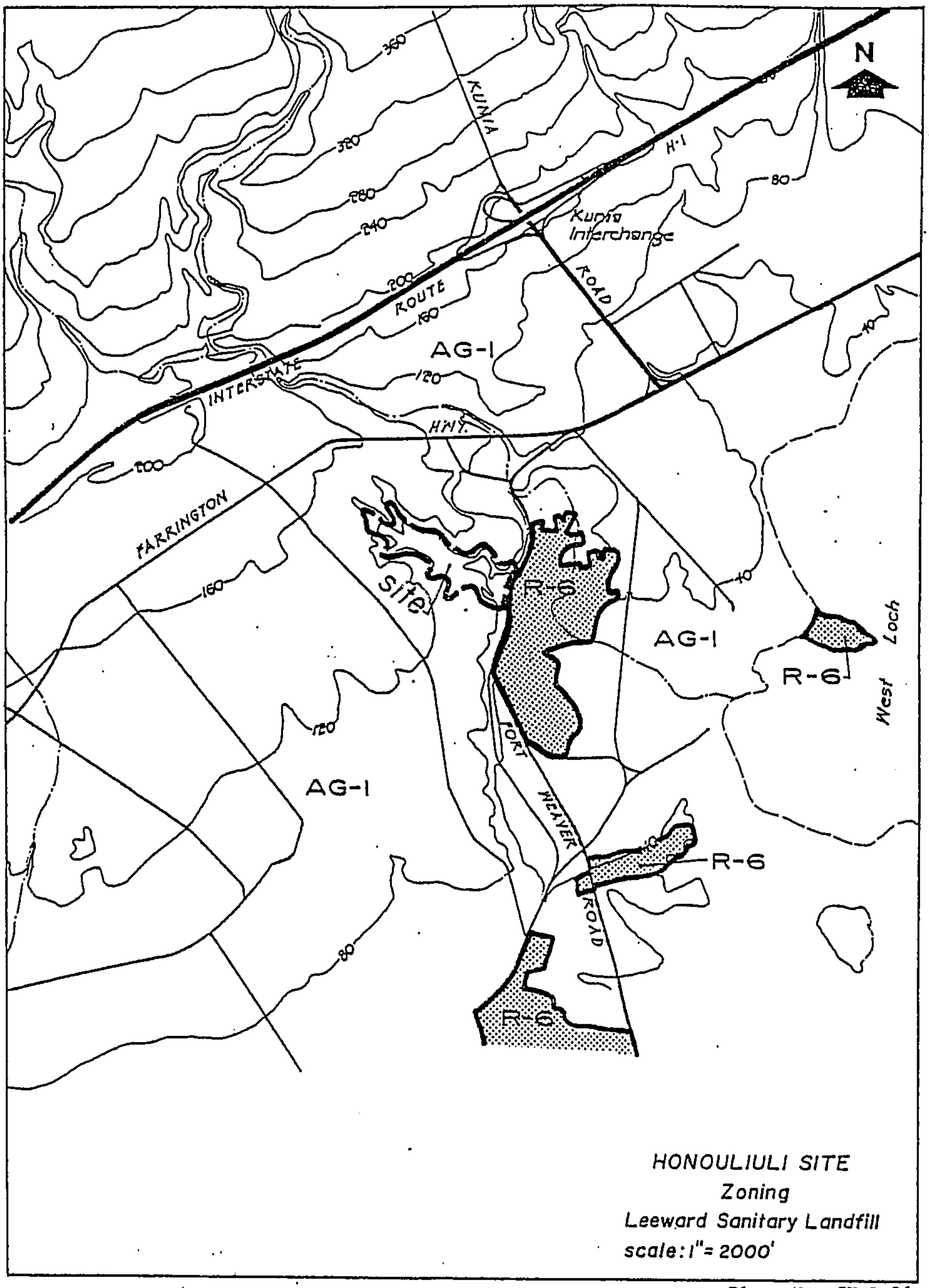


Plate No. IV-D-36

APPENDIX E

SOILS CLASSIFICATION

APPENDIX E

SOILS CLASSIFICATION

(From U. S. Soil Conservation Service)
(Soil Survey of State of Hawaii)
(August 1972)

ALAELOA SERIES

This series consists of well-drained upland soils developed in material weathered from basic igneous rock. Depth to bedrock is greater than 5 feet, permeability is moderately rapid at 2.0 to 6.3 inches per hour and shrink-swell ratio is moderate. Soils are good sources of topsoil and roadfill, and may be sloped as much as 70%. The natural vegetation consists of guava, Java plum, Christmas berry, Japanese tea and hilograss.

a. Alaeloa silty clay, 15% to 35% slopes (AeE), occurs on smooth side slopes and toe slopes in uplands. Runoff is medium and the erosion hazard is moderate. Workability is difficult because of slope. This soil is used for pineapple, pasture, truck crops, orchards, wildlife habitat and homesites. Small areas are used for sugar cane.

b. Alaeloa silty clay, 40% to 70% slopes (ALF), occurs in common slope ranges of 45% to 53%. Runoff is rapid to very rapid and the erosion hazard is severe. This soil is used for pasture and wildlife habitat.

HANALEI SERIES

This series consists of somewhat poorly drained to poorly drained soils on bottom lands of Oahu. These soils developed in alluvium derived from basic igneous rock. They are level to gently sloping. Elevations range from nearly sea level to 300 ft. The annual rainfall amounts to 20-120 in. These soils are used for taro, pasture, sugarcane, and vegetable. The natural vegetation consists of paragrass, sensitiveplant, honohono, Java plum and guava.

a. Hanalei silty clay, 0 to 2 percent slopes (HnA): This soil is on stream bottoms and flood plains. On Oahu there are small areas of very deep, well-drained alluvian soils and small areas of very poorly drained to poorly drained clay soils that are strongly mottled and are underlain by peat, muck, or massive marine clay.

   The soil is strongly acid to very strongly acid in the surface layer and neutral in the subsoil. Permeability is moderate. Runoff is very slow, and the erosion hazard is no more than slight. The available moisture capacity is about 2.1 inches per foot of soil. Roots penetrate to the water table. Flooding is a hazard.

   This soil is used for taro, pasture and sugarcane.

b. Hanalei stony silty clay, 2 to 6 percent slopes (HoB): This soil has a profile like that of Hanalei silty clay 0 to 2 percent slopes, except that it is stony. Runoff is slow, and the erosion hazard is slight. Stones hinder machine cultivation. This soil is used for sugarcane and pasture.

c. Hanalei silty clay, deep water table, 0 to 6 percent slopes (HrB): This soil has a profile like that of Hanalei silty clay, 0 to 2 percent slopes, except that it has fewer mottles and the water table is at a depth of more than 3 feet. There are small areas of stony soils.

This soil is used for sugarcane, taro, pasture and vegetables.

HELEMANO SILTY CLAY, 30% TO 90% SLOPES (HLMG)

This soil consists of well-drained soils on alluvial fans and colluvial slopes on the sides of V-shaped gulches. It developed in alluvium and colluvium derived from basic igneous rock and is steep to extremely steep. Permeability is moderately rapid at 2.0 to 6.3 inches per hour; runoff is medium to very rapid; and the erosion hazard is severe to very severe. Depth to bedrock is greater than 5 feet and shrink-swell ratio is moderate. This soil is a fair source of topsoil and roadfill; may be sloped from 40% to 70%; and is susceptible to sliding.

This soil is used for pasture, woodland and wildlife habitat. The natural vegetation consists of bermudagrass, Christmas berry, eucalyptus, Formosa koa, guava, Japanese tea, Java plum and koa haole.

KAWAIHAPAI SERIES

This series consists of well-drained soils in drainage ways and alluvial fans on the coastal plains formed in alluvium derived from basic igneous rock in humid uplands. They are nearly level to moderately sloping; depth to bedrock is greater than 5 feet; permeability is moderate at 0.63 to 2.0 inches per hour; and shrink-swell ratio is moderate. These soils are good sources of topsoil and roadfill; may be sloped as much as 15%, and have high shear strength. The natural vegetation consists of kiawe, koa haole, lantana and bermudagrass.

a. Kawaihapai clay loam, 0 to 2 percent slopes (KlA): This soil occupies smooth slopes. The natural vegetation consists of guava, honohono, kukui, and hala.

Permeability is moderate. Runoff is slow, and erosion hazard is no more than slight. In some places this soil is subject to flooding.

This soil is used for sugarcane, truck crops, pasture and orchards.

b. Kawaihapai stony clay loam, 2 to 6% slopes (KlaB): Contains enough stones to hinder but not prevent cultivation. Runoff is slow and the erosion hazard is slight. This soil is used for sugarcane, truck crops and pasture.

c. Kawaihapai clay loam, 6 to 15% slopes (KlC): Is slightly difficult to work because of slope. Runoff is slow to medium. Erosion hazard is slight to moderate, and in areas of drainageways, is very stony. This soil is used for sugarcane and pasture.

LOLEKAA SERIES

This series consists of well-drained soils on fans and terraces on the windward side of the island of Oahu. These soils developed in old, gravelly colluvium and alluvium. They are gently sloping to very steep. Elevations range from nearly sea level to 500 ft. The annual rainfall amounts to 70-90 in. and is well distributed throughout the year. The mean annual soil temperature is 71°F. Lolekaa soils are geographically associated with Alaeloa and Waikane soils.

These soils are used for pasture, homesites, orchards, and truck crops. The natural vegetation consists of guava, Christmas berry, californiagrass, hilograss, and ricegrass.

a. Lolekaa Silty Clay, 15 to 25 percent slopes (LoD): This soil occurs on side slopes of terraces and along drainageways. Runoff is medium and the erosion hazard is moderate. Workability is slightly difficult because of the slope.

b. Lolekaa silty clay, 40 to 70 percent slopes (LoF): This soil occurs along drainageways and on fans adjacent to the Koolau Range. Runoff is rapid, and the erosion hazard is severe. It is impractical to cultivate this soil. This soil is used for pasture.

LUALUALEI SERIES

This series consists of well-drained soils on the coastal plain, alluvial fans, and on talus slopes of Oahu, Kauai, Molokai and Lanai. These soils developed in alluvium and colluvium. They are nearly level and gently sloping. Elevations range from 10 to 125 feet.

In most places the annual rainfall amounts to 18-30 inches. Most of the rainfall occurs during storms in the period from November to April. There is a prolonged dry period in summer. The mean annual soil temperature is 75°F.

Lualualei soils are geographically associated with Honouliuli, Jaucas, and Kekaha soils. These soils are used for sugarcane, truck crops, pasture, wildlife habitat, urban development, and military installations.

The natural vegetation consists of kiawe, koa haole, bristly foxtail, uhaloa, and fingergrass.

a. Lualualei clay, 0 to 2 percent slopes (LuA): This soil is on alluvial fans. In a representative profile, the surface layer about 10" thick, is very dark grayish-brown, very sticky and very plastic clay that has prismatic structure. The next layer, 37-42+ inches thick is very similar, but in addition has gypsum crystals. The soils are underlain by coral, gravel, sand or clay at depths below 40 inches. This soil cracks widely upon drying: It is neutral in the surface layer and medium acid to moderately alkaline in the underlying layers.

   Permeability is slow, runoff is slow, and the erosion hazard is no more than slight. The available water capacity is about 1.4 inches per foot of soil. In places roots penetrate to a depth of 5 ft. or more. The shrink-swell potential is high.

   This soil is used for sugarcane, truck crops, pasture, wildlife habitat, urban development, and military installations. The very sticky and very plastic nature of the clay makes cultivation difficult and practical only within a narrow range of moisture content. Because of the high shrink-swell potential, considerable care is necessary when using this soil as a site for buildings or highways.

b. Lualualei stony clay, 2 to 6 percent slopes (LvB): This soil occurs on Oahu adjacent to drainageways. It is similar to Lualualei clay, 0 to 2 percent slopes, except that there are enough stones to hinder machine cultivation. Runoff is slow, and the erosion hazard is slight.

   This soil is used for urban development, military installations, pasture, truck crops, and sugarcane.

c. Lualualei extremely stony clay, 3 to 35 percent slopes (LPE): This soil occurs on talus slopes on Oahu and Kauai. The slope range is 3 to 35 percent, but in most places the soil is moderately sloping to steep. This soil is similar to Lualualei clay, 0 to 2 percent slopes, except that there are many stones on the surface and in the profile. It is impractical to cultivate this soil unless the stones are removed. Runoff is medium to rapid and the erosion hazard is moderate to severe. This soil is used for pasture.

MAHANA BADLAND COMPLEX (MBL)

This soil consists of Mahana soils and Badland. Mahana soils are well-drained uplands soils developed in volcanic ash. They are moderately steep to very steep; runoff is medium to very rapid; and the erosion hazard is moderate to very severe. Depth to bedrock is greater than 5 feet; permeability is moderately rapid at 2.0 to 6.3 inches per hour; and shrink-swell ratio is moderate. This soil is a fair source of topsoil and roadfill, has poor stability, is erodible, may be sloped as much as 35% and is susceptible to siltation.

This complex is used for pasture. The natural vegetation consists of púakeawe, aalii, ricegrass, molassesgrass, silver oak, yellow foxtail, lantana, joee, Japanese tea, passion flower, and associated plants.

MAMALA SERIES

This series consists of shallow, well-drained soils along the coastal plains. These soils formed in alluvium deposited over coral limestone and consolidated calcareous sand. They are nearly level to moderately sloping. Elevations range from nearly sea level to 100 feet on Oahu.

Mamala soils are geographically associates with Ewa, *Honouliuli* and Lualualei soils on Oahu. These soils are used for sugarcane, truck crops, orchards and pasture.

The natural vegetation consists of kiawe, koa haole, bristly foxtail, and swollen fingergrass.

a. Mamala Stony Silty Clay Loam, 2 to 12 percent slopes (MnC): The slope range of this soil is 0 to 12 percent, but in most places, the slope does not exceed 6 percent. Stones, mostly coral rock fragments, are common in the surface layer and in the profile.

   In a representative profile, the surface layer is dark reddish-brown stony silty clay loam about 8 inches thick. The subsoil is dark reddish-brown silty clay loam about 11 inches thick. The soil is underlain by coral limestone and consolidated calcareous sand at depths of 8 to 20 inches. This soil is neutral to mildly alkaline.

   Permeability is moderate. Runoff is very slow to medium, and the erosion hazard is slight to moderate. The available water capacity is about 2.2 inches per foot in the surface layer and 1.9 inches per foot in the subsoil. Roots are affected by the coral limestone and consolidated sand. The stones hinder, but do not prevent cultivation. This soil is used for sugarcane, truck crops, and pasture.

MOLOKAI SILTY CLAY LOAM, 15 to 25% slopes (MuD)

This soil consists of well-drained upland soils formed in material weathered from basic igneous rock. It is nearly level to moderately steep, not exceeding 20%, runoff is medium; the erosion hazard is severe; and workability is slightly difficult because of slope. Depth to bedrock is greater than 5 feet; permeability is moderate at 0.63 to 2.0 inches per hour; and shrink-swell ratio is low.

This soil is a good source of topsoil and roadfill, may be sloped as much as 25%, and is susceptible to siltation.

This soil is used for sugarcane and pineapple. The natural vegetation consists of kiawe, ilima, uhaloa, feather fingergrass and buffelgrass.

PULEHU SERIES

This series consists of well-drained soils on alluvial fans and stream terraces and in basins. These soils developed in alluvium washed from basic igneous rock. They are nearly level to moderately sloping. Elevations range from nearly sea level to 300 ft. The annual rainfall amounts to 10-35 inches.

These soils are used for sugarcane, truck crops, pasture, homesites and wildlife habitat. The natural vegetation consists of bermudagrass, bristly foxtail, fingergrass, kiawe, klu, lantana, koa haole, and sandbur.

a. Pulehu clay loam, 0 to 3 percent slopes (PsA): This soil is on alluvial fans and stream terraces and in basins.

   In a representative profile the surface layer is dark brown clay loam about 21 inches thick. This is underlain by dark-brown, dark grayish-brown, and brown massive and single grain, stratified loam, loamy sand, fine sandy loam, and silt loam about 39 inches thick. Below this is coarse gravelly or sandy alluvium. The soil is neutral in the surface layer and neutral to mildly alkaline below the surface layer.

   Permeability is moderate. Runoff is slow, and the erosion hazard is no more than slight. The available water capacity is about 1.4 inches per foot in the surface layer and subsoil. In places roots penetrate to a depth of 5 ft. or more. Low areas are subject to flooding.

   This soil is used for sugarcane, truck crops, and pasture.

b. Pulehu very stony clay loam, 0 to 12 percent slopes (PvC): This soil is similar to Pulehu clay loam, 0 to 3 percent slopes, except that as much as 3 percent of the surface is covered with stones. Runoff is slow to medium and the erosion hazard is slight to moderate. Workability is difficult because of the stones. This soil is used for pasture and wildlife habitat.

ROCK LAND (fRK)

These series occur in gulches and mountain sides; is made up of areas where exposed rock covers 25% to 90% of the surface and has very shallow soil material. The rock outcrops are mainly basalt and andesite; land type is nearly level to very steep; and soil material are sometimes very sticky, very plastic, with high shrink-swell potential. Soils on steep slopes are susceptible to sliding when soil is saturated and to cracking when soil is dried.

Rock land is used for pasture, wildlife habitat and water supply. The natural vegetation at the lower level consists of kiawe, kiu, piligrass, Japanese tea and koa haole. Lantana, guava, Natal redtop and molassesgrass are dominant at the higher elevations.

STONY STEEP LAND (rSY) consists of a mass of boulders and stones deposited by water and gravity on side slopes of drainageways. The slope ranges from 40-70 percent. Elevations range from 100 to 1500 ft. The annual rainfall amounts to 20-80 inches.

Stones and boulders cover 50-90 percent of the surface. There is a small amount of soil among the stones that provide a foothold for plants. Rock outcrops occur in many places.

This land typs is used for wildlife habitat and recreation. The natural vegetation consists of kiawe, koa haole, and grasses.

WAIALUA SERIES

This series consists of moderately well drained soils on alluvial fans on Oahu. These soils developed in alluvium weathered from basic igneous rock. They are nearly level to steep. Elevations range from 10 to 100 ft. The annual rainfall amounts to 25-50 inches; most of it occurs between November and April. These soils are used for sugarcane, truck crops, orchards and pasture. The natural vegetation is swollen fingergrass, koa haole and uhaloa.

a. Waialua silty clay, 0 to 3 percent slopes (WkA): This soil is on smooth coastal plains. In a representative profile the surface layer is dark reddish-brown silty clay about 12 inches thick. The subsoil, about 26 inches thick, is dark reddish-brown and reddish-brown silty clay that has sub-angular blocky structure. The sub-stratum is dark reddish-brown, mottled silty clay. The soil is neutral in the surface layer and slightly acid in the subsoil.

Permeability is moderate. Runoff is slow, and the erosion hazard is no more than slight. The available water capacity is about 1.8 inches per foot in the surface layer and 1.6 inches per foot in the subsoil. In places roots penetrate to a depth of 5 feet or more.

This soil is used for sugarcane, truck crops and pasture.

b. Waialua silty clay, 3 to 8 percent slopes (WkB): On this soil runoff is slow and the erosion hazard is slight. This soil is used for sugarcane, truck crops and pasture.

WAIKANE SERIES

This series consists of well-drained soils on alluvial fans and terraces on the island of Oahu. These soils developed in alluvium and colluvium derived from basic igneous rock. They are nearly level to very steep.

These soils are used for pasture, truck crops, and homesites. The natural vegetation consists of Christmas berry, guava, hilograss, and ricegrass.

a. Waikane silty clay, 25 to 40 percent slope (WpE): This soil is on steep terraces and alluvial fans. Permeability is moderately rapid. Runoff is medium to rapid, and the erosion hazard is moderate to severe. The available water capacity is about 1.1 inches per foot in the surface layer and 1.3 inches per foot in the subsoil. In places roots penetrate to a depth of 5 feet or more. This soil is used for pasture.

b. Waikane silty clay, 3 to 8 percent slopes (WpB): On this soil, runoff is slow and the erosion hazard is slight. Workability is easy. This soil is used for truck crops, pasture and homesites.

c. Waikane silty clay, 40 to 70 percent slopes (WpF): On this soil, runoff is rapid to very rapid and the erosion hazard is severe. This soil is used for pasture and woodland.

APPENDIX F

BOARD OF WATER SUPPLY DATA

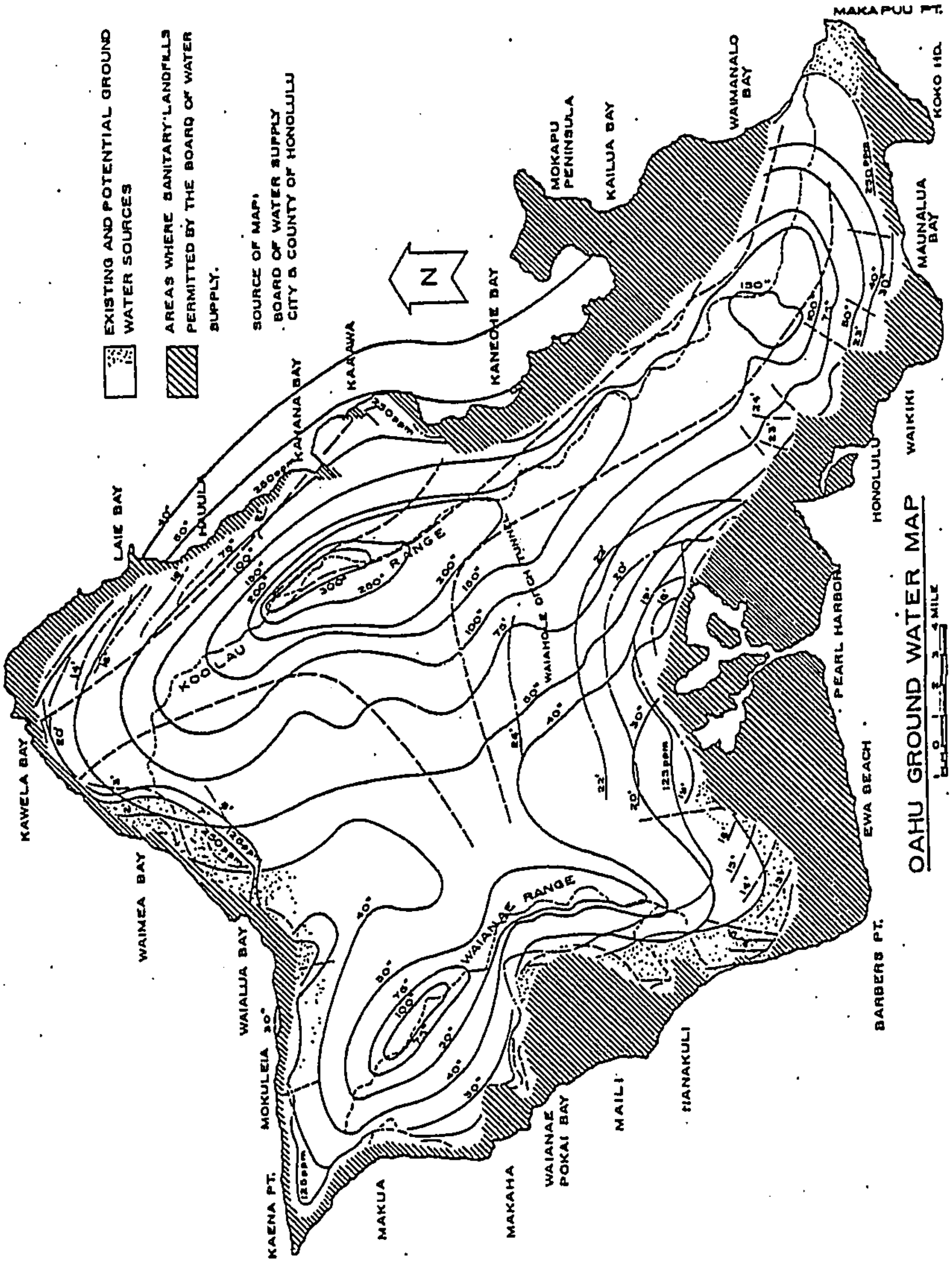


Plate No. IV-F-1

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU
630 SOUTH BERETANIA
HONOLULU, HAWAII 96813

September 24, 1976

Mr. Harold I. Yoshizaki
Vice President
Stanley S. Shimabukuro &
Associates, Inc.
1126 12th Avenue
Honolulu, Hawaii 96816

Dear Mr. Yoshizaki:

SUBJECT: Your Letter Dated September 14, 1976
Regarding Sanitary Landfill Study

We have reviewed the potential landfill sites submitted to us and find the following sites acceptable for use as either a sanitary or demolition landfill:

1. Heeia
2. Kapaa - Existing
3. Kapaa #1
4. Kapaa #2
5. Kapaa #3
6. Kapaa #4
7. Kalaheo
8. Auloa
9. Olomana
10. Bellows
11. Waimanalo North
12. Kawailoa - Existing
13. Keekee
14. Waianae - Existing
15. Maili
16. Nanakuli
17. Makaiwa
18. Honouliuli
19. Waipahu
20. Waipio
21. Koko Crater

Also, the following sites may be used only as demolition landfills provided that disposed materials be limited to only construction debris free of any toxic substances and that the operating control measures receive our approval:

1. Punaluu
2. Kaaawa
3. Waikane
4. Waiahole
5. Waihee
6. Kahaluu
7. Poamoho
8. Kaukonohua
9. Mililani
10. Kaloi

However, the above mentioned sites may be considered for use as sanitary landfills provided the following conditions are met:

1. A documented study or guarantee indicating that generated leachate will not pollute potable groundwater resources.

2. Monitoring of landfill to assure leachate is confined.

3. Monitoring of groundwater quality to assure non-degradation of the underlying groundwater aquifer.

4. Liability of source replacement in the event of contamination is agreed upon.

These conditions are needed to protect our valuable and virtually irreplaceable potable groundwater resources from any potential contamination.

Portions of the following three sites may be used as sanitary landfills without being restricted to the preceding conditions:

1. Waimanalo South
2. Makua
3. Ohikilolo

Before any commitment is made regarding the boundaries of the acceptable portions, a larger scale map delineating the boundaries of each site must be submitted for review and approval. Also, the entire portion of these three sites may be used as demolition landfill subject to the previously noted conditions.

Please call Mr. Lawrence Whang at 548-5221 if further information is needed.

Very truly yours,

Edward Y. Hirata

EDWARD Y. HIRATA
Manager and Chief Engineer

APPENDIX G

ENVIRONMENTAL IMPACT STATEMENT PREPARATION NOTICES AND ASSESSMENT

CITY AND COUNTY OF HONOLULU

DEPARTMENT OF PUBLIC WORKS

DIVISION OF REFUSE

ENVIRONMENTAL IMPACT STATEMENT PREPARATION NOTICE

FOR

KAPAA SANITARY LANDFILL EXPANSION

KAILUA, KOOLAUPOKO, OAHU, HAWAII

TMK: 4-2-14, 4-2-15

Submitted Pursuant to Chapter 343, HRS

Responsible Official: [signature]
KAZU HAYASHIDA
Director and Chief Engineer

Date: Nov. 1, 1976

Accepting Authority: ______________________
Department of General Planning
for
Mayor, City and County of Honolulu

ENVIRONMENTAL IMPACT STATEMENT PREPARATION NOTICE
KAPAA SANITARY LANDFILL EXPANSION
KAILUA, KOOLAUPOKO, OAHU, HAWAII
TAX MAP KEY: 4-2-15 : Portions of 1, 3, 4, and 7
4-2-14 : Portions of 2

PROPOSING AGENCY: CITY AND COUNTY OF HONOLULU
DEPARTMENT OF PUBLIC WORKS
DIVISION OF REFUSE

ACCEPTING AUTHORITY: DEPARTMENT OF GENERAL PLANNING (for)
MAYOR, CITY AND COUNTY OF HONOLULU

I. DESCRIPTION OF THE PROPOSED PROJECT

A. Background

The basic document for solid waste management on Oahu is the City and County of Honolulu's Solid Waste Management Plan (SWMP). The plan, which was prepared in 1970 and is continuously being refined and updated, recommended a waste management system based on sanitary landfill disposal. Sanitary landfills would be the primary disposal sites until a resource recovery or waste utilization system is initiated for the island of Oahu. Present estimates indicate that an island-wide resource recovery system will not be in operation until 1981, at the earliest. At that time, landfills will still be required for the disposal of all non-recoverable materials, which will amount to 15-25 percent of all waste.

Currently, solid waste from municipal and commercial refuse collection is either incinerated at the Kewalo, Kapalama, and Waipahu Incinerators and the ash then disposed of in landfills, or refuse is directly landfilled at sites located at Kapaa, Kawailoa, Palailai, and Waianae. The Kapaa Landfill has been serving the Koolauloa and Koolaupoko Solid Waste Districts, and portions of the Honolulu District. The Kawailoa Landfill has been serving the Waialua District, the Waianae Landfill, the Waianae District and the Palailai Landfill has been the disposal site for privately-collected materials.

Solid waste disposal in the windward and leeward districts of Oahu is becoming a critical problem due to growing solid waste loads and an increasing inability of disposal facilities to accommodate solid waste loads. The solid waste disposal problem has been accelerated by the fact that 1) the Kewalo and Kapalama Incinerators have been operating without effective air pollution controls to maintain ambient air quality standards and must be closed in 1977 to comply with an Environmental Protection Agency order, and 2) all existing sanitary landfill sites are nearly full. The Kapaa landfill is estimated to have less than one and one half years of capacity left, while the Waianae and Kawailoa Landfills are estimated to have less than five years of landfill life left. New disposal sites must therefore be found and used for waste disposal.

In order to meet the solid waste disposal problem, and in accordance with the SWMP, the City and County of

Honolulu proposes to establish major landfills on the windward and leeward sides of the island. The windward sanitary landfill will fulfill all of the solid waste disposal requirements of the windward districts and part of the Honolulu District. In 1980, the windward areas are expected to generate 221 tons of refuse per day (TPD), exclusive of military and agricultural wastes.

A recent consultant's report evaluating potential landfill disposal sites indicates that an expansion of the existing Kapaa Sanitary Landfill is the most desirable alternative for the windward area until such time when a new major windward landfill site is established. The City and County of Honolulu proposes to develop, therefore, extensions to the existing landfill, labeled parcels 1, 2, and 3, as shown in Plates 1 and 2.

B. Technical Characteristics

The three parcels for the proposed expansion to the Kapaa Sanitary Landfill contain approximately 125 acres, and are located in an existing landfill and quarry operation area. All are currently vacant. The City and County of Honolulu will lease parcel 1 from its owner the Harold K. Castle Trust. Parcels 2 and 3 will be leased from the following owners: Michael C. Baldwin Trust, John C. Baldwin Trust, James C. Castle, Jr. Trust, and James C. McIntosh Trust.

Landfill Capacity

The total area of parcel 1 is 60 acres, of which 40 acres will be used as a landfill. The capacity of this site is approximately 3,028,000 cubic yards. Parcels 2 and 3 have a total area of 74 acres, of which 42 acres will be used for landfilling. The capacity of the two sites is approximately 2,380,700 cubic yards.

Based on an average daily disposal rate of 1,000 cubic yards of unprocessed wastes,* and a total capacity of 5,408,700 cubic yards, it is anticipated that the project sites would have a projected cumulative life of approximately 11 years. At lesser rates of disposal, landfill life will be proportionately longer. Landfilling activities can be extended beyond the projected 11 years if resource recovery programs are implemented in the future, or if refuse shredding is initiated. If the proposed Kapaa Refuse Processing and Transfer Station is constructed, processed waste will be disposed of in the landfill. The useful life of the landfill(s) could be extended by approximately 30 percent with the initiation of refuse shredding. The landfill expansion, therefore, will serve as the primary disposal area for the Windward districts, and as a disposal facility for non-processable waste and residue when a resource recovery program is implemented.

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*Estimated theoretical disposal rate.

Landfill Operations

The three parcels will be cleared, grubbed, and graded beginning with parcels 2 and 3. Landfilling operations will employ the trench or area methods or a combination of these techniques. Initially, disposed refuse will consist of unprocessed wastes, which will be compacted and covered daily with a minimum 6-inch layer of cover material. The cover material is required by Chapter 46, Public Health Regulationa of the State Department of Health to prevent possible vector, odor, fire, and litter problems. When waste is processed prior to disposal, cover material may not be required and shredded refuse can be used as cover material for any unprocessed refuse. The final cover for the completed landfill will be a 2 foot soil mantle which will be graded and seeded to grass to permit the site to return to its natural state.

Refuse cells will contain all wastes and perforated vent pipes will be inserted into the cells to disperse gases generated by decomposing refuse. The gases, primarily, methane, have been the cause of fires and explosions at landfills when not properly vented and dispersed into the atmosphere.

Site Improvements

Minimal site improvements are planned for parcels 2 and 3. Water, power, and telephone service are available from the existing Kapaa Corporation Yard. An access road, and operations and maintenance facilities will not be required due to the proximity of the Kapaa Yard.

Parcel 1 will require infrastructure improvements. Access will be provided by the construction of 24-foot wide asphaltic concrete roadway from Kapaa Quarry Road to the site. Water, power, and telephone services are available but must be extended to the site from Kapaa Quarry Road. An administration and maintenance facility may also be constructed. Cesspools will be installed to accommodate sewage. Lined interceptor ditches will divert surface runoff away from the landfill into Kawainui Swamp.

When each parcel is filled to capacity, the parcel will be covered with topsoil, seeded, and landscaped to blend harmoniously with the surrounding area.

C. Project Phasing

The three parcels will be developed incrementally, beginning with parcels 2 and 3. Parcel 1 will be developed as the other two sites reach their capacity.

II. DESCRIPTION OF THE AFFECTED ENVIRONMENT

REGIONAL SETTING

A. Climate

Fair weather predominates throughout the year on the windward side of the Island of Oahu. The weather is subtropical and mild with a mean annual temperature of 75°F. Average rainfall for the area is 40 inches per year. Winds occur 70 percent of the time from the northeast with velocities ranging from 8 to 20 miles per hour. The average wind velocity is 10.5 miles per hour.

B. Geology

According to MacDonald and Kyselka (MacDonald, 1967), Oahu was formed during the mid-Tertiary period by volcanic activity. Two volcanoes, the Waianae in the western part of the island and the Koolau to the eastern part provided the material for the land mass. The Koolau Range is the eroded remnant of the volcano which extends northwestward for 35 miles and serves as the western boundary of the Koolaupoko District.

There are a series of relatively narrow, alluvial coastal plains which lie at the foot of the mountain. A large number of valleys have been carved out of the coastal plains during times of lowered sea level which occurred during the Pleistocine epoch. During the time of higher sea level, coral reefs flourished around the island and built a thick platform that now underlies the coastal plain sediments.

Kawainui Swamp is believed to be the main vent of the Koolau volcano (Stearns, 1935). The Ulumawao Ridge and the ridge north of the swamp consist of coarse breccia. Stearns believes that these rocks are throat breccia built up chiefly as talus within a crater or caldera. The two ridges separating the Kailua-Maunawili area to the northwest from Kaneohe and southeast from Waimanalo are composed of rocks from the Koolau and Kailua Volcanoes Series. Throughout the valley are scattered remnant from the lava flows of the Honolulu Volcanic Series.

C. Land Use

The area to be served by the Kapaa Landfill Expansion consists primarily of the medium density urban areas of Kailua, and Kaneohe, in addition to the smaller residential communities of Waimanalo, Kahuluu, and Hauula. There are no large concentrations of commercial, industrial, or resort zoning in the subject service area.

D. Population

The 1975 population for the Koolaupoko and Koolauloa Solid Waste Districts was estimated at 115,440. Population for this service area is projected to increase to 151,500 by the year 2000. This projection is based on the October 6, 1976 draft of the General Plan for Oahu, which was based on the E-2 Population Projection

Series developed by DPED. Although unofficial and not yet approved, the General Plan draft figures are considered reasonable estimates of population growth that may be anticipated in the service area.

E. Solid Waste Quantities

Solid waste loads for the windward service area are anticipated to increase in direct proportion to population increases. By 1985, the service area is anticipated to generate approximately 272 TPD of refuse, increasing to 323 TPD by 1990, and to 388 TPD by 1995.

F. Solid Waste Collection and Disposal System

Collection

Most of the solid waste in the windward service area is collected by the City and County of Honolulu which collects approximately 74 percent of all refuse generated within the service area. Private refuse collectors collect most of the remaining 26 percent. Generally, all wastes generated by the military and agricultural activities are collected and disposed of by those operations.

Municipal collection is provided on a 6-day per week basis, allowing for a twice-a-week pickup from each residence. Refuse is collected by 3-man crews in 20 cubic yard compactor trucks. Residential refuse having a density of approximately 150 pounds per cubic yard is compacted within the collection truck to a density of approximately 500 pounds per cubic yard. Each truck carries approximately 4.0 to 5.0 tons of refuse per trip and makes approximately two to three trips per day. Compactor trucks are stationed at the Kapaa base yard located off Kapaa Quarry Road, makai of the Kapaa Sanitary Landfill, and begin their routes as early as 6:00 a.m., and complete their daily collection at approximately 12:00 p.m.

Disposal

Solid waste collected within the service area is disposed of at the Kapaa Sanitary Landfill located in the Kapaa Quarry area. All municipal and private collection trucks are weighed at the Kapaa Base Yard before proceeding to the landfill site. Private commercial haulers are assessed a fee by the City based on the tonnage load.

The Kapaa landfill is open to the general public and a large number of leeward and windward residents use this site for disposal. No disposal fee is charged and public use accounts for the majority of weekend traffic. The hours of operation at the landfill are from 7:00 a.m. to 5:30 p.m. except Sundays when the hours are 8:30 a.m. to 4:30 p.m., respectively. The Department of Public Works Division of Refuse's current estimates show that the Kapaa disposal site will be filled to capacity in less than one and one-half years.

Expansion of the existing refuse disposal site and development of other new disposal sites tq service the windward area will meet refuse needs until resource recovery or waste utilization programs can be implemented.

PROJECT SITE

A. Location

The proposed landfill parcels 1, 2, and 3 are located near the Kapaa Quarry, in Kailua, Koolaupoko, Oahu. Parcel 1 is located west of the Kapaa Quarry Road and Kawainui Swamp and east of Ulumawao Peak. Parcel 1 is approximately 500 yards southeast of the existing Kapaa Landfill site and comprises approximately 60 acres. Parcels 2 and 3 are located west of the Quarry Road and Kawainui Swamp and northeast of Ulumawao Peak and comprise a total area of approximately 74 acres.

B. Topography

Parcel 1 consists of a moderately steep hillside depression on the eastern slopes of Ulumawao Peak. Three defined gullies are located in the depression which begins at elevation 70' at the lower eastern end mauka of the Kapaa Quarry Road and rises westward to elevation 500 feet over a distance of 2,000 feet. The site is approximately 1,200 feet wide at its widest point.

The mauka-makai slope of the site varies from 4 percent at the lower end to 60 percent at the upper end with an average slope of 20 percent. The transverse slope of the depression varies from 0 percent to 5 percent near its gullies and from 30 percent to 70 percent at its upper reaches. The depth of the depression from the top of the ridges to the gullies varies from 50' near the lower end to over 300' at the upper end.

Parcel 2 is a moderately steep hillside ridge on the northern slopes of Ulumawao Peak adjacent and south of Interstate Route H-3. The ridge begins at elevation 120' and rises to elevation 415' over a distance of 1700'.

Parcel 3 and the original Kapaa Landfill, when completed, will form a moderately steep depression on the northern slopes of Ulumawao Peak. One gully is located in the depression which begins at elevation 35' at the lower eastern end mauka of the Kapaa Corporation Yard and rises westward to elevation 270' over a distance of 1400'. The site is approximately 1200' wide at its widest point.

The mauka-makai slope of the site varies from 10 percent to 15 percent at the lower end to 25 percent to 30 percent at the upper end with an average slope of about 18 percent. The transverse slope of the depression varies from 5 percent near the gully to over 50% at its upper reaches. The depth of the depression from the top of the adjacent ridges and the existing Kapaa Landfill site varies from 150 feet near the lower end to over 200 feet at the upper.

C. Soils

According to the U. S. Soil Conservation Service Survey, soils for parcel 1 generally consist of the following:

> Rock land occurs in the upper reaches; Halemano silty clay, 30% to 90% slopes, and Alaeloa silty clay, 40% to 70% slopes, occuring along the upper sides of a major portion of the depression; Kawaihapai clay loam, 6% to 15% slopes, occur in the gullies of a major portion of the depression and Alaeloa silty clay, 15% to 35% slopes, and Kawaihapai stony clay loam, 2% to 6% slopes, occur in the lower end of the depression.

Parcels 2 and 3 consist of the above soils, except for Kawaihapai stony clay loam, which does not occur on these sites.

D. Land Use

Parcel 1 is zoned Preservation and Residential (R-6), general planned Agriculture, and designated Conservation by the State Land Use Commission. The site is currently in open space use and not utilized for any activity. Adjacent land uses and designations are identical to those of the site, except that land east of the site is general planned Preservation and designated as an Urban

State Land Use District, and land west of the site is general planned Preservation.

Parcels 2 and 3 are zoned Preservation, and portions are general planned Industrial, Public Facilities, Agriculture and Residential. The sites are designated as Urban and Conservation by the State Land Use Commission. Adjacent land uses are zoned and designated as the sites above. Parcels 2 and 3 are currently in open space use.

Future land uses of the area may be subject to change, although most of the area will remain in open space use. Proposals have been made regarding the recreational use of the Kawainui Swamp area as a regional park.

E. Flora and Fauna

The biota of the Kapaa parcels are composed of plant and animal species found elsewhere on Oahu and throughout the State. Few native species occur and those that do are relatively common. An inventory of existing flora and fauna will be included in the project's EIS.

F. Archaeology

There are no known sites of historical significance located on the three proposed landfill expansion sites. However, Historic Site No. 359, the Pahukini Heiau, is immediately adjacent to parcels 2 and 3 and is located within the existing Kapaa landfill site.

G. Hydrology

There are no groundwater supplies at the proposed landfill sites.

H. Infrastructure

Access

Parcel 1 is accessible from the Kapaa Quarry Road. Parcels 2 and 3 are accessible from the adjacent Kapaa Corporation Yard.

Water

Water is available through a 36-inch transmission line that parallels the Kapaa Quarry Road.

Power

Overhead pcwer lines are available from the Hawaiian Electric Company transformer station, which presently provides power to the Kapaa Base Yard.

Telephone

Overhead telephone lines presently serve the Kapaa Base Yard and are available to accommodate the needs of the proposed project.

Sewer

The Kapaa Base Yard and the HC&D Quarry are serviced by cesspools. There are no connections to the municipal sewer system from these facilities or the project sites.

Drainage

Storm runoff from the 60 acres of parcel 1 is conveyed by three defined gullies which converge into one and connects to an existing 54-inch drain pipe across the Kapaa Quarry Road. Storm runoff from the 44 acres of parcel 2 flows over land by sheet flow; runoff from the 30 acres of parcel 3 and the future completed Kapaa Landfill depression is conveyed by one defined gully into and across the Kapaa Corporation Yard site.

III. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATIVE MEASURES THAT MAY BE TAKEN TO MINIMIZE ADVERSE IMPACTS

A. Noise

Noise will be generated by the operation of general construction equipment during site development activities and by vehicular traffic necessary to construction activities. General construction noise should not present a significant problem in the area, since the surrounding areas are vacant.

Noise levels will increase during the operation of the proposed project, but are not anticipated to be a problem, as surrounding areas are expected to remain vacant or in agricultural use.

B. Air Quality

Ambient air quality will be affected by dust and exhaust emissions generated during site preparation activities which is anticipated to last 6 months. Dust and emissions may be a short-term nuisance but will be mitigated by appropriate measures. Dust levels will be controlled by water-wagons and/or other water sprinkling systems as required. Roadways near the project site will be periodically sprinkled to contain and control vehicular dust generation.

Combustion emissions from construction vehicles and equipment are not anticipated to cause a significant problem. Control measures will be taken to minimize the discharges and will include, but not be limited to, the proper maintenance and operation of equipment to promote maximum efficiency and minimum discharge.

Air quality may be altered by the generation of dust during landfilling activities and the escape of gases from refuse decomposition within the landfill. Dust levels can be minimized by water sprinkling as required. Methane gas, a by-product of organic material decomposition within the landfill, is a potentially explosive gas if allowed to accumulate in pockets within the landfill. Methane hazard will be reduced through the proper venting system vents in the landfill that allows methane to escape into the open atmosphere and be diluted and dispersed by prevailing winds.

C. Land Alteration

Site development activities will alter the landform and remove existing vegetation. Preliminary engineering plans will determine the extent of site excavation and fill activites, which will be discussed in the project's EIS.

D. Flora and Fauna

During site development and project implementation, site vegetation will be removed and it is anticipated that site wildlife will relocate to other areas. The site will be developed by sections and will be landscaped as each section is completed. Large trees removed from the site will be relocated along the periphery of the site to provide a screen for site activities.

Operation of the proposed project is not anticipated to significantly affect wildlife of surrounding areas. Traffic and noise impacts on wildlife will be further discussed in the project's EIS.

E. Water Quality

The water quality of Kawainui Swamp is not anticipated to be altered as previous landfill operations within the swamp, makai of the Kapaa Quarry Road, have not significantly altered the water quality of the swamp. This information is based on previous studies conducted for the City and County of Honolulu. As proposed landfilling activities will occur at a greater distance from the swamp, mauka of the Kapaa Quarry Road, effects on water quality will be even less.

F. Vectors

Rodents and insects may be attracted to the landfill if proper sanitary landfilling procedures are not followed. With the provision of daily soil cover upon compacted unprocessed waste within the landfill, rodents and flies will not be attracted, and are not anticipated to be a problem. Shredded refuse, if left uncovered, is not anticipated to attract vectors. Rodents are not attracted to nor can they survive on a diet of shredded refuse. Studies on flies have indicated that (1) shredding kills nearly 100 percent of maggots present in incoming refuse; (2) the necessary conditions for freshly shredded refuse to support the fly reproduction cycle are rarely obtained in a landfill; (3) after shredded refuse is aged several months, the ability to support the fly cycle is destroyed; (4) flies are not more attracted to uncovered shredded refuse than covered non-shredded refuse (Solid Waste Sanitary Landfill - Predesign Report, Cowlitz County, Washington, 1973).

G. Litter

Litter will be generated in the area where refuse is deposited by collector and transfer trailer trucks. Litter is not expected to be a problem as all refuse will be compacted and covered with a 6-inch soil mantle at the end of each working day.

Portable fences will be used to contain blowing litter, if needed.

H. Odor

Odor will be generated in varying levels according to refuse composition, and the length of time it remains uncovered. The daily application of cover material on compacted refuse and/or the use of chemical masking agents should mask decomposing waste odors. Odor is not anticipated to affect surrounding areas which are vacant.

I. Fire

Fires are a potential hazard if proper sanitary landfilling procedures are not followed. Potential fires can be prevented by construction of vented refuse cells and daily application of 6 inches of suitable cover material over the compacted refuse.

J. Drainage

Studies on the possible impacts resulting from alteration of existing drainage patterns are being conducted.

K. Visual

The proposed landfill site will be visible to motorists along the Kapaa Quarry Road and the adjacent Interstate Route H-3. Parcel 1 will be particularly visible from distances beyond Kapaa Quarry Road. Landscaping will be provided to minimize adverse visual effects as much as possible before, during and after landfill operations.

L. Traffic

The proposed project will not affect existing traffic patterns on Kapaa Quarry Road, as the project sites are located close to or adjacent to the existing Kapaa Landfill.

M. Archaeological - Historical Significance

Precautions will be taken to protect Historic Site 359 from any damage from landfilling activities. A buffer zone will be established around all sides of the site, which will be clearly marked. The State Historic Preservation officer will be contacted to approve or recommend further proposals regarding safeguards to protect the site.

IV. ALTERNATIVES TO THE PROPOSED ACTION

A. No Action

If the proposed project is not implemented, refuse disposal for the windward area will be severely impacted as refuse disposal in the windward area will not be possible. Refuse collection trucks will be required to travel to a leeward disposal site, resulting in greater expenditures, transport, and labor costs and time.

B. Alternative Sites

In addition to the Kapaa sites, several alternative sites in the windward area were investigated for their landfill potential. As shown in Figures 3 to 6, these include sites in Heeia, Waimanalo, Kalaheo, and Auloa. These sites were evaluated according to the following site selection criteria: a) refuse hauling distance, b) landfill capacity, c) availability of site utilities, infrastructure, and access, d) availability of cover material, e) compatability of existing and proposed land uses of the site and surrounding areas,

f) displacement of families or businesses, g) site acquisition, development and operation costs, h) environmental compatibility of site in terms of climatology, geology, drainage, and hydrology, i) social and cultural compatibility of site in terms of surrounding land uses, affect on sites of archaeological or historical significance, and visual intrusion, and j) acceptability by landowner, adjacent landowners, and the community. A more detailed discussion of alternative sites will be presented in the project's EIS.

C. Alternative Disposal/Processing

Disposal of refuse occurs either on land or at sea. Ocean disposal of solid waste is currently prohibited by the U. S. Environmental Protection Agency.

Waste disposal on land can be facilitated by alternative processing methods which can reduce waste volume and weight and prolong the use of landfill disposal sites. Alternative processing methods include 1) shredding, 2) incineration, 3) baling, and 4) composting. However, these processes do not account for the total disposal of solid waste; a landfill is therefore required to dispose of all waste that cannot be processed or to dispose of residues resulting from processing. The City and County is studying the feasibility of shredding and the implementation of an island-wide resource recovery plant that will focus on the recovery of energy and materials from solid waste.

V. DETERMINATION AND FINDING AND REASONS SUPPORTING DETERMINATION

In accordance with Chapter 343, Hawaii Revised Statutes, this agency has determined that an Environmental Impact Statement for the proposed Kapaa Sanitary Landfill Expansion is required.

The proposed project may generate impacts affecting ambient air quality, landform, drainage channels, noise levels, vegetation, and wildlife. Operation of the landfill may also generate visual impacts. In addition, the project will be developed using County funds.

VI. PUBLIC AGENCIES CONSULTED DURING THE ASSESSMENT

State

Department of Land and Natural Resources

City and County of Honolulu

Board of Water Supply
Department of Land Utilization

VII. AGENCIES TO BE CONSULTED IN THE PREPARATION OF THE EIS

Federal

U. S. Army Engineer District, Honolulu
U. S. Army Support Command, Hawaii
U. S. Department of Agriculture, Soil Conservation Service
U. S. Department of Interior, Fish and Wildlife Services

State

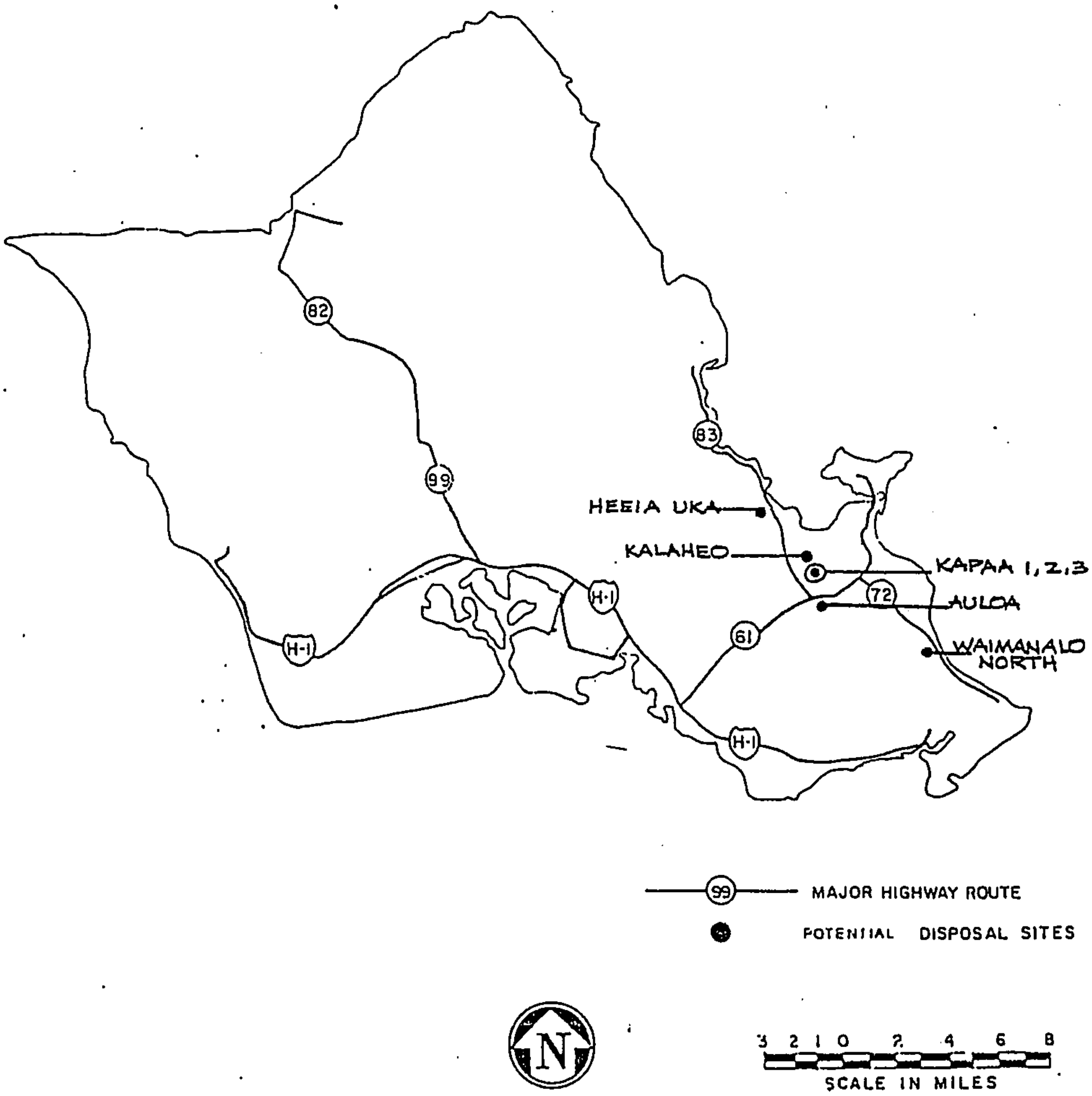
Department of Agriculture
Department of Health
Department of Land and Natural Resources
Department of Planning and Economic Development
Department of Transportation
Office of Environmental Quality Control

City and County

Department of General Planning
Department of Land Utilization
Department of Parks and Recreation
Department of Transportation Services
Board of Water Supply, Honolulu

Others

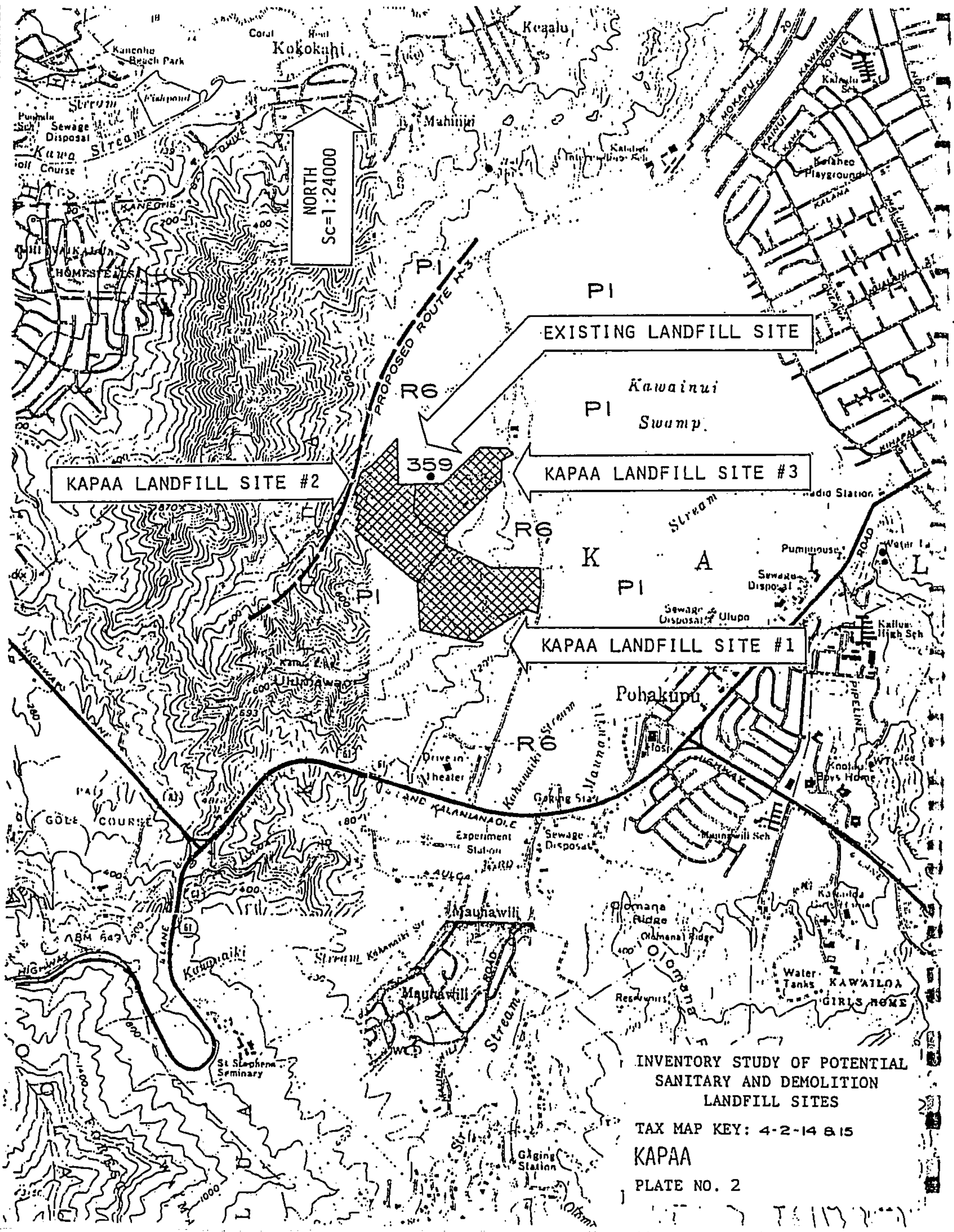
Life of the Land
Lani-Kailua Outdoor Circle
Ad Hoc Committee for Kawainui
Ad Hoc Committee for Windward Landfill Site
Windward Regional Council
Kaneohe Community Council
Kailua Community Council
Neighborhood Board 30
Neighborhood Board 31
Community groups along Windward coast



CITY AND COUNTY OF HONOLULU
DEPARTMENT OF PUBLIC WORKS
DIVISION OF REFUSE COLLECTION AND DISPOSAL

POTENTIAL DISPOSAL SITES

Plate 1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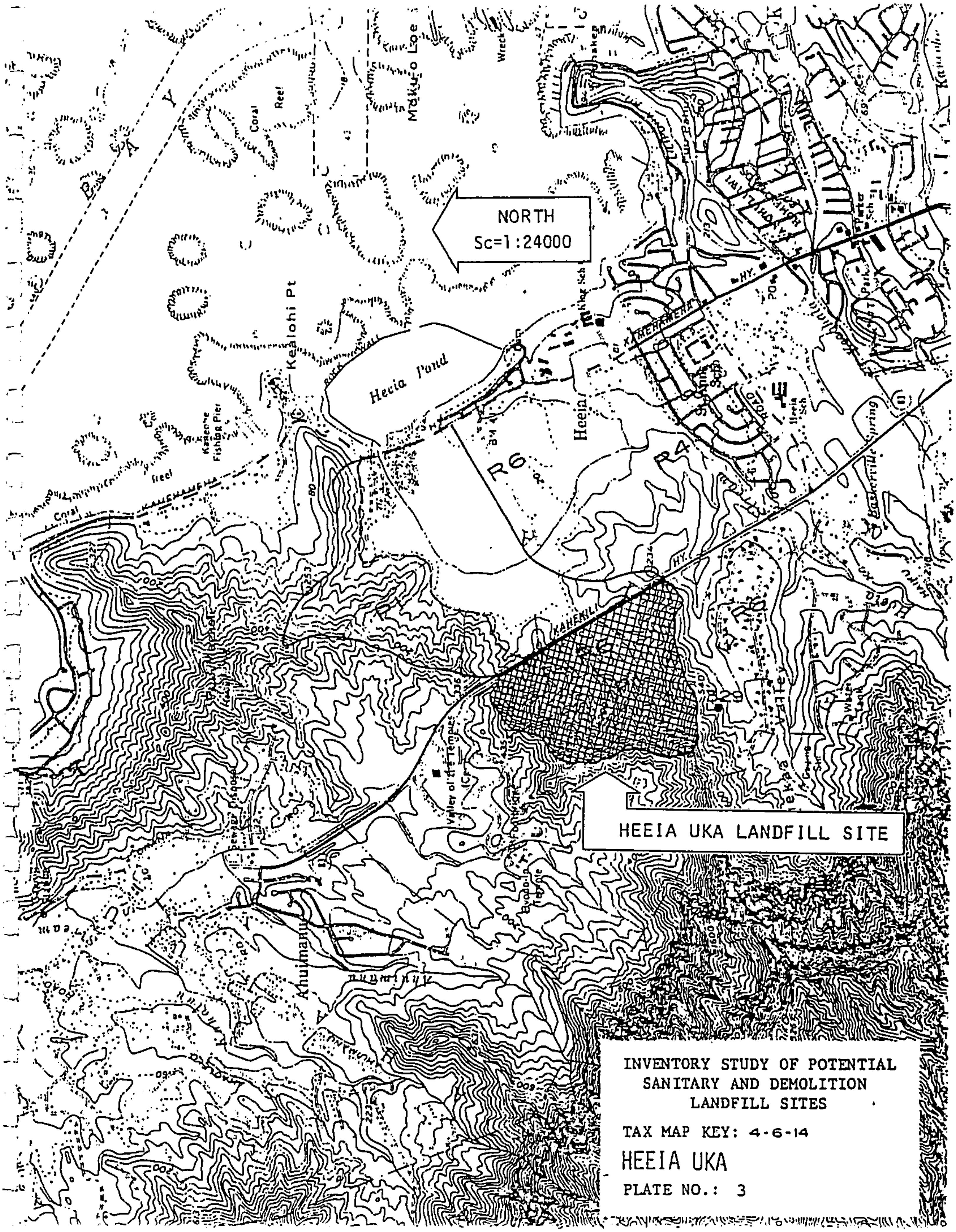
EXISTING LANDFILL SITE
KAPAA LANDFILL SITE #2
KAPAA LANDFILL SITE #3
KAPAA LANDFILL SITE #1
PROPOSED ROUTE H-3
359
P1
R6
Kawainui
Swamp
Kokokahi
Pohakupu
Mauhawili
INVENTORY STUDY OF POTENTIAL
SANITARY AND DEMOLITION
LANDFILL SITES
TAX MAP KEY: 4-2-14 & 15
KAPAA
PLATE NO. 2


NORTH
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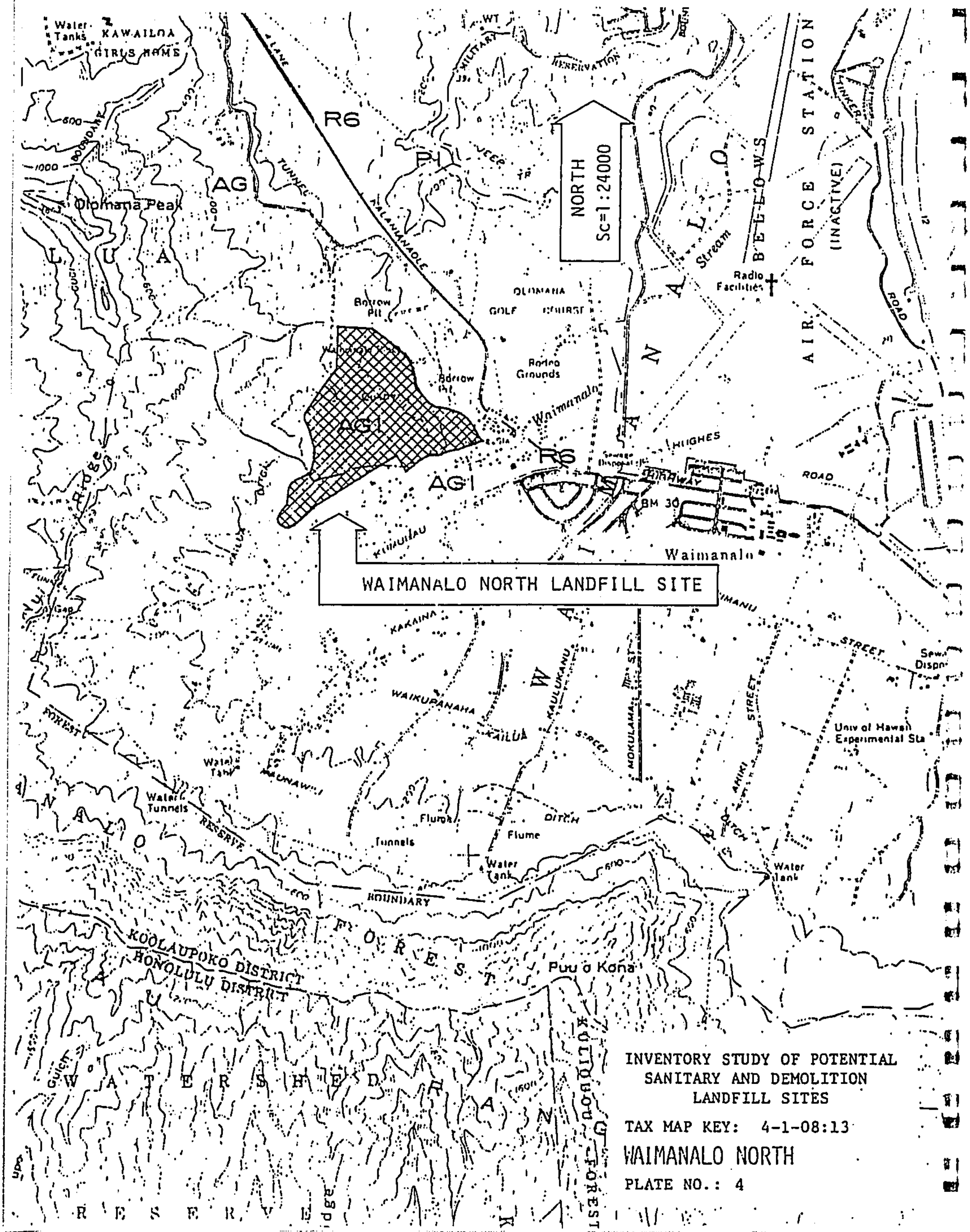
Heeia Pond
Kealohi Pt
Kaneohe Fishing Pier
KAMEHAMEHA HY.
KAHEKILI HY.
R6
R4
HEEIA UKA LANDFILL SITE
INVENTORY STUDY OF POTENTIAL
SANITARY AND DEMOLITION
LANDFILL SITES
TAX MAP KEY: 4-6-14
HEEIA UKA
PLATE NO.: 3

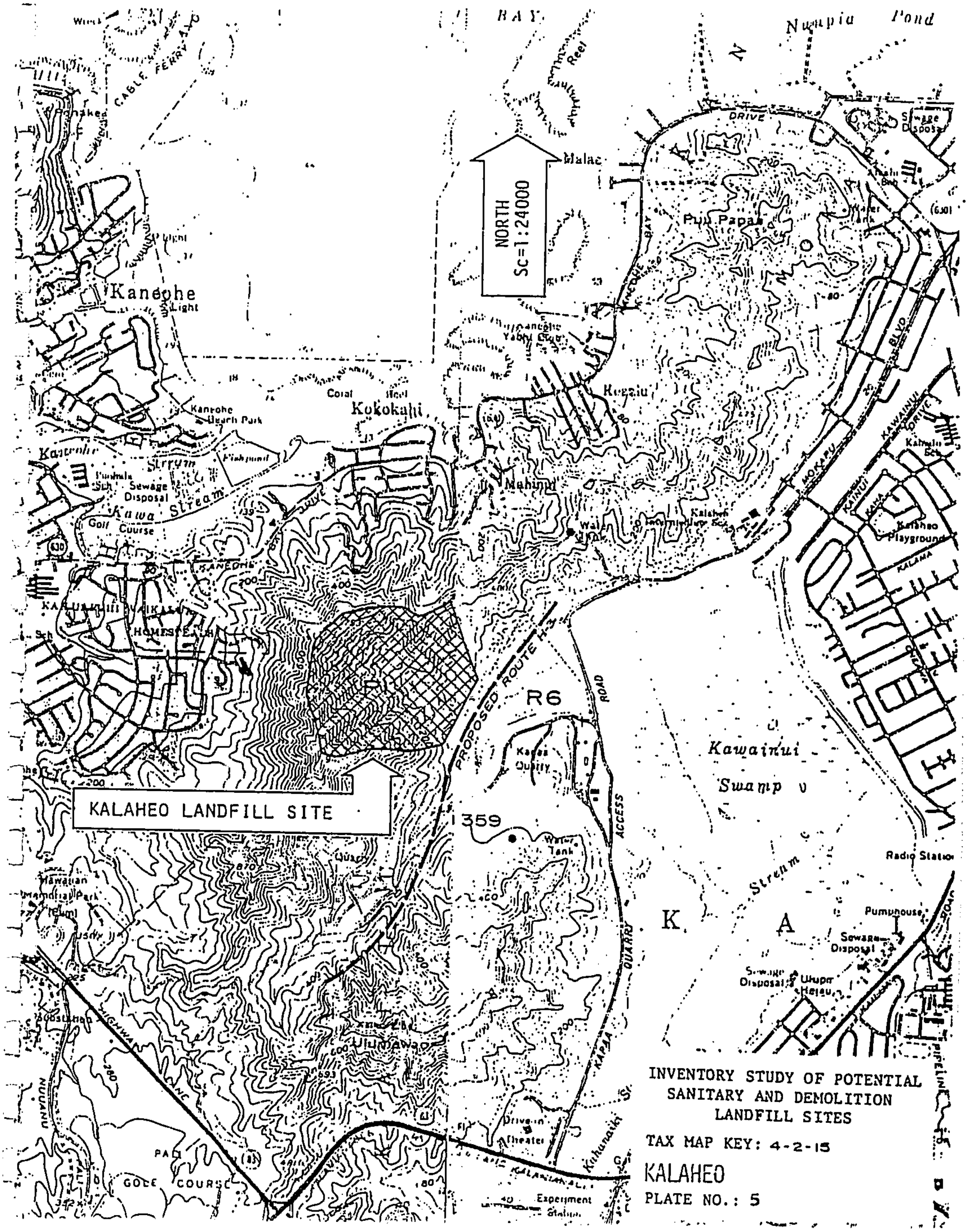


INVENTORY STUDY OF POTENTIAL SANITARY AND DEMOLITION LANDFILL SITES

TAX MAP KEY: 4-1-08:13

WAIMANALO NORTH

PLATE NO.: 4

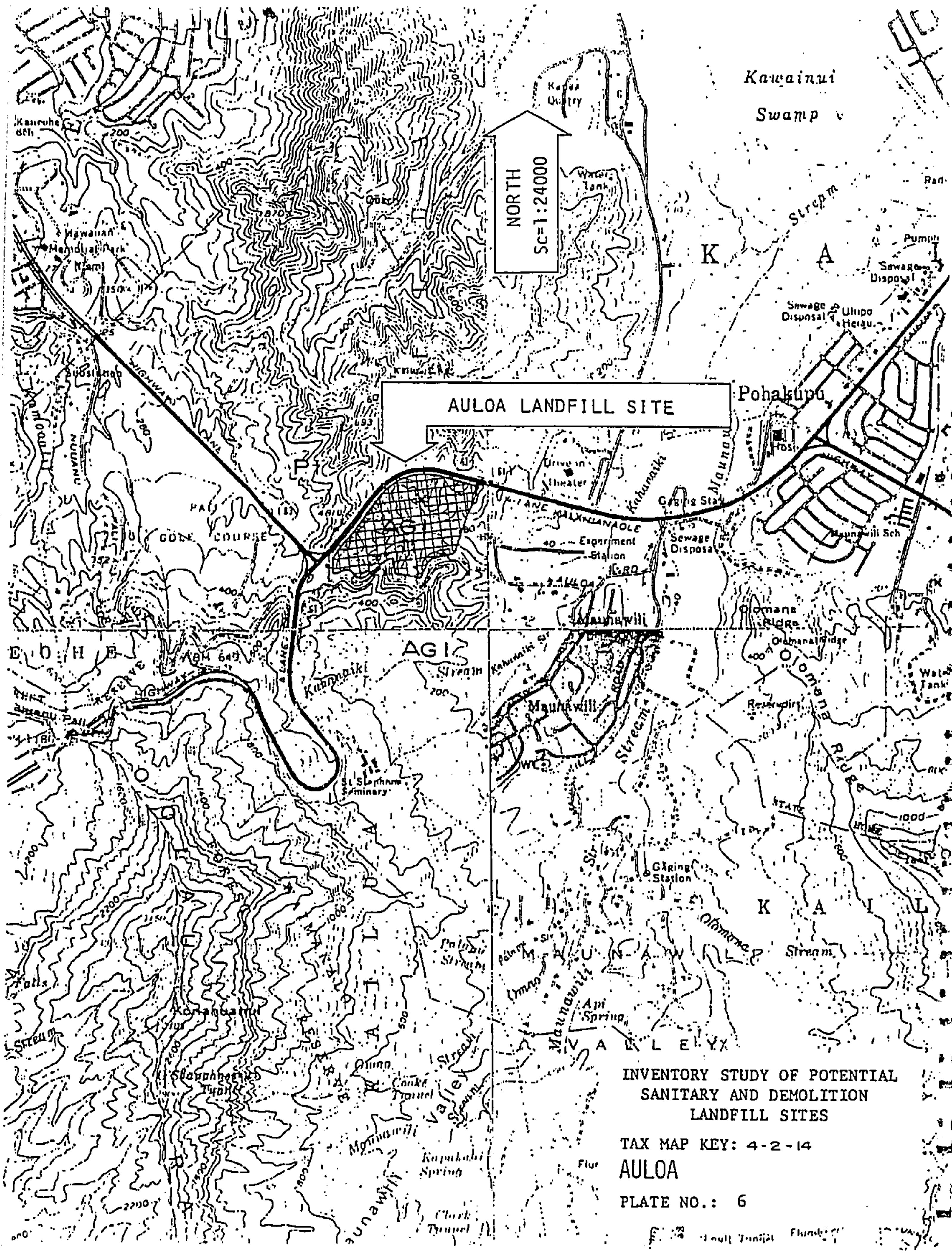


INVENTORY STUDY OF POTENTIAL
SANITARY AND DEMOLITION
LANDFILL SITES

TAX MAP KEY: 4-2-15

KALAHEO

PLATE NO.: 5



Kawainui
Swamp
NORTH
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AULOA LANDFILL SITE
Pohakupu
K A I
Stream
Sewage Disposal
Ulupo Heiau
Drive-in Theater
Experiment Station
Sewage Disposal
Gaging Sta
Maunawili Sch
Maunawili
Olomana Ridge
Water Tank
Reservoirs
Kahanaiki
Stream
St Stephens Seminary
Gaging Station
K A I L
Olomana
Stream
M A U N A W I L I
Api Spring
V A L L E Y
Konahuanui
Kapakahi Spring
Maunawili
Clark Tunnel
Cooke Tunnel
Falls
Stream
PALI GOLF COURSE
Hawaiian Memorial Park
INVENTORY STUDY OF POTENTIAL
SANITARY AND DEMOLITION
LANDFILL SITES
TAX MAP KEY: 4-2-14
AULOA
PLATE NO.: 6

CITY AND COUNTY OF HONOLULU

DEPARTMENT OF PUBLIC WORKS

ENVIRONMENTAL IMPACT STATEMENT PREPARATION NOTICE

FOR

LEEWARD SANITARY LANDFILL

Submitted Pursuant to Chapter 343, HRS

Responsible Official: [signature]

Wallace Miyahira
Director and Chief
Engineer

Date: DEC 2[illegible] 1976

Accepting Authority: Department of General Planning
for
Mayor, City and County of Honolulu

ENVIRONMENTAL IMPACT STATEMENT PREPARATION NOTICE

PROPOSED LEEWARD SANITARY LANDFILL

PROPOSING AGENCY:	CITY AND COUNTY OF HONOLULU DEPARTMENT OF PUBLIC WORKS DIVISION OF REFUSE COLLECTION AND DISPOSAL
ACCEPTING AUTHORITY:	DEPARTMENT OF GENERAL PLANNING (for) MAYOR, CITY AND COUNTY OF HONOLULU

I. DESCRIPTION OF THE PROPOSED PROJECT

A. Background

The basic document for solid waste management on Oahu is the City and County of Honolulu's Solid Waste Management Plan (SWMP). The plan, which was prepared in 1971 and is continuously being refined and updated, recommended a waste management system based on sanitary landfill disposal. Sanitary landfills would be the primary disposal sites until a resource recovery or waste utilization system is initiated for the island of Oahu. Present estimates indicate that an island-wide resource recovery system will not be in operation until 1981, at the earliest. At that time, landfills will still be required for the disposal of all non-recoverable materials, which will amount to 15-25 percent by volume of all waste.

Currently, solid waste from municipal and commercial refuse collection is either incinerated at the Kewalo, Kapalama, and Waipahu Incinerators and the ash then disposed of in landfills, or refuse is directly landfilled at sites located at Kapaa, Kawailoa, Palailai, and Waianae. The Kapaa Landfill has been serving the Koolauloa and Koolaupoko Solid Waste Districts, and portions of the Honolulu District. The Kawailoa Landfill has been serving the Waialua amd Wahiawa areas. The Waianae Landfill serves the Waianae district, and the Palailai Landfill has been the disposal site for a portion of the solid waste collected by private refuse hauling firms.

Solid waste disposal in the windward and leeward districts of Oahu is becoming a critical problem due to growing solid waste loads and an increasing inability of disposal facilities to accommodate solid waste loads. The solid waste disposal problem has been accelerated by the fact that 1) the Kewalo and Kapalama Incinerators have been operating without effective air pollution controls to maintain ambient air quality standards and must be closed in 1977 to comply with an Environmental Protection Agency order, and 2) all existing sanitary landfill sites are nearly full. The Kapaa landfill is estimated to have less than one and one-half years of capacity left, while the Waianae and Kawailoa Landfills are estimated to each have less than five years of landfill life based on current rates of disposal. New disposal sites must therefore be found and used for waste disposal.

In order to meet the solid waste disposal problem, the City and County of Honolulu proposes to establish major landfills on the windward and leeward sides of the island. The leeward sanitary landfill, together with the Waipahu Incinerator, will fulfill most of the solid waste disposal requirements of the Honolulu, Waianae, Wahiawa, and Ewa Solid Waste Districts. In 1980, these areas are expected to generate 1250 tons of refuse per day (TPD), exclusive of military and agricultural wastes. The City's engineering consultant recently completed a study to identify all potential sanitary and demolition landfill sites on the island. The consultant's preliminary report identified three sites which have potential for use as the major leeward sanitary landfill. As shown in Plate 1, these consist of sites located in the Ewa and Waianae districts: Makaiwa Gulch, Kaloi Gulch, and Nanakuli, in the vicinity of an abandoned quarry.

B. Purpose and Scope of EIS

The purpose of the EIS is to discuss the environmental impacts of implementing a sanitary landfill at the Makaiwa Gulch, Kaloi Gulch and the Nanakuli sites. The Makaiwa Gulch site is being proposed by the City as the site for the Leeward Sanitary Landfill Site.

C. Sanitary Landfill Operation

A sanitary landfill is a solid waste disposal facility in which refuse is placed and compacted for final deposition. The operation is termed "sanitary" since a daily earth cover is placed on top of all raw refuse to minimize odor, litter, and vector potential, with no open burning permitted. Within the sanitary landfill area, refuse is deposited at a specific area by municipal and private collection and transfer vehicles. The refuse is compacted and at the end of a day's activities covered with a 6-inch soil mantle. This combination of refuse and cover is termed a cell. Cell construction can be accomplished through basically three methods of operation: trench, area, and ramp methods. These methods are varied to take advantage of the topographical conditions of the landfill site.

In the trench method, a long narrow excavation is made in the earth and the soil removed is stockpiled. Wastes are placed at one end of the excavation on the sloped end of the trench. The refuse is spread in a shallow inclination and compacted. At the end of the day's activity, the compacted layers of refuse are covered with a layer of soil that was excavated earlier. If excavated soil is unsuitable for cover or not available in sufficient quantity, cover must be imported and is usually stockpiled near the landfill site.

In the area method of landfilling, refuse is deposited on an undisturbed ground surface. It is spread over the ground in a uniform layer, compacted, and then covered with a soil mantle. Cover material is almost always imported and stockpiled nearby in this method.

The ramp method is a combination of the trench and area methods and usually used in areas of slope. An excavation is made in front of the proposed face of an existing slope. The soil removed is stockpiled nearby. Refuse is placed within the cut, spread, compacted, and then covered with a soil mantle at the end of a day. The process is repeated at the face of newly created slopes so that a succession of slopes are produced in a line across the landfill site.

The completed succession of adjoining cells over the landfill is termed a lift. Each lift is approximately eight feet in depth. Additional lifts can be placed on top of the original lift. When the design height of a landfill is reached, the completed landfill is covered with 2 feet or more of topsoil, graded, seeded, and landscaped as desired.

D. Sanitary Landfill Design and Selection

The design and selection of a sanitary landfill are dependent on several factors which must be closely evaluated in order to prevent air and water quality alterations, to promote efficient and economic use of the site, and to minimize disturbance to neighboring activities. These factors include: a) refuse hauling distance, b) landfill capacity, c) availability of site utilities, infrastructure, and access, d) availability of cover material; e) compatability of existing and proposed land uses of the site and surrounding areas, f) displacement of families or businesses, g) site acquisition, development and operation costs, h) environmental compatibility of site in terms of geology, drainage, and hydrology, and effects on air and water quality, noise levels, and flora and fauna, i) social and cultural compatibility of the site in terms of effects on surrounding land uses, effect on sites of archaeological or historical significance, and visual intrusion, and j) acceptability by the community.

The above factors will, to a large extent, determine the scope and cost of improvements that must be implemented to operate an efficient and environmentally compatible sanitary landfill. The most favorable landfill site will require minimal improvements consisting of an all-weather access road and an operation and maintenance facility with scale for weighing the loads of incoming refuse collection and transfer trucks. The trucks would then proceed to the landfill area, deposit their loads, and return to either collection routes or to the transfer station. Less favorable

Less favorable sites may require more site improvements including: 1) surface drainage works to prevent contact of surface waters with deposited refuse, 2) an impervious membrane over the site and leachate collection systems to prevent landfill leachate from coming into contact with groundwater supplies, if present, 3) installation of water, telephone, and electrical lines if not present, and 4) construction of adequate access routes to and within the site. If cover material is not available onsite, it must be imported, and acquisition and transport costs must also be considered in an economic analysis of the site. In addition, green buffer zones and appropriate land-scaping will be required if the site is visually prom-inent or located near residential or commercial centers.

II. DESCRIPTION OF THE PROPOSED SITES AND REQUIRED IMPROVEMENTS

The proposed sites are located within the Ewa and Waianae districts which have relatively large areas of land available for landfilling purposes, receive little rainfall, thereby reducing potential site runoff and leachate production, and are generally in agricultural or low-density use. All proposed sites are shown in Plates 2 to 4.

A. Makaiwa Gulch

General

The Makaiwa site is recommended by the City's engineering consultant as the most promising of the sites under evaluation as the major sanitary landfill site for the Leeward Oahu area. The City is proposing to use this site for the Leeward Sanitary Landfill.

The site is located in the Ewa District, directly mauka of Farrington Highway and between Waimanalo Gulch on the west, Palailai Gulch on the east, and below Puu

Manawahua to the north.

The Makaiwa site is approximately 17 acres in area and has a capacity of approximately 14,674,000 cubic yards equivalent to 30$\pm$ years of life based on a disposal rate of 500 TPD. The site is leased from Campbell Estate by Hawaii Meat Co. and further subleased to Tongg Ranch. The present lease extends to 1987. Tongg Ranch has applied for extending their lease holdings in this area to 1996 but this potential site is not included in their lease extension plans. This site is approximately 18 miles from the Shafter Flats Transfer Station which will transfer and process, if shredding equipment is eventually installed, the bulk of the island's waste. Most of the travel to the site is on a modern, high-speed highway.

Land Use

The site is presently vacant and used as ranch land. The site is zoned Agriculture (Ag-1), general planned Agriculture, and its State Land Use designation is Agriculture. Adjacent land uses mauka of Farrington Highway are in open space, with a military reservation located to the northwest of the site. Surrounding land use designations mauka of the highway are Agricultural and Military. The nearest residential areas consist of Honokai Hale, makai of Farrington Highway and across from a portion of the site, and Makakilo City, located approximately 2.8 miles east of the site. Nanakuli is located approximately 4.2 miles northwest of the site, and Waipahu is approximately 8.3 miles east of the site.

Topography

The project site is located to the south of Puu Manawahua and to the northwest of Puu Palailai. The overall length of the site is approximately 7,600 feet, with average width approximately 2,000 feet. The lower portion of the site consists of a well-defined gully approximately 1,700 feet in width with an average slope of 13%. The upper portion of the site consists of three well-defined gullies totaling approximately 2,600 feet in width, with an average slope of 17%.

Soils

The project site consists of the following soils, according to the Soil Conservation Soil Survey: Stony steep land, Mahana Badland, on 3 to 35% slopes, Malualei extremely stony clay; on 30 to 90% slopes, and Helemano silty clay.

Hydrology and Drainage

The project site is not located over a source of potable groundwater supply, nor are there any streams on the site. The site is part of a drainage area approximately 12,000 feet long, covering an area of about 464 acres. The three gullies in the upper reaches of the site drain into the lower gully and surface runoff flows under a bridge on Farrington Highway.

Flora and Fauna

The Makaiwa site is located in a dry lowland vegetation zone dominated primarily by kiawe (Prosopis pallida) and koa haole (Leucaena leucocephala). Heavy undergrowth consists mainly of slender mimosa (Desmanthus virgatus) and fingergrass (Chloris sp.). Spiny amaranth (Amaranthus spinosus), buffelgrass (Cenchrus ciliaris), apple of Peru (Nicandra physalodes), Spanish needle (Bidenspilosa) and hi'aloa (Waltheria americana) are common along the bull-dozed access road.

Avifauna seen on the project site include barred dove (Geopelia striata) sparrow (Passer domesticus), white-eye (Zosterops japonica) and francolin (Francolinus sp.). Mammalian wildlife recorded were mongoose (Herpestes auropunctatus) and dog (Canis familiaris). Rat (Rattus sp.), cat (Felis catus), and mouse (Mus musculus) are probably found in the project area due to its close proximity to populated areas. No rare or endangered species are believed to be in the project area and all dominant species are exotic to Hawaii.

Archaeological Sites

There are no known archaeological sites within the project site. An archaeologist will be contracted to conduct a survey of the site to determine if any such sites exist.

Existing and Proposed Site Improvements

Access Road

Access to the site is from Farrington Highway. Improvements to Farrington Highway must be made to provide safe egress onto and from the site. In addition, approximately 1,000 feet of an all-weather access road will be required. A bulldozed access road is present on the site.

Operation and Maintenance Facilities

Permanent facilities must be constructed, as none exist on-site.

Utilities

Electric power, telephone and water connections are available on Farrington Highway. Power lines also cross the upper portion of the site. These overhead power lines may require relocation if the entire site is to be fully utilized for landfilling. No sewage facilities are located on site; a sanitary sewer line must be extended from the Honokai Hale subdivision across the highway to the landfill site.

Drainage System

A major drainage system must be constructed.

Leachate Control System

Although the site is not over a source of groundwater supply, methods to minimize landfill pollutants from entering the groundwater will be incorporated into the landfill design.

Landscaped Buffer Zone

As the site is readily visible from Farrington Highway and is near a residential area, a landscaped buffer zone is necessary to minimize visual obtrusiveness.

Cover Material

Cover material is scarce along the southern Waianae Range, although some cover material is available on-site. Cover material will have to be imported, although such amounts may be reduced if refuse shredding capability is added to the Shafter Flats Refuse Transfer Station, which is currently under construction. The shredded waste can be used as the daily cover material for the refuse not processed through the shredder. Shredding will serve to minimize cover requirements from daily to possibly weekly or longer intervals, decreasing the need for cover material. If all refuse is shredded, the compactability of the refuse will be increased, and thereby increasing the life of landfill.

Summary

Advantages

1. Long (30± years) landfill life expectancy, based on a 500 TPD disposal rate
2. Easily accessible
3. 18 miles from Shafter Flats Transfer Station
4. Utilities available
5. Minimum measures required for groundwater protection

6. No surface waters located on site or nearby

7. Good topographical conditions

Disadvantages

1. Near existing residential area (Honokai Hale)

2. Visually prominent

3. Lacks sufficient fill material

4. Requires major drainage improvement system

Estimated Site Development Cost: $12,310,000

B. Nanakuli--Vicinity of the Abandoned Quarry Area

General

The project site is located in Nanakuli approximately 2,000 feet mauka of the Nanaikapono Beach Park. The site, divided by the Lualualei Naval Road, is approximately 611 acres in area, and is owned by Shigeru Horita, et al., The Hawaii Corp., and the U.S. Financial Inc. Its capacity is estimated at 13,396,000± cubic yards with a useful life of approximately 27 years based on a disposal rate of 500 TPD.

This site is considered feasible for proposed landfill use because the existing terrain precludes economical development in its present state for other uses. In order to convert the site to residential or urban use, extensive grading (imported fill) on the western patch of the site will be required, making site development extremely costly. On the eastern half of the site, residential or urban use development will require a new access road and major drainage improvements.

Land Use

The site is presently vacant and in open space land use. Portions of the western half of the site were formerly used for quarry activities, and presently sections of this portion are used for unauthorized dumping and littering. Charred areas indicate that fires have been common occurrences in recent times.

The western half of the site is zoned Agriculture (Ag-1), and general planned Agriculture, Residential, Apartment, and School and Park. Its State Land Use designation is Urban. The eastern portion of the site is zoned Planned Development Housing (PDH), Agriculture (Ag-1) and Preservation (P-1). This section is general planned Agriculture, Park, and Open Space. Its State Land Use designation is Conservation and Agriculture. Surrounding land uses consist of residential developments to the west and south, vacant lands to the east, a cement plant to the north, and residences to the northwest. The distances of urban areas other than Nanakuli are: Maile 3 miles, Waianae 4.7 miles, Makaha 7 miles, and Waipahu 12 miles.

Topography

The site is located between Puu Heleakala on the east and Puu o Hulu Oka on the west. The land west of Lualualei Naval Road contains depressions of approximately 40 feet with mounds of 30 feet existing on the southern 60% of the site. These mounds and depressions are the result of abandoned quarry activities. The northern 40% of the site is in its natural state with two defined shallow gullies meeting Ulehawa Stream. The slope in this area varies between 2% to 10%. The land east of Lualualei Naval Road is relatively flat in the lower reaches along the road, gradually sloping upward toward the ridge line of Puu Heleakala.

Soils

Soils of the site, according to the Soil Conservation Service, consist of the following: 2 to 6% slope, Lualualei clay; 3 to 35% slope, Lualualei extremely stony clay; 0 to 12% slope, Mamala stony silty clay loam; 0 to 12% slopes, Pulehu very stony clay loam; and rock land.

Hydrology/Drainage

The site is not over a supply of groundwater. Surface waters consist of the Ulehawa Stream, an intermittant stream located along the western border of the site. Portions of the site drain directly into the stream. Some surface runoff from Puu Heleakala is conveyed under Lualualei Naval Road and flows across the site to Ulehawa Stream.

Flora and Fauna

The Nanakuli project site is located at the site of a previous quarrying operation. The coastal location of the site is evidenced by the dominance of coral where the surface soil has been removed.

Vegetation in the western portion of the site include kiawe (Prosopis pallida), koa haole (Leucaena leucocephala), slender mimosa (Desmanthus virgatus), and fingergrass (Chloris sp.). Additional common species include Australian salt bush (Atriplex semibaccata), hi'aloa (Waltheria americana), tree tobacco (Nicotiana glauca), scarlet fruited passion flower (Passiflora foetida), golden crown-beard (Verbesina encelioides), castor bean (Ricinus communis) and pluchea (Pluchea odorata). The eastern portion of the site is relatively undisturbed and dominant vegetation includes kiawe, koa haole, and fingergrass.

Avifauna recorded during the site survey include sparrow (Passer domesticus), barred dove (Geopelia striata), lace-necked dove (Streptopelia chinesis), white-eye (Zosterops japonica), cardinal (Richmondena cardinalis) and mynah (Acridotheres tristis). The presence of refuse on portions of the site accounted for the large number of birds on the site. Mammalian wildlife surveyed include dog (Canis familiaris), mongoose (Herpestes auropunctatus) and cat (Felis catus). The presence of refuse and birds indicates the presence of mouse (Mus musculus) and rat (Rattus rattus).

Archaeological Sites

As portions of the project site have been excavated over the years, it is anticipated that any archaeological sites, if present, would have since been destroyed by quarry activities. Undisturbed sections of the site will be surveyed by an archaeologist to determine if any significant historical or archaeological sites are present.

Existing and Proposed Site Improvements

Access

Access to the project site is from Lualualei Naval Road. The Navy, who controls the road, has been receptive to the City takeover of the road if this site is selected for landfilling activities. The road will require widening and portions may require realignment.

Operations and Maintenance Facilities

Permanent facilities must be constructed.

Utilities

Electric power, telephone and water connections are available at the adjacent Lualualei Homestead Lots. A cesspool must be constructed for sewage disposal.

Drainage System

On and off-site surface runoff must be conveyed to Ulehawa Stream through a moderate sized drainage system to minimize stream siltation.

Leachate Control System

No control system is required for protection of groundwater. Dikes may have to be constructed to prevent pollutants from entering Ulehawa Stream and the coastal waters.

Cover Material

Some cover material is available on site. The balance must be imported unless refuse is shredded.

Landscaping

A landscaped buffer area will be required around all sides of the site to minimize visual obtrusiveness.

Summary

Advantages

1. Long (27 years) landfill life expectancy, based on a 500 TPD disposal rate
2. Utilities available
3. Minimum measures required for groundwater protection
4. Good topographical conditions as portions of the site are abandoned quarry areas.

Disadvantages

1. Surrounded by existing and proposed residential developments
2. Access road must be improved
3. Moderate drainage improvement system required
4. Surface waters flow next to site.
5. Furthest distance from Shafter Flats Refuse Processing and Transfer Station
6. Lacks sufficient fill material
7. May be visually obtrusive

Estimated Site Development Cost: $8,490,000

C. Kaloi Gulch

General

The project site is located in the foothills of the Waianae Mountain Range, off Farrington Highway and Palehua Road, approximately 2,500 feet northwest of the H-1 highway. The site, approximately 400 acres in area, is owned by the James Campbell Trust Estate. The site is estimated to have a landfill capacity of 24,300,000 cubic yards, with an approximate life of 50 years based on 500 TPD disposal rate. The site is considered desirable for landfill use as it is remote from residential centers, is not easily visible, and has a long life expectancy. However, site development costs may be prohibitive.

Land Use

Lands surrounding the project site are predominantly in sugar cane production. A residential community, Makakilo town, is located approximately 1.5 miles south of the project site. No other residential areas are located nearby.

The project site is currently vacant, with a portion of the site leased to the Tongg Ranch for grazing. The site is designated as Agriculture by the State Land Use Commission. Portions of the project site are general planned Agriculture and Residential, but the entire site is zoned Agriculture (Ag-1).

Topography

The project site is located between two mountain peaks, Puu Makakilo and Puu Kapuai. Within the gulch, longitudinal slopes vary from 5 percent at the entrance to 13 percent at the western boundary of the project site. The floor of the gulch is characterized by flatlands and hilly terrain which give way to steep slopes further into the gulch. The typical depth of the gulch is approximately 175 feet.

Soils

The project area generally consists of the following soil series according to the Soil Conservation Service Soil Survey: Rock Land, Kawaihapai stony clay loam, two types of Mahana silty clay loam, and Mahana-Badland complex. The primary soil association is the Helemano-Wahiawa Association.

Hydrology/Drainage

A portion of the project site may overlie a basal aquifer. Water from the aquifer supplies Barbers Point Naval Air Station, a military reservation on top of the Waianae Mountain Range, and Oahu Sugar Company for irrigation purposes.

Kaloi Gulch is part of the Kaloi drainage basin which drains an area of approximately 1,300 acres.

Kaloi Stream, which flows through the gulch, is intermittent. This suggests the natural drainage ways in the gulch are inactive except during heavy storms.

Flora and Fauna

The project site consists of dry shrubland and a mixed shrub/forest. The predominant shrub found at the project site is haole koa (Leucaena glauca) which often reaches tree size, particularly along Kaloi Stream. Kiawe (Prosopis pallida) is the most common tree and is scattered throughout the area. Endemic species include wiliwili (Erythrina sandwicensis), uhaloa (Waltheria americana) and ilima (Sida fallax).

Wildlife in the project area include dog (Canis familiaris), cat (Felis catus) and mongoose (Herpestes auropunctatus). Rat (Rattus sp.), mouse (Mus musculus) and pig (Sus scrofa) are also probably found here. Two reptiles, the fox gecko (Hemidactylus garnottii) the snake-eyed skink (Ablepharus boutoni) are found here with the mourning gecko (Lepidodactylus lugubris) probably present also. Avifauna consists of dove (Streptopelia chinesis) and Geopelia striata), Japanese white-eye (Zosterops j. japonica), American cardinal (Richmondena cardinalis), house finch (Cardpodacus mexicanus frontalis) and ricebird (Lonchura punctulata). Brazilian cardinal (Paroaria cristata), black-headed mannikin (Lonchura mallacca), cattle egret (Bulbulcus *ibis*) and mockingbird (*Mimus polyglottos*) are also prevalent in the area.

Archaeological Sites

The project site will be surveyed by an archaeologist to determine if any significant archaeological sites are present. A literature search has not revealed the presence of any such sites.

Existing and Proposed Site Improvements

Access

Access to the project area is via Palehua Road, an unpaved cane-haul roadway used by Oahu Sugar Company.

Portions of Palehua Road must be upgraded and realigned for increased traffic, and a new bridge and approximately 2,200 feet of new access road into the site must be constructed. Approximately one acre of cane must be removed for road realignment.

Operation and Maintenance Facilities

Permanent facilities must be constructed.

Utilities

A 4-inch water line owned by Oahu Sugar Company, an inverted water siphon, and an irrigation ditch are located within the project site. Existing water, irrigation and power lines crossing the site must be relocated. Power is available. Water and telephone service must be brought to the site, and sanitary waste facilities must be installed.

Drainage system

Major drainage works are required for surface runoff conveyance.

Leachate Control System

An impervious membrane and a leachate collection and treatment system must be provided to protect groundwater resources.

Cover Material

Some cover material is available on site, and the balance required must be imported unless shredded refuse is used to reduce cover material requirements.

Summary

Advantages

1. Largest landfill capacity and longest landfill life expectancy (50 Years) based on a 500 TPD disposal rate
2. Minimum impact on surrounding land uses as surrounded by vacant lands in agricultural use
3. Not visually obtrusive
4. Good site location
5. Low anticipated land cost
6. Excellent topographical conditions for landfill
7. Nearest distance (approximately 15 miles) to Shafter Transfer Station.

Disadvantages

1. Poor access to adequate roads and major access improvements required

2. Lack of utility facilities

3. Maximum measures required for protection of groundwater

4. Lack of sufficient cover material

5. Maximum measures required for on and off-site drainage improvement

Estimated Site Development Cost: $63,780,000

III. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATIVE MEASURES TO MINIMIZE ADVERSE IMPACTS

A. Noise

Noise will be generated by the operation of general construction equipment during site development and construction activities, and by vehicular traffic necessary to construction activities. Noise levels may also be increased during the operation of the proposed landfill, generated primarily by refuse collection and transfer vehicles. Noise levels will be discussed in further detail in the EIS.

1. Makaiwa

Noise levels generated by landfill construction and operation activities at Makaiwa are not anticipated to be a problem as adjacent lands are vacant or in agricultural use. The Farrington Highway traffic corridor will mask much of the noise emanating from the site from the Honokai Hale residences across portions of the site.

2. Nanakuli

Noise levels generated during construction are not anticipated to be great, but may be a short-term nuisance to surrounding residences. Landfilling operations and refuse truck traffic will increase ambient noise levels which may affect surrounding residences.

3. Kaloi

Noise impacts will be negligible on this site as surrounding areas are vacant and are anticipated to remain vacant or in agricultural use.

B. Air Quality

Ambient air quality will be affected by dust and exhaust emissions generated during site development activities. Dust and emission impacts due to construction activities will vary according to the extent of site development activities. These impacts may be a short-term nuisance but will be mitigated by appropriate measures. Dust levels will be controlled by water wagons and/or other water sprinkling systems as required.

Air quality may also be altered by the generation of dust during landfilling activities and the escape of gases from refuse decomposition within the landfill. Methane gas, a by-product of organic material decomposition within a landfill, is a potentially explosive gas if allowed to accumulate in pockets within the landfill. These impacts will be controlled by 1) water sprinkling to control dust levels, and 2) a gas venting system constructed within the landfill to allow methane to escape into the open air and be dispersed and diluted by prevailing winds.

1. Makaiwa

Air quality impacts as enumerated above are not anticipated to be a problem as adjacent lands are vacant. Water-sprinkling will alleviate any potential dust problems that may be felt by Honokai Hale residents. In addition, the landscaped buffer zone at the entrance of the landfill will further screen areas makai of the landfill from dust.

2. Nanakuli

Existing and proposed residential areas surround portions of the proposed Nanakuli site. Impacts to these areas will be mitigated by the use of extensive water sprinkling to control dust levels and landscaping around the periphery of the site to further buffer adjacent areas from landfilling activities.

3. Kaloi

Air quality impacts generated at the Kaloi site will not be a problem as surrounding areas are vacant or in agricultural use. However, water sprinkling will be utilized to control dust levels.

C. Land Alteration

Site development activities will alter the land form and remove existing vegetation.

1. Makaiwa

Landform alteration at the Makaiwa site will not be extensive during site development activities. However, completion of landfill activities will result in greatly altered landform. Existing gullies and depressions will be filled and the entire Makaiwa gulch will be graded and landscaped to form an open green space.

2. Nanakuli

Site development alterations at this site will not be extensive; however, the access road will require improvements and portions may be realigned, and drainage works must be constructed. Completion of the landfill will raise excavated portions to grade with surrounding areas, and the entire completed landfill will be graded and landscaped to form an open green area.

3. Kaloi

It is expected that extensive site development activities are required at this site, including the installation of 1) an impervious membrane over the areas to be landfilled, 2)surface drainage works, 3) leachate control system, and 4) access road and bridge, and 5) relocation of existing improvements. Completion of the landfill will result in an open green space.

D. Flora and Fauna

The biota of all potential landfill sites are composed of plant and animal species found elsewhere on Oahu and throughout the State. Few native species occur and those that do are relatively common. Flora and fauna are most abundant at the Kaloi and Makaiwa sites which have been relatively undisturbed.

E. Water Quality

Water quality may be affected by leachate from the landfill percolating down into the water table, depending upon the specific hydro-geologic characteristics of the project site.

1. Makaiwa

According to information from the Honolulu Board of Water Supply, the Makaiwa site overlies a groundwater aquifer containing brackish water. Any leachate produced by the landfill is not anticipated to affect groundwater supplies due to the presence of 1) hydrologic barriers, 2) depth of groundwater, 3) soil and geological characteristics.

2. Nanakuli

Landfilling activities on this site are not anticipated to affect groundwater supplies due to 1) hydrologic barriers, 2) depth of groundwater, and 3) soil and geological characteristics.

3. Kaloi

The site overlies a basal aquifer. Water quality may be affected by the production of leachate. However, abatement measures to protect water quality are being considered which include the installation of 1) an impervious soil or synthetic membrane, 2) surface drainage works, 3) a leachate control system.

F. Vectors

Rodents and insects may be attracted to the landfill if proper sanitary landfilling procedures are not followed. With the provision of a daily soil cover upon compacted waste within the landfill, rodents and flies will be discouraged, and are not anticipated to be a problem. Shredded refuse, if left uncovered, is not anticipated to attract vectors. Rodents are not attracted to nor can they survive on a diet of shredded refuse. Studies on flies have indicated that (1) shredding kills nearly 100 percent of maggots present in incoming refuse; (2) the necessary conditions for freshly shredded refuse to support the fly reproduction cycle are rarely obtained in a landfill; (3) after shredded refuse is aged several months, the ability to support the fly cycle is destroyed; (4) flies are more attracted to uncovered shredded refuse than covered non-shredded refuse.

G. Litter

Litter will be generated in the area where refuse is deposited by collector and transfer trailer trucks. Litter is not expected to be a problem as all refuse will be compacted and either covered with a 6-inch soil mantle or with shredded refuse at the end of each working day. In addition, portable fences may be used to contain any loose litter generated during landfilling activities prior to the refuse being covered with a soil mantle.

H. Odor

Odor will be generated in varying levels according to refuse composition and the length of time it remains uncovered. Odor is not anticipated to affect surrounding areas which are vacant or devoted to agricultural activities. However, residents downwind of the Makaiwa and Nanakuli sites may be affected by odors if proper landfilling activities are not followed. To a great extent, odor prevention will depend on the proper sanitary operation of the landfill. The daily application of cover material on compacted refuse as well as the use of chemical masking agents, as required, should mask decomposing waste odors.

I. Fire

Fires are a potential hazard if proper sanitary landfilling procedures are not followed. Potential fires can be prevented by construction of vented refuse cells and daily application of 6 inches of suitable cover material over the compacted refuse.

J. Traffic

Landfilling activities are anticipated to generate daily traffic in the following amounts: 30 transfer trailer trips, 10 collector truck trips, and an undetermined number of private refuse vehicle trips if non-municipal vehicles are allowed to utilize the site.

1. Makaiwa

As the site is easily accessible from Farrington

Highway and adjacent lands are vacant, traffic impacts are anticipated to be minimal.

2. Nanakuli

The site is easily accessible from major thoroughfares. However, daily refuse traffic would be routed through existing residential areas. Measures to minimize this impact to surrounding areas are presently being investigated.

3. Kaloi

Permission will be required from Oahu Sugar for use of and improvements to Palehua Road. Specific requirements such as widening, egress, and ingress into the proposed landfill site and methods to mitigate traffic conflicts and to provide for the safety of road uses are presently being investigated.

K. Water Supply

Water requirements for the operation of the landfill have not yet been determined. When water demand has been calculated, the Board of Water Supply will be consulted to determine if water is available and can be obtained from existing supplies and systems for each of the proposed sites.

L. Drainage

Studies on the possible impacts resulting from alteration of existing drainage patterns are being conducted for each of the sites.

Preliminary investigations reveal that Kaloi will require extensive drainage works to protect surface and groundwaters. Nanakuli will require a less extensive system to protect surface waters, and Makaiwa will require moderate drainage improvements.

M. Visual

The Kaloi site will be the least visible while the Makaiwa site is readily visible from Farrington Highway. The Nanakuli site is not visible to most motorists, but it is surrounded by existing and proposed residential areas.

In order to mitigate visual impact, the Makaiwa site will be heavily landscaped at the entrance and a green buffer zone of approximately 6± acres is proposed.

The Nanakuli site will be extensively landscaped around its entire border to screen landfilling activities from residential areas. The Kaloi site is remote and located in an agricultural area, and will not be visually obtrusive.

IV. ALTERNATIVES TO THE PROPOSED ACTION

A. No Action

If the proposed project is not implemented, refuse disposal would be severely impacted. The termination of refuse processing at the Kewalo and Kapalama Incinerators will place greater demands on existing landfills and the Waipahu Incinerator to handle refuse previously processed at Kewalo and Kapalama. The increase in future refuse quantities would shorten the lifespan of landfills which are already close to full capacity.

A no action alternative may also result in the City having to dispose of more refuse at Palailai, a private landfill. This will result in added expenses for municipal refuse disposal as disposal fees will be charged to the City. However, the limited lifespan and capacity of Palailai makes this an undesirable alternative.

The City may also have to limit refuse disposal at City disposal sites to only municipally collected refuse. Private haulers may thus be required to use private landfills, which may result in increased costs and charges to their customers.

B. <u>Alternative Sites</u>

In addition to the Makaiwa, Nanakuli, and Kaloi sites, several sites in Waipahu, Waianae, and Kunia were investigated for their landfill potential. All sites were evaluated according to specific criteria previously stated which included the following: 1) refuse hauling distance, 2) landfill capacity, 3) site accessibility and availability of utilities, 4) availability of cover material, 5) existing and future proposed land uses, 6) proximity to incompatible land uses, 7) displacement of families or businesses, 8) site acquisition, development and operation costs, 9) environmental compatibility in terms of climatology, geology, drainage, and hydrology, 10) social and cultural compatibility in terms of surrounding land uses, affect on sites of archaeological or historical significance, and visual intrusion, 11) acceptability by landowner, adjacent landowners, and the community, and 12) environmental affects including alterations to air and water quality, noise levels, and flora and fauna.

These alternative landfill sites were determined to have far less potential than the Makaiwa, Kaloi and Nanakuli sites. These sites will be further discussed in the forthcoming EIS for the proposed project.

C. Purchase of Privately Owned Palailai Landfill

The Palailai Landfill currently is a privately operated site that accommodates primarily refuse collected by private operators. Substantial costs would be incurred if the City were to purchase this landfill for municipal purposes. There is no real justification for City acquisition of this facility since it is already used by the public and the remaining life of the facility is limited.

D. Alternative Disposal/Processing Options

Disposal of refuse occurs either on land or at sea. Ocean disposal of solid waste is currently prohibited by the U. S. Environmental Protection Agency.

Waste disposal on land can be facilitated by alternative processing methods which can reduce waste volume and weight. This prolongs the use of landfill disposal sites. Alternative processing methods include 1) shredding, 2) incineration, 3) baling, and 4) composting. However, these processes do not account for the total disposal of solid waste; a landfill is still required to dispose of all waste that cannot be processed or to dispose of residues resulting from processing. The City and County is currently studying the feasibility of an island-wide resource recovery plant that will focus on the recovery of energy from solid waste. However, this plant, if implemented, will not be in operation before 1981.

V. DETERMINATION AND FINDING AND REASONS SUPPORTING DETERMINATION

In accordance with Chapter 343, Hawaii Revised Statutes, this agency has determined that an Environmental Impact Statement for the proposed Leeward Sanitary Landfill is required.

The proposed project may generate impacts that affect ambient air quality, landform, drainage channels, noise levels, water quality, and traffic. In addition, the project will be developed using County funds.

VI. PUBLIC AGENCIES CONSULTED DURING THE ASSESSMENT

State

Department of Land and Natural Resources

City and County of Honolulu

Board of Water Supply
Department of Land Utilization

VII. AGENCIES TO BE CONSULTED IN THE PREPARATION OF THE EIS

Federal

U. S. Army Engineer District, Honolulu
U. S. Army Support Command, Hawaii
U. S. Department of Agriculture, Soil Conservation Service
U. S. Department of Interior, Fish and Wildlife Services
Headquarters, Fourteenth Naval District

State

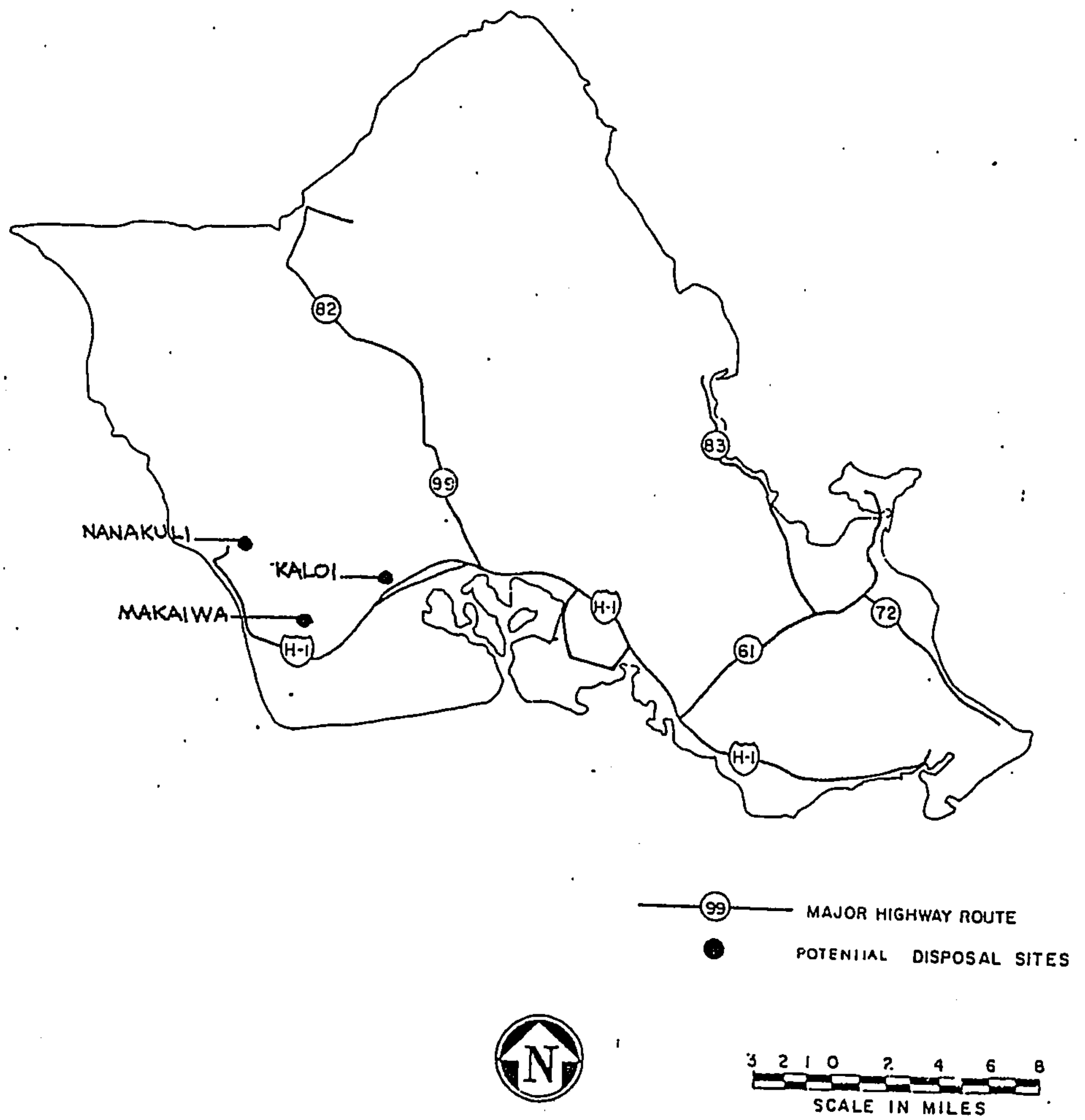
Department of Agriculture
Department of Health
Department of Land and Natural Resources
Department of Planning and Economic Development
Department of Transportation
Department of Hawaiian Home Lands
Office of Environmental Quality Control

City and County

Department of General Planning
Department of Land Utilization
Department of Transportation Services
Board of Water Supply, Honolulu

Others

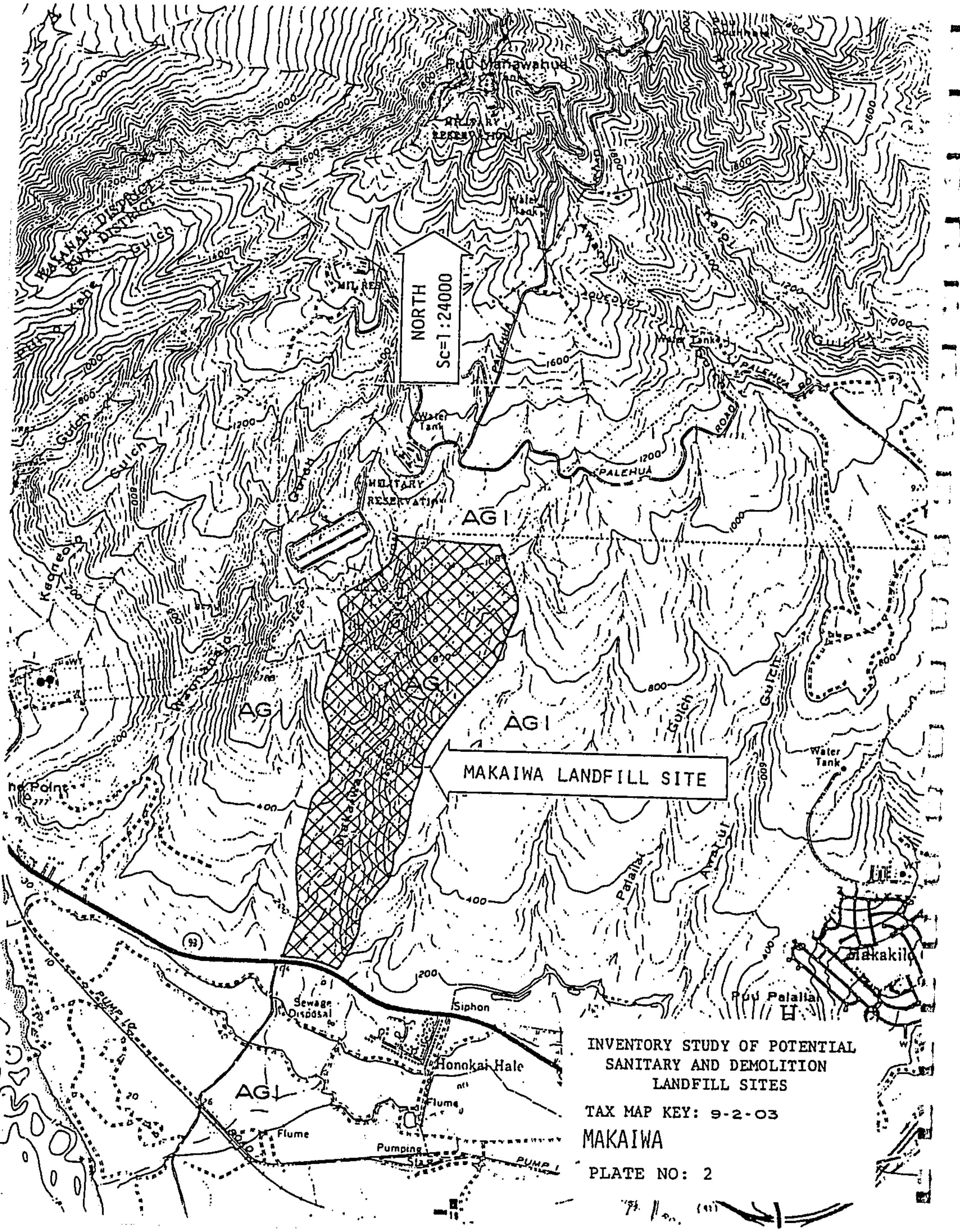
Life of the Land
The Outdoor Circle
Pickups Unlimited
Campbell Estate
Oahu Sugar Company
Hawaiian Sugar Planters Association
Makakilo Community Association
Waipahu Community Association
Ewa Beach Community Association
Nanakuli Community Association
Honokai Community Association
Tongg Ranch



CITY AND COUNTY OF HONOLULU
DEPARTMENT OF PUBLIC WORKS
DIVISION OF REFUSE COLLECTION AND DISPOSAL

POTENTIAL DISPOSAL SITES

PLATE NO: 1

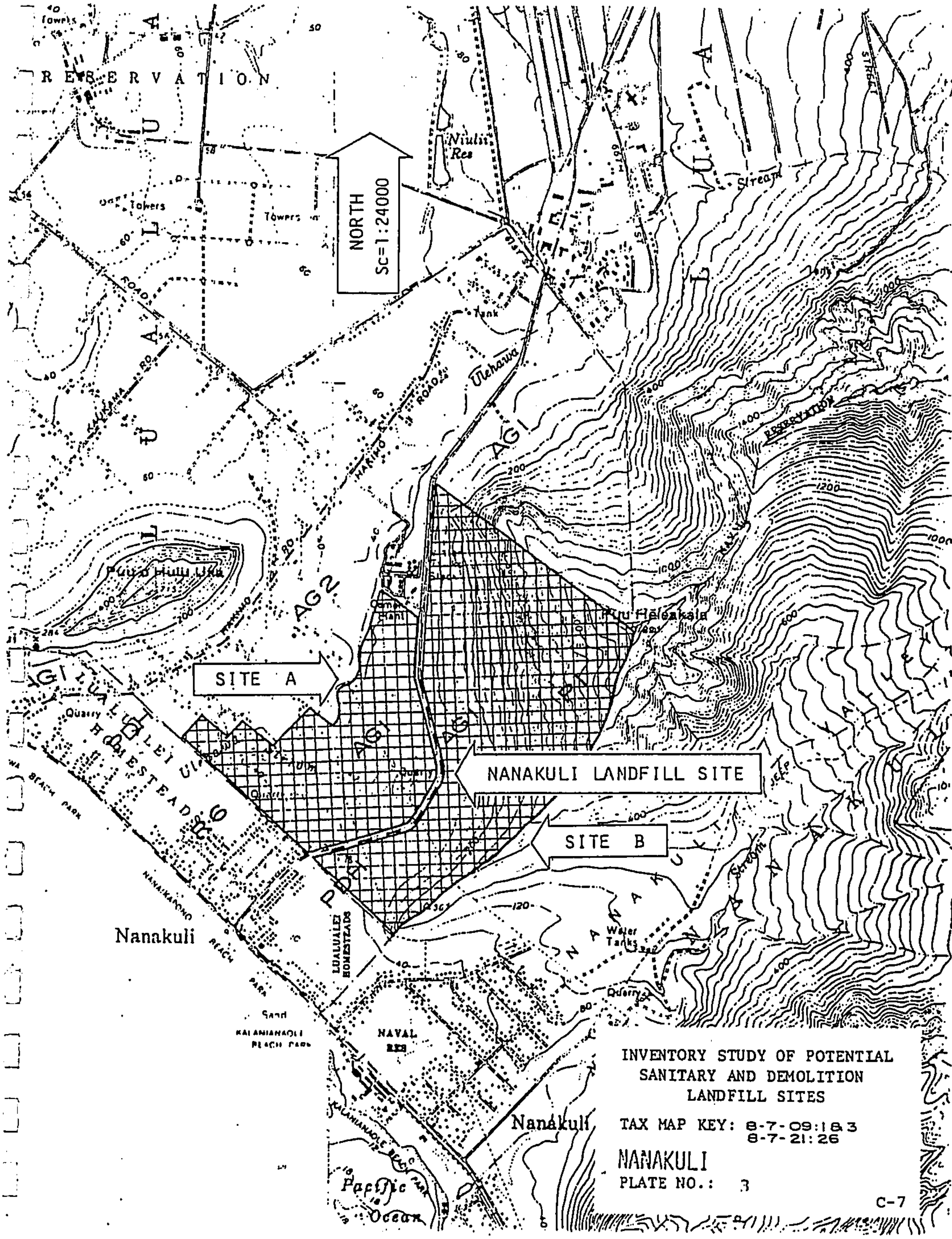


INVENTORY STUDY OF POTENTIAL SANITARY AND DEMOLITION LANDFILL SITES

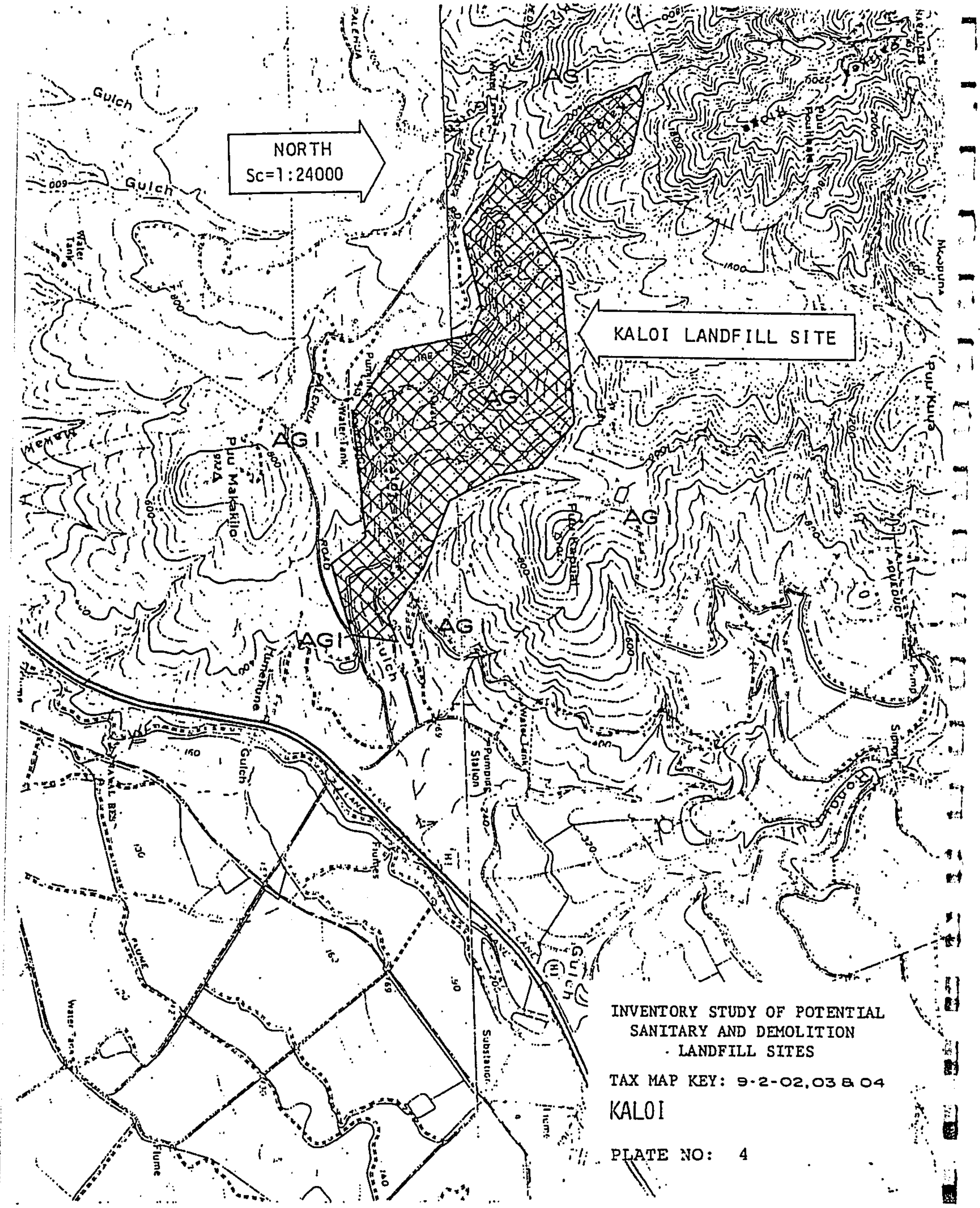
TAX MAP KEY: 9-2-03

MAKAIWA

PLATE NO: 2



NORTH
Sc=1:24000
SITE A
NANAKULI LANDFILL SITE
SITE B
Nanakuli
Pacific Ocean
INVENTORY STUDY OF POTENTIAL
SANITARY AND DEMOLITION
LANDFILL SITES
TAX MAP KEY: 8-7-09:1&3
8-7-21:26
NANAKULI
PLATE NO.: 3
C-7



INVENTORY STUDY OF POTENTIAL
SANITARY AND DEMOLITION
LANDFILL SITES

TAX MAP KEY: 9-2-02,03 & 04

KALOI

PLATE NO: 4

ENVIRONMENTAL ASSESSMENT
FOR THE
KALAHEO SANITARY LANDFILL SITE

PREPARED FOR: STANLEY S. SHIMABUKURO
& ASSOCIATES, INC.
Honolulu, Hawaii

PREPARED BY: ENVIRONMENT IMPACT
STUDY CORPORATION
Honolulu, Hawaii

TABLE OF CONTENTS

SECTION 1

DESCRIPTION OF THE PROPOSED PROJECT

I. BACKGROUND

The basic document for solid waste management on Oahu is the City and County of Honolulu's Solid Waste Management Plan (SWMP) prepared in 1970. The plan, which is continuously being refined and updated, provides the City and County of Honolulu with basic planning data and recommendations for implementing total solid waste management for the island of Oahu. The plan evaluated four alternative solid waste management systems for Oahu as follows:

* System A developed around incineration in the down town area
* System B developed around incineration in outlying areas
* System C developed around maximum usage of landfills
* System D developed around complete recovery for reuse of materials

Systems A and B were unacceptable due to citizen opposition to incinerators, to air pollution considerations and to the incompatibility of such systems with a resource recovery program. In the plan, System D was recommended as the ideal system to be adopted. The City and County of Honolulu, however, was unwilling to commit itself financially to a system which had not yet been proven feasible either in terms of market conditions or technology. Until refuse recovery becomes feasible, System C presented itself as a logical and flexible waste management system which would accommodate existing refuse disposal needs as well as allow for future waste recovery programs. Present estimates indicate that an island-wide resource recovery system will not be in operation until 1981 at the earliest. At that time, landfills will still be required for the disposal of all non-recoverable materials, which will be 15-25 percent of all waste.

Currently, solid waste from municipal and private refuse collection is either: 1) incinerated at the Kewalo, the Kapalama and the Waipahu Incinerators and the ash then disposed of in landfills or 2) directly landfilled at sites located at Kapaa, Kawailoa, Palailai and Waianae. The Kapaa Landfill has been serving the Koolauloa and Koolaupoko Solid Waste Districts and portions of the Honolulu District. The Kawailoa Landfill has been serving the Waialua District. The Waianae Landfill has been serving the Waianae District. The privately owned Palailai Landfill has been a disposal site for private collections and excess municipal collections from the Waipahu Incinerator.

Solid waste disposal in both the windward and leeward solid waste districts of Oahu is a critical problem because solid waste loads are increasing while availability of disposal facilities is decreasing. The problem has become particularly urgent because: 1) the Kewalo and Kapalama Incinerators have been operating without effective air pollution controls and must be closed in 1977 to comply with an Environmental Protection Agency order and 2) all existing sanitary landfill sites are nearly full. The Kapaa Landfill is estimated to have less than one and one-half years of capacity left while the Waianae and Kawailoa Landfills are each estimated to have less than five years of landfill life left. New sites, therefore, must be found for waste disposal.

The City and County of Honolulu proposes to establish Kalaheo Landfill Site to meet the solid waste disposal problem of the windward districts and part of the Honolulu District. It is situated ideally between the urban and refuse generation centers of Kaneohe and Kailua in a hillside area of Kapaa Valley near existing landfill and quarry operations (see Figure 1).

II. TECHNICAL CHARACTERISTICS

The proposed Kalaheo landfill contains approximately 100 acres which the City and County of Honolulu will lease from its owners the Michael C. Baldwin Trust, John C. Baldwin Trust, James C. Castle, Jr. Trust and James C. McIntosh Trust. A small portion of the site is leased by HC&D, Ltd.

A. Landfill Capacity

Of the 100 total acres approximately 55 acres will be used as a landfill. The capacity of this site is approximately 5,585,000 cubic yards.

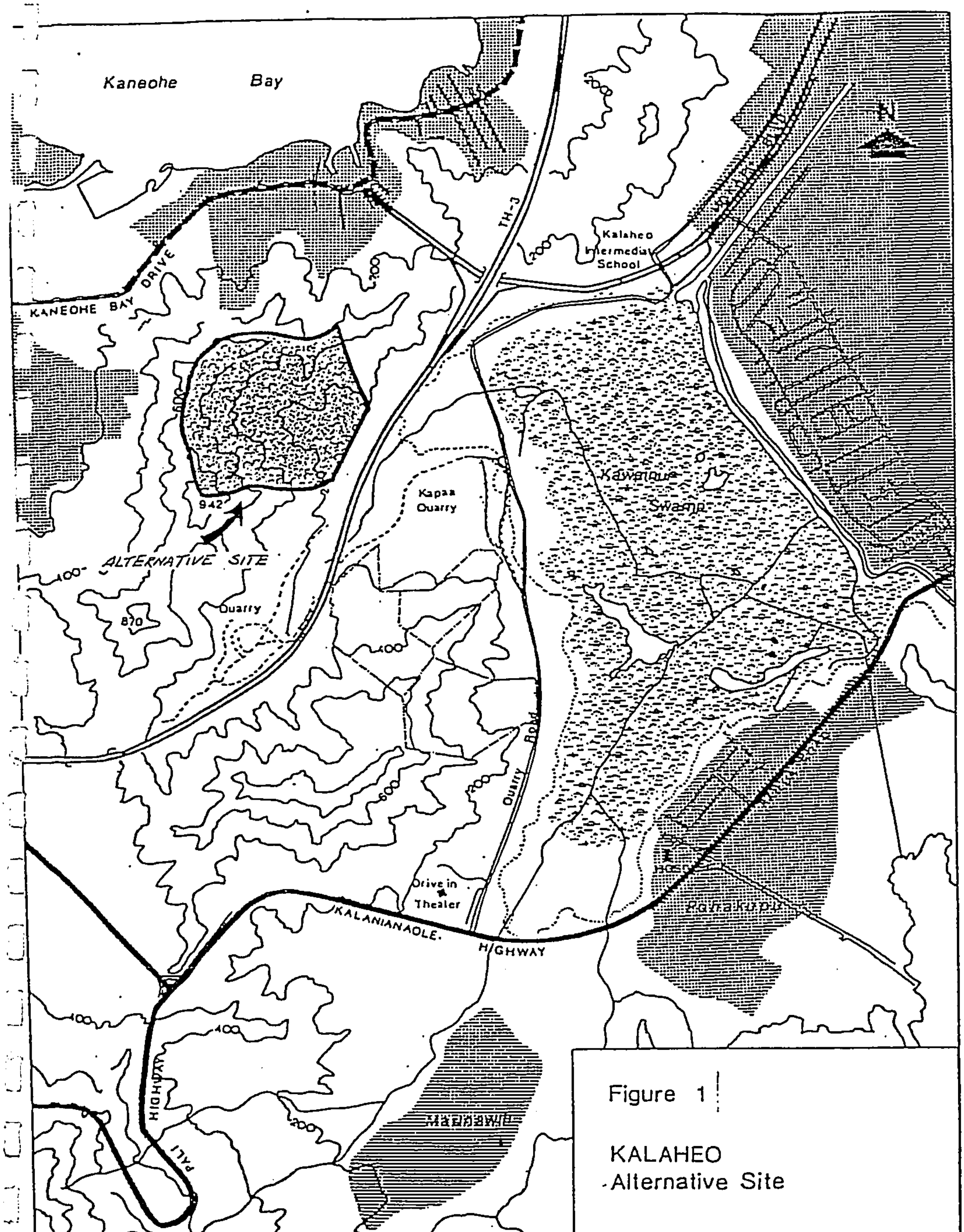


Figure 1

KALAHEO
Alternative Site

Based on an average daily disposal rate of 1,000 cubic yards of unprocessed wastes,* it is anticipated that the project site would have a projected cumulative life of approximately 11.5 years. At lesser rates of disposal, landfill life will be proportionately longer. Landfilling activities can be extended beyond the projected 11.5 years if resource recovery programs are implemented in the future, or if refuse shredding is initiated.

B. Landfill Operations

The site will be cleared, grubbed, and graded. Landfilling operations will employ the trench or area methods or a combination of these techniques. Initially, disposed refuse will consist of unprocessed wastes, which will be compacted and covered daily with a minimum 6 inch layer of cover material. The cover material is required by Chapter 46, Public Health Regulations of the State Department of Health to prevent possible vector, odor, fire, and litter problems. When waste is processed prior to disposal, cover material may not be required and shredded refuse can be used as cover material for any unprocessed refuse. The final cover for the completed landfill will be a 2 foot soil mantle which will be graded and seeded to grass to permit the site to return to its natural state.

*Estimated theoretical disposal rate.

Refuse cells will contain all wastes and perforated vent pipes will be inserted into the cells to disperse gases generated by decomposing refuse. The gases, primarily methane, have been the cause of fires and explosions at landfills when not properly vented and dispersed into the atmosphere.

C. Site Improvements

Water and telephone service are not available and must be extended to the site. Power lines presently cross the site and must be relocated. The site is not accessible to vehicular traffic. A new access must be constructed from the Kapaa Quarry Road, east of the H-3 Freeway, incluing an overpass structure over H-3. Lined interceptor ditches will divert surface runoff away from the landfill. Temporary operation and maintenance facilities may also be constructed to include cesspools to accommodate sewage.

As the site is filled to capacity, it will be covered with topsoil, seeded, and landscaped to blend harmoniously with the surrounding area.

SECTION 2

DESCRIPTION OF THE AFFECTED ENVIRONMENT

I. REGIONAL SETTING

A. CLIMATE

Fair weather predominates throughout the year on the windward side of the Island of Oahu. The weather is sub-tropical and mild with a mean annual temperature of 75°F. Average rainfall for the area is 40 inches per year. Winds occur 70 percent of the time from the northeast with velocities ranging from 8 to 20 miles per hour.

B. GEOLOGY

According to MacDonald and Kyselka (MacDonald, 1967), Oahu was formed during the mid-Tertiary period by volcanic activity. Two volcanoes, the Waianae in the western part of the island and the Koolau to the eastern part provided the material for the land mass. The Koolau Range is the eroded remnant of the volcano which extends northwestward for 35 miles and serves as the western boundary of the Koolaupoko District.

There are a series of relatively narrow, alluvial coastal plains which lie at the foot of the mountain. A large number of valleys have been carved out of the coastal plains during times of lowered sea level which occurred during the Pleistocine epoch. During the time of higher sea level, coral reefs flourished around the island and built a thick platform that now underlies the coastal plain sediments.

Kawainui Swamp is believed to be the main vent of the Koolau volcano (Stearns, 1935). The Ulumawao Ridge and the ridge north of the swamp consist of coarse breccia. Stearns believes that these rocks are throat breccia built up chiefly as talus within a crater or caldera. The two ridges separating the Kailua-Maunawili area to the northwest from Kaneohe and southeast from Waimanalo are composed of rocks from the Koolau and Kailua Volcanoes Series. Throughout the valley are scattered remnant from the lava flows of the Honolulu Volcanic Series.

C. LAND USE

The area to be served by the Kalaheo Landfill consists primarily of the medium density urban areas of Kailua, and Kaneohe, in addition to the smaller residential communities of Waimanalo, Kahuluu, and Hauula. There are no large concentrations of commercial, industrial, or resort zoning in the subject service area.

D. Population

The 1975 population for the Koolaupoko and Koolauloa Solid Waste Districts was estimated at 115,440 and is projected to increase to 151,500 by the year 2000. This projection and the 1975 population estimate are based on the October 6, 1976 draft of the General Plan for Oahu, which was based on the E-2 Population Projection Series developed by the State Department of Planning and Economic Development (DPED). Although not yet approved, the General Plan draft figures are considered reasonable estimates of population growth for the service area.

E. Solid Waste Quantities

Solid waste quantities on Oahu are anticipated to increase proportionately to the increase in population, as shown in Table 2-1. The solid waste quantities and population of the service area are expected to increase at the same rate as the island as a whole.

In the 1975-76 fiscal year, about 603 TPD was disposed at Kapaa, more than half of it from leeward, as shown in Table 2-2. About 70 TPD of municipal collections from the Nuuanu and Hawaii Kai areas of the Honolulu District was delivered to Kapaa because it was the nearest disposal facility. For the same reason, about 11 TPD collected in the northern Koolauloa District was delivered to the Kawailoa Sanitary Landfill.

In April 1977, Division of Refuse records indicate the 935 TPD was disposed at Kapaa. Only the municipal category is broken down according to source so only 76 TPD are known to have come from leeward, as shown in Table 2-3. Of this amount 65 TPD was excess from the

Kewalo Incinerator and 11 TPD was collected in Nuuanu and Hawaii Kai.

Closing of Kewalo Incinerator and opening of Shafter Flats Transfer Station is scheduled for mid-September, 1977. Thereafter, the excess refuse from Kewalo will no longer be disposed at Kapaa. In addition, most of the leeward Municipal collections disposed at Kapaa will be diverted to Shafter Flats Transfer Station at that time.

Quantities disposed at Kapaa could decrease, however, if alternatives for the disposal of Leeward waste now disposed at Kapaa are developed.

Leeward Private collections account for about 45 percent of total refuse disposed at Kapaa. Shafter Flats Transfer Station will not have the capacity to accept Private collections and will not be expanded until 1981, at the earliest. It is estimated that 50 percent of the leeward Private collectors now using Kapaa would use the Transfer Station if permitted. Table 2-4 shows projected refuse quantities to be disposed at Kapaa if Private collections from leeward are not diverted.

F. Solid Waste Collection and Disposal System

1. Collection

Approximately 74 percent of all refuse generated in the windward service area is

Table 2-1

PROJECTIONS OF POPULATION AND MUNICIPAL SOLID WASTE QUANTITIES ON OAHU

	Fiscal Year 1975-76	1980	1985	1990	1995	2000
Defacto Population*	759,700	819,900	908,600	1,005,800	1,111,500	1,226,300
Assuming an Increasing Rate of Generation**						
Pounds per Capita per Day	3.34-3.82	3.61-4.13	3.99-4.56	4.19-4.79	4.40-5.03	4.62-5.29
Municipal Solid Waste in Tons per Day	1270-1450	1480-1695	1810-2070	2110-2410	2445-2795	2830-3245
Assuming a Stable Rate of Generation						
Pounds per Capita per Day	3.34-3.82	3.34-3.82	3.34-3.82	3.34-3.82	3.34-3.82	3.34-3.82
Municipal Solid Waste in Tons Per Day	1270-1450	1370-1565	1515-1735	1680-1920	1855-2120	2045-2340

*Includes resident population plus average daily visitor population.
**Annual increase of two percent to 1985 and one percent thereafter.

SOURCE: Analysis of the Feasibility of Resource Recovery for Honolulu, April 1977.

Table 2-2

REFUSE DISPOSED AT KAPAA SANITARY LANDFILL
(1975-76 Fiscal Year)

Collector	From Windward (TPD)	From Leeward (TPD)	Total (TPD)
Municipal (C&C)	116	70	186
Private (Commercial and Demolition)	43*	273	316
Public (Self Haul)	Unknown	Unknown	101
		Total	603

Source: Analysis of the Feasibility of Resource Recovery for Honolulu, April 1977, Table 2-X with numbers converted to TPD by dividing by 365, except as otherwise noted.

*Division of Refuse data.

Table 2-3

REFUSE DISPOSED AT KAPAA IN APRIL 1977

Collector	Vehicles per Day	Tons per Day
Municipal (C&C)		
Collection Trucks	22	124
Transfer Trucks	4*	65
Other C&C, e.g., Parks Dept.	2	17
Private (Commercial and Demolition)	160	687
Public (Self Haul)	189	33
Other (Self Haul)	2	9
	379	935

Source: Monthly Disposal Record, except as otherwise noted, with numbers converted to "per day" by dividing by 30.

*From Daily Work Sheet.

Table 2-4

PROJECTED REFUSE DISPOSED AT KAPAA (TPD)

Collector	April 1977[1]	Initially[2]	1980[3]	1985[4]
Municipal (C&C)				
Collection Trucks	124	113	118	136
Transfer Trucks	65	65		
Other C&C, e.g., Parks Dept.	17	17	18	20
Private (Commercial and Demolition)	687	687	728	815
Public (Self Haul)	33	33	34	40
Other (Self Haul)	9	9	9	11
	935	859	907	1,022

1. From this report, Table 2-3.
2. Same as for April 1977 less leeward Municipal collections.
3. 6 percent increase in all collections.
4. 12 percent increase in all collections since 1980.

collected by the City & County of Honolulu. Private refuse operators collect most of the remaining 26 percent. Generally, all wastes generated by the military and by agricultural activities are collected and disposed of by themselves.

Municipal collection is provided 6 days per week, with a twice-a-week pickup from each residence. Refuse is collected by 3-man crews, each crew operating a 20 cubic yard compactor truck. Residential refuse with a density of approximately 150 pounds per cubic yard is compacted within the collection truck to a density of approximately 500 pounds per cubic yard. Each truck carries 4 to 5 tons of refuse per trip and makes one or two trips per day.

Compactor trucks are stationed at the Kapaa Base Yard, also known as the Kailua Collection Yard, and at the Laie Collection Yard. The collection crews begin their routes as early as 6:00 a.m. and continue until they are completed, generally requiring less than six hours.

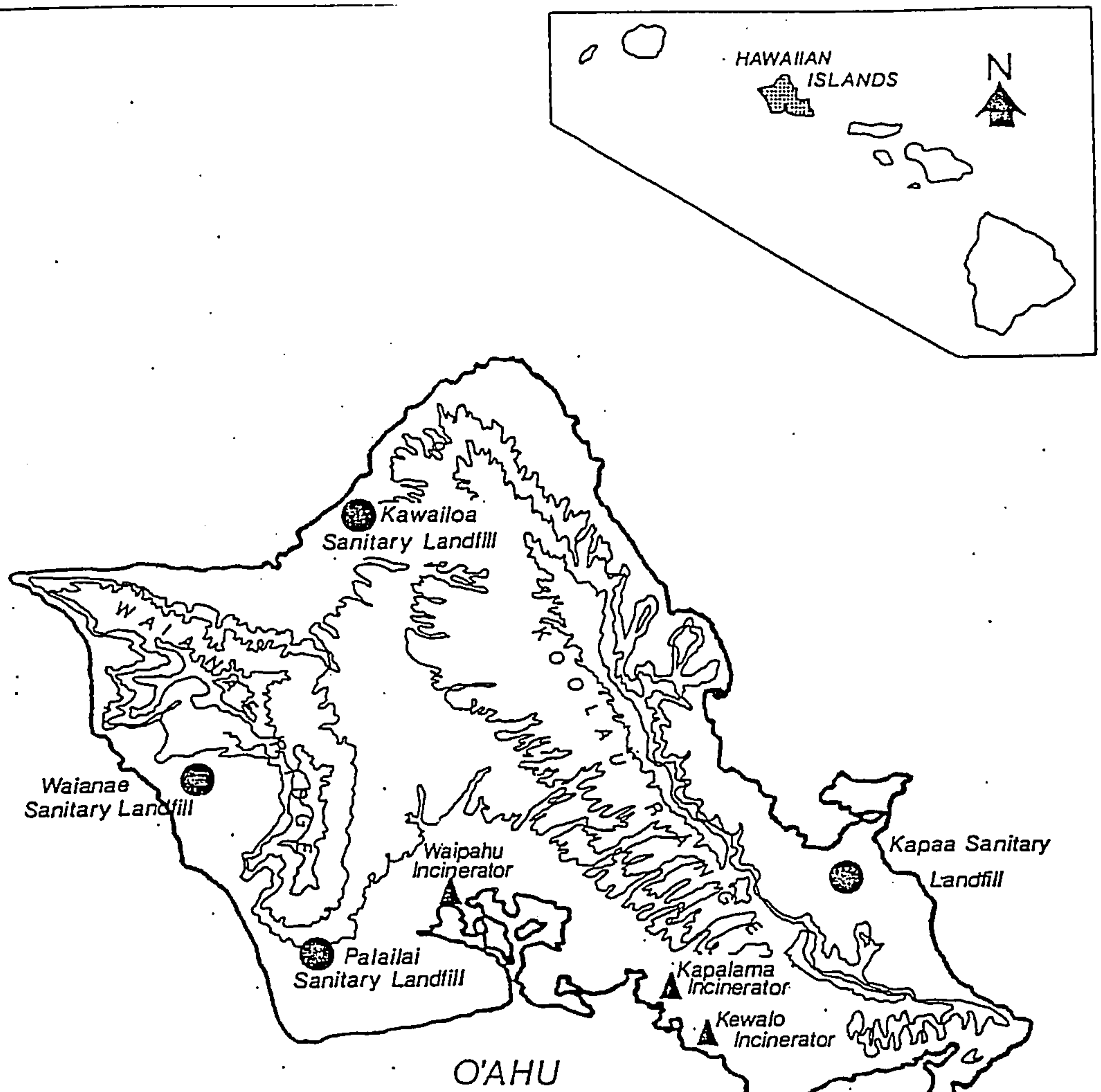
Figure 2-2 shows solid waste districts, collection yards and municipal disposal facilities on Oahu. Table 2-5 shows quantities collected according to collection yards.

2. Disposal

Generally, waste is disposed at the municipal facility closest to the last stop on a collection route. Waste generated within the Nuuanu and Hawaii Kai areas of the Honolulu District is disposed at Kapaa Sanitary Landfill and waste generated in the northern Koolauloa District is disposed at Kawailoa Sanitary Landfill. Table 2-6 shows disposed quantities according to municipal facility.

All municipal and private collection trucks using Kapaa Sanitary Landfill are weighed at the Kapaa Base Yard before proceeding to the landfill site. Private commercial haulers are assessed a fee by the City based on their tonnage load.

The Kapaa Landfill is open to the general public and a large number of leeward and windward residents use this site for disposal. They are not charged a disposal fee and account for the majority of weekend traffic. The hours of operation at the landfill are from 7:00 a.m. to 5:30 p.m. except Sundays when the hours are from 8:30 a.m. to 4:30 p.m. Based on existing disposal rates the Department of Public Works, Division of Refuse estimates that the Kapaa disposal site will be filled to capacity in less than one and one-half



Solid Waste Districts,
Collection and Disposal Facilities

LEEWARD SANITARY LANDFILL

0 5 10 miles
scale

figure 2-2

Table 2-5

COLLECTIONS BY COLLECTION YARD

Collection Yard	1972-73 Fiscal Year Tons	1972-73 % of Total	1973-74 Fiscal Year Tons	1973-74 % of Total	1974-75 Fiscal Year Tons	1974-75 % of Total	1975-76 Fiscal Year Tons	1975-76 % of Total
Honolulu	118,684	47.6	131,858	52.6	123,486	51.6	121,472	51.0
Pearl City	42,185	16.9	39,335	15.7	39,873	16.7	41,235	17.3
Kailua	59,376	23.8	47,414	18.9	42,521	17.8	41,287	17.3
Wahiawa	11,564	4.6	11,799	4.7	12,150	5.1	12,220	5.1
Waianae	8,452	3.4	10,139	4.0	10,017	4.2	9,652	4.0
Waialua	4,148	1.7	4,675	1.9	5,985	2.5	6,959	2.9
Laie	4,995	2.0	5,247	2.1	5,167	2.2	5,259	2.2
Total	249,404	100%	250,467	99.9%	239,199	100.1%	238,084	99.8%

Table 2-6

DISPOSAL BY MUNICIPAL FACILITY

Facility	1972-73 Fiscal Year Tons	1972-73 % of Total	1973-74 Fiscal Year Tons	1973-74 % of Total	1974-75 Fiscal Year Tons	1974-75 % of Total	1975-76 Fiscal Year Tons	1975-76 % of Total
Incinerator								
Waipahu	107,302	22.0	92,727	20.8	63,005	15.3	64,181	15.3
Kewalo	58,546	12.0	51,674	11.6	46,437	11.3	43,595	10.4
Kapalama	49,161	10.0	43,905	9.9	43,958	10.7	41,147	9.8
Subtotal	215,009	44.0	188,306	42.3	153,400	37.3	148,923	35.5
Landfill								
Kapaa	177,311	36.4	224,578	50.4	211,964	51.4	219,922	52.5
Kawailoa	10,993	2.3	20,641	4.6	21,377	5.2	19,300	4.6
Waianae	83,934 (Waipahu)	17.2	12,082	2.7	25,557	6.2	31,072	7.4
Subtotal	272,238	55.9	257,301	57.7	258,898	62.8	270,294	64.5
Total	487,247	99.9%	445,607	100%	412,298	100.1%	419,217	100%

Source for both tables: <u>Analysis of the Feasibility of Resource Recovery for Honolulu</u>, April 1977.

years. Expanding of existing landfill site will help meet refuse disposal needs for the windward area until resource recovery or waste utilization programs can be implemented.

II. PROJECT SITE

A. Location

The proposed landfill is located west of Interstate Route H-3 and Kawainui Swamp, north of the new HC&D Kappa Quarry and south of Mokapa Saddle Road in Kailua. It is located approximately 2000 feet northwest of the existing Kapaa landfill site and comprises approximately 100 ares.

B. Topography

The proposed landfill consists of a moderately deep hillside depression on the slopes of Kapaa Valley. Four defined gullies are located in the depression which begins at elevation 50 feet at the lower eastern end mauka to Interstate Route H-3 and rises westward to elevation 490 feet over a distance of 2300 feet. The site is approximately 1400 feet wide at its widest point.

The mauka-makai slope of the site varies from 6 percent at the lower end to 45 percent at the upper end with an average slope of about 23 percent. The transverse slope of the depression varies from 0 percent to 10 percent near its gullies and from 20 percent to 60 percent at its upper end. The depth of the depression from the top of the ridges to the gullies varies from 50 feet near the lower end to over 300 feet at the upper end.

C. Soils

According to the U.S. Soil Conservation Service Survey, soils generally consist of the following:

Helemano silty clay, 30% to 90% slopes occurs in the upper reaches; Alaeloa silty clay, 40% to 70% slopes occur in the major portion of the depression and Kawaihapai stoney clay loam, 2% to 6% slopes occcur in th lower gully.

D. Land Use

The site is zoned Preservation and Residential, general planned Agriculture, and designated Conservation by the State Land Use Commission. The site is currently in open space use and not utilized for any activity. Adjacent land uses and designations are identical to those of the site, except that land west of the site is general planned Preservation and State Land Use District is Urban east of the site.

Future land use of the area may be subject to change, although most of the area will remain in open space use.

E. Flora & Fauna

The biota of the Kalaheo site is composed of plant and animal species found elsewhere on Oahu and throughout the state. Avifauna inhabiting the project site include sparrow (Passer domesticus), barred dove (Geopelia striata), and rice bird (Lonchura punctalata).

Mammalian fauna include dog (Canis striata), cat (Felis catus) and mouse (Mus musculus). The mongoose (Herpestes Auropunctatus) and rat (Rattus rattus, R. noruegicus and R. exulans) are probably also present because of the existing landfill in the area.

To the east of the project site, Kawainui Swamp encompasses approximately 750 acres and is the largest freshwater marsh in Hawaii. Presently, according to a preliminary study done by the Water Resources Research Center (Ford, 1975), Kawainui is believed to provide habitat and feeding grounds for four endangered waterbird species: The Hawaiian coot (Fulica americana alai), the Hawaiian duck or Koloa (Anas wyuilliana), the gallinule (Gallinula chloropus sandvicensis) and occasionally the Hawaiian stilt (Himanotopus himanotopus knudseni). Some species inhabiting Kawainui Swamp may also frequent the project site.

F. Archaeology

There are no known sites of historical significance located on the Kalaheo Landfill site (Hawaii Register of Historic Places, 1974).

G. Hydrology

There are no groundwater supplies at the proposed landfill sites. (Shimabukuro 1976).

H. Infrastructure

Access

The site is not accessible to vehicular traffic. Access is not permitted from the adjacent H-3 Freeway. A new access must be constructed from the Kapaa Quarry Road east of H-3 Freeway, including an overpass structure over H-3.

Water

Water from a 36 inch transmission line that parallels the Kapaa Quarry Road would have to be extended to the project site.

Power

Overhead power lines presently cross the site and must be relocated.

Telephone

Overhead telephone lines presently serve the Kapaa base yard and must be extended to the project site.

Sewer

Sanitary facilities must be installed to accommodate sewage from the temporary operation and maintenance facilities.

Drainage

Storm runoff from approximately 130 acres is conveyed by four defined gullies which converge into one and connects to an existing 120 inch drain pipe across Interstate H-3. Drainage works will be required for the access road.

SECTION 3

ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATIVE MEASURES THAT MAY BE TAKEN TO MINIMIZE ADVERSE IMPACTS

I. NOISE

Noise will be generated by the operation of general construction equipment during site development and access construction. General construction noise should not present a significant problem in the area, since the adjacent areas are vacant. General construction noise can be better mitigated by limiting the hours of construction. In addition, the contractor will ensure that all mufflers on construction equipment are functional and properly maintained.

Noise levels may increase during operation of the proposed project and may be of some nuisance to Kalaheo Intermediate School located approximately one-half mile makai of the project site.

II. AIR QUALITY

Ambient air quality will be affected by dust and exhaust emissions generated during site preparation activities and acccess construction. Dust and emissions may be a short-term nuisance but will be mitigated by appropriate measures. Dust levels will be controlled by water-wagons and/or other water sprinkling systems as required. Roadways near the project site will be periodically sprinkled to contain and control vehicular dust generation.

Combustion emissions from construction vehicles and

CORRECTION

THE PRECEDING DOCUMENT(S) HAS BEEN REPHOTOGRAPHED TO ASSURE LEGIBILITY
SEE FRAME(S)
IMMEDIATELY FOLLOWING

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Combustion emissions from construction vehicles and equipment are not anticipated to cause a significant problem. Control measures will be taken to minimize the discharge and will include, but not to be limited to, the proper maintenance and operation of equipment to promote maximum efficiency and minimum discharge.

Air quality may be altered by the generation of dust during landfilling activities and the escape of gases from refuse decomposition within the landfill. Dust levels can be minimized by water sprinkling as required. Methane gas, a by-product of organic material decomposition within the landfill, is a potentially explosive gas if allowed to accumulate in pockets within the landfill. Methane hazard will be reduced through the proper venting system in the landfill that allows methane to escape into the open atmosphere and be diluted and dispersed by prevailing winds.

III. LAND ALTERATION

Site development activities and access construction will alter the land form and remove existing vegetation. These activities will comply with the County Grading Ordinance relating to grubbing, grading and dirt stockpiling.

IV. FLORA AND FAUNA

During site development, access construction and project implementation, site vegetation will be removed and it is anticipated that site wildlife will relocate to other areas. The site will be developed by sections and will be landscaped as each section is completed. Operation of the proposed project is not anticipated to significantly affect wildlife at surrounding areas.

V. WATER SUPPLY

The water quality of Kawainui Swamp is not anticipated to be altered as previous landfill operations within the swamp, makai of the Kapaa Quarry Road, have not significantly altered the water quality of the swamp. This information is based on previous studies conducted for the City and County of Honolulu. As proposed landfilling activities will occur at a greater distance from the swamp, mauka of the Kapaa Quarry Road, effects on water quality will be even less.

VI. VECTORS

Rodents and insects may be attracted to the landfill if proper sanitary landfilling procedures are not followed. With the provision of daily soil cover upon compacted unprocessed waste within the landfill, rodents and flies will not be attracted, and are not anticipated to be a problem. Shredded refuse, if left uncovered, is not anticipated to attract vectors.

VII. LITTER

Litter will be generated in the area where refuse is deposited by collector and transfer trailer trucks.

Litter is not expected to be a problem as all refuse will be compacted and covered within a 6 inch soil mantle at the end of each working day. Portable litter control fences will be used to contain blowing litter, if needed.

VIII. ODOR

Odor will be generated in varying levels according to refuse composition, and the length of time it remains uncovered. The daily application of cover material on compacted refuse and/or the use of chemical masking agents should mask decomposing waste odors. Odor is not anticipated to affect surrounding areas which are vacant.

IX. FIRE

Fires are a potential hazard if proper sanitary landfilling procedures are not followed. Potential fires can be prevented by construction at vented refuse cells and daily application of 6 inches of suitable cover material over the compacted refuse.

X. DRAINAGE

Surface drainage works will be minimal due to a small drainage area. Drainage works will be required for the access road.

XI. VISUAL

The site and sanitary landfill activities will be visible to motorists along Interstate H-3 and Mokapu Saddle Road. Landscaping will be provided to minimize adverse visual effects as much as possible before, during and after landfill operations.

XII. TRAFFIC

A 2,000 foot access road is required from Kapaa Quarry Road including an overpass structure over Interstate H-3. The access road and overpass structure may alter the existing traffic patterns on Kapaa Quarry Road but is not anticipated to affect the traffic flow.

XIII. ARCHAEOLOGICAL-HISTORICAL SIGNIFICANCE

There are no known sites of Archaeological or Historical Significance located on the Kalaheo Landfill Site (Hawaii Register of Historic Places, 1974).

SECTION 4

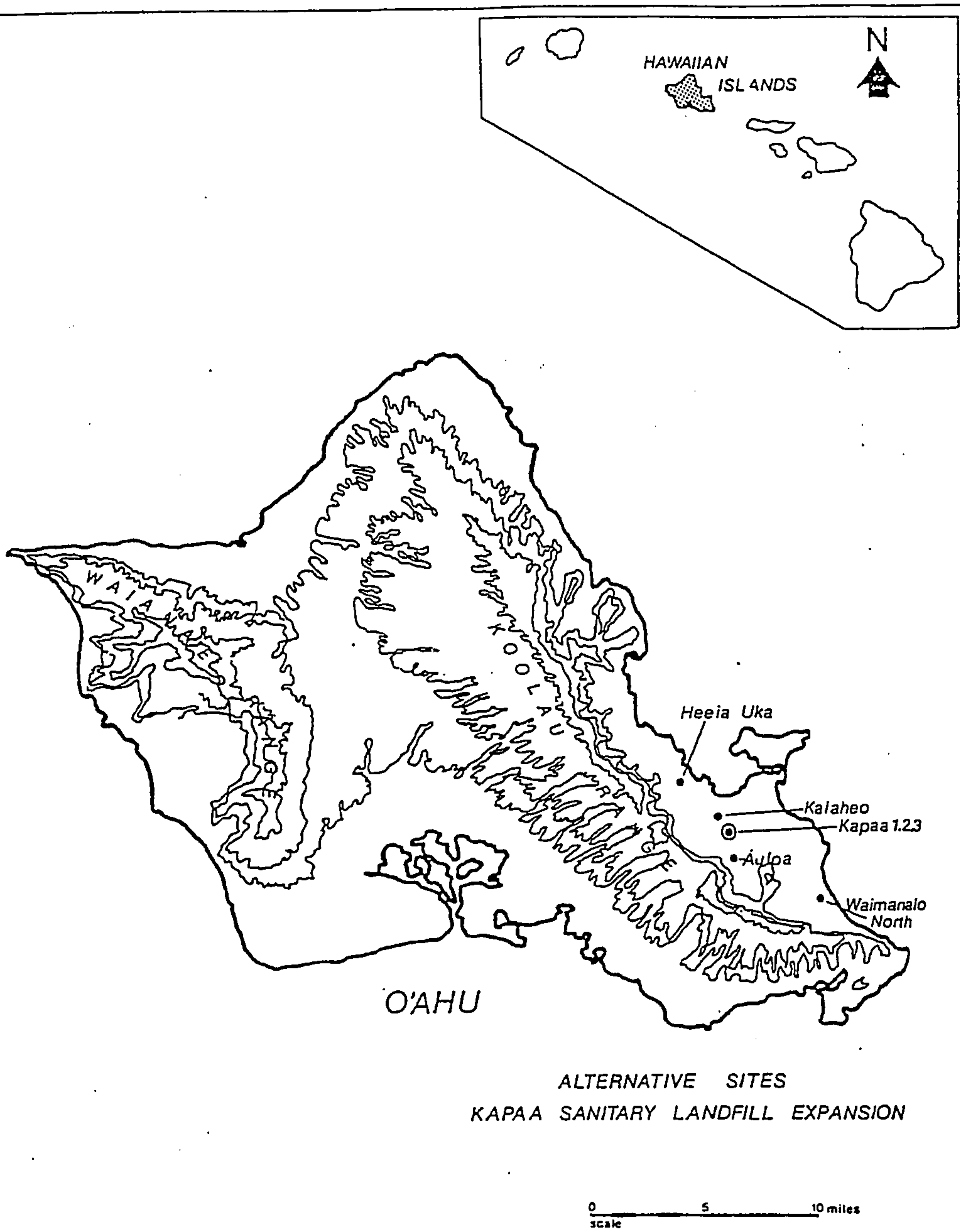
ALTERNATIVES TO THE PROPOSED ACTION

I. NO ACTION

If the proposed project is not implemented, refuse disposal for the windward area will be severely impacted. The life for the existing landfill is estimated to be a little over a year after which time a disposal site will be needed. If refuse must be hauled over a long distance to another site, transport and labor costs will increase.

II. ALTERNATIVE SITES

Several alternative sites in the windward area were investigated for their landfill potential, and these include sites in Kapaa, Heeia, Waimanalo North and Auloa (see Figure 4-1). These sites were evaluated according to specific environmental, social and/or economic criteria, including: a) refuse hauling distance, b) landfill capacity, c) available utilities for the site, infrastructure and access, d) available cover material, e) compatible existing and proposed land uses of the site and surrounding areas, f) displacement of families or businesses, g) site acquisition, development and operation costs, h) environmental compatibility of site according to climatology, geology, drainage and hydrology, i) social and cultural compatibility of site according to surrounding land uses, affect on sites of archaeological or historical significance, i) visual intrusion and k) acceptability by landowner, adjacent landowners



ALTERNATIVE SITES
KAPAA SANITARY LANDFILL EXPANSION

figure 4-1

e.i.s.c.

and the community.

The optimum landfill site would produce the least environmental and social disruption at the least economic cost. It would be located close to major refuse generation centers, remote from residential areas, schools and hospitals, have sufficient cover material (soil) and require minimal improvements.

The proposed Heeia, Waimanalo North and Aulou landfill sites have several disadvantages which make them less attractive as alternative sanitary landfill sites. These include:

Heeia

a) short landfill life (approximately 5 years)

b) portions of the site are zoned R-6 and the surrounding areas are residential. There is some opposition from adjacent land owners

c) the site is visually prominent from Kahekili Highway and will require heavy landscaping for screening landfill operations to minimize visual pollution

d) high speed traffic on Kahekili Highway would be interrupted by landfill traffic and on and off ramps would need to be constructed to minimize traffic congestion

Waimanalo North

a) turnoff access from Kalanianaole Highway would interrupt thru traffic and increase traffic hazard

b) residential area to the south of site

c) approximately 1800 feet of the old Kalanianaole Highway will need to be upgraded and a 1500 foot access road will need to be constructed

Auloa

a) near residential community

b) traffic may create problems since Auloa Road is narrow and goes through a residential area

c) there are strong objections from the surrounding community and from adjacent land owners

Of the five proposed landfill sites, Kalaheo and Kapaa appear more advantageous based on the selection criteria outlined above. However, the high developmental cost resulting from the construction of an access road and an overpass structure for Kalaheo may make Kapaa more ideally situated as a sanitary landfill.

III. ALTERNATIVE DISPOSAL/PROCESSING METHODS

Disposal of refuse can occur either on land or at sea. However, ocean disposal of solid waste is currently prohibited by the U. S. Environmental Protection Agency.

Alternatives to sanitary landfills to process waste include: 1) shredding, 2) incineration, 3) baling and 4) waste utilization, including composting, pyrolysis, recycling and steam and energy generation. These alternative processes, however, cannot totally dispose of solid waste; a landfill is, therefore required to dispose of waste that cannot be processed or to dispose of residues resulting from processing. Of the alternatives, incineration is the only method with extensive data on operation, efficiency and cost.

The newest type of solid waste management is resource recovery. Although it is attractive from an environmental viewpoint, it has yet to prove itself in terms of economics and efficiency. In other parts of the country pilot programs are currently being studied and will provide much information necessary to completely evaluate these recovery processes.

SECTION 5

DETERMINATION AND FINDING AND REASONS SUPPORTING DETERMINATION

In accordance with Chapter 343, Hawaii Revised Statutes, this agency has determined that an Environmental Impact Statement for the proposed Kalaheo Landfill Site is required.

The proposed project may generate impacts affecting ambient air quality, landform, drainage channels, noise levels, vegetation, and wildlife. Operation of the landfill may also generate visual impacts. In addition, the project will be developed using County funds.

SECTION 6

PUBLIC AGENCIES CONSULTED DURING THE ASSESSMENT

State

Department of Land and Natural Resources

City and County of Honolulu

Board of Water Supply
Department of Land Utilization

SECTION 7

AGENCIES TO BE CONSULTED IN THE PREPARATION OF THE EIS

Federal

U.S. Army Engineer District, Honolulu
U.S. Army Support Command, Hawaii
U.S. Department of Agriculture, Soil Conservation Service
U.S. Department of Interior, Fish and Wildlife Services

State

Department of Agriculture
Department of Health
Department of Land and Natural Resources
Department of Planning and Economic Development
Department of Transportation
Office of Environmental Quality Control

City and County

Department of General Planning
Department of Land Utilization
Department of Parks and Recreation
Department of Transportation Services
Board of Water Supply, Honolulu

Others

Life of the Land
Lani-Kailua Outdoor Circle
Ad Hoc Committee for Kawainui
Ad Hoc Committee for Windward Landfill Site
Windward Regional Council
Kaneohe Community Council
Kailua Community Council
Neighborhood Board 30
Neighborhood Board 31
Community groups along Windward coast

RECEIVED AS FOLLOWS

APPENDIX H.

REFERENCES

APPENDIX H

REFERENCES

1. Solid Waste Management Plan for City and County of Honolulu, Metcalf & Eddy, Inc., July, 1971.

2. Feasibility of Power Generation from Solid Wastes on Oahu, Sunn, Low, Tom & Hara, Inc., Metcalf & Eddy, Inc., Feb., 1975.

3. Sanitary Landfill, ASCE Manuals and Reports on Engineering Practice - No. 39, 1976.

4. Decision Makers Guide - Solid Waste Management, U.S. Environmental Protection Agency, 1976.

5. Sanitary Landfill Design and Operation - U. S. Environmental Protection Agency, 1972.

6. Sanitary Landfill Technology, Samuel Weiss, 1974.

7. Zoning Maps, City & County of Honolulu.

8. General Plan, City & County of Honolulu.

9. Detail Land Use Map, State of Hawaii.

10. Special Management Area Maps, City & County of Honolulu.

11. Planning Department Aerial Photo Contour Maps, 1" = 200', City & County of Honolulu.

12. U.S.G.S. Topographic Maps, 1 : 24,000 scale.

13. Drainage Standards, City & County of Honolulu.

14. Waste Age, January 1975.

15. Solid Waste Journals.

16. Hawaii Water Resources Regional Study, Baseline Population Projections, Study Element Report, 1976.

17. Mitre Corporation Report, Analysis of the Feasibility of Resource Recovery for Honolulu, April 1977.

APPENDIX D

Supplement to Inventory of Potential Sanitary and Demolition Landfill Sites on the Island of Oahu

City and County of Honolulu
Department of Public Works

November 1979

SUPPLEMENT TO
INVENTORY OF POTENTIAL
SANITARY AND DEMOLITION LANDFILL SITES
ON THE ISLAND OF OAHU

PREPARED FOR THE

CITY AND COUNTY OF HONOLULU

DEPARTMENT OF PUBLIC WORKS

DIVISION OF REFUSE COLLECTION AND DISPOSAL

BY

STANLEY S. SHIMABUKURO AND ASSOCIATES, INC.

1126 - 12th Avenue

Honolulu, Hawaii 96816

November 1979

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I. PURPOSE OF SUPPLEMENTAL STUDY

I. PURPOSE OF SUPPLEMENTAL STUDY

The purpose of this supplemental study is to:

A. Develop new landfill site selection criteria by use of a matrix.

B. Re-evaluate the Leeward sites contained in Appendix C of "Inventory Study of Potential Sanitary and Demolition Landfill Sites" (Shimabukuro-1977).

C. Conduct inventory study based on new site selection criteria.

D. Gather, develop and evaluate new site data.

E. Prepare and file Notice of Preparation for an Environmental Impact Statement.

F. Select sites for further study.

G. Make final site selection recommendations to the City.

H. Prepare conceptual development plan of site selected by the City.

I. Prepare cost/capacity data of site.

J. Prepare a report on the study.

To carry out Part I, Purpose of Supplemental Study, the following Site Selection Process was organized:

1. Develop and apply new site selection criteria (matrix) and complete items A thru E of the purpose. This task involved the development of a new landfill site selection matrix which was used to re-evaluate the sites contained in the original study and to evaluate new potential

landfill sites. It included the filing of Notice of Preparation for an Environmental Impact Statement to obtain input from the public and other government agencies. Descriptions of the various potential sites are contained in Part II, Detailed Site Data and Descriptions, and the matrix used for the site evaluations in Part III, Site Selection Matrix.

2. Evaluate input from the public and other government agencies and recommend potential landfill sites and complete items F and G of the Purpose after all potential sites have been evaluated. This task involved the selection of high potential sites for further evaluation and the recommendation of the best of these sites for final site selection by the City. Evaluation of the sites are contained in Part IV, Discussion and Recommendation, and views of the sites are shown in Part V, Aerial Views of Recommended Sites (later).

3. Submit copies of the preliminary report, Parts I thru IV, to the City and County of Honolulu for distribution to the Neighborhood Boards for further review, comments and input on the recommended sites. This task assured community involvement in the Site Selection Process.

4. After input from the Neighborhood Boards have been evaluated and final site selections by the City have been made, complete items H thru J of the Purpose. These tasks included the preparation of a conceptual development plan, cost/capacity data of the site, and a report of the study. The plan and data are discussed in Part VI, Conceptual Development Plan and Cost Estimate for Selected Site (later).

5. Prepare an Environmental Impact Statement for the Leeward District Sanitary Landfill after site has been selected by the City. This task is required by Chapter 343, HRS, State of Hawaii (later).

Reader is referred to the original study "Inventory Study of Potential Sanitary and Demolition Landfill Sites" (Shimabukuro-1977) for background to this Report and to Plate No. 1 for the general location of potential landfill sites discussed in this Report.

II. DETAILED SITE DATA AND DESCRIPTIONS

BARBERS POINT LANDFILL SITE

A. BASIC DATA OF SITE

1. Location: An abandoned quarry site adjacent to Barbers Point Naval Air Station main entrance, about 1.5 miles south of Interstate Route H-1, about 2 miles southeast of Makakilo on the Ewa plains of Leeward Oahu. See Plate No. 2.

2. Tax Map Key: 9-1-16 : 18 and portion of 1

3. Total Area: 15 acres

4. Owner: James Campbell Trust Estate and leased to Oahu Sugar Co., Ltd. and to Benjamin Kekona.

5. Present Use of Land: Open space, junkyard and canefields.

6. City Zone District: Agriculture AG-1

7. City General Plan Land Use: Agriculture

8. State Land Use District: Agricultural

9. Adjacent Land Uses, Zones: Residential, Military, Urban, Agriculture

10. Restrictions and Setbacks: Special Permit required from State for construction in Agricultural District. Site is being used by Oahu Sugar as source of irrigation water.

11. Historical and Archaeological Significance: No sites known to exist.

12. Proximity to Population and Refuse Centers: 2 miles southeast of Makakilo, 8 miles southeast of Nanakuli, 7 miles southwest of Waipahu and 18 miles from Keehi Refuse Transfer Station.

B. DESCRIPTION OF SITE

1. Accessibility: Accessible from Barbers Point Access Road via Farrington Highway or Interstate Route H-1.

2. Topography: Pit created by past coral quarry operation with top of pit at about elevation 60 feet. Pit is about 1,000 feet long, 400 feet wide and 60 feet deep. Surface runoff collects at low point of pit during inclement weather in a pond used by Oahu Sugar as a source of irrigation water.

3. Soil Classification: Site consists of the following soils taken from S.C.S. Soil Survey:

Ewa silty clay loam, moderately shallow, 0 to 2% slopes
Mamala stony silty clay loam, 0 to 12% slopes
Coral outcrop

See Appendix E.

4. Availability of Cover Material: Little available on site and must be imported.

5. Surface Drainage: Some surface runoff enters pit by sheet flow.

6. Groundwater Supply: Outside BWS groundwater zone. Irrigation water supply for Oahu Sugar Company.

7. Rainfall: 20 inches per year. See Appendix I.

8. Wind: Prevailing wind in direction of populated area more than 50% of the time.

9. Existing Utilities: Electricity and telephone are available on site. Potable water and sanitary sewer not available on site or adjacent to site. Pumps and 24" steel pipe irrigation water transmission line located on site.

C. SITE AS LANDFILL

1. Usable Area: 15 acres

2. Type of Operation: Combination of trench and area methods

3. Capacity: 740,000 cubic yards

4. Life: 1.5 years

5. Land Use After Development: Open space

D. ENVIRONMENTAL CONCERNS OF SITE

1. General Landfill Nuisances: Noise, dust, pests, odor and litter associated with landfill operations will be generated. Effective control measures must be instituted to minimize landfill nuisances.

2. Visual Pollution: Since most of site is a pit, site is slightly visible to the public from Barbers Point Access Road and from the Barbers Point N.A.S. adjacent to the site. Site is very visible from canefields and B. Kekona's lease. Landscaping prior to, during and after landfilling operations will minimize visual pollution. Landfill expected to rise about 10 feet above existing ground.

3. Groundwater Pollution: No protection measures required. Area is not a source of groundwater supply.

4. Surface Drainage Works: Nominal site drain system must be constructed to route surface runoff around the site and to minimize infiltration.

5. Destruction of Natural Resources: Land will be committed to landfill. However, the site can be reverted to open space after landfill operations are completed.

6. Displacement: Irrigation water source will be displaced. Landfill will be constructed on a junkyard located in a portion of the abandoned quarry pit and on a portion of canefield.

7. Other Environmental Concerns: Traffic will increase on Barbers Point Access Road and the addition of an intersection at the site will increase hazards.

   Impact on flora and fauna is not expected to be significant and these and other concerns will be discussed in detail in an environmental impact statement if this site is selected.

8. Safety: Operational hazard to the public is minimal.

9. Objection by Owner and Adjacent Landowners: Opposition from residents of Barbers Point N.A.S. located adjacent and makai of the site and from Benjamin Kekona, lessee, can be expected.

10. Objections by Public, Community Organizations: Adjoining communities and organizations with interests for preservation of the existing environment will probably express their objections.

E. SITE PREPARATION FOR LANDFILL

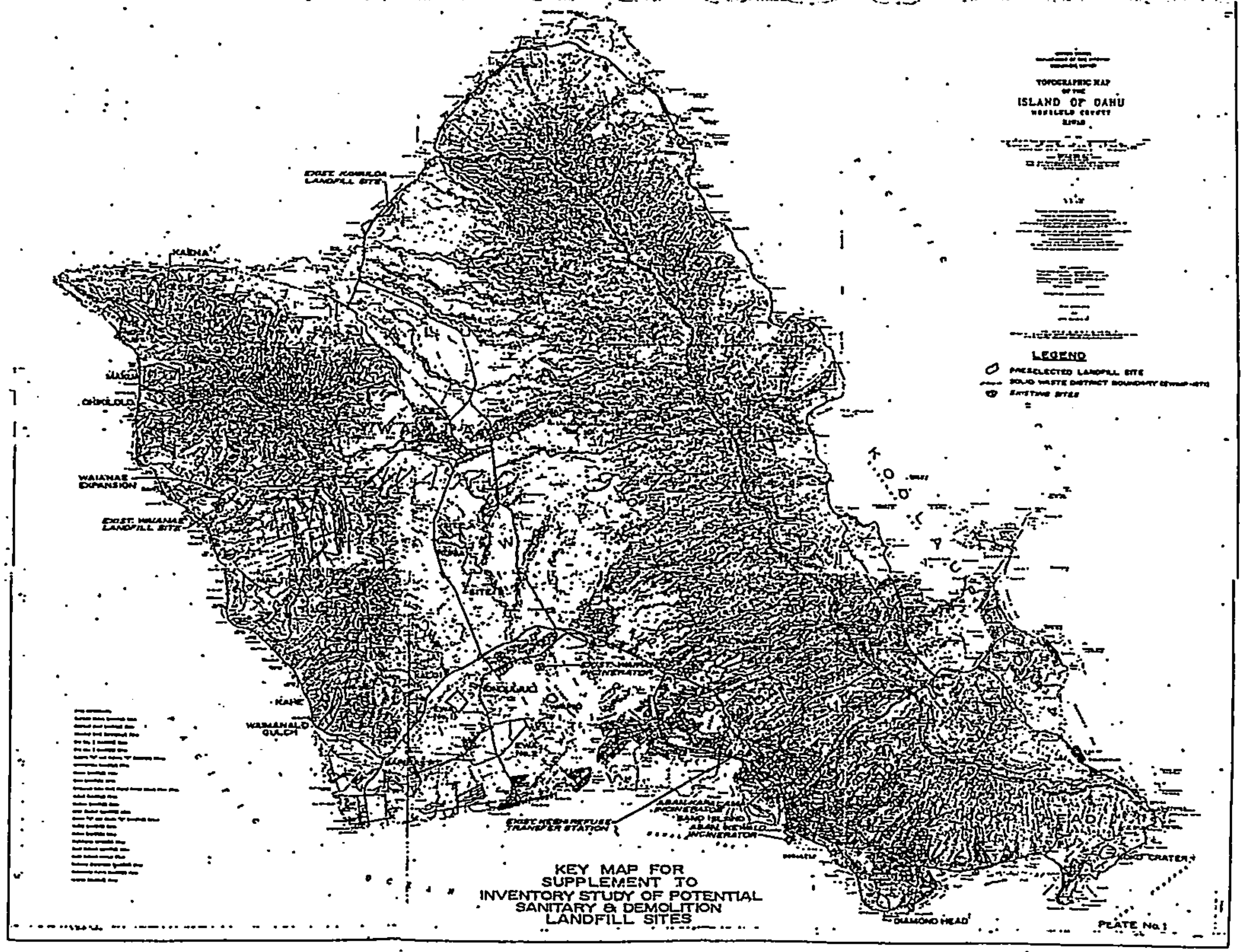
1. Access Road: Improvements must be constructed on Barbers Point Access Road to provide a safe intersection. About 500 feet of new access road must be constructed to the site.

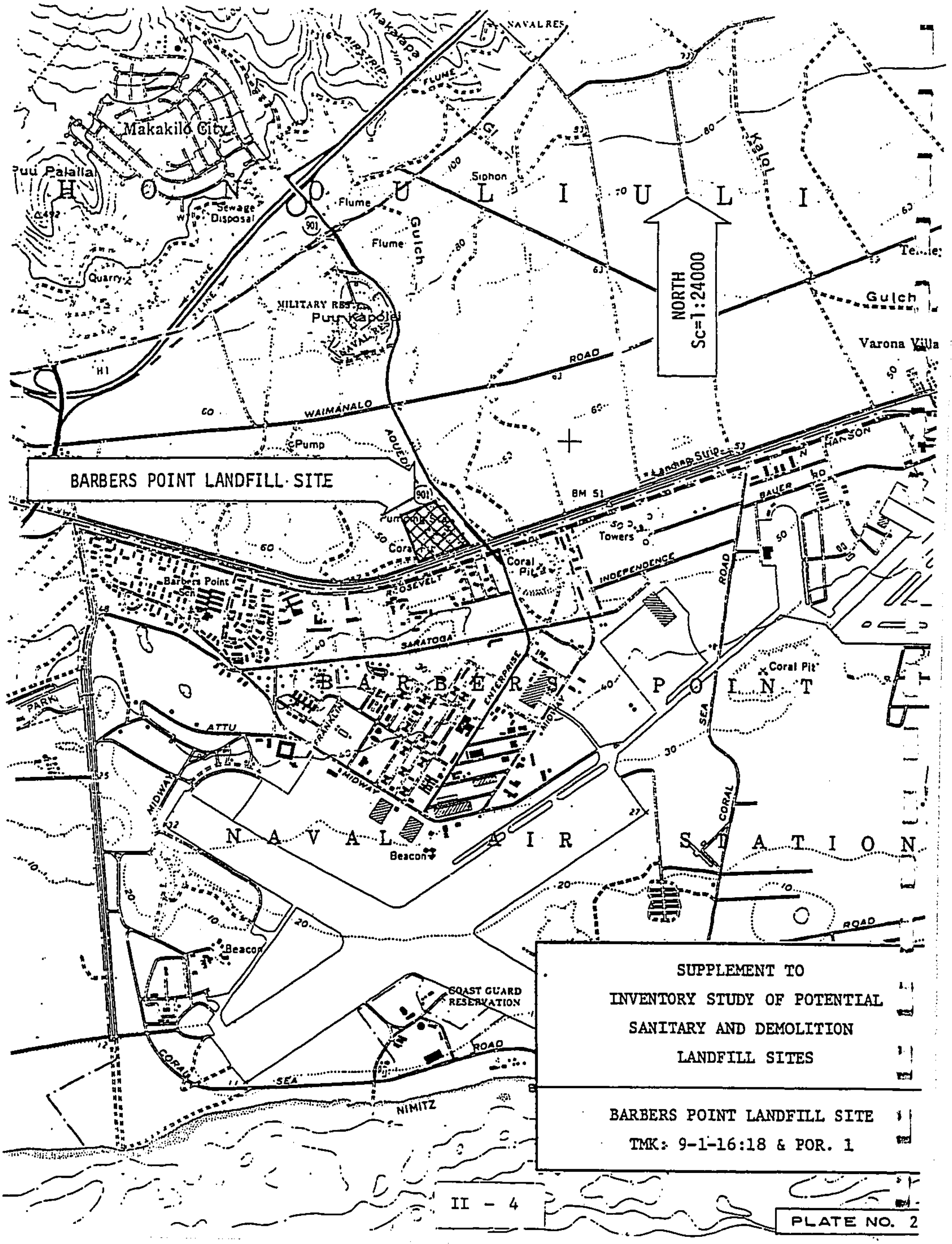
2. Operations and Maintenance Facilities: Temporary facilities must be constructed.

3. Utilities: Electricity and telephone available on site. Water and sanitary sewer system must be installed or extended to the site.

4. Drainage System: A nominal drainage system must be constructed.

5. Leachate Control System: None required but leachate movement should be monitored.


TOPOGRAPHIC MAP
ISLAND OF OAHU
LEGEND
PRESELECTED LANDFILL SITE
SOLID WASTE DISTRICT BOUNDARY
EXISTING SITES
EXIST. KAWAILOA LANDFILL SITE
KAENA
WAIANAE EXPANSION
EXIST. WAIANAE LANDFILL SITE
KAHE
WAIMANALO GULCH
EXIST. WAIPAHU INCINERATOR
EXIST. KEEHI REFUSE TRANSFER STATION
SAND ISLAND
DIAMOND HEAD
KOKO CRATER
PACIFIC
OCEAN
KEY MAP FOR
SUPPLEMENT TO
INVENTORY STUDY OF POTENTIAL
SANITARY & DEMOLITION
LANDFILL SITES
PLATE No. 1


BARBERS POINT LANDFILL SITE
NORTH
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H O N O U L I U L I
B A R B E R S P O I N T
N A V A L A I R S T A T I O N
Makakilo City
Puu Palailai
Sewage Disposal
Quarry
MILITARY RES
Puu Kapolei
NAVAL RES
Flume
Siphon
Gulch
WAIMANALO
ROAD
Pump
Landing Strip
HANSON
BAUER
INDEPENDENCE
ROOSEVELT
SARATOGA
ENTERPRISE
FRANKLIN
MIDWAY
ATTU
PARK
SEA
CORAL
NIMITZ
Towers
Coral Pit
Barbers Point Sch
Beacon
COAST GUARD RESERVATION
Varona Village
Makakilo
AIRSTRIP
SUPPLEMENT TO
INVENTORY STUDY OF POTENTIAL
SANITARY AND DEMOLITION
LANDFILL SITES
BARBERS POINT LANDFILL SITE
TMK: 9-1-16:18 & POR. 1
PLATE NO. 2

DIAMOND HEAD LANDFILL SITE

A. BASIC DATA

1. Location: In the southwest portion of Diamond Head Crater in the Diamond Head State Monument on the southeastern end of Leeward Oahu. See Plate No. 3.

2. Tax Map Key: 3-1-42 : portion of 6

3. Total Area: 115 acres

4. Owner: State of Hawaii

5. Present Use of Land: Open space with National Guard and FAA facilities adjacent and to the northeast

6. City Zone District: Preservation, P-1

7. City General Plan Land Use: Military

8. State Land Use District: Conservation

9. Adjacent Land Uses, Zones: Park, Residential, Urban

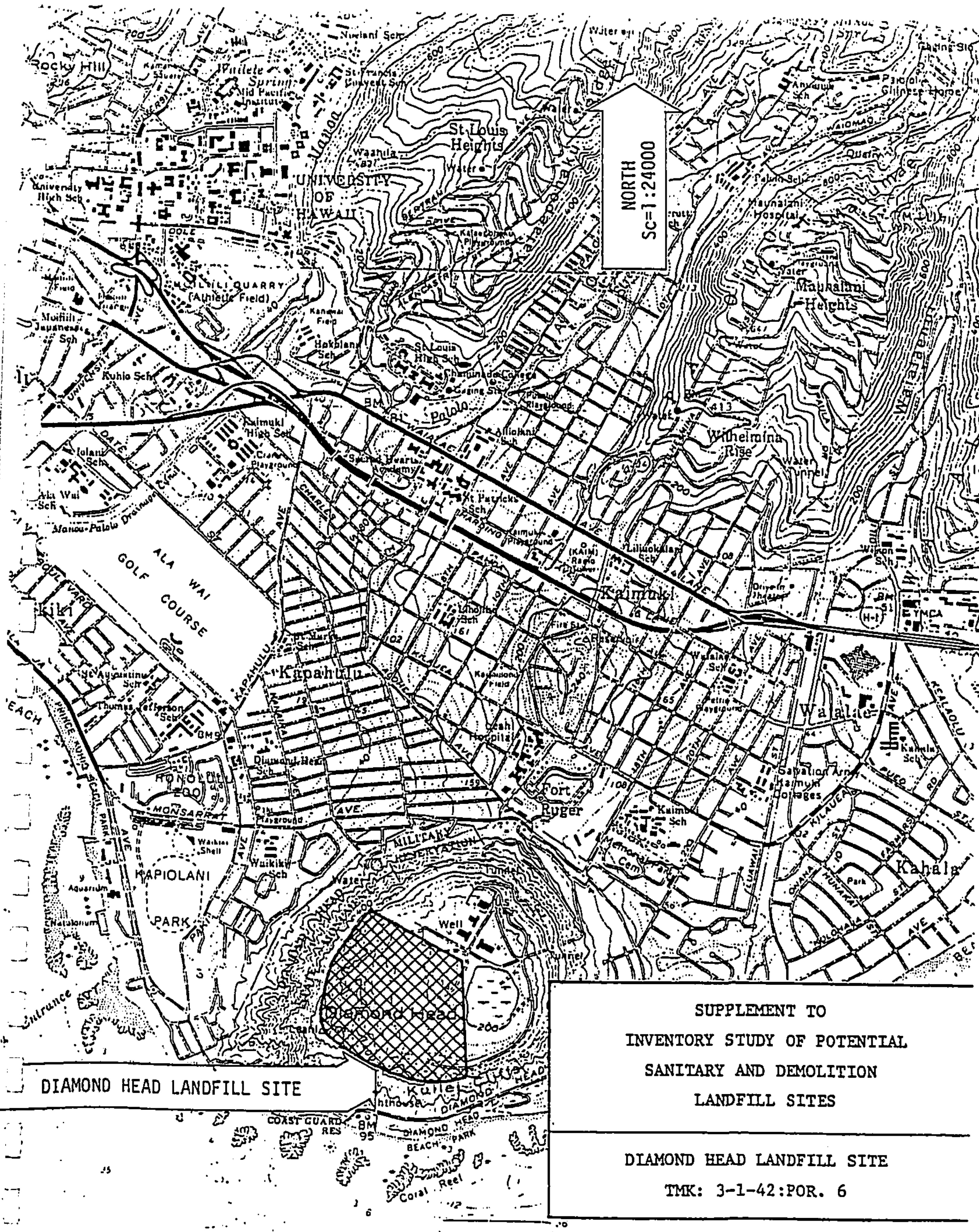
10. Restrictions and Setbacks: Special Permit required from State for construction in Conservation District. State has an approved conceptual plan of development for the Diamond Head State Monument and the stated objective of preserving and enhancing the natural beauty of the Monument is in conflict with the construction of a landfill in the Crater. See Plate No. 4.

11. Historical and Archaeological Significance: No archaeological sites known to exist. Diamond Head has been designated a State Monument and a Natural Landmark. It is known to millions of visitors, aside from Waikiki Beach, as Hawaii's most famous landmark. A Task Force of State, community and environmental organizations have accepted a conceptual plan to establish a Natural Wildlife Reserve recreational area in Diamond Head Crater.

12. Proximity to Population and Refuse Centers: Approximately 1,500 feet from the urban areas of Kapahulu, Waikiki, Kahala and Diamond Head which are buffered from the site by the crater walls. National Guard and Federal Aviation Agency facilities are located adjacent to the site in the north portion of the crater.

B. DISCUSSION

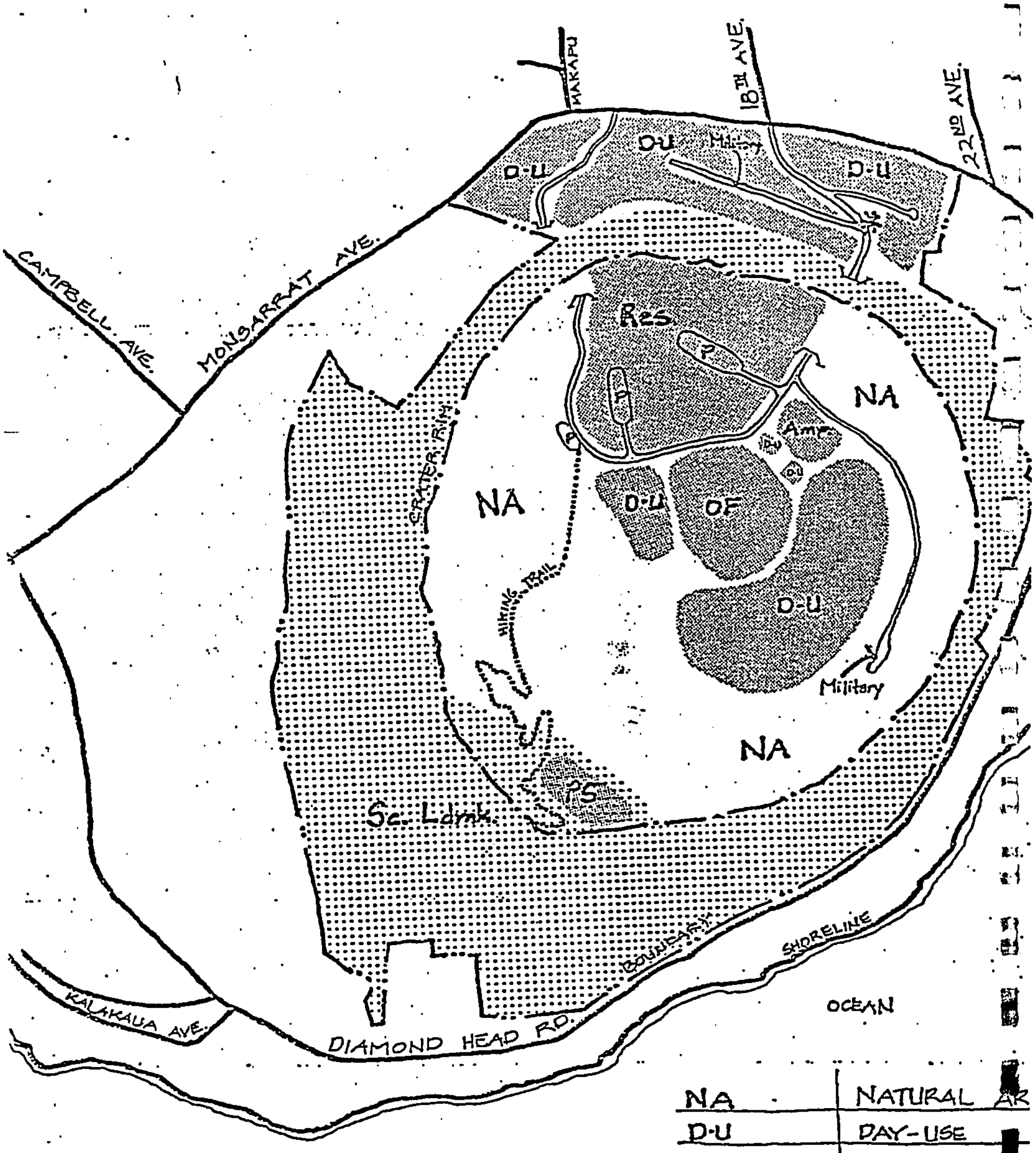
This site has been designated a State Monument and a Natural Landmark and will be developed as a Natural Wildlife Reserve recreational area. Because construction of a landfill at the site will conflict with present plans and policies, this Special Consideration will eliminate this site from further evaluation as a potential landfill site.



SUPPLEMENT TO
INVENTORY STUDY OF POTENTIAL
SANITARY AND DEMOLITION
LANDFILL SITES

DIAMOND HEAD LANDFILL SITE
TMK: 3-1-42:POR. 6

PLATE NO. 3



NA	NATURAL AR
D-U	DAY-USE
Amp.	AMPHITHEAT
OF	OPEN FIELD
PS	PLANT SANC
Sc. Ldmk.	SCENIC LAND
P	PARKING
Res.	RESERVE

DIAMOND HEAD

CONCEPTUAL PLAN

February 1978

SOURCE: State of Hawaii, Dept. of Land and Natural Resources, Diamond Head State Monument Conceptual Plan Report

EWA NO. 1 LANDFILL SITE

A. BASIC DATA OF SITE

1. Location: In canefield 1,200 feet south of Farrington Highway, 0.5 miles west of Honouliuli, 1 mile north of Ewa on the Ewa plains of Leeward Oahu. See Plate No. 5.

2. Tax Map Key: 9-1-17 : portion of 4

3. Total Area: 210 acres

4. Owner: James Campbell Trust Estate and leased to Oahu Sugar Co., Ltd.

5. Present Use of Land: Open space and canefields; prime land under intensive agricultural use.

6. City Zone District: Agriculture AG-1

7. City General Plan Land Use: Agriculture

8. State Land Use District: Agricultural

9. Adjacent Land Uses, Zones: Agriculture

10. Restrictions and Setbacks: Special Permit required from State for construction in Agricultural District. A 5-ft. wide Hawaiian Telephone Co. cable easement crosses the site.

11. Historical and Archaeological Significance: No sites known to exist

12. Proximity to Population and Refuse Centers: 1 mile north of Ewa, 3 miles east of Makakilo, 3 miles west of Waipahu and 14 miles from Keehi Refuse Transfer Station.

B. DESCRIPTION OF SITE

1. Accessibility: Accessible from Farrington Highway. About 1,500 feet of new access road thru canefield required to site.

2. Topography: Relatively flat land on the Ewa plain with elevation of about 105 feet at the lower end, slopes up at 1 to 2%, and elevation 150 feet at the upper end 3,100 feet away.

3. Soil Classification: Site consists of the following soils taken from the S.C.S. Soil Survey:

   Honouliuli clay, 0 to 2% slopes
   Kunia silty clay, 0 to 3% slopes
   Waipahu silty clay, 0 to 2% slopes
   Waipahu silty clay, 2 to 6% slopes

   See Appendix E.

4. Availability of Cover Material: Available on site.

5. Surface Drainage: Surface runoff flows by sheet across site.

6. Groundwater Supply: Outside of BWS groundwater zone. Movement of groundwater must be determined.

7. Rainfall: 25 inches per year. See Appendix I.

8. Wind: Populated area of Honouliuli located upwind of site and prevailing wind in that direction less than 10% of the time.

9. Existing Utilities: None available on site.

C. SITE AS LANDFILL

1. Usable Area: 150 acres

2. Type of Operation: Combination of trench and area methods

3. Capacity: 12,000,000 cubic yards

4. Life: 25 years

5. Land Use After Development: Open space

D. ENVIRONMENTAL CONCERNS OF SITE

1. General Landfill Nuisances: Noise, dust, pests, odor and litter associated with landfill operations will be generated. Effective control measures must be instituted to minimize landfill nuisances.

2. Visual Pollution: Site is visible to the public from Farrington Highway during periods when cane has been harvested and will not be visible during other periods. Landscaping prior to, during and after landfilling operations will minimize visual pollution. Landfill expected to rise about 5 to 10 feet above existing ground.

3. Groundwater Pollution: No protection measures required. Area is not a source of groundwater supply.

4. Surface Drainage Works: Nominal site drain system must be constructed to route surface runoff to adjacent canefield to minimize surface runoff infiltration.

5. Destruction of Natural Resources: Prime agricultural land will be committed to landfill. However, the site can be reverted to light agriculture or open space after landfill operations are completed.

6. Displacement: None. Prime land will be removed from intensive agricultural use.

7. Other Environmental Concerns: Traffic will increase on Farrington Highway and the addition of an intersection will increase hazards.

   Impact on flora and fauna is not expected to be significant and these and other concerns will be discussed in detail in an environmental impact statement if the site is selected.

8. Safety: Operational hazard to the public is minimal.

9. Objection by Owner and Adjacent Landowners: Strong opposition from the Campbell Estate and Oahu Sugar Co., Ltd. can be expected.

10. Objections by Public, Community Organizations: State of Hawaii, nearby communities and organizations with interests for preservation of the existing environment will probably express their objections.

E. SITE PREPARATION FOR LANDFILL

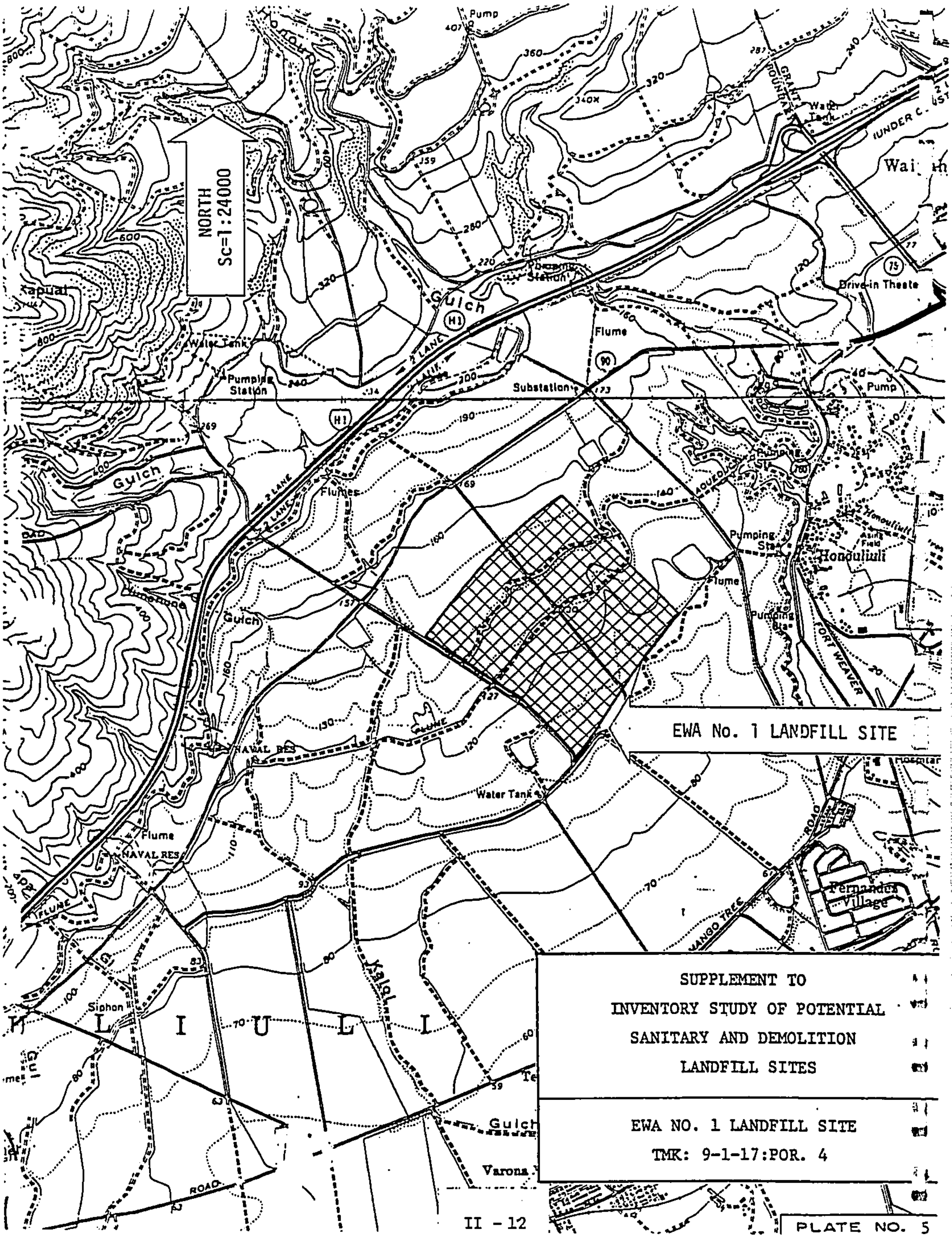
1. Access Road: Improvements must be constructed on Farrington Highway to provide a safe intersection. About 1,500 ft. of new access road must be constructed to the site.

2. Operations and Maintenance Facilities: Permanent facilities must be constructed.

3. Utilities: Telephone, electricity and water must be extended from Farrington Highway. Sanitary sewer system must be installed. Portions of an existing Hawaiian Telephone Co. cable easement will require relocation.

4. Drainage System: Nominal drainage system must be constructed.

5. Leachate Control System: None required but leachate movement should be monitored.



SUPPLEMENT TO
INVENTORY STUDY OF POTENTIAL
SANITARY AND DEMOLITION
LANDFILL SITES

EWA NO. 1 LANDFILL SITE
TMK: 9-1-17:POR. 4

EWA NO. 2 LANDFILL SITE

A. BASIC DATA OF SITE

1. Location: In canefield 1.8 miles south of Farrington Highway, 4,000 feet east of Fernandez Village, 1 mile north of Ewa on the Ewa plains of Leeward Oahu. See Plate No. 6.

2. Tax Map Key: 9-1-10 : portion of 2

3. Total Area: 200 acres

4. Owner: James Campbell Trust Estate and leased to Oahu Sugar Co., Ltd.

5. Present Use of Land: Canefields; prime land under intensive agricultural use.

6. City Zone District: Agriculture AG-1

7. City General Plan Land Use: Agriculture

8. State Land Use District: Agricultural

9. Adjacent Land Uses, Zones: Agriculture, Military

10. Restrictions and Setbacks: Special Permit required from State for construction in Agricultural District. Several easements cross the site. Within Navy Blast Zone--needs Special Construction.

11. Historical and Archaeological Significance: No sites known to exist

12. Proximity to Population and Refuse Centers: About 4,000 feet east of Fernandez Village, 3.5 miles east of Makakilo, 3 miles west of Waipahu and 14 miles from Keehi Refuse Transfer Station.

B. DESCRIPTION OF SITE

1. Accessibility: Accessible from Fort Weaver Road. About 3,000 feet of new access road thru canefield required to site.

2. Topography: Relatively flat land on the Ewa plain with elevation of about 30 feet at the lower point, slopes at 1 to 2% and elevation 40 feet in the high areas.

3. Soil Classification: Site consists of the following soils taken from the S.C.S. Soil Survey:

   Honouliuli clay, 0 to 2% slopes
   Kunia silty clay, 0 to 3% slopes
   Waipahu silty clay, 0 to 2% slopes
   Waipahu silty clay, 2 to 6% slopes

   See Appendix E.

4. Availability of Cover Material: Partially available on site.

5. Surface Drainage: Surface runoff flows by sheet across site.

6. Groundwater Supply: Outside of BWS groundwater zone. Groundwater movement must be determined.

7. Rainfall: 25 inches per year. See Appendix I.

8. Wind: Prevailing wind in direction of populated area less than 25% of the time.

9. Existing Utilities: None available on site.

C. SITE AS LANDFILL

1. Usable Area: 160 acres

2. Type of Operation: Combination of trench and area methods

3. Capacity: 6,900,000 cubic yards

4. Life: 14 years

5. Land Use After Development: Open space

D. ENVIRONMENTAL CONCERNS OF SITE

1. General Landfill Nuisances: Noise, dust, pests, odor, and litter associated with landfill operations will be generated. Effective control measures must be instituted to minimize landfill nuisances.

2. Visual Pollution: Site will be visible to the public from Fort Weaver Road during periods when cane has been harvested and level of filling is still below the existing ground. Site will not be visible during other periods. Landscaping prior to, during, and after landfilling operations will minimize visual pollution. Height of landfill expected to be about 10 feet above existing ground.

3. Groundwater Pollution: No protection measures required. Area is not a source of groundwater supply.

4. Surface Drainage Works: Nominal site drain system must be constructed to route surface runoff to adjacent canefield to minimize surface runoff infiltration.

5. Destruction of Natural Resources: Prime agricultural land will be committed to landfill. However, the site can be reverted to light agriculture or open space after landfill operations are completed.

6. Displacement: Prime land will be removed from intensive agricultural use.

7. Other Environmental Concerns: Traffic will increase on Farrington Highway and Fort Weaver Road. Impact on flora and fauna is not expected to be significant and these and other concerns will be discussed in detail in an environmental impact statement if the site is selected.

8. Safety: Operational hazard to the public is minimal. Within Navy Blast Clearance Zone of the ammunition handling area across West Loch.

9. Objection by Owner and Adjacent Landowners: Strong opposition from the Campbell Estate and Oahu Sugar Co., Ltd. can be expected if landfill does not fit into overall plans. U.S. Navy negotiating for land. May put restrictions due to proximity of Blast Zone.

10. Objections by Public, Community Organizations: State of Hawaii, nearby communities and organizations with interest in preservation of the existing environment will probably express their objections.

E. SITE PREPARATION FOR LANDFILL

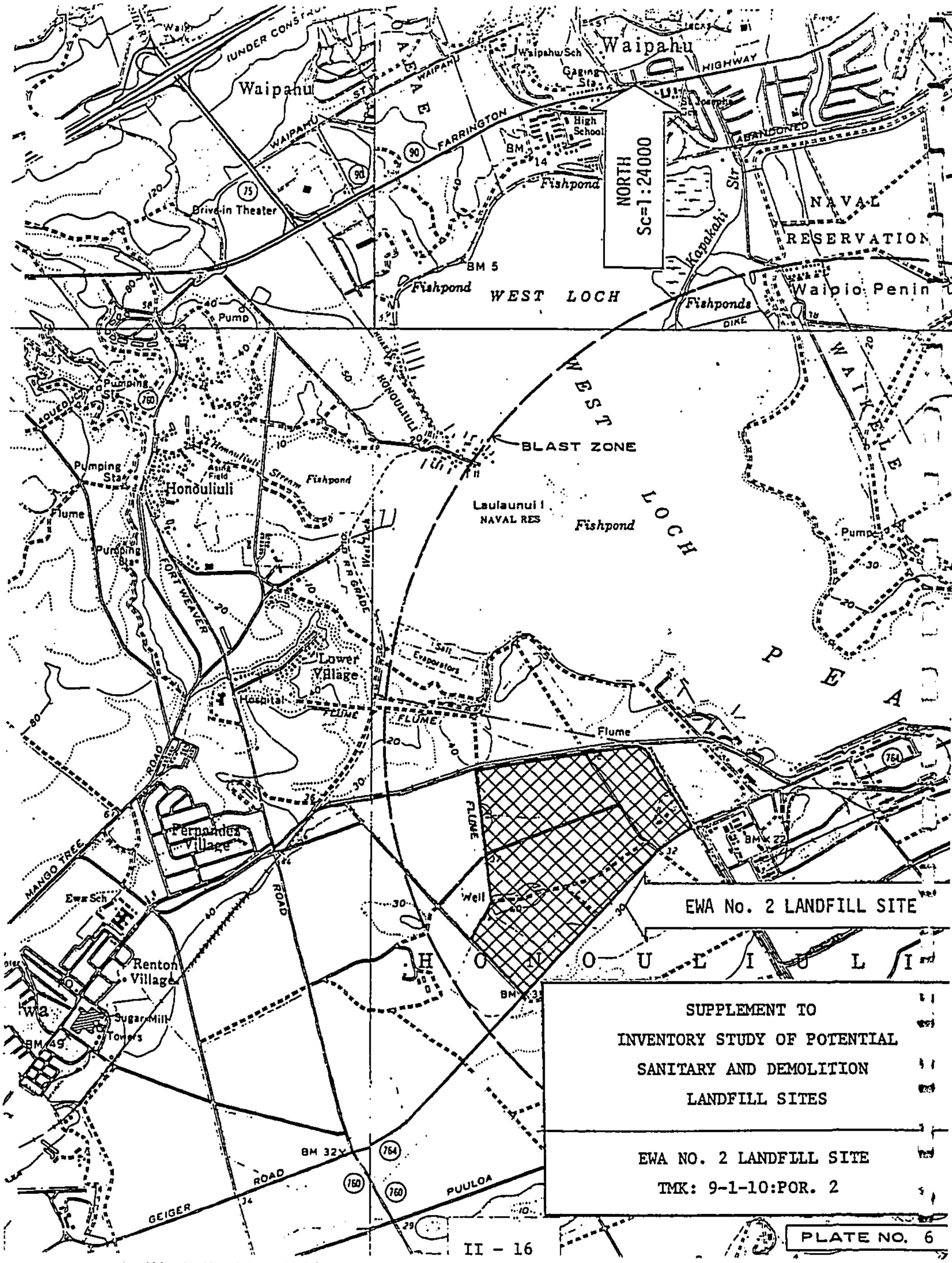
1. Access Road: Improvements must be constructed on Fort Weaver Road to provide a safe intersection. About 3,000 feet of new access road must be constructed to the site.

2. Operations and Maintenance Facilities: Permanent facilities must be constructed. Must conform to Blast Zone requirements established by U.S. Navy.

3. Utilities: Telephone, electricity and water must be extended from Fort Weaver Road. Sanitary sewer system must be installed. Portions of an existing Hawaiian Telephone Co. cable easement will require relocation.

4. Drainage System: Nominal drainage system must be constructed.

5. Leachate Control System: None required but leachate generation should be monitored.


Waipahu
Waipahu
UNDER CONSTR
WAIPAHU ST
FARRINGTON
HIGHWAY
High School
Drive-in Theater
Fishpond
WEST LOCH
Fishponds
NORTH
Sc=1:24000
NAVAL RESERVATION
Waipio Penin
ABANDONED
Kapakahi Str
BLAST ZONE
Honouliuli
Pumping Sta
Flume
FORT WEAVER ROAD
Laulaunui I
NAVAL RES
Fishpond
WEST LOCH
PEARL
WAIKELE
Salt Evaporators
Lower Village
Hospital
FLUME
Fernandez Village
MANGO TREE
Ewa Sch
Renton Village
Ewa
Sugar Mill
Towers
GEIGER ROAD
PUULOA
Well
HONOULIULI
EWA No. 2 LANDFILL SITE
SUPPLEMENT TO
INVENTORY STUDY OF POTENTIAL
SANITARY AND DEMOLITION
LANDFILL SITES
EWA NO. 2 LANDFILL SITE
TMK: 9-1-10:POR. 2
PLATE NO. 6

HALAWA LANDFILL SITES

A. COMMENTARY OF SITES

Two potential sites in Halawa, mauka of the Moanalua Freeway, were evaluated for landfill development. See Plate No. 7.

1. Location: Site "A" is located in North Halawa Valley mauka of the Halawa Industrial Park, id designated by tax map keys 9-9-10 : 8, 9, and portions of 10 & 26, is owned by the Honolulu Board of Water Supply, the City and County of Honolulu, and Queens Medical Center and contains an area of about 150 acres.

   Site "B" is located on the Lone Star Industries, Inc.'s Halawa Quarry site at the nose of the ridge dividing North and South Halawa Valleys, is designated by tax map key 9-9-10 : 27, and portion of 10, is owned by the Queens Medical Center with portions leased to Lone Star Industries, Inc. and subleased to Grace Brothers, Ltd., and contains about 150 acres.

   Both sites are located within the BWS groundwater zone which is on existing potential groundwater sources. See Plate IV-F-1. They are located in areas where sanitary landfills are not permitted by the BWS.

2. Discussion: According to the BWS letter of September 24, 1976 (see Appendix F-2 and F-3, Inventory Study of Potential Sanitary and Demolition Landfill Sites, Shimabukuro, 1977) sites within their groundwater zone "may be considered for use as sanitary landfills provided the following conditions are met:

   1. A documented study or guarantee indicating that generated leachate will not pollute potable groundwater resources.

   2. Monitoring of landfill to assure leachate is confined.

   3. Monitoring of groundwater quality to assure non-degradation of the underlying groundwater aquifer.

   4. Liability of source replacement in the event of contamination is agreed upon.

   These conditions are needed to protect our valuable and virtually irreplaceable potable groundwater resources from any potential contamination."

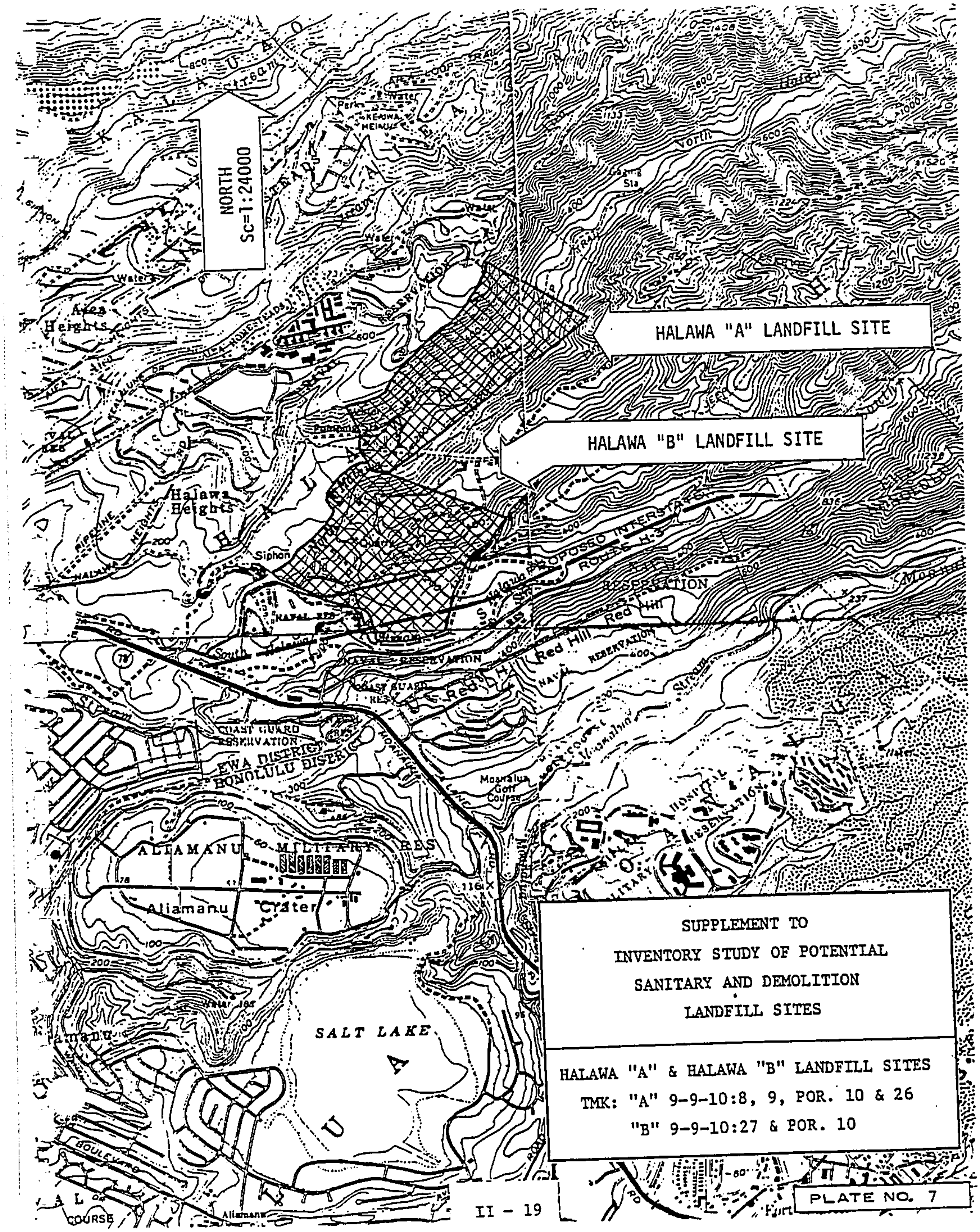
Conditions 2 and 3 can be met. Condition 1 will be difficult to meet since no prudent engineer will become responsible for making an absolute statement such as "generated leachate will not pollute potable groundwater resources." Solid waste technology has not yet advanced to a stage where anyone can assure that leachate will not pollute our groundwater resources. If it can happen, it may happen and it may happen through no fault of the engineer or the City but through the negligence of others or by an act of God.

Condition 4 will be impossible to meet. As stated in the BWS letter, Oahu's potable groundwater resources are virtually irreplaceable and no prudent person or underwriter will agree to undertake the "liability of source replacement in the event of contamination." The possible liability would be enormous, incalculable, and too great to assume since our potable groundwater resources are virtually irreplaceable.

3. Conclusion: These sites are located within the BWS groundwater zone. Rainfall averages 40 inches per year and leachate may be generated. Landfills constructed under these circumstances may cause pollution of our potable groundwater sources. The City should avoid sites over our potable groundwater sources where rainfall exceeds 30 inches per year.

These sites are not acceptable to the BWS according to their letter of July 30, 1979. See Appendix J.

These Special Considerations will eliminate these sites from further consideration.


NORTH
Sc=1:24000
HALAWA "A" LANDFILL SITE
HALAWA "B" LANDFILL SITE
Aiea Heights
Halawa Heights
Siphon
Red Hill
NAVAL RESERVATION
COAST GUARD RESERVATION
EWA DISTRICT
HONOLULU DISTRICT
Moanalua Golf Course
ALIAMANU MILITARY RES
Aliamanu Crater
SALT LAKE
SUPPLEMENT TO
INVENTORY STUDY OF POTENTIAL
SANITARY AND DEMOLITION
LANDFILL SITES
HALAWA "A" & HALAWA "B" LANDFILL SITES
TMK: "A" 9-9-10:8, 9, POR. 10 & 26
"B" 9-9-10:27 & POR. 10
PLATE NO. 7

HONOULIULI LANDFILL SITE

A. BASIC DATA OF SITE

1. Location: 2.6 miles east of Puu Makakilo, 0.5 mile south of Farrington Highway, 2.4 miles east-southeast of Puu Kapuai and 4.5 miles north-northwest of Ewa Beach. See Plate No. 8.

2. Tax Map Key: 9-1-17

3. Total Area: 22 acres

4. Owner: James Campbell Trust Estate

5. Present Use of Land: 20% Agricultural and 80% Open

6. City Zone District: Agricultural

7. City General Plan Land Use: Agricultural

8. State Land Use District: Agricultural

9. Adjacent Land Uses, Zones: Agricultural, Residential and Commercial

10. Restrictions and Setbacks: Special Permit required from State for construction in Agricultural District.

11. Historical and Archaeological Significance: No sites known to exist.

12. Proximity to Population and Refuse Centers: Honouliuli residential and commercial area 1,700 feet southeast, Waipahu business district 2.3 miles northeast, Fernandez Village 1.4 miles south and Makakilo City 2.7 miles west-southwest of the site.

B. DESCRIPTION OF SITE

1. Accessibility: Access from Fort Weaver Road or Farrington Highway.

2. Topography: The site is a gully approximately 1,400 feet in length with the bottom sloped 3%. The average width is 400 feet and depth is 35 feet.

3. Soil Classification: Site consists of the following soils taken from the S.C.S. Soil Survey:

   0 to 8% slope, Waialua silty clay
   30 to 90% slope, Helemano silty clay

   See Appendix E.

4. Availability of Cover Material: Available on site.

5. Surface Drainage: Surface runoff drains toward Ft. Weaver Road.

6. Groundwater supply: Outside of Board of Water Supply groundwater zone. Source of irrigation and domestic water supply for Oahu Sugar Co.

7. Rainfall: 25 inches per year. See Appendix I.

8. Wind: Prevailing wind in direction of Honouliuli less than 25% of the time.

9. Existing Utilities: None on site. Electric power, telephone, and water are available on Ft. Weaver Road.

C. SITE AS LANDFILL

1. Usable Area: 22 acres

2. Type of Operation: Combination of trench and area methods.

3. Capacity: 1,650,000 cubic yards

4. Life: 3.4 years

5. Land Use After Development: Agriculture, or can be active and passive recreational park according to Parks and Recreation Dept.

D. ENVIRONMENTAL CONCERNS OF SITE

1. General Landfill Nuisances: Will be generated. Effective control measures must be in effect during the life of the site to minimize nuisances associated with landfill operations.

2. Visual Pollution: Landscaping prior to, during and after landfill operations will minimize visual pollution.

3. Groundwater Pollution: Protective measures required.

4. Surface Drainage Works: Drainage system must be constructed to minimize rainfall infiltration.

5. Destruction of Natural Resources: Land and vegetation will be committed to landfill. However, site can be planted in cane after landfill activities cease.

6. Displacement: Approximately 4.0 acres of cane land will be removed during the life of the landfill.

7. Other Environmental Concerns: Increase of traffic on Ft. Weaver Road will occur. Impact on flora and fauna is not expected to be significant, and these and other concerns will be addressed in more detail in an environmental impact statement if this site is selected for development.

8. Safety: Minimal

9. Objection by Owner and Adjacent Owners: Minimal since 10% of land is not being utilized at present and only 4.0 acres will be removed from cane production.

10. Objections by Public, Community Organizations: The community adjacent to the site will probably object.

E. SITE PREPARATION FOR LANDFILL

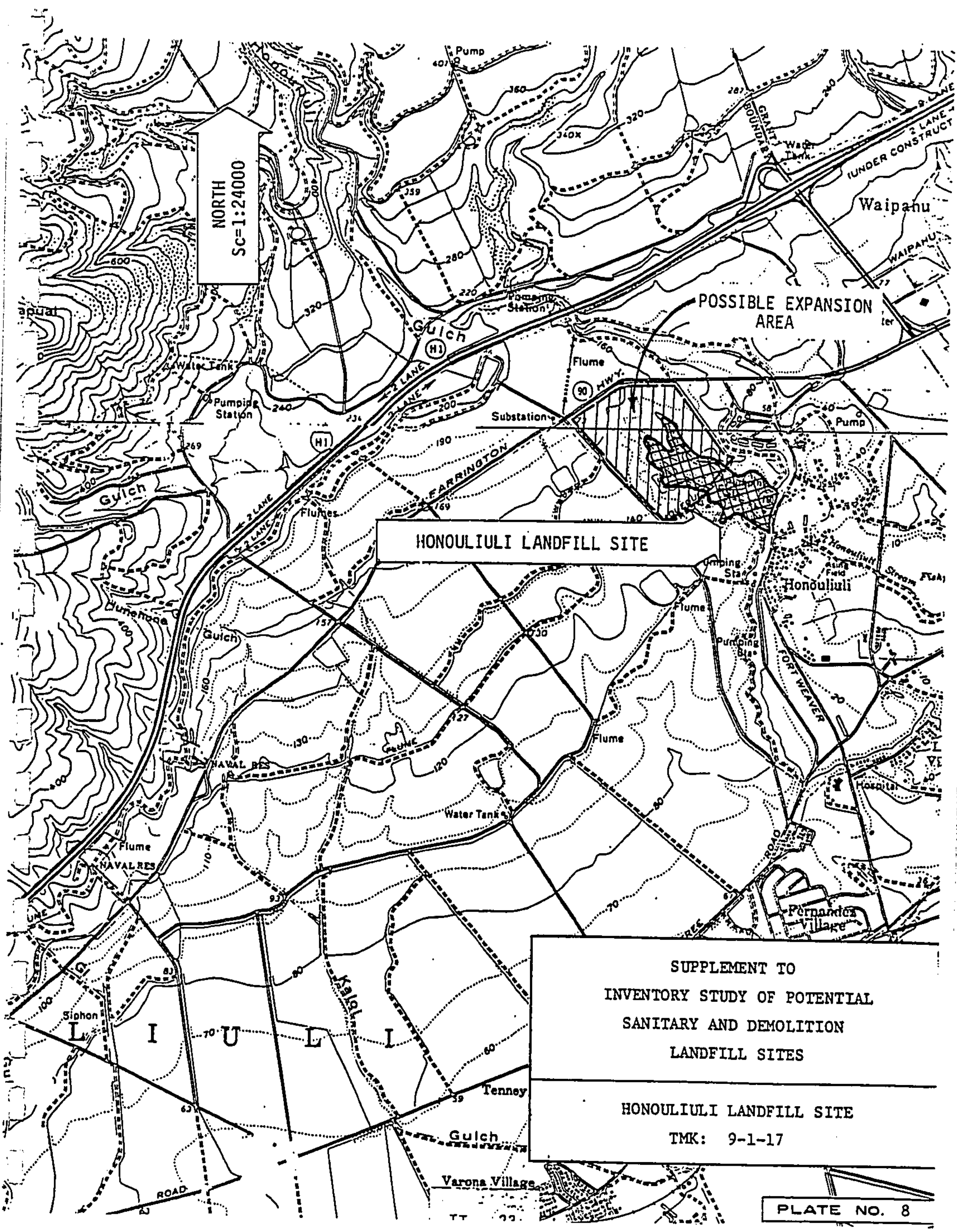
1. Access Road: 1,200 feet of access road must be constructed.

2. Operations and Maintenance Facilities: Permanent facilities must be constructed.

3. Utilities: Electric power, telephone and water connections must be made on Ft. Weaver Road.

4. Drainage System: Nominal surface drainage system on site and an underground pipe system to and across Ft. Weaver Road to Honouliuli Stream must be constructed.

5. Leachate Control System: None required but leachate movement should be monitored.


NORTH
Sc=1:24000
POSSIBLE EXPANSION AREA
HONOULIULI LANDFILL SITE
Waipahu
Honouliuli
Fernandez Village
Varona Village
Gulch
Pumping Station
Water Tank
Substation
Flume
FARRINGTON
HWY.
FORT WEAVER
NAVAL RES
Siphon
Tenney
L I U L I
SUPPLEMENT TO
INVENTORY STUDY OF POTENTIAL
SANITARY AND DEMOLITION
LANDFILL SITES
HONOULIULI LANDFILL SITE
TMK: 9-1-17
PLATE NO. 8

KAENA LANDFILL SITE

A. BASIC DATA OF SITE

1. Location: At west mauka end of Dillingham A.F.B., 1,000 ft. mauka of Farrington Highway, 6 miles west of Waialua on the north coast of Oahu. See Plate No. 9.

2. Tax Map Key: 6-9-01 : portions of 3, 33 and 34

3. Total Area: 40 acres

4. Owners: State of Hawaii and Dillingham Corporation

5. Present Use of Land: Abandoned quarry and open space

6. City Zone District: Preservation P-1

7. City General Plan Land Use: Preservation

8. State Land Use District: Conservation

9. Adjacent Land Uses, Zones: Agriculture, Preservation, Military

10. Restrictions and Setbacks: Special Permit required from State for construction in Conservation District. Site is located at Kaena entrance to Makua-Kaena State Park and is under condemnation by the State.

11. Historical and Archaeological Significance: Site 189, Ulehula Heiau, is located west of the site.

12. Proximity to Population and Refuse Centers: 6 miles west of Waialua, 30 miles from Keehi Refuse Transfer Station and removed from Leeward refuse generation centers.

B. DESCRIPTION OF SITE

1. Accessibility: Accessible from Farrington Highway via Kamehameha Highway and Interstate Route H-2 thru Wahiawa and Waialua.

2. Topography: Pit created by past quarry operation at the nose of a ridge. Pit is about 1,200 feet long, 700 feet wide and 80 feet deep.

3. Soil Classification: Site consists of the following soils taken from the S.C.S. Soil Summary:

   Jaucus sand, 0 to 15% slopes
   Rock land
   Stony steep land

   See Appendix E.

4. Abailability of Cover Material: Little available on site and must be imported.

5. Surface Drainage: Some surface runoff enters pit. An underground spring discharges into pit and must be diverted or pumped out from pit.

6. Groundwater Supply: Outside of BWS groundwater zone.

7. Rainfall: 20 inches per year. See Appendix I.

8. Wind: Prevailing wind in direction of populated area less than 25% of the time.

9. Existing Utilities: Except for sanitary sewer, utilities are available on the site.

C. SITE AS LANDFILL

1. Usable Area: 20 acres

2. Type of Operation: Combination of trench and area methods

3. Capacity: 1,500,000 cubic yards

4. Life: 3.0 years

5. Land Use After Development: Open space

D. ENVIRONMENTAL CONCERNS OF SITE

1. General Landfill Nuisances: Noise, dust, pests, odor, and litter associated with landfill operations will be generated. Effective control measures must be instituted to minimize landfill nuisances.

2. Visual Pollution: Site is highly visible to the public from Farrington Highway and from the beaches along the north shore. Users of the Makua-Kaena State Park will find landfill construction incompatible with the State Park. Landscaping prior to, during and after landfilling operations will minimize visual pollution.

3. Groundwater Pollution: No protection measures required. Area is not a source of groundwater supply.

4. Surface Drainage Works: Drain system must be constructed to route surface runoff around the site and to minimize surface runoff infiltration. Underground spring discharge must be diverted or pumped out of pit.

5. Destruction of Natural Resources: Land will be committed to landfill. However, the site can be reverted to open space after landfill operations are completed.

6. Displacement: None. Landfill will be constructed on land being condemned for the Makua-Kaena State Park.

7. Other Environmental Concerns: Traffic will increase on Farrington Highway to and from the site.

   Impact on flora and fauna is not expected to be significant and these and other concerns will be discussed in detail in an environmental impact statement if the site is selected.

8. Safety: Hazard to the public is minimal.

9. Objection by Owners and Adjacent Landowners: Opposition can be expected.

10. Objections by Public, Community Organizations: Adjoining communities and organizations with interests for preservation of the existing natural environment and the development of the State Park will probably express their objections.

E. SITE PREPARATION FOR LANDFILL

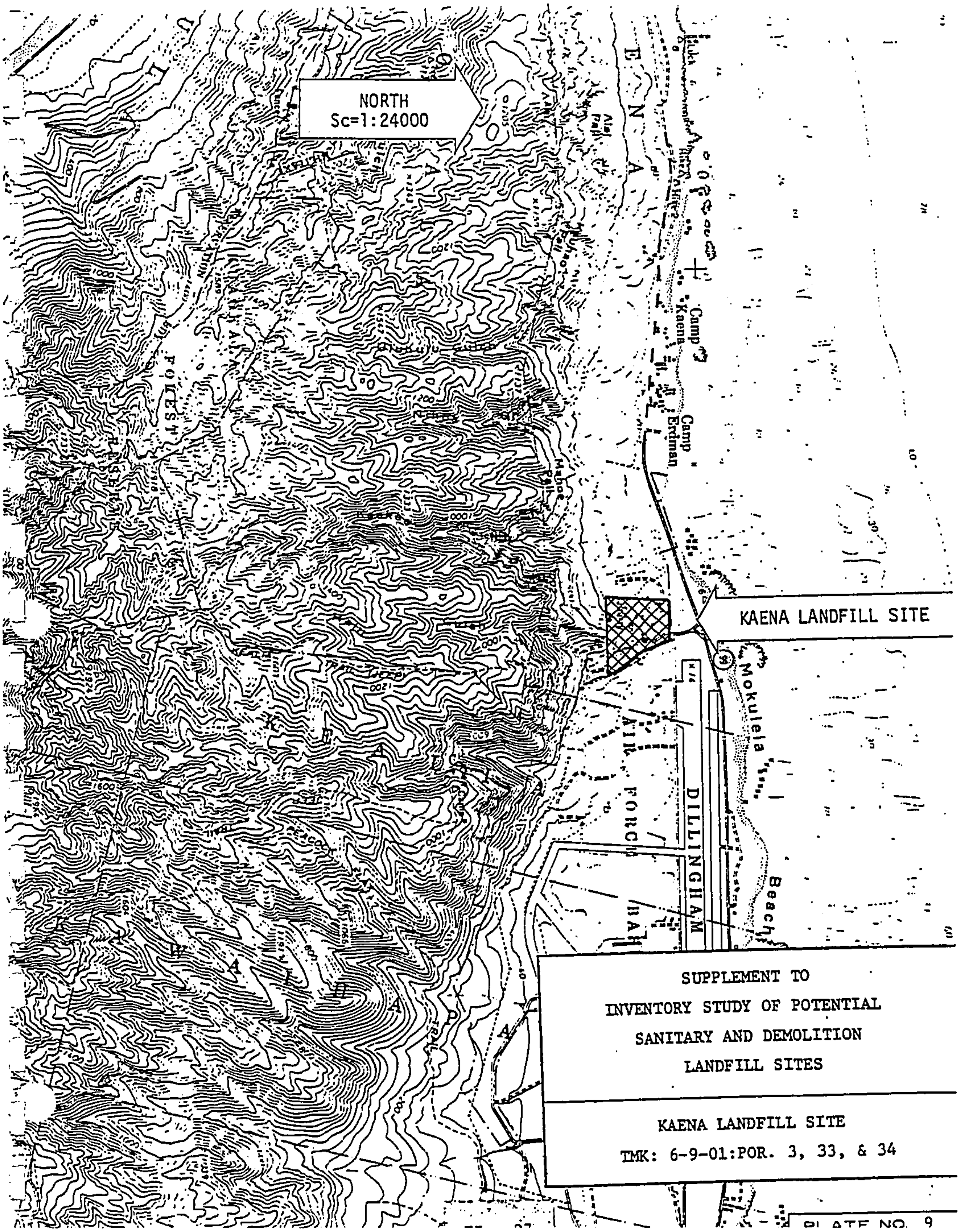
1. Access Road: Improvements must be constructed on Farrington Highway to provide a safe intersection. About 1,000 feet of new access road must be constructed to the site.

2. Operations and Maintenance Facilities: Temporary facilities must be constructed although existing quarry operations and maintenance facilities could be upgraded.

3. Utilities: Sanitary sewer system must be installed. Water, electricity and telephone available on site.

4. Drainage System: Nominal drainage system must be constructed.

5. Leachate Control System: None required but leachate movement should be monitored.


NORTH
Sc=1:24000
KAENA LANDFILL SITE
Camp Kaena
Camp Erdman
Mokuleia
Beach
DILLINGHAM
SUPPLEMENT TO
INVENTORY STUDY OF POTENTIAL
SANITARY AND DEMOLITION
LANDFILL SITES
KAENA LANDFILL SITE
TMK: 6-9-01:POR. 3, 33, & 34
PLATE NO. 9

KAHE LANDFILL SITE INCLUDING

LIMALOA AND KEONEOIO GULCHES

A. BASIC DATA OF SITE

1. Location: In the northern portion of Kahe Valley, 4.5 miles north of Barbers Point, 1 mile south of Nanakuli on the southwestern coast of Leeward Oahu. The site includes the Limaloa and Keoneoio Gulches within the Valley. See Plate No. 10.

2. Tax Map Key: 9-2-03 : portion of 27

3. Total Area: 200 acres

4. Owner: Hawaiian Electric Co., Inc.

5. Present Use of Land: Open space with electric power generation facilities adjacent and to the south

6. City Zone District: Industrial I-1

7. City General Plan Land Use: Industrial

8. State Land Use District: Urban

9. Adjacent Land Uses, Zones: Preservation P-1, Agriculture AG-1, Open space

10. Restrictions and Setbacks: Permit required from State for access at Farrington Highway. Variance must be obtained from the City for landfill construction in Industrial I-1 zone. Hawaiian Electric Co. has master planned the entire Kahe Valley for power generation facilities development and landfill construction will be in conflict with their future plans. This is HECo's only available site with areas to accommodate future developments and expansion. See Plate No. 11.

11. Historical and Archaeological Significance: No sites known to exist.

12. Proximity to Population and Refuse Centers: Approximately 1 mile south of Nanakuli, 2 miles northwest of Honokai Hale and 21 miles from Keehi Refuse Transfer Station. HECo's Kahe Power Plant which generates electric power is located in this valley.

B. DESCRIPTION OF SITE

1. Accessibility: Accessible from Farrington Highway. About 1,000 feet of new access road must be extended into the site.

2. Topography: A small valley opening to the ocean on the west. The valley floor has an elevation of about 20 feet and gradually slopes up to the ridges with elevations of over 800 feet. The slope at the lower end of the valley near the highway is about 3% and increases to over 50% at the upper reaches. Permanent HECo facilities exist on the south portion of the valley next to the highway.

3. Soil Classification: Site consists of the following soils taken from the S.C.S. Soil Survey:

   Lualualei extremely stony clay, 3 to 35% slopes
   Rock land
   Stony steep land
   Fill land, mixed

   See Appendix E.

4. Availability of Cover Material: Little available on site and must be imported.

5. Surface Drainage: Surface runoff from Limaloa and Keoneoio Gulches cross the site.

6. Groundwater Supply: Outside of BWS groundwater zone.

7. Rainfall: 20 inches per year. See Appendix I.

8. Wind: Prevailing wind in direction of populated area less than 25% of the time.

9. Existing Utilities: Except for sanitary sewer, utilities are available from Farrington Highway adjacent to the site.

C. SITE AS LANDFILL

1. Usable Area: 70 acres

2. Type of Operation: Combination of trench and area methods

3. Capacity: 7,400,000 cubic yards

4. Life: 15 years

5. Land Use After Development: Open space

D. ENVIRONMENTAL CONCERNS OF SITE

1. General Landfill Nuisances: Noise, dust, pests, odor, and litter associated with landfill operations will be generated. Effective control measures must be instituted to minimize landfill nuisances.

2. Visual Pollution: Site is highly visible to the public from Farrington Highway and Kahe Beach Park and to HECo employees from their adjacent facilities. Landscaping prior to, during and after landfilling operations will help reduce visual pollution.

3. Groundwater Pollution: No protection measures required. Area is not a source of groundwater supply.

4. Surface Drainage Works: Major site drain system must be constructed to route surface runoff from Limaloa and Keoneoio Gulches around the site and to minimize surface runoff infiltration.

5. Destruction of Natural Resources: Land and natural vegetation will be committed to landfill. However, a passive recreational area can be developed after landfill operations are completed.

6. Displacement: Landfill will be constructed adjacent to HECo facilities. There will be displacement of future HECo facilities planned for the site.

7. Other Environmental Concerns: Traffic will increase on Farrington Highway and the addition of an intersection will increase hazards.

   Impact on flora and fauna is not expected to be significant and these and other concerns will be discussed in detail in an environmental impact statement if the site is selected.

8. Safety: Operational hazard to the public is minimal.

9. Objection to Owner and Adjacent Landowners: Strong opposition from HECo can be expected since this is the only viable site available for future expansion of power generation facilities.

10. Objections by Public, Community Organizations: Adjoining communities and organizations with interests for preservation of the existing natural environment will probably express their objections.

E. SITE PREPARATION FOR LANDFILL

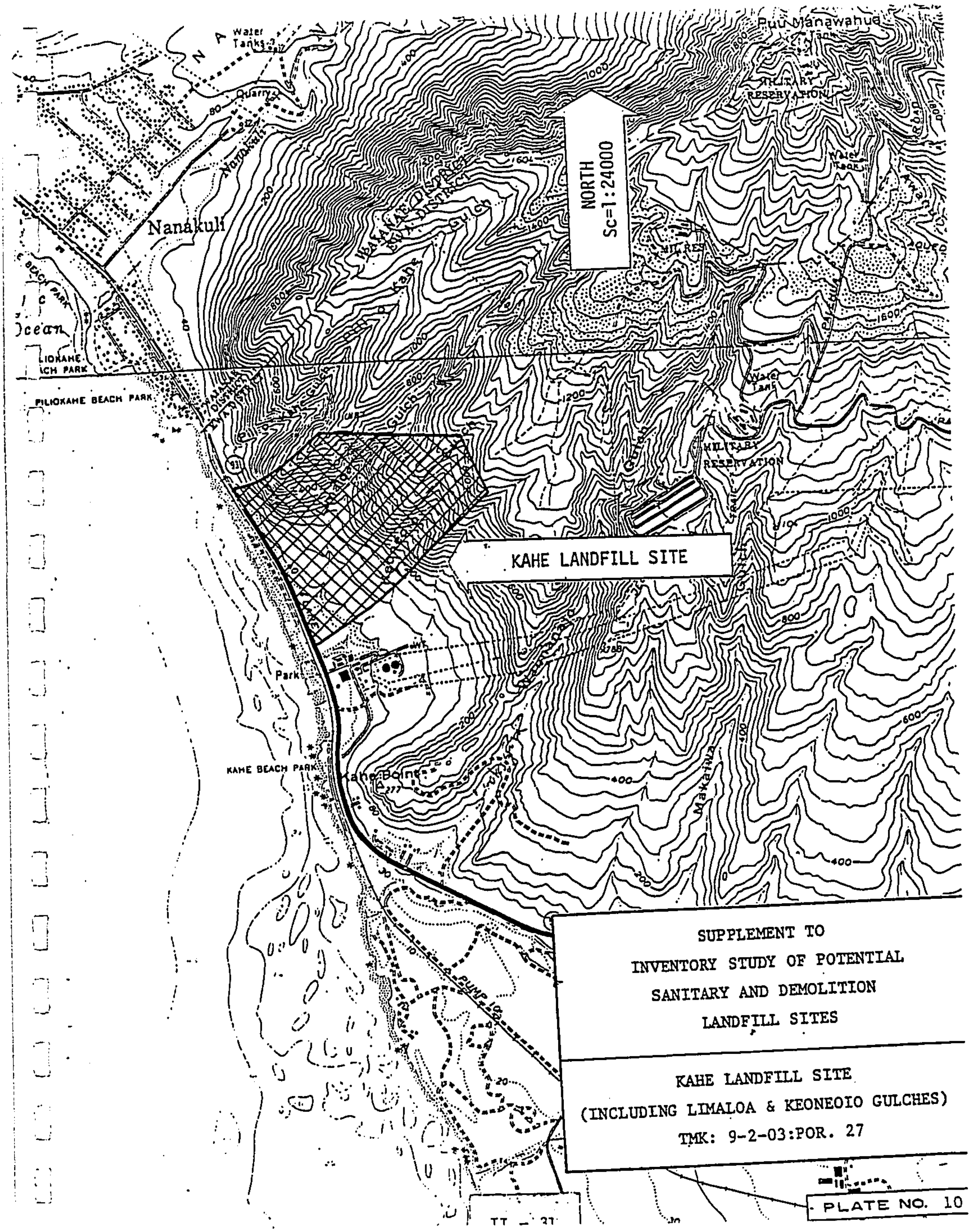
1. Access Road: Improvements must be constructed on Farrington Highway to provide a safe intersection. About 1,000 feet of new access road must be constructed to the site.

2. Operations and Maintenance Facilities: Permanent facilities must be constructed.

3. Utilities: Must be extended to site from Farrington Highway. Sanitary sewer system must be installed.

4. Drainage System: A major drainage system must be constructed.

5. Leachate Control System: None required but leachate movement should be monitored.


Puu Manawahua
MILITARY RESERVATION
Water Tanks
Quarry
Nanakuli
NORTH
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Ocean
PILIOKAHE BEACH PARK
MILITARY RESERVATION
KAHE LANDFILL SITE
Park
KAHE BEACH PARK
Kahe Point
Makaiwa
SUPPLEMENT TO
INVENTORY STUDY OF POTENTIAL
SANITARY AND DEMOLITION
LANDFILL SITES
KAHE LANDFILL SITE
(INCLUDING LIMALOA & KEONEOIO GULCHES)
TMK: 9-2-03:POR. 27
PLATE NO. 10

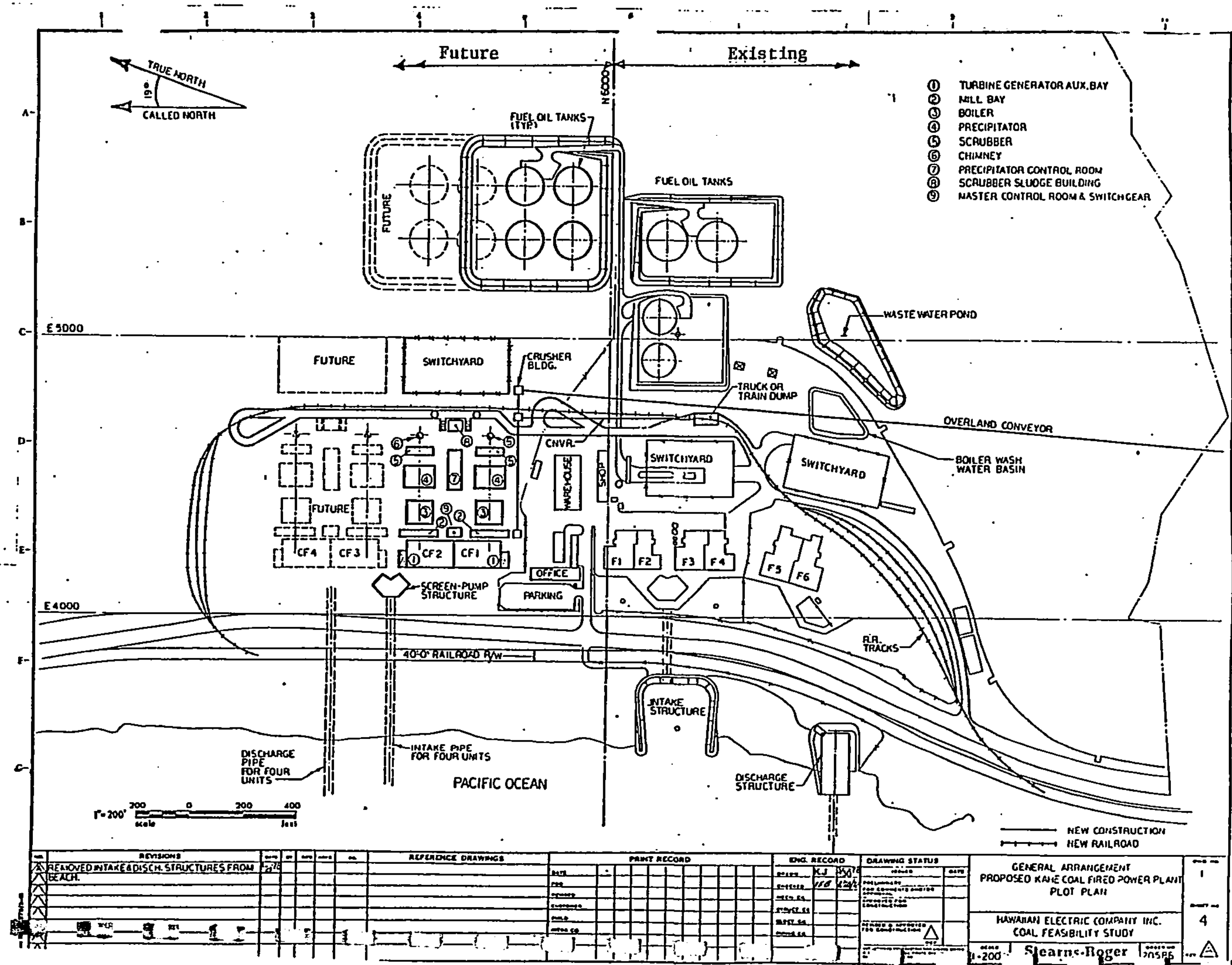

Future
Existing
TRUE NORTH
19°
CALLED NORTH
N 6000
① TURBINE GENERATOR AUX. BAY
② MILL BAY
③ BOILER
④ PRECIPITATOR
⑤ SCRUBBER
⑥ CHIMNEY
⑦ PRECIPITATOR CONTROL ROOM
⑧ SCRUBBER SLUDGE BUILDING
⑨ MASTER CONTROL ROOM & SWITCHGEAR
FUEL OIL TANKS (TYP)
FUTURE
FUEL OIL TANKS
WASTE WATER POND
E 5000
FUTURE
SWITCHYARD
CRUSHER BLDG.
TRUCK OR TRAIN DUMP
OVERLAND CONVEYOR
CNVR.
SWITCHYARD
SWITCHYARD
BOILER WASH WATER BASIN
WAREHOUSE
SHOP
FUTURE
CF4
CF3
CF2
CF1
F1
F2
F3
F4
F5
F6
OFFICE
PARKING
SCREEN-PUMP STRUCTURE
E 4000
40'-0" RAILROAD R/W
R.R. TRACKS
INTAKE STRUCTURE
DISCHARGE PIPE FOR FOUR UNITS
INTAKE PIPE FOR FOUR UNITS
PACIFIC OCEAN
DISCHARGE STRUCTURE
1" = 200'
200 0 200 400
NEW CONSTRUCTION
NEW RAILROAD
REVISIONS
REMOVED INTAKE & DISCH. STRUCTURES FROM BEACH.
REFERENCE DRAWINGS
PRINT RECORD
ENG. RECORD
DRAWING STATUS
GENERAL ARRANGEMENT
PROPOSED KAHE COAL FIRED POWER PLANT
PLOT PLAN
HAWAIIAN ELECTRIC COMPANY INC.
COAL FEASIBILITY STUDY
1"=200'
Stearns-Roger
1
4

Plate No. 11

KALOI LANDFILL SITE

A. BASIC DATA OF SITE

1. Location: South of Puu Kapuai and north of Puu Makakilo in Kaloi Gulch, Ewa. See location map, Plate No. 12. Site is approximately 2,500 feet northwest of Interstate Route H-1.

2. Tax Map Key: 9-2-02 : portion of 1;
   9-2-03 : portion of 2;
   9-2-04 : portion of 5.

3. Total Area: 400 acres

4. Owner: James Campbell Trust Estate (Oahu Sugar Co. and Hawaii Meat Co. lessees, Tongg Ranch, sublessee)

5. Present Use of Land: Sugar cane, ranching and open space

6. City Zone Districts: Agricultural and Residential

7. City General Plan Land Uses: Agriculture and Residential

8. State Land Use District: Agriculture

9. Adjacent Land Uses, Zones: Same as 5 thru 8 above. In addition, State Land Use District is Urban to the south of the site.

10. Restrictions and Setbacks: Special Permit required from State for construction in Agricultural District.

11. Historical and Archaeological Significance: No sites known to exist.

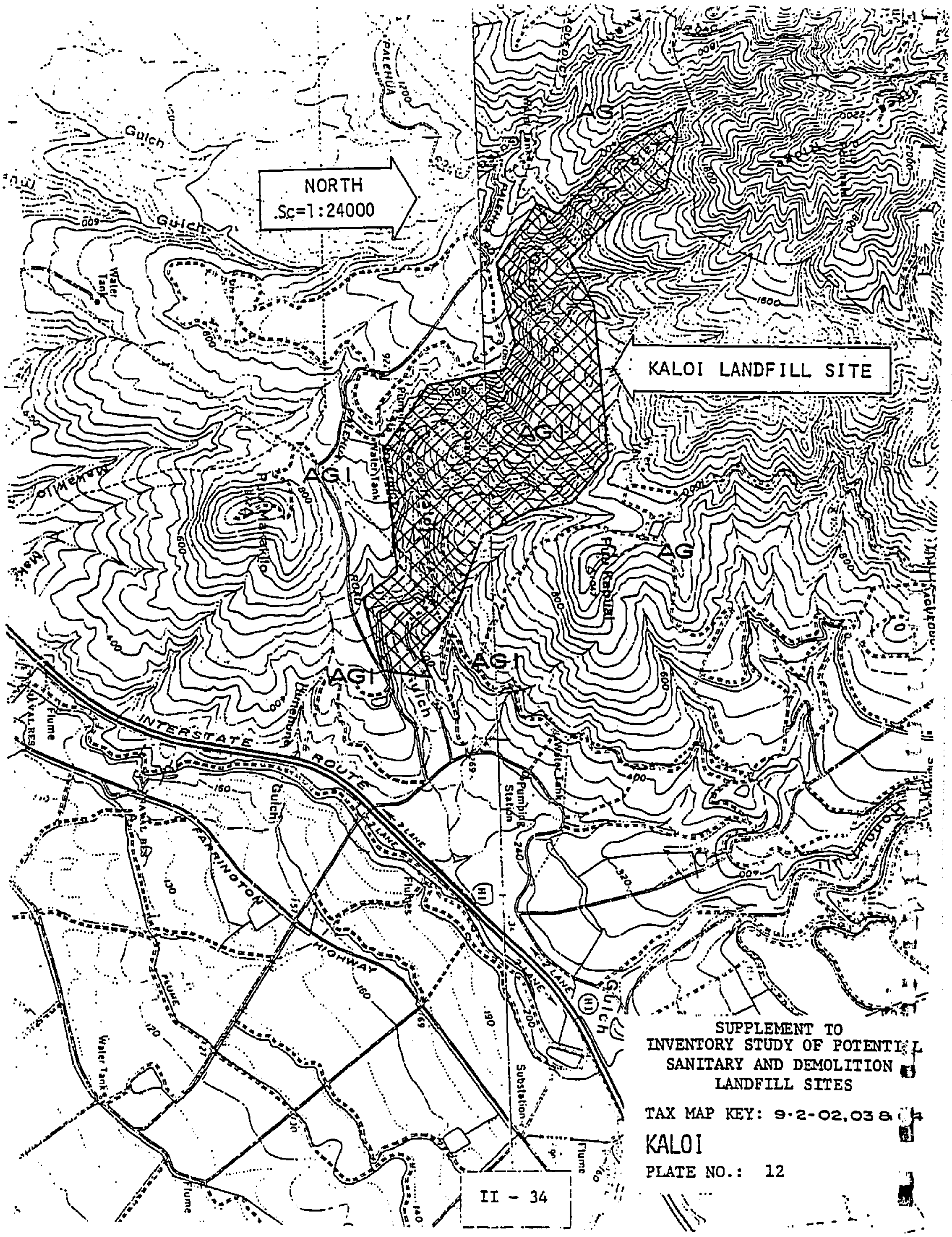
12. Proximity to Population and Refuse Centers: Between Nanakuli and Waipahu, 1 mile north of Makakilo City, 18 miles west of downtown Honolulu, 4 miles west of Waipahu, and 5 miles east of Nanakuli.

B. DISCUSSION

This site is over the BWS groundwater zone. Average annual rainfall is about 35 inches and leachate may be generated. Landfills constructed under these circumstances may cause pollution of our potable groundwater sources. The City should avoid sites over our potable groundwater sources where rainfall exceeds 30 inches per year.

This site is not acceptable to the BWS according to their letter of July 30, 1979. See Appendix J.

These Special Considerations will eliminate this site from further consideration.



SUPPLEMENT TO
INVENTORY STUDY OF POTENTIAL
SANITARY AND DEMOLITION
LANDFILL SITES

TAX MAP KEY: 9-2-02,03 & 04

KALOI

PLATE NO.: 12

KEEKEE LANDFILL SITE

A. BASIC DATA OF SITE

1. Location: An abandoned quarry site about 0.5 miles west of Dillingham A.F.B., 1,500 feet mauka of Farrington Highway, 6 miles west of Waialua on the north coast of Oahu. See Plate No. 13.

2. Tax Map Key: 6-9-01 : portions of 3 & 4 and
   6-9-03 : portion of 2

3. Total Area: 40 acres

4. Owner: State of Hawaii

5. Present Use of Land: Open Space

6. City Zone District: Preservation P-1

7. City General Plan Land Use: Preservation

8. State Land Use District: Agricultural

9. Adjacent Land Uses, Zones: Agriculture, Preservation, Conservation

10. Restrictions and Setbacks: Special Permit required from State for construction in Agricultural District. Site is located at Kaena entrance to Makua-Kaena State Park. Access from Farrington Highway must be obtained from Mokuleia Ranch and Land Co. or Dillingham Corp.

11. Historical and Archaeological Significance: Site 189, Ulehula Heiau, is located east of the site.

12. Proximity to Population and Refuse Centers: 6 miles west of Waialua, 30 miles from Keehi Refuse Transfer Station and removed from Leeward refuse generation centers.

B. DESCRIPTION OF SITE

1. Accessibility: Accessible from Farrington Highway via Kamehameha Highway and Interstate Route H-2 thru Wahiawa and Waialua.

2. Topography: At mouth of Keekee Gulch. Site begins at elevation 160 feet, slopes up to about 15% at the lower half, slopes in excess of 30% at the upper half to elevation 400 feet.

3. Soil Classification: Site consists of the following soils taken from the S.C.S. Soil Summary:

Rock land
Stony steep land
Rock outcrop

See Appendix E.

4. Availability of Cover Material: Little available on site and must be imported.

5. Surface Drainage: Surface runoff from Keekee Gulch traverses site.

6. Groundwater Supply: Outside of BWS groundwater zone.

7. Rainfall: 20 inches per year. See Appendix I.

8. Wind: Prevailing wind in direction of populated area less than 25% of the time.

9. Existing Utilities: Except for sanitary sewer, utilities are available from Farrington Highway.

C. SITE AS LANDFILL

1. Usable Area: 15 acres

2. Type of Operation: Combination of trench and area methods

3. Capacity: 1,200,000 cubic yards

4. Life: 2.5 years

5. Land Use After Development: Open space

D. ENVIRONMENTAL CONCERNS OF SITE

1. General Landfill Nuisances: Noise, dust, pests, odor and litter associated with landfill operations will be generated. Effective control measures must be instituted to minimize landfill nuisances.

2. Visual Pollution: Site is highly visible to the public from Farrington Highway and from the beaches along the north shore. Users of the Makua-Kaena State Park will find landfill construction incompatible with the State Park. Landscaping prior to, during and after landfilling operations will minimize visual pollution.

3. Groundwater Pollution: No protective measures required. Area is not a source of groundwater supply.

4. Surface Drainage Works: Major drain system must be constructed to route surface runoff from Keekee Gulch around the site and to minimize surface runoff infiltration.

5. Destruction of Natural Resources: Land and natural vegetation will be committed to landfill. However, the site can be reverted to open space after landfill operations are completed.

6. Displacement: None. Landfill will be constructed on the Makua-Kaena State Park land.

7. Other Environmental Concerns: Traffic will increase on Farrington Highway to and from the site.

   Impact on flora and fauna is not expected to be significant and these and other concerns will be discussed in detail in an environmental impact statement if the site is selected.

8. Safety: Hazard to the public is minimal.

9. Objection by Owners and Adjacent Landowners: Opposition can be expected.

10. Objections by Public, Community Organizations: Adjoining communities and organizations with interests for preservation of the existing natural environment and the development of the State Park will probably express their objections.

E. SITE PREPARATION FOR LANDFILL

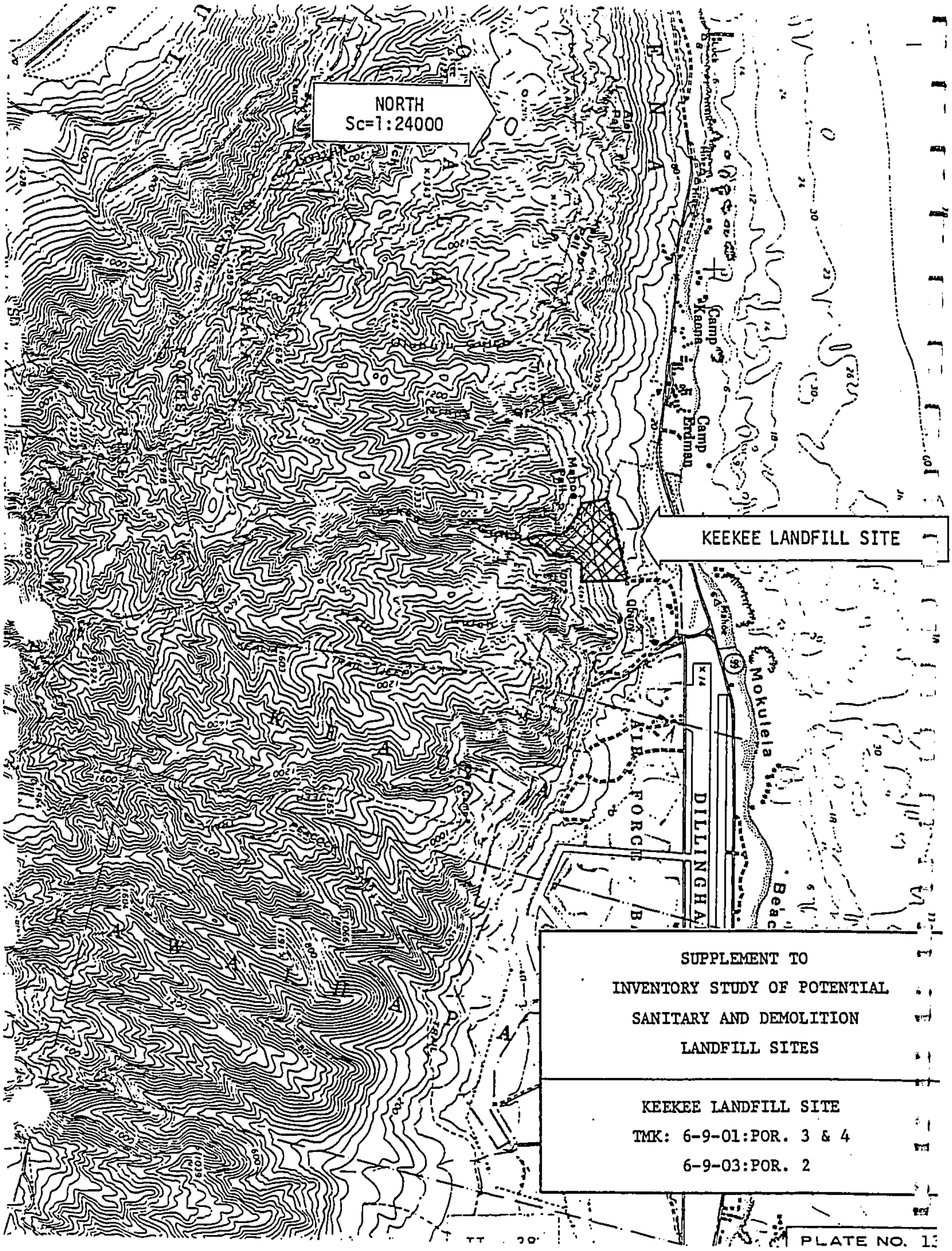
1. Access Road: Improvements must be constructed on Farrington Highway to provide a safe intersection. About 1,500 feet of new access road must be constructed to the site on a new road right-of-way.

2. Operations and Maintenance Facilities: Temporary facilities must be constructed.

3. Utilities: Sanitary sewer system must be installed. Water, electricity and telephone must be extended to the site from Farrington Highway.

4. Drainage System: Major drainage system must be constructed.

5. Leachate Control System: None required but leachate movement should be monitored.


NORTH
Sc=1:24000
KEEKEE LANDFILL SITE
Camp Kaena
Camp Erdman
Mokuleia
DILLINGHA
AIR FORCE
SUPPLEMENT TO
INVENTORY STUDY OF POTENTIAL
SANITARY AND DEMOLITION
LANDFILL SITES
KEEKEE LANDFILL SITE
TMK: 6-9-01:POR. 3 & 4
6-9-03:POR. 2
PLATE NO. 13

KOKO CRATER LANDFILL SITE

A. BASIC DATA OF SITE

1. Location: In Koko Crater on the southeastern tip of Leeward Oahu, 2.5 miles west-southwest of Makapuu Point, one mile east of Kuapa Pond, 1.3 miles northwest of Hanauma Bay. See Plate No. 14.

2. Tax Map Key: 3-19-12 : portion of 1

3. Total Area: 140 acres

4. Owner: City and County of Honolulu

5. Present Use of Land: Open space with botanical garden

6. City Zone District: Preservation P-1

7. City General Plan Land Uses: Park

8. State Land Use District: Conservation

9. Adjacent Land Uses, Zones: Preservation, Park, Conservation

10. Restrictions and Setbacks: Special Permit required from State for construction in Conservation District. Site was deeded to the City by Bishop Estate for use as a park which is in conflict with its use as a landfill.

11. Historical and Archaeological Significance: No sites known to exist.

12. Proximity to Population Centers: Approximately 2,000 ft. from urban area of Hawaii-Kai which are buffered from the site by the crater walls and 16 miles from Keehi Refuse Transfer Station. Koko Crater Stables about 1,000 feet outside northeast opening to Crater.

B. DESCRIPTION OF SITE

1. Accessibility: Not accessible to refuse traffic. New access required from Kealahou Street about 4,000 feet northeast of site.

2. Topography: An extinct crater with a moderately deep depression. Opening of the crater is located on the northeast wall and has an elevation of approximately 230 feet. The highest point is located along the southwest rim of the crater at Kahelepelepe with an elevation of 1,208 feet.

The slope at the center portion of the crater is about 8%. The slopes rapidly increase toward the crater rim where they are very steep at approximately 80%. A botanical garden with succulent plants occupies a small portion of the crater.

3. Soil Classification: Site consists of the following soils taken from the S.C.S. Soil Summary:

   Koko silt loam, 6 to 12% slopes
   Rock land

   See Appendix E.

4. Availability of Cover Material: Little available on site and must be imported.

5. Surface Drainage: Runoff from the crater exits at the northeast lower opening of the crater.

6. Groundwater Supply: Outside of BWS groundwater zone.

7. Rainfall: 25 inches per year. See Appendix I.

8. Wind: Populated area located upwind of site, and prevailing wind in that direction less than 10% of the time.

9. Existing Utilities: Not available on site but are available from nearby urbanized areas.

C. SITE AS LANDFILL

1. Usable Area: 75 acres

2. Type of Operation: Combination of trench and area methods

3. Capacity: 5,500,000 cubic yards

4. Life: 11.4 years

5. Land Use After Development: Park

D. ENVIRONMENTAL CONCERNS OF SITE

1. General Landfill Nuisances: Noise, dust, pests, odor, and litter associated with landfill operations will be generated but will be confined within the crater. Effective control measures must be instituted to minimize landfill nuisances.

2. Visual Pollution: Site is not visible to the public except from opening in crater. Landscaping prior to, during and after landfilling operations will minimize visual pollution.

3. Groundwater Pollution: No protective measures required. Area is not a source of groundwater supply.

4. Surface Drainage Works: On-site drain system must be constructed to minimize surface runoff infiltration. Off-site drain system required to connect to existing concrete channel.

5. Destruction of Natural Resources: Land and natural vegetation will be committed to landfill. However, botanical garden can be developed after landfill operations are completed.

6. Displacement: Koko Crater Stables would be displaced. Landfill will be constructed around an existing botanical garden.

7. Other Environmental Concerns: Traffic will increase from both leeward and windward approach roads via Kalanianaole Highway, Hawaii Kai Drive and Kealahou Street. Impact on flora and fauna is not expected to be significant and these and other concerns will be discussed in detail in an environmental impact statement if the site is selected.

8. Safety: Hazard to the public is minimal.

9. Objection by Owner and Adjacent Landowners: Moderate opposition from Department of Parks and Recreation, a City agency. Opposition may be overcome by reconsideration of City priorities.

10. Objections by Public, Community Organizations: Adjoining communities and organizations with interests for preservation of the existing natural environment will express their objections. Kalama Valley residents will object due to proximity of site.

E. SITE PREPARATION FOR LANDFILL

1. Access Road: 4,000 feet of access road into and along the side slopes of the crater must be constructed.

2. Operations and Maintenance Facilities: Permanent facilities must be constructed.

3. Utilities: Electric power, telephone, water and sanitary sewer must be brought to the site.

4. Drainage System: Moderate site drainage system required on-site. Off-site underground system connecting to existing system is required.

5. Leachate Control: None required, but leachate movement should be monitored.

KUNIA LANDFILL SITES

A. COMMENTARY OF SITES

Two potential sites in Hoaeae, north of Interstate Route H-1, east of Kunia Road, west of Waikele Gulch, and south of Kunia Camp were evaluated for landfill development. See Plate No. 15.

1. Location: Site "A" is located in Huliwai Gulch and an unnamed north branch 0.5 miles north of the Hawaii Country Club, is designated by tax map key 9-4-04 : portion of 4, owned by James Robinson's heirs et al and leased to Dole Corporation and Oahu Sugar Co., Ltd., and contains an area of about 150 acres.

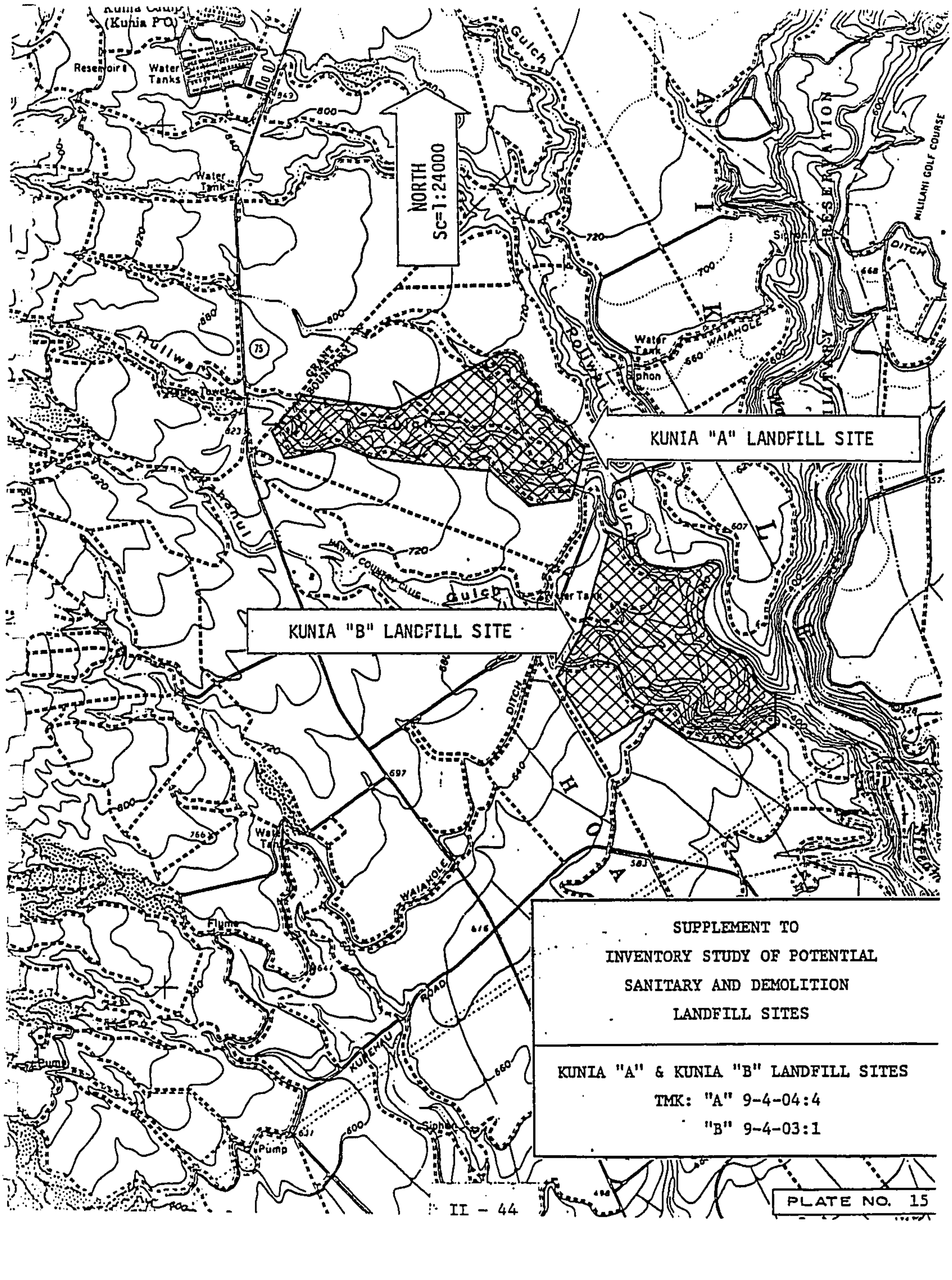
   Site "B" is located in Ekahanui Gulch and portion of Poliwai Gulch, adjacent and east of the Hawaii Country Club, is designated by tax map keys 9-4-03 : portion of 19, is owned by James Robinson's heirs et al and leased to Oahu Sugar Co., Ltd., and contains about 190 acres.

2. Discussion: Both sites are located within the Board of Water Supply groundwater zone which is an existing potential groundwater source. See Plate IV-F-1. They are located in areas where sanitary landfills are not permitted by the BWS. See discussion under HALAWA LANDFILL SITES.

3. Conclusion: The sites are located within the BWS groundwater zone. Rainfall averages 35 inches per year and leachate may be generated. Landfills constructed under these circumstances may cause pollution of our potable groundwater sources. The City should avoid sites over our potable groundwater sources where rainfall exceeds 30 inches per year.

   These sites are not acceptable to the Board of Water Supply according to their letter of July 30, 1979. See Appendix J.

   These Special Considerations will eliminate this site from further consideration.



SUPPLEMENT TO
INVENTORY STUDY OF POTENTIAL
SANITARY AND DEMOLITION
LANDFILL SITES

KUNIA "A" & KUNIA "B" LANDFILL SITES
TMK: "A" 9-4-04:4
"B" 9-4-03:1

PLATE NO. 15

MAILI LANDFILL SITE

A. BASIC DATA OF SITE

1. Location: In Maili, 3,500 feet mauka of Farrington Highway, 4 miles northwest of Nanakuli, 3 miles south of Waianae, on the Leeward coast of Oahu. See Plate No. 16.

2. Tax Map Key: 8-7-10 : 3

3. Total Area: 200 acres

4. Owner: Kaiser Cement & Gypsum Corp.

5. Present Use of Land: Limestone quarry and open space

6. City Zone District: Agriculture AG-1

7. City General Plan Land Use: Agriculture

8. State Land Use District: Agricultural

9. Adjacent Land Uses, Zones: Agriculture, Military, Urban

10. Restrictions and Setbacks: Special Permit required from State for construction in Agricultural District. Limestone quarrying operations for cement production is expected to continue for 25 more years.

11. Historical and Archaeological Significance: No sites known to exist.

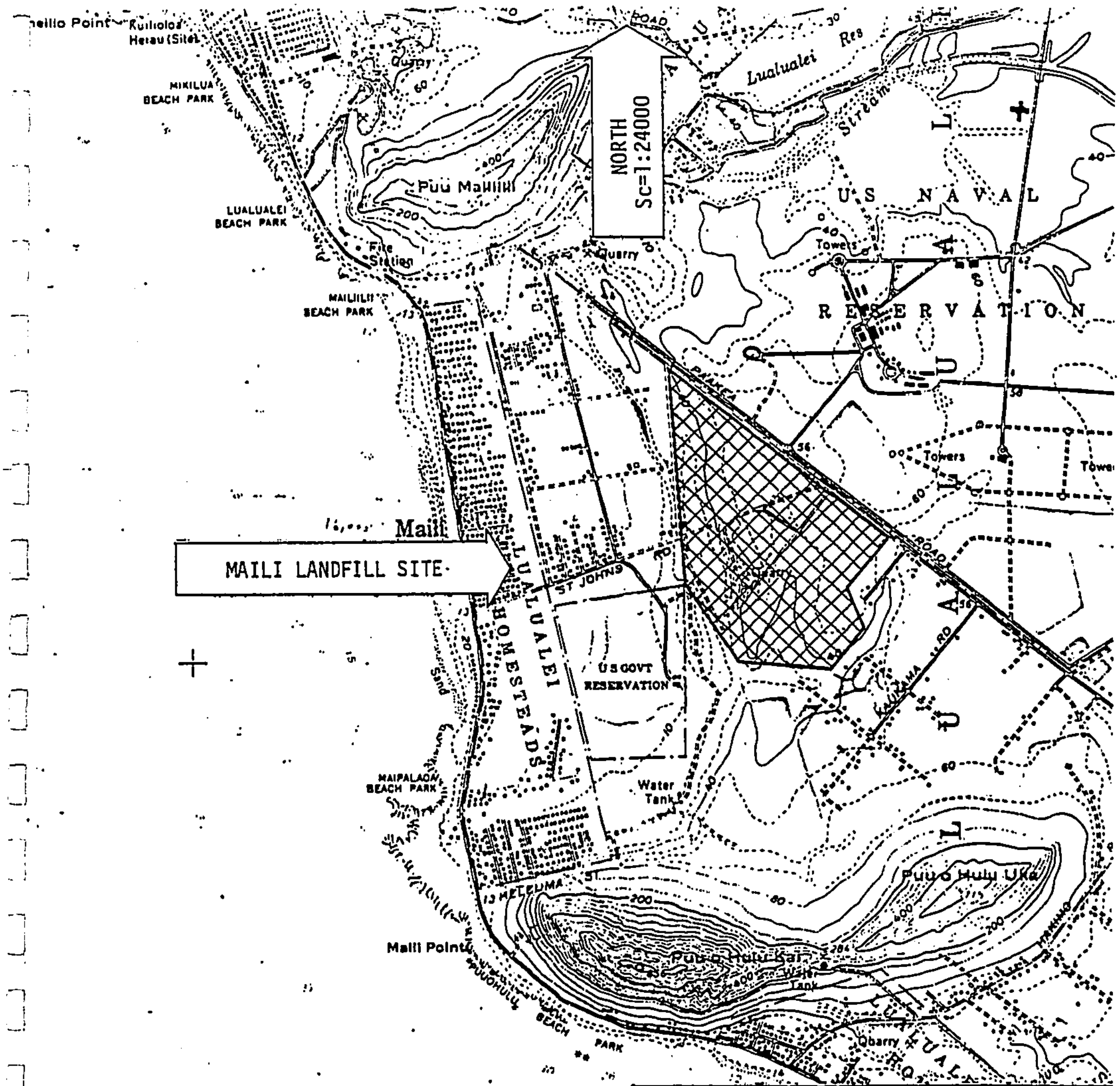
12. Proximity to Population and Refuse Centers: Four miles northwest of Nanakuli and 27 miles from Keehi Refuse Transfer Station.

B. DISCUSSION

The site is presently committed to limestone quarry operations by Kaiser Cement. Its resources are being utilized to their highest and best use and are necessary for the continued production of cement, a vital building material to the construction industry of Hawaii. Displacement of this activity by a landfill prior to its full use is a very inefficient use of the resources of the site. Also, the cement plant is adjacent to this quarry which makes it ideal for the production of cement. The quarry operation is expected to continue for another 25 years.

This site is also over a potential groundwater source and is not acceptable to the Board of Water Supply according to their letter of July 30, 1979. See Appendix J.

These Special Considerations will eliminate this site from further consideration at this time.



SUPPLEMENT TO
INVENTORY STUDY OF POTENTIAL
SANITARY AND DEMOLITION
LANDFILL SITES

MAILI LANDFILL SITE
TMK: 8-7-10:3

PLATE NO. 16

MAKUA LANDFILL SITE

INCLUDING KAHANAHAIKI

A. BASIC DATA OF SITE

1. Location: In Makua Valley including Kahanahaiki, 5 miles southeast of Kaena Point, 4 miles north of Makaha Valley on the northwestern coast of Leeward Oahu. See Plate No. 17.

2. Tax Map Key: Portions of 8-1-01 and 8-2-01

3. Total Area: Over 600 acres

4. Owners: United States of America and State of Hawaii, leased to U. S. Army

5. Present Use of Land: The following excerpts were taken from the Makua-Kaena State Park EIS:

   "With the advent of World War II, the United States Government declared martial law and confiscated Makua Valley for military purposes. It has since been under control of the United States Army."

   "The military currently uses Makua Valley for training and live firing exercises. The continued use of Makua Valley to these activities is essential for the combat readiness of the 25th Infantry Division."

   "The largest parcel of federally owned land within the study area was ceded to the United States in 1964 and is defined as the Makua Valley Training Area. This area is divided into a major maneuver area and a heavily used impact area for live fire exercises, aerial helicopter gunnery, and is the sole facility for the disposal of approximately one hundred fifty to two hundred ten tons of explosives and unserviceable ordnance annually. The impact area is closed to the public and is heavily contaminated with unexploded ordnance varying from aerial bombs to artillery projectiles covering several generations of air force, naval, and infantry weapons. The quantity and location of any undetonated material is unknown and has created an area of potential hazard for future public recreational use or development."

   "The Federal Government has also leased the coastal lands fronting Makua Valley.....for military training purposes, bivouacs, command post exercises, and tactical problems involving units no larger than company size."

"The joint civilian-military use of Makua Valley mauka of Farrington Highway is one of the major unresolved issues. This issue cannot be resolved at this time. It involves policy decisions and future plans and will be an on-going discussion topic between the State and the Federal Governments."

6. City Zone District: Agriculture AG-1

7. City General Plan Land Uses: Agriculture and Military

8. State Land Use District: Conservation

9. Adjacent Land Uses, Zones: Agriculture, Preservation, Military, Conservation

10. Restrictions and Setbacks: Special Permit required from State for construction in Conservation District. Permit or easement required from State of Hawaii and United States of America for landfill construction on their lands.

11. Historical and Archaeological Significance: The following excerpts were taken from the Makua-Kaena State Park EIS:

    "McAllister, in his 1933 island-wide survey of archaeological sites, listed several sites along the shore of Makua. As shown in Figure 2-9, these sites consisted of Kumuakuopio Heiau (Site 178) and a fishing shrine (Site 179). Kaneana Cave also was reported by McAllister to be 'the dwelling place of a shark goddess who held sway from Kaena Point to Kepuhi Point'."

    "McAllister listed three archaeological sites for Kahanahaiki. Site 181, Ukanipo Heiau, apparently was the principal heiau for Kahanahaiki. The heiau was used as a place of burial, but not in the sense of a cemetery. The bodies of ali'i were said to have been placed on the lele or flat stone, until the kahana-nui was informed by the gods to remove the bodies to their final resting place in some designated cave. They were actually 'buried' in the cave, that is, placed with the appropriate ceremonies and offerings. Site 182 was said to have been a swimming pool on the makai side of the Ukanipo heiau, which was used exclusively by the ali'i."

    The Kaahiki Heiau, Site 180, is also located in Makua Valley.

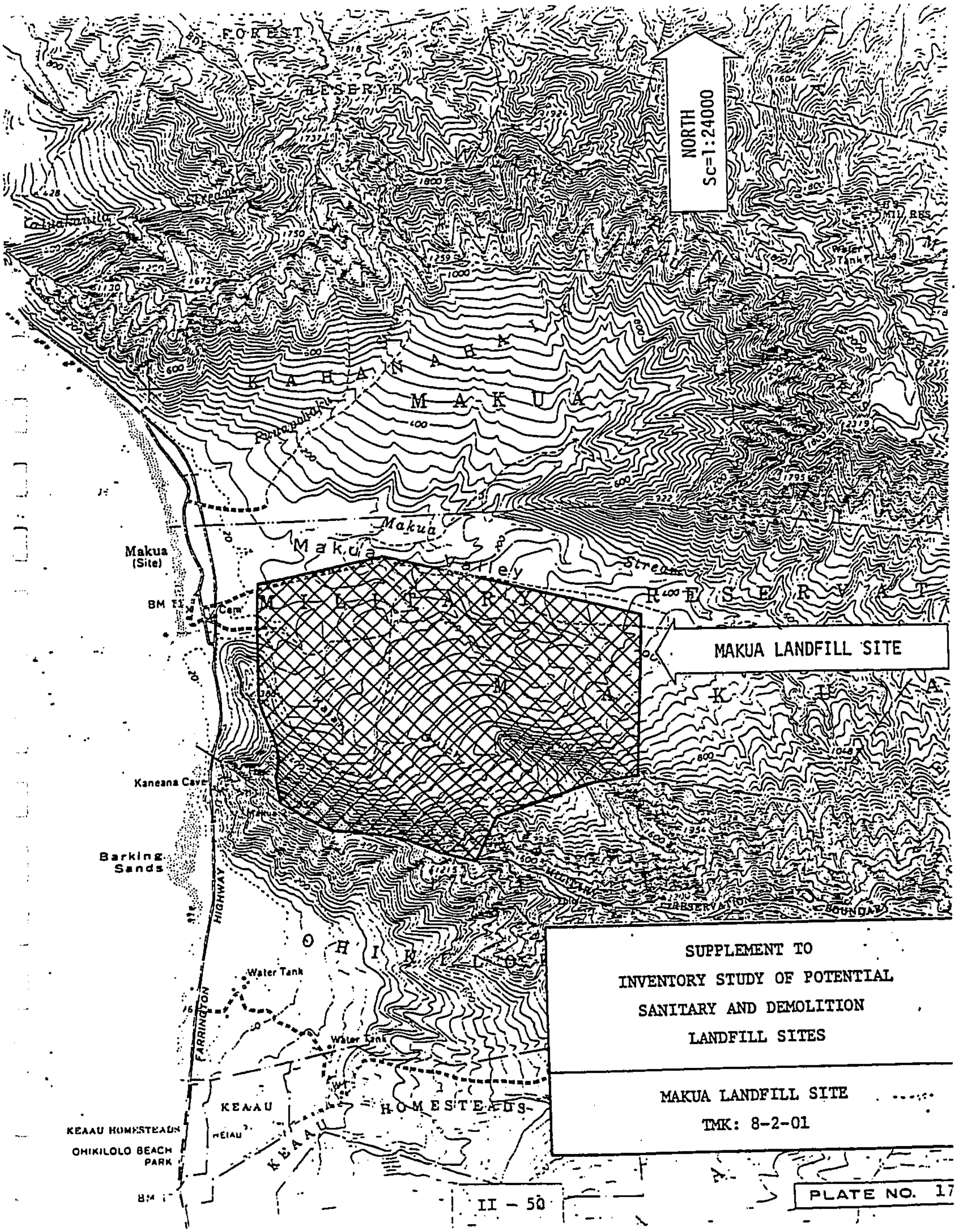
12. Proximity to Population and Refuse Centers: Approximately 7 miles from the urban area of Waianae, 16 miles from Kahe Point, 37 miles from the City's Keehi Refuse Transfer Station and removed from Leeward refuse generating centers.

B. DISCUSSION

This site is used by the military for training and live firing exercises. The probability of receiving acceptance and approval of landfill development at the site by the City is minimal. Landfill development also conflicts with present plans and policies.

This site is also over a potential groundwater source and is not acceptable to the Board of Water Supply according to their letter of July 30, 1979. See Appendix J.

These Special Considerations will eliminate this site from further consideration at this time.


NORTH
Sc=1:24000
MAKUA LANDFILL SITE
FOREST
RESERVE
MAKUA
Makua Valley
Stream
Makua
(Site)
BM 11
Cem
Kaneana Cave
Barking
Sands
FARRINGTON
HIGHWAY
Water Tank
Water Tank
KEAAU
HOMESTEADS
KEAAU HOMESTEADS
OHIKILOLO BEACH
PARK
SUPPLEMENT TO
INVENTORY STUDY OF POTENTIAL
SANITARY AND DEMOLITION
LANDFILL SITES
MAKUA LANDFILL SITE
TMK: 8-2-01
PLATE NO. 17

OHIKILOLO LANDFILL SITE

A. BASIC DATA OF SITE

1. Location: In Ohikilolo in the north portion of Keaau Valley, 3 miles north of Makaha Valley, 1 mile south of Makua Valley on the northwestern coast of Leeward Oahu. See Plate No. 18.

2. Tax Map Key: 8-3-01 : 13

3. Total Area: 706 acres

4. Owners: Elizabeth Marks, Elizabeth Stack, Cynthia Salley, Lester Marks.

5. Present Use of Land: Agriculture, open space and recreation.

6. City Zone Districts: Preservation P-1 and Agriculture Ag-1

7. City General Plan Land Use: Agriculture and Preservation

8. State Land Use District: Agricultural

9. Adjacent Land Uses, Zones: Agricultural, Preservation, Conservation

10. Restrictions and Setbacks: Special Permit required from State for construction in Agricultural District. This site is located at the Makua entrance to the Makua-Kaena State Park. First Hawaiian Bank's recreation center is located on the south portion of the site and Paniolo Country Ohikilolo Makua Ranch is located on the north portion of the site.

11. Historical and Archaeological Significance: No sites known to exist.

12. Proximity to Population and Refuse Centers: 6 miles northwest of Waianae, 36 highway miles from Keehi Refuse Transfer Station and removed from Leeward refuse generating centers.

B. DESCRIPTION OF SITE

1. Accessibility: Accessible from Farrington Highway which narrows to a two-lane road beyond Waianae. About 1,000 feet of new access road must be built into the site.

2. Topography: North portion of Keeau Valley with many small gullies and opening to the ocean on the west. The valley floor near the highway has an elevation of about 20 feet and gradually rises to the ridges with elevations of over 1,600 feet. At the lower end of the valley the ground slopes at about 1% and increases to over 100% at the upper reaches.

3. Soil Classification: Site consists of the following soils taken from the S.C.S. Soil Survey:

   Lolekaa silty clay, 15 to 25% slopes
   Lualualei clay, 0 to 2% slopes
   Lualualei stony clay, 2 to 6% slopes
   Lualualei extremely stony clay, 3 to 35% slopes
   Pulehu clay loam, 0 to 3% slopes
   Pulehu very stony clay loam 0 to 12% slopes
   Rock land
   Rock outcrop
   Stony land
   Stony steep land

   See Appendix E.

4. Availability of Cover Material: Some available on site but most must be imported.

5. Surface Drainage: Surface runoff from upper reaches collect in the many gullies which cross the site.

6. Groundwater Supply: Mauka portion of site is over BWS groundwater zone and may affect potential water sources.

7. Rainfall: 25 inches per year. See Appendix I.

8. Wind: Prevailing wind in direction of populated area more than 50% of the time.

9. Existing Utilities: Electricity and telephone service available from Farrington Highway. Water and Sanitary Sewer System not available on site.

C. SITE AS LANDFILL

1. Usable Area: 150 acres

2. Type of Operation: Combination of trench and area methods.

3. Capacity: 15,600,000 cu. yds.

4. Life: 32 years

5. Land Use After Development: Open space

D. ENVIRONMENTAL CONCERNS OF SITE

1. General Landfill Nuisances: Noise, dust, pests, odor, and litter associated with landfill operations will be generated. Effective control measures must be instituted to minimize landfill nuisances.

2. Visual Pollution: Site is very visible to the public from Farrington Highway and the users of the Makua-Kaena State Park will find landfill construction incompatible with the State Park. Landscaping prior to, during and after landfilling operations will minimize visual pollution.

3. Groundwater Pollution: Mauka portion of site is over BWS groundwater zone and cannot be used for landfilling. Makai portion of site will be used for landfilling, is not over BWS groundwater zone and requires no protective measures.

4. Surface Drainage Works: Drain system must be constructed to route surface runoff from gullies around the site and to minimize runoff infiltration.

5. Destruction of Natural Resources: Land and natural vegetation will be committed to landfill. However, open space can be developed after landfill operations are completed.

6. Displacement: Paniolo Country Ohikilolo Makua Ranch and about three agricultural residences will require displacement. First Hawaiian Bank's recreation center will require displacement.

7. Other Environmental Concerns: Traffic will increase on Farrington Highway thru Nanakuli, Maili, Waianae and Makaha. Impact on flora and fauna is not expected to be significant and these and other concerns will be discussed in detail in an environmental impact statement if the site is selected.

8. Safety: Hazard to the public is minimal.

9. Objection by Owner and Adjacent Landowners: Objections can be expected.

10. Objections by Public, Community Organizations: Leeward communities and organizations with interests for preservation of the existing natural environment will probably express their objections.

E. SITE PREPARATION FOR LANDFILL

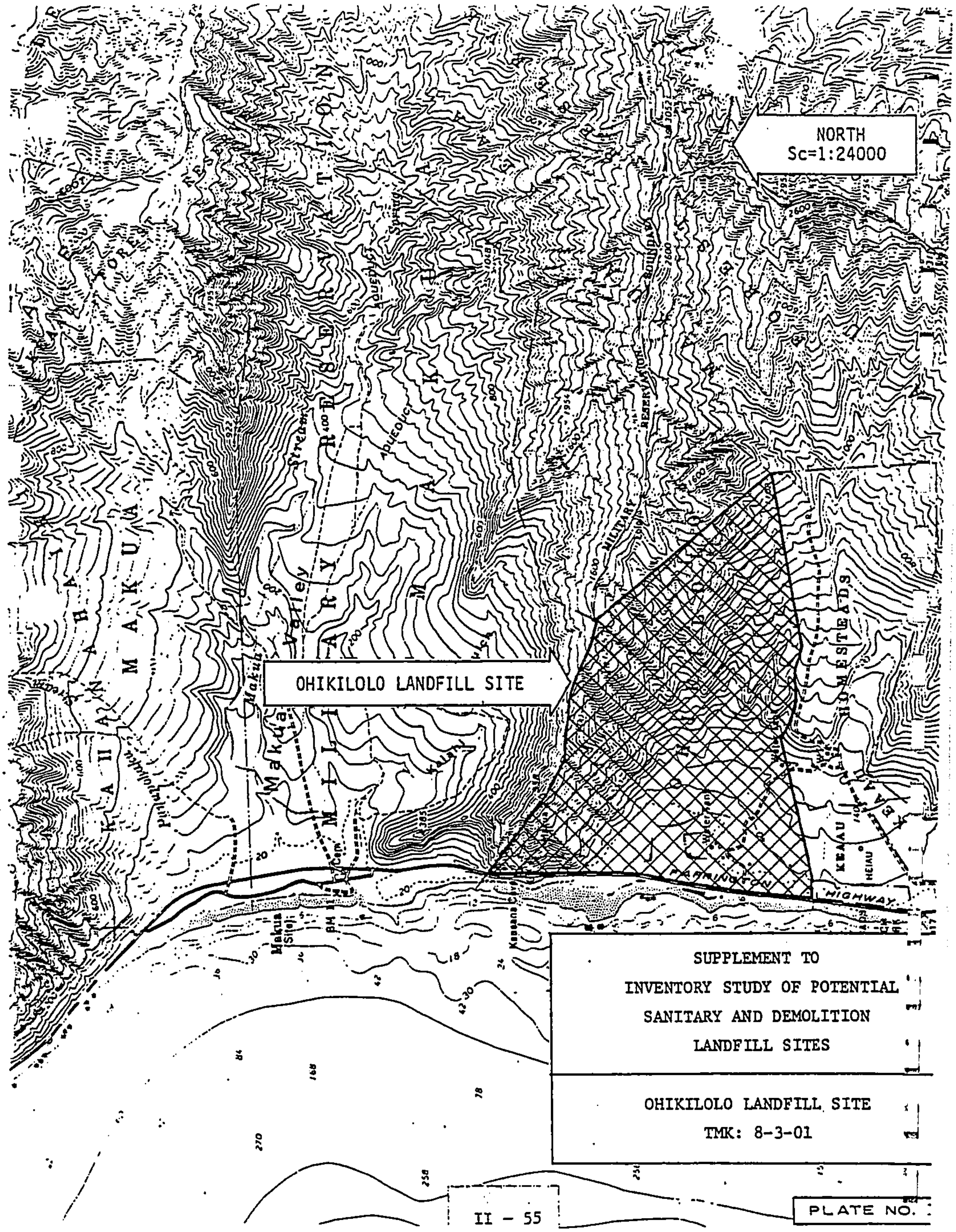
1. Access Road: Improvements must be constructed on Farrington Highway to provide a safe intersection. About 1,000 feet of new access road must be constructed into the site.

2. Operations and Maintenance Facilities: Permanent facilities must be constructed.

3. Utilities: Electricity and telephone service must be extended from Farrington Highway. Water and sanitary sewer system must be developed or brought to the site.

4. Drainage System: A major drainage system must be constructed.

5. Leachate Control System: None required but leachate movement should be monitored.


NORTH
Sc=1:24000
OHIKILOLO LANDFILL SITE
MAKUA
MILITARY RESERVATION
Makua Valley
HOMESTEADS
FARRINGTON
HIGHWAY
SUPPLEMENT TO
INVENTORY STUDY OF POTENTIAL
SANITARY AND DEMOLITION
LANDFILL SITES
OHIKILOLO LANDFILL SITE
TMK: 8-3-01
PLATE NO.

PEARL HARBOR SWAMPLANDS

These sites are the unused swamp areas along the perimeter of Pearl Harbor. Specific sites have not been designated. According to the Federal Register (40 CFR Part 241), Volume 44, No. 59, Monday, March 26, 1979:

> "Environmentally sensitive areas, including wetlands, 100-year flood-plains, permafrost areas, critical habitats of endangered species, and recharge zones of sole source aquifers should be avoided or receive lowest priority as potential locations for landfill disposal facilities. If these areas are to be considered, the following subjects need to be addressed:"
>
> (1) Alternatives
>
> (2) Impact
>
> (3) Apprcvals

Since alternative sites are available, obtaining approval for a landfill in a wetland would be extremely difficult if not impossible.

These Special Considerations will eliminate these sites from further evaluation as potential landfill sites.

SAND ISLAND LANDFILL SITE

A. BASIC DATA OF SITE

1. Location: At Sand Island State Park on the south and east sides of Sand Island in Honolulu Harbor across downtown commercial and Iwilei industrial areas on the south Leeward coast of Oahu. See Plate No. 19.

2. Tax Map Key: 1-5-41 : portion of 6

3. Total Area: 150 acres

4. Owners: State of Hawaii

5. Present Use of Land: Park, recreation and junkyard

6. City Zone District: Residential R-6, Industrial I-2, and Park P-1

7. City General Plan Land Uses: Industrial

8. State Land Use Districts: Urban

9. Adjacent Land Uses, Zones: Industrial I-3 and Park

10. Restrictions and Setbacks: 1995 Master Plan for Honolulu Harbor developed by a Multi-Modal Task Force was approved by the Governor of the State on April 23, 1976. Sand Island has been allocated various land uses and the construction of a landfill is in conflict with the Master Plan. Eastern increment of Sand Island State Park has been constructed. See Plate No. 20. Also variance must be obtained from the City for landfill construction in Industrial I-2 zone.

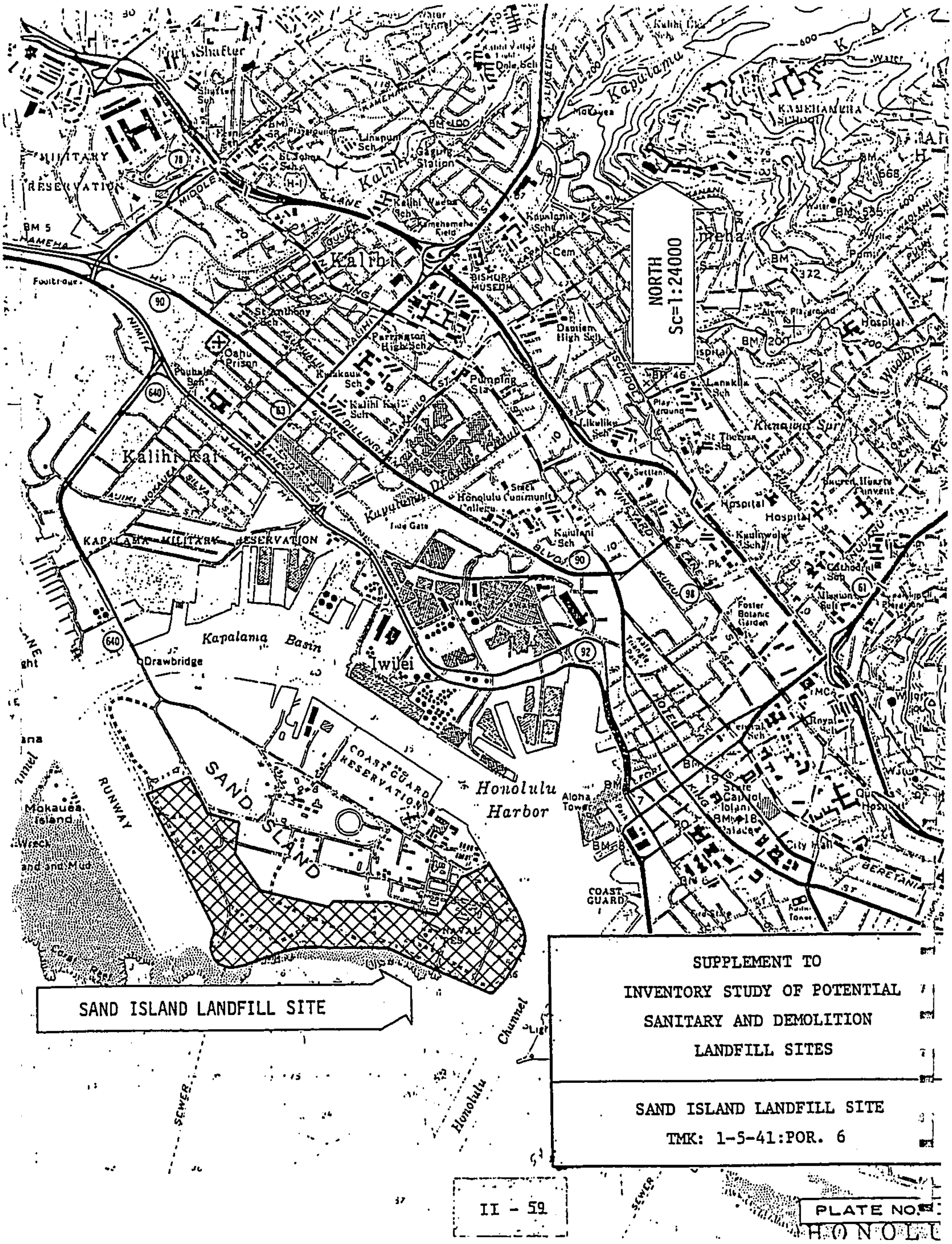
11. Historical and Archaeological Significance: No archaeological sites known to exist. From 1868 to 1929 Sand Island was used as an immigration quarantine island. During World War II it served as a temporary detention camp for aliens suspected of being enemy agents. Since then it has been used primarily as a junkyard and refuse dump. Except for the Coast Guard Station, the U.S. Government released control of the island to the State in 1965. With various interests vying for space on the island, the 1995 Master Plan including the proposed development of Sand Island was developed by the Task Force.

12. Proximity to Population and Refuse Centers: Adjacent to existing City sewage plant, State container facility, U.S. Coast Guard station and proposed foreign trade zone and maritime industries. 2,000 feet across the harbor from Aloha Tower and 1,000 feet across the harbor from Piers 1 and 2.

B. DISCUSSION

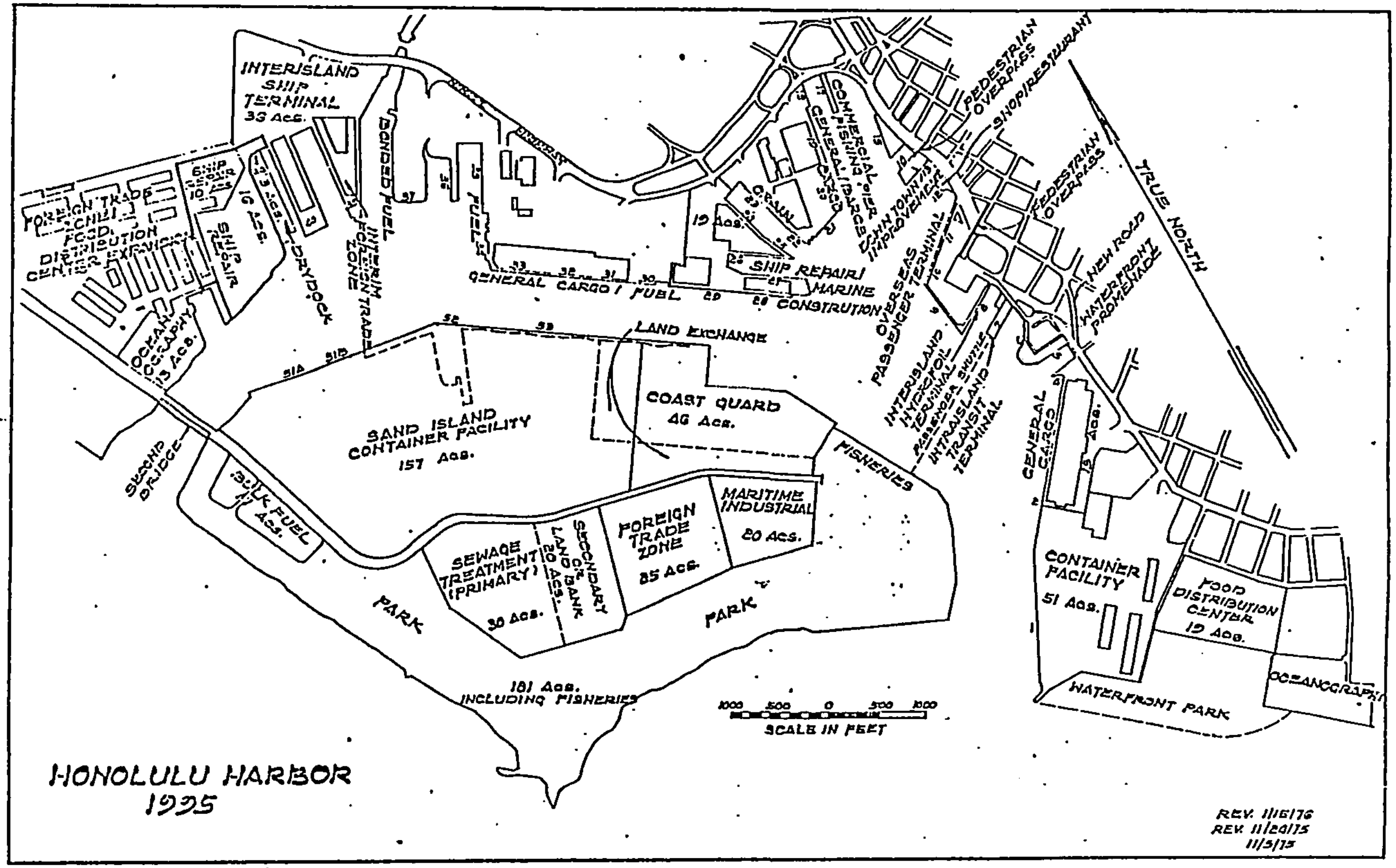
This site has been designated on the 1995 Master Plan for Honolulu Harbor as the Sand Island State Park and construction of the park has been substantially completed. Landfill development will conflict with present plans and policies for the site.

This Special Consideration will eliminate this site from further evaluation as a potential landfill site.



SUPPLEMENT TO
INVENTORY STUDY OF POTENTIAL
SANITARY AND DEMOLITION
LANDFILL SITES

SAND ISLAND LANDFILL SITE
TMK: 1-5-41:POR. 6



SOURCE: State of Hawaii, Department of Transportation, 1995 Master Plan for Honolulu Harbor Memorandum

SAND ISLAND MASTER PLAN
Plate No. 20

WAIANAE LANDFILL EXPANSION

A. BASIC DATA OF SITE

1. Location: Adjacent to existing landfill, 0.9 miles mauka of Farrington Highway. See Plate No. 21.

2. Tax Map Key: 8-50-3 : 1, 29, 30, 31, 32 and 8-5-06 : 10

3. Total Area: 140 acres

4. Owners: City and County of Honolulu; State of Hawaii, leased to Tamotsu Sugiyama; Joseph Moon Wong; Tao Chien Chong; Antone Ruiz, Jr., leased to Mountain View Dairy; Timmy Au.

5. Present Use of Land: Open land apparently idle.

6. City Zone District: Agriculture AG-1

7. City General Plan Land Use: Agriculture

8. State Land Use District: Agricultural

9. Adjacent Land Uses, Zones: Agriculture

10. Restrictions and Setbacks: Special Permit required from State for construction in Agricultural District. Several easements cross the site.

11. Historical and Archaeological Significance: No sites known to exist.

12. Proximity to Population and Refuse Centers: About 1 mile mauka of the Waianae Business District and approximately 30 miles from Keehi Refuse Transfer Station.

B. DESCRIPTION OF SITE

1. Accessibility: Accessible from Plantation Road. About 4,000 feet of roadway improvements required to site.

2. Topography: Relatively flat land in the lower areas at the level of the existing landfill. Slope rises to about 20% in upper areas.

3. Soil Classification: Site consists of the following soils taken from the S.C.S. Soil Survey:

   Stony Lualualei Clay, 3 to 35%

   See Appendix E.

4. Availability of Cover Material: Partially available on site.

5. Surface Drainage: Surface runoff flows by sheet across site into Kawiwi Stream.

6. Groundwater Supply: Mauka portion of this site is over BWS groundwater zone and may affect potential water sources.

7. Rainfall: 30 inches per year. See Appendix I.

8. Wind: Prevailing wind in direction of populated area more than 50% of the time.

9. Existing Utilities: None available on site.

C. SITE AS LANDFILL

1. Usable Area: 130 acres

2. Type of Operation: Combination of trench and area methods

3. Capacity: 6,800,000 cubic yards

4. Life: 14 years

5. Land Use After Development: Open space

D. ENVIRONMENTAL CONCERNS OF SITE

1. General Landfill Nuisances: Noise, dust, pests, odor, and litter associated with landfill operations will be generated. Effective control measures must be instituted to minimize landfill nuisances.

2. Visual Pollution: Site will be visible to the public as the landfill rises to its final elevation. Site will not be visible during other periods. Landscaping prior to, during and after landfilling operations will minimize visual pollution.

3. Groundwater Pollution. No protection measures required. Area is not a source of groundwater supply.

4. Surface Drainage Works: Nominal site drain system must be constructed to route surface runoff to adjacent stream to minimize surface erosion and infiltration.

5. Destruction of Natural Resources: Agricultural land will be committed to landfill. However, the site can be reverted to light agriculture or open space after landfill operations are completed.

6. Displacement: Prime land will be removed from intensive agricultural use.

7. Other Environmental Concerns: Traffic will increase on Farrington Highway, Plantation Road and the access road. There will be great impact to the local residents due to this additional traffic. Impact on flora and fauna is not expected to be significant and these and other concerns will be discussed in detail in an environmental impact statement if the site is selected.

8. Safety: Operational hazard to the public is minimal.

9. Objection by Owner and Adjacent Landowners: Strong opposition from the residents and landowners can be expected.

10. Objections by Public, Community Organizations: State of Hawaii, nearby communities and organizations with interest in preservation of the existing environment will probably express their objections.

E. SITE PREPARATION FOR LANDFILL

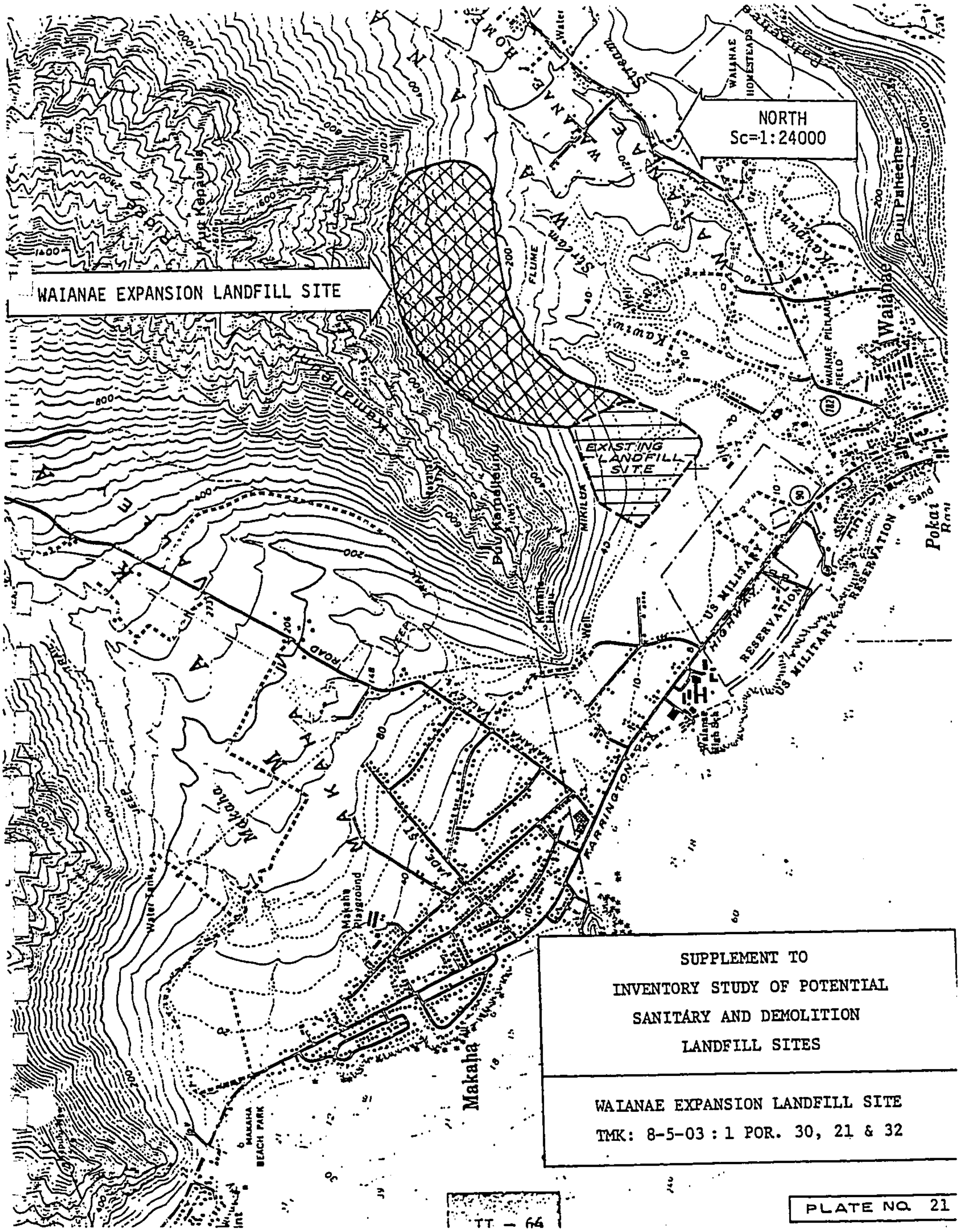
1. Access Road: Improvements must be constructed on Plantation Road and the access road to provide a safe route. About 4,000 feet of roadway must be improved.

2. Operations and Maintenance Facilities: Permanent facilities must be constructed.

3. Utilities: Telephone, electricity and water must be extended from Plantation Road. Sanitary sewer system must be installed.

4. Drainage System: Niminal drainage system must be constructed.

5. Leachate Control System: None required but leachate generation should be monitored.



SUPPLEMENT TO
INVENTORY STUDY OF POTENTIAL
SANITARY AND DEMOLITION
LANDFILL SITES

WAIANAE EXPANSION LANDFILL SITE
TMK: 8-5-03 : 1 POR. 30, 21 & 32

PLATE NO. 21

WAIMANALO GULCH SANITARY LANDFILL

A. BASIC DATA OF SITE

1. Location: In Waimanalo Gulch 0.5 miles southeast of Kahe Valley, a mile northwest of Makaiwa Gulch, north/mauka of Farrington Highway and 0.5 miles east of Kahe Point. See Plate No. 22.

2. Tax Map Key: 9-2-03 : 13, 40 and portion of 2

3. Total Area: 260 acres

4. Owners: James Campbell Trust Estate, Robert & Audrey Au, Raymond & Betty Au, Edward & Lai Fong Au, Hawaiian Electric Co., Inc.

5. Present Use of Land: Agricultural and open space

6. City Zone District: Agriculture, AG-1

7. City General Plan Land Use: Agriculture and Preservation

8. State Land Use District: Agricultural

9. Adjacent Land Uses, Zones: Industrial, Urban, Preservation

10. Restrictions and Setbacks: Special Permit required from State for construction in Agricultural District and for access at Farrington Highway. Twelve agricultural residences and Kahe Beach Park exist southwest of the site.

    Kahe Theme Park, an ethnic cultural amusement attraction, is proposed at the lower portion of the site owned by the Au families and identified by tax map key 9-2-03:13. Special permit from the State and Conditional Use Permit from the City have been obtained for the project by the developer, Oahu Corporation.

    West Beach development by Herbert K. Horita Realty, Inc. is proposed across Farrington Highway and south of the site on Campbell Estate land. The status of construction of the proposed Kahe Theme Park and the West Beach development is uncertain at this time.

    HECo's Kahe Reflector site identified by tax map key 9-2-03:40 and HECo's Kahe Mobile Radio Station must be provided with access.

11. Historical and Archaeological Significance: No sites known to exist.

12. Proximity to Population and Refuse Centers: Adjacent to an agricultural subdivision, 2 miles southeast of Nanakuli, a mile west of Honokai Hale and 20 miles from Keehi Refuse Transfer Station.

B. DESCRIPTION OF SITE

1. Accessibility: Accessible from Farrington Highway. About 2,000 feet of new access road required into site.

2. Topography: Long, narrow, well-defined, stony gulch about 1,500 feet wide and 7,500 feet long. The lower end slopes at 8% and the upper end slopes at 18%.

3. Soil Classification: Site consists of the following soils taken from the S.C.S. Soil Survey:

   Lualualei extremely stony clay, 3 to 35% slopes
   Rock land
   Stony steep land

   See Appendix E.

4. Availability of Cover Material: Little available on site and must be imported.

5. Surface Drainage: Surface runoff from Waimanalo Gulch traverses site.

6. Groundwater Supply: Outside of BWS groundwater zone.

7. Rainfall: 20 inches per year. See Appendix I.

8. Wind: Prevailing wind in direction of populated area more than 50% of the time.

9. Existing Utilities: Except for sanitary sewer, utilities are available from Farrington Highway adjacent to site. HECo power lines cross upper portion of site.

C. SITE AS LANDFILL

1. Usable Area: 80 acres

2. Type of Operation: Combination of trench and area methods

3. Capacity: 3,700,000 cubic yards

4. Life: 7.6 years

5. Land Use After Development: Open space

D. ENVIRONMENTAL CONCERNS OF SITE

1. General Landfill Nuisances: Noise, dust, pests, odor and litter associated with landfill operations will be generated. Effective control measures must be instituted to minimize landfill nuisances.

2. Visual Pollution. Site is highly visible to the public from Farrington Highway, from the agricultural subdivision adjacent to the site and from the proposed West Beach development. Landscaping prior to, during and after landfilling operations will minimize visual pollution.

3. Groundwater Pollution: No protection measures required. Area is not a source of groundwater supply.

4. Surface Drainage Works: Major site drain system must be constructed to route surface runoff from Waimanalo Gulch around the site and to minimize surface runoff infiltration.

5. Destruction of Natural Resources: Land and natural vegetation will be committed to landfill. However, the site can be reverted to open space after landfill operations are completed.

6. Displacement: None. Landfill will be constructed adjacent to existing agricultural residences. There will be displacement of the proposed Kahe Theme Park planned at the site.

7. Other Environmental Concerns: Traffic will increase on Farrington Highway and the addition of an intersection will increase hazards.

   Impact on flora and fauna is not expected to be significant and these and other concerns will be discussed in detail in an environmental impact statement if the site is selected.

8. Safety: Operational hazard to the public is minimal.

9. Objection by Owner and Adjacent Landowners: Strong Opposition from the agricultural residents, Au families and Oahu Corporation can be expected.

10. Objections by Public, Community Organizations: Adjoining communities and organizations with interests for preservation of the existing natural environment will probably express their objections.

E. SITE PREPARATION FOR LANDFILL

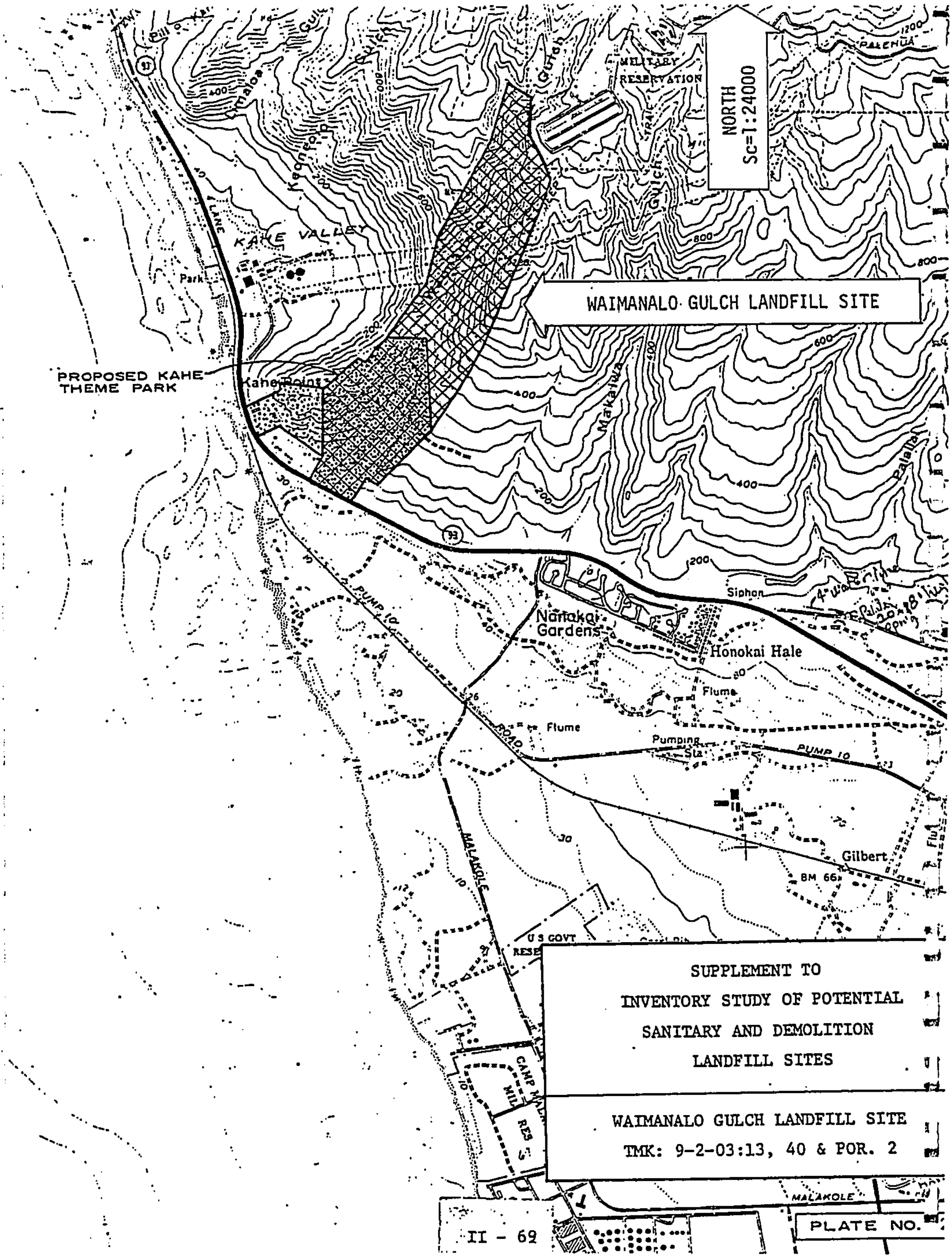
1. Access Road: Improvements must be constructed on the 4-lane Farrington Highway to provide a safe intersection. About 2,000 feet of new access road must be constructed to the site.

2. Operations and Maintenance Facilities: Permanent facilities must be constructed.

3. Utilities: Must be extended from Farrington Highway. Sanitary sewer system must be installed. Portions of existing HECo power lines may require relocation.

4. Drainage System: A major drainage system must be constructed.

5. Leachate Control System: None required but leachate movement should be monitored.



SUPPLEMENT TO
INVENTORY STUDY OF POTENTIAL
SANITARY AND DEMOLITION
LANDFILL SITES

WAIMANALO GULCH LANDFILL SITE
TMK: 9-2-03:13, 40 & POR. 2

PLATE NO.

WAIPIO LANDFILL SITE

A. BASIC DATA OF SITE

1. Location: On Waipio Peninsula, Pearl Harbor Naval Reservation, 1.4 miles south of Waipahu. See Plate No. 23.

2. Tax Map Key: 9-3-02 : portion of 1

3. Total Area: 75 acres

4. Owner: United States of America and leased to Oahu Sugar Co., Ltd.

5. Present Use of Land: Canefield and disposal site for cane bagasse. Within Navy Blast Zone.

6. City Zone District: Agriculture AG-1

7. City General Plan Land Use: Military.

8. State Land Use District: Agriculture

9. Adjacent Land Uses, Zones: Agriculture and Military

10. Restrictions and Setbacks: Special Permit required from State for construction in Agricultural District. Permit or easement required from United States of America for landfill construction on its land. Oahu Sugar Co. will be required to find and develop another site for disposal of cane bagasse. Within Navy Blast Zone--needs special construction.

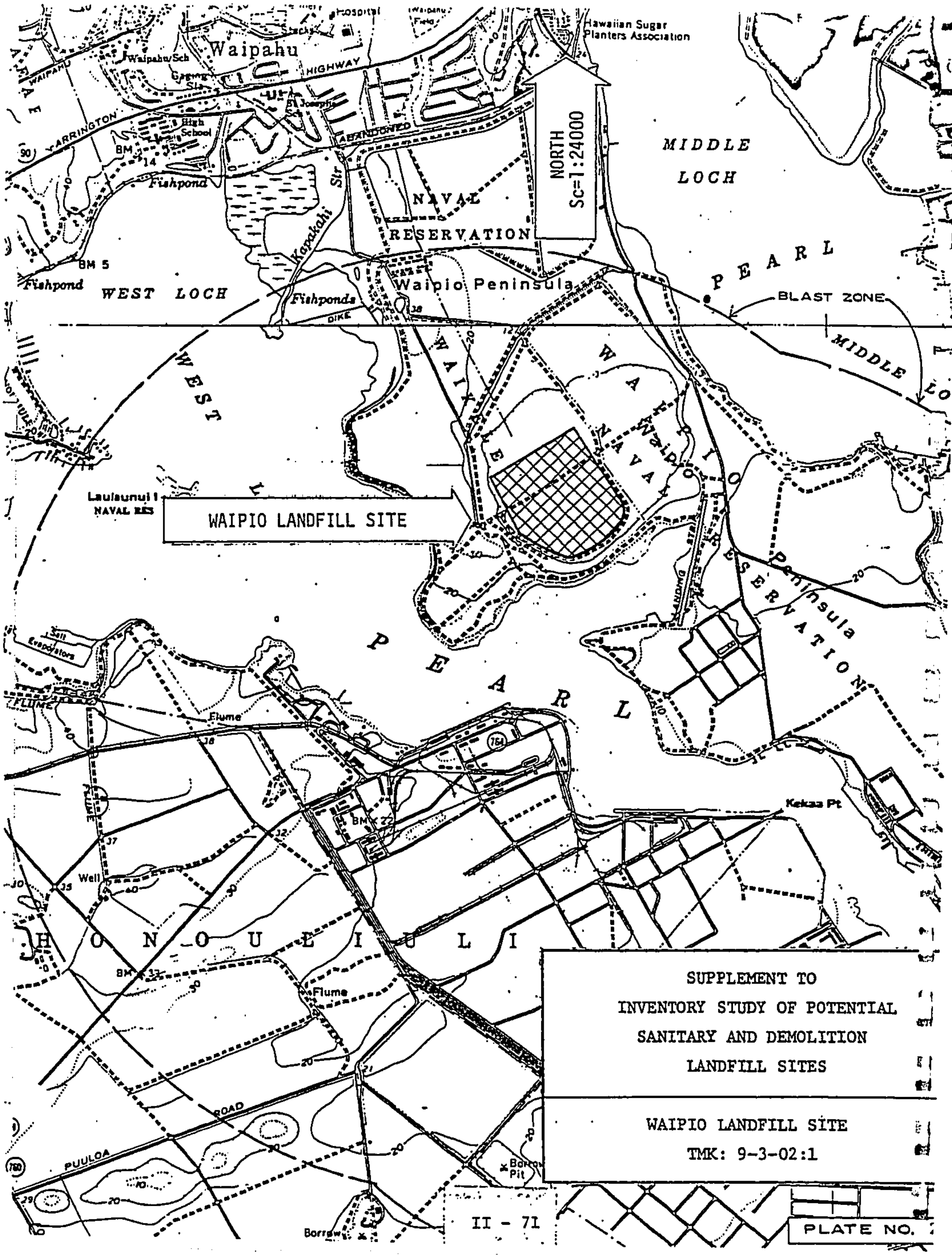
11. Historical and Archaeological Significance: No sites known to exist.

12. Proximity to Population and Refuse Centers: About 1.5 miles south of Waipahu and 11 miles from Keehi Refuse Transfer Station.

B. DISCUSSION

The Waipio Peninsula was once considered by the Navy (1976 Study) for landfill development. However, due to subsequent planning, Waipio Peninsula has been designated as a future site for an ammunition storage facility. The Navy has indicated that they will not approve a landfill development at the site. Landfill development also conflicts with present plans and policies.

These Special Considerations will eliminate this site from further evaluation as a potential landfill site.



SUPPLEMENT TO
INVENTORY STUDY OF POTENTIAL
SANITARY AND DEMOLITION
LANDFILL SITES

WAIPIO LANDFILL SITE
TMK: 9-3-02:1

III. SITE SELECTION MATRIX

A. General Landfill Site Selection Requirements

Landfill sites are very difficult to locate on Oahu for the following reasons: limited land space due to Honolulu being a small island community; the restrictions imposed by the Board of Water Supply over the groundwater supply areas; the scarcity of low cost, undeveloped suitable lands; existence of urbanization and developments throughout the island; and local community objections to landfills adjacent to or near their homes.

The selection of a sanitary landfill site is dependent on several factors which must be closely evaluated in order to control air and water quality alterations, to promote efficient and economic use of the site, and to minimize disturbance to neighboring activities. These factors include: 1) landfill capacity, 2) refuse hauling distance, 3) access to adequate roads, 4) availability of utilities for site, infra-structure and access, 5) availability of cover material, 6) acquisition, development and operation costs, 7) compatibility of existing and proposed land uses of the site with surrounding areas, 8) final land uses of the landfill, 9) displacement of residents or businesses, 10) environmental compatibility of the site in terms of geology, drainage, hydrology and effects on air and water quality, noise levels, and flora and fauna, 11) social and cultural compatibility of the site in terms of effect on sites of archaeological or historical significance and of visual intrusion upon surrounding areas, and 12) acceptability by landowner, adjacent landowners and the community. These factors generally have environmental, social and economic impact.

The ideal site would produce the least environmental disruption and at the least cost. It would be located close to major refuse generation centers, remote from residential areas, schools and hospitals, have sufficient cover material, require minimal improvements, be operationally efficient, and be acceptable to the public and adjacent communities. However, sites which combine little environmental impact and low development, operations and maintenance costs are usually non-existent, and the implementation of new landfill facilities will? ~~may~~ require tradeoffs between environmental and economic considerations.

B. The Matrix

To assist in determining the environmental, social and economic suitability of proposed sites, a Site Evaluation Matrix was devised (Tables IIIA, IIIB, and IIIC). The final form of this matrix was arrived at after receiving comments from citizen groups and government agencies, and evaluating and reducing the comments into usable form for inclusion in the matrix.

1. Environmental and Social Factors

The matrix evaluated environmental and social concerns by rating the degree of impact of each factor for each site through a numerical value 1 to 5 as follows:

(1) None -- No impact; no effect.

(2) Minimal -- Hardly any impact; little effect.

(3) Minor -- Some impact but not significant; effect noticeable but within tolerable limits.

(4) Moderate -- Some impact with enough significance that it cannot be ignored and must be considered; effect noticeable and may be objectionable to many.

(5) Major -- Great impact with significant effect; must be addressed extensively.

The following factors were measured in the matrix:

a. Population Within 1-Mile Radius. A mile distance from a landfill site was selected as the distance within which vectors (rats, flies, odor, litter), property values, noise, stigma of living nearby would have an effect. (The EPA guidelines suggest recording all land use and zoning within 1/4 mile of the landfill site.) This item rates these effects by the number of people living within the 1-mile radius.

0	1 - 100	100 - 500	500 - 1,500	>1,500
1	2	3	4	5

Due to increased concern of impact on human beings rating on this factor was multiplied by 2 before being entered into the matrix.

b. <u>Distance to Nearest Residence</u>. A mile distance (5,000 ft.) was considered to be far enough removed from the landfill not to be impacted by it. Distance was measured in a straight line. Natural barriers such as mountains, gullies, bodies of water, and vegetation were considered together with the distance to arrive at the final rating number.

<u>≤5,000'</u>	<u>≤4,000'</u>	<u>≤3,000'</u>	<u>≤2,000'</u>	<u>≤1,000'</u>

Due to increased concern of impact on human beings, rating on this factor was multiplied by 2 before being entered into the matrix.

c. <u>Wind Direction in Relation to Populated Areas</u>. The direction and duration of wind and natural barriers such as mountains and vegetation were considered to evaluate the effect of wind on populated areas. Wind does have a great effect on dust, noise, odor and litter. The prevailing direction and duration were considered of most importance.

Populated Area Upwind	Populated Area Downwind < 10%	Populated Area Downwind < 25%	Populated Area Downwind > 25%	Populated Area Downwind > 50%
1	2	3	4	5

d. Visual. The degree of visibility from near and afar was evaluated. Landfill activities are not esthetically pleasing and should be hidden from view by gullies, vegetation, and landscaping as much as possible.

1) Not visible.
2) Minimal. Visible from afar only.
3) Minor. Partly visible from adjacent public street.
4) Moderate. Readily visible from adjacent public street or highway.
5) Major. Readily visible from two or more adjacent public streets or highway and from afar.

e. Existing Land Use. Present use of land, existing City Zoning and State Land Use Designations as well as adjacent land uses and zones were considered to evaluate the public and government's acceptance or objection of the landfill site in terms of existing land use.

The following equipment and operational requirements were estimated, based on discussions with the Refuse Division and the operational requirements of each landfill site. Almost two complete shifts of personnel will be required per site, due to the long hours of operation (hrs. per week).

1. EQUIPMENT REQUIREMENTS:

1 - D-8 Size Landfill Dozer w/Acc.	$ 205,000
1 - Loader w/Acc.	97,000
~~1 - Compactor w/Acc.~~	123,000
1 - Water Tank Truck 60,000 48,000 lbs 3500 gal capacity	35,000
1 - One-Half Ton Pickup	7,000
1 - Scraper - 20± C.Y.	125,000
Total Equipment Cost	$ 592,000 per site

Annual equipment cost amortized over 8-yr. period @ 6%, CRF - 0.16104 — $ 95,300 per yr. per site

Due to each site handling the same volume of refuse, manpower and equipment requirements are assumed to be the same for all sites.

2. OPERATIONAL REQUIREMENTS:

a. Operation and maintenance cost of equipment (approximated from local contractor's costs) — $ 58,400 per site

b. Annual Manpower Costs (overhead of 30.17% included):

2 - Supervisors	$ 36,400	
5 - Equipment Operators	69,000	
2 - Scale Operators	20,800	
5 - Laborers	45,500	
Total Annual Manpower Costs		$ 171,700 per site

Due to increased concern of the public, citizen groups and the State Department of Agriculture regarding the use of agricultural lands for other purposes, a site located wholly in prime agricultural land and under intensive use was considered to have a major impact on existing land use. A site located on open steep lands or in a gulch and left in open space was considered to have minimal impact on existing land use. Minor and Moderate ratings were given to lands under low to medium use.

None	Minimal	Minor	Moderate	Major
1	2	3	4	5

f. Future Land Use. City General Plan land use; owner, lessee or government's future development plans for the site; and development trends and and patterns were considered to evaluate the acceptance of the landfill site in terms of future land use by the owner, public and the government.

Landfill construction can create new land forms with exciting potential for recreational, open space and agricultural uses. A site which can be developed to City General Plan or owner, lessee or government's future development plan after completion of landfill construction, such as agricultural or recreational use, was considered to have minimal impact on future land use.

A site which cannot be developed to the City General Plan or to future development plan land use after completion of landfill construction was considered to have a major impact on future land use. A site with minor to moderate conflicts was rated according to the degree of conflict with the future land use.

<u>None</u>	<u>Minimal</u>	<u>Minor</u>	<u>Moderate</u>	<u>Major</u>
1	2	3	4	5

g. <u>Traffic and Safety</u>. Landfill facilities will generate traffic on highways, through local streets up to the landfill site access road. Volume of existing and new traffic, existing roadside conditions and grades, and location of access routes will affect traffic safety. Effects of these items were considered in evaluating traffic and safety.

1) None. Existing roads have additional capacity. Additional traffic can easily be accommodated. Increase in hazard not noticeable.

2) Minimal. Existing roads still adequate to accommodate additional traffic without overloading roadway. New condition not hazardous.

3) Minor. Additional traffic hazard noticeable. Will have some impact. May require minor road improvements such as widening, slight realignment and signing.

4) Moderate. Additional traffic hazard of enough significance. Must be alleviated with additional roadway improvements to those listed in 3), such as left turn storage and deceleration lanes.

5) Additional traffic hazard of great significance. Must be alleviated with major roadway improvements such as signalization in addition to those listed in 3) and 4).

h. Surface Water Quality. Geology (soil type), topography (shape and slope of the site) and hydrology (rainfall quantity and pattern, vegetal cover and climate) affect leachate generation and erosion potential. Their impact on surface water quality were considered when evaluating the effect on non-potable water sources, downstream surface waters, and Class A and AA ocean waters.

Site conditions which added to the difficulty of handling surface runoff were also considered.

1) None. No impact.
2) Minimal. Rainfall 25 inches/year or less. Erosion hazard slight. Uncontrolled runoff from site into streams or surface waters unlikely. Leachate generation and movement potential slight.
3) Minor. Rainfall 25 inches/year or less. Erosion hazard slight. Occasional runoff from site into streams or surface waters possible. Distance to Class A or Class AA ocean waters one mile or more. Leachate generation and movement potential slight.
4) Moderate. Rainfall 25 inches/year or less. Erosion hazard moderate. Class A or AA waters less than one mile distant with moderately sloping terrain. Leachate generation and movement potential slight.
5) Major. Rainfall greater than 25 inches/year. Erosion hazard severe. Class A or Class AA ocean waters immediately downstream of site with steep terrain. Leachate generation and movement potential moderate.

2. Economic Factors

The matrix evaluated the economic effects by measuring the relative costs of the following:

a. Hauling. Distance from refuse generation centers was an important consideration in siting a landfill. A remote landfill will require an increase in transfer equipment and personnel, fuel and supplies.

With the City seriously pursuing resource recovery with the HPOWER project, hauling distances from the two potential HPOWER sites at Waipahu or Campbell Industrial Park to the potential landfill sites also became a factor.

The HPOWER project's effect on the site selection process was caused by the need to haul ash and non-recoverable items to the potential landfill sites from the HPOWER project site.

Hence, hauling distances without HPOWER as well as hauling distances with HPOWER at Waipahu or at Campbell Industrial Park were evaluated.

Without HPOWER, the haul cost was computed by considering the total system cost of hauling to the Kapaa and the Leeward Landfills. The split in refuse quantity between the Kapaa and Leeward Landfills was determined by considering the location of the refuse generation centers and assuming that the most economical hauling system would eventually evolve from all of the possibilities. The refuse quantity so derived for the Leeward Landfill was then used to determine the unit cost of hauling to all of the potential sites. This unit cost of hauling includes hauling by collection trucks, transfer trailers and private haulers.

With HPOWER, the haul cost was computed by considering the cost of hauling residue ash and non-recoverable items from Waipahu and Campbell Industrial Park to the landfill sites.

To evaluate and rate the three different conditions of hauling, three tables were constructed (Tables IIIA, IIIB and IIIC). The environmental and social effects remained the same for all with only the economic effects changed.

All haul costs are measured in cost per ton.

b. Development. Site development costs for landfill sites generally consisted of access road, operations and maintenance facilities, utilities, drainage and gas and leachate control costs.

Cost data from the "Inventory Study of Potential Sanitary and Demolition Landfill Sites" (Shimabukuro-1977) were used and construction estimates were made for these development costs. Cost per ton, based on landfill capacity and capital recovery over twenty years or on actual life of landfill when less than twenty years, was then computed.

The economic effect was evaluated relative to the estimated site development cost per ton of refuse.

c. Operations. Cost of equipment, personnel, supplies, and operational and general maintenance requirements were considered equal for all sites. Cover material was the only variable considered for cost of operations. Cost of cover material was then estimated on on-site availability based on 500 tons/day of refuse or 333 cubic yards of cover/day, and economic effects of operational and general maintenance costs were evaluated relative to the availability of on-site cover material as follows:

Cost of imported cover material: $6.00/CY

Cost per year: 333 x 365 x 6 = $729,270.

Cost per ton of refuse: $\dfrac{\$729,270/\text{year}}{182,500\ \text{Tons/year}} = \$4.00$

This cost of cover material per ton of refuse is representative of all the tonnages of refuse that the City may handle.

Availability of Cover Material	Cost/Ton of Refuse
100% available on site	-0-
75% available on site	$1.00
50% available on site	$2.00
25% available on site	$3.00
0% available on site	$4.00

3. Special Considerations

To simplify evaluations and to minimize unnecessary work, sites having one or more major obstacles which could prevent or lengthily delay the establishment of a landfill were removed from consideration prior to evaluation. Some examples of major obstacles were:

a. Unavailability of land owned by the City, State or Federal Government programmed for future use and not available for release, negotiation for purchase or condemnation;

b. Existing zoning or uses very much higher or better than for landfilling, which would create conflicts with present zoning, uses, public policies and/or laws;

c. Site over Board of Water Supply potable groundwater basin and recharge area. Sites above existing or potential underground water sources and recharge areas have potential for contamination by leachate. It would be virtually impossible for the City to guarantee the safety of the potable groundwater from contamination once leachate is generated by landfill activities. The City should avoid the use of such areas when this possibility exists because other more acceptable sites are available. Sites above potential brackish water supplies are not anticipated to have adverse effects on the Board of Water Supply's plan to develop brackish water sources. See Supplement to Appendix F (AP-9).

4. Matrix Evaluation

The environmental & social and economic factors discussed above head the columns in the matrix (III-16, 17, 18). The sites listed in the matrix for evaluation were selected from map surveys and ground and aerial reconnaissance. The matrix focuses on the high potential sites after which a final selection will be made.

The following methodology was used:

a. Each potential site listed, unless eliminated by Special Considerations, was subject to evaluation by the factors heading the columns.

b. All factors were considered for each site. A number value (1 to 5) was assigned to the environmental and social factors according to the criteria established. Some values were multiplied by 2 as discussed in Section III.B.

Number Values for economic factors (cost per ton) were determined by using relative costs of: hauling;

development, obtained from the previous study "Inventory of Potential Sanitary Landfill Sites" (Shimabukuro-1977); and operations as determined by III.B.2.c.

c. Environmental and social number values and economic number values were then totaled separately for each site to obtain a sum (Columns 11 and 16, respectively). A lower sum indicated a better site.

d. To compute the weighted environmental and economic values for each site, a value of 1 was assigned to the site with the lowest sum and a value of 10 was assigned to the site with the highest sum. Then the values for the other sites were computed based on linear distribution corresponding to their sums (Columns 12 and 17)

Comments on the EIS Notice of Preparation by citizen groups and government agencies generally favored assigning more total weight to the environmental and social effects than to the economic effects. In response to these comments, the total environmental and social effects was given twice the value of the economic effects in the final evaluation by doubling the results in Column 12.

doubled
e. The/environmental and social value (Column 12) was then combined with the economic value (Column 17) to obtain a new sum (Column 18) for each site. This sum gave a composite assessment of the proposed site's suitability for landfilling. A lower sum indicated a better site. The sites were then ranked numerically (Column 19).

TABLE IIIA

SITE EVALUATION MATRIX - WITHOUT HPOWER

(1)	(2)	ENVIRONMENTAL AND SOCIAL EFFECTS										ECONOMIC EFFECTS					RANK		(20)
No.	POTENTIAL SITE	(3) Population One Mile	(4) Nearest Residence	(5) Wind Direction	(6) Visual Exposure	(7) Existing Land Use	(8) Future Land Use	(9) Traffic & Safety	(10) Surface Water Quality	(11) Sum	(12)* Environ. & Social Value	(13) Hauling $/Ton	(14) Development $/Ton	(15) Operations $/Ton	(16) Sum $/Ton	(17) Economic Value	(18) Sum/Envir. Social & Econ. Value	(19) Actual Rank	NBS REMARKS
1.	Barbers Point	10	10	5	3	3	4	3	2	40	8.6	4.79	4.36	4.00	13.15	10	27.2	11	Small capacity but can be increased
2.	Diamond Head																		Site eliminated by Special Consideration, See II-6
3.	Eva No. 1	6	6	2	2	5	5	2	2	30	1.7	4.82	2.07	0	6.89	1	4.4	1	On Prime Agricultural Land
4.	Eva No. 2	8	4	3	2	4	3	3	2	29	[illegible]	4.88	2.44	2.00	9.27	4.4	6.4	2	On Prime and Other Important Agricultural Lands
5.	Halawa A & B																		Site eliminated by Special Consideration, See II-18
6.	Honouliuli	10	10	3	4	3	5	[illegible]	2	41	9.3	4.67	2.89	0	7.56	2.0	20.6	7	Protection against leachate contamination may be required
7.	Kaena	4	10	3	5	2	2	4	4	34	4.5	5.73	3.23	3.00	11.96	8.3	17.3	3	Site is remote
8.	Kahe	6	10	3	5	3	5	3	3	40	8.6	4.98	2.41	2.00	9.39	4.6	21.8	9	Needed for Hawaiian Electric Co. expansion
9.	Kaloi																		Site eliminated by Special Consideration, See II-33
10.	Keekee	4	10	3	5	2	2	4	4	34	4.5	5.81	4.32	3.00	13.13	10.0	19.0	6	Site is remote
11.	Koko Crater	10	10	2	3	3	2	4	4	38	7.2	4.01	2.79	2.00	8.80	3.8	18.2	5	In Koko Head Natural Park
12.	Kunia A & B																		Site eliminated by Special Consideration, See II-43
13.	Haili																		Site eliminated by Special Consideration, See II-45
14.	Makua																		Site eliminated by Special Consideration, See II-47
15.	Ohikilolo	4	10	5	5	4	3	4	3	38	7.2	6.28	2.52	2.00	10.80	6.6	21.0	8	Site remote. Has substantial rest & recreation area on site
16.	Pearl Harbor Swamplands																		Site eliminated by Special Consideration, See II-56
17.	Sand Island																		Site eliminated by Special Consideration, See II-57
18.	Waianae Expansion	10	10	5	4	2	3	5	3	42	10	5.88	2.68	1.00	9.56	4.8	24.8	10	Site remote; bad access
19.	Waimanalo Gulch	4	10	5	4	2	3	3	4	35	5.2	4.89	3.22	3.00	11.11	7.1	17.5	4	Steep sides; narrow
20.	Waipio																		Site eliminated by Special Consideration, See II-70

* Numbers in this column (12) have been doubled, then added to Column 17 to arrive at the Sum in Column 18.

to NL's

TABLE IIIB

SITE EVALUATION MATRIX - WITH HPOWER AT WAIPAHU

(1)	(2)	ENVIRONMENTAL AND SOCIAL EFFECTS										ECONOMIC EFFECTS					RANK		(20)
No.	POTENTIAL SITE	(3) Population One Mile	(4) Nearest Residence	(5) Wind Direction	(6) Visual Exposure	(7) Existing Land Use	(8) Future Land Use	(9) Traffic & Safety	(10) Surface Water Quality	(11) Sum	(12)* Environ. & Social Value	(13) Hauling $/Ton	(14) Development $/Ton	(15) Operations $/Ton	(16) Sum $/Ton	(17) Economic Value	(18) Sum/Envir. Social & Econ. Value	(19) Actual Rank	REMARKS
1.	Barbers Point	10	10	5	3	3	4	3	2	40	8.6	0.81	4.36	4.00	9.17	9.5	26.7	11	Small capacity but can be increased
2.	Diamond Head																		Site eliminated by Special Consideration, See II-6
3.	Ewa No. 1	6	6	2	2	5	5	2	2	30	1.7	0.66	2.07	0	2.73	1	4.4	1	On Prime Agricultural Land
4.	Ewa No. 2	8	4	3	2	4	3	3	2	29	1	0.70	2.44	2.00	5.14	4.2	6.2	2	On Prime and Other Important Agricultural Lands
5.	Halawa A & B																		Site eliminated by Special Consideration, See II-18
6.	Honouliuli	10	10	3	4	3	5	4	2	41	9.3	0.51	2.89	0	3.40	1.9	20.5	6	Protection against leachate contamination may be required
7.	Kaena	4	10	3	5	2	2	4	4	34	4.5	2.23	3.23	3.00	8.46	8.6	17.6	4	Site is remote
8.	Kahe	6	10	3	5	5	5	6	3	40	8.6	1.02	2.41	2.00	5.43	4.6	21.8	9	Needed for Hawaiian Electric Co. expansion
9.	Kaloi																		Site eliminated by Special Consideration, See II-33
10.	Keekee	4	10	3	5	2	2	4	4	34	4.5	2.27	4.32	3.00	9.53	10	19.0	5	Site is remote
11.	Koko Crater	10	10	2	3	3	2	4	4	38	7.2	2.36	2.79	2.00	7.15	6.9	21.3	8	In Koko Head Natural Park
12.	Kunia A & B																		Site eliminated by Special Consideration, See II-43
13.	Maili																		Site eliminated by Special Consideration, See II-45
14.	Makua																		Site eliminated by Special Consideration, See II-47
15.	Ohikilolo	4	10	5	5	4	3	4	3	38	7.2	2.26	2.52	2.00	6.78	6.4	20.8	7	Site remote. Has substantial rest & recreation area on site
16.	Pearl Harbor Swamplands																		Site eliminated by Special Consideration, See II-56
17.	Sand Island																		Site eliminated by Special Consideration, See II-57
18.	Waianae Expansion	10	10	5	4	2	3	5	3	42	10	1.93	2.68	1.00	5.61	4.8	24.8	10	Site remote; bad access
19.	Waimanalo Gulch	4	10	5	4	2	3	3	4	35	5.2	0.93	3.22	3.00	7.15	6.9	17.3	3	Steep sides; narrow
20.	Waipio																		Site eliminated by Special Consideration, See II-70

* Numbers in this column (12) have been doubled, then added to Column 17 to arrive at the Sum in Column 18.

TABLE IIIC

SITE EVALUATION MATRIX - WITH HPOWER AT CAMPBELL INDUSTRIAL PARK

(1)	(2)	ENVIRONMENTAL AND SOCIAL EFFECTS										ECONOMIC EFFECTS					RANK		(20)
No.	POTENTIAL SITE	(3) Population One Mile	(4) Nearest Residence	(5) Wind Direction	(6) Visual Exposure	(7) Existing Land Use	(8) Future Land Use	(9) Traffic & Safety	(10) Surface Water Quality	(11) Sum	(12)* Environ. & Social Value	(13) Hauling $/Ton	(14) Development $/Ton	(15) Operations $/Ton	(16) Sum $/Ton	(17) Economic Value	(18) Sum/Envir. Social & Econ. Value	(19) Actual Rank	REMARKS
1.	Barbers Point	10	10	5	3	3	4	3	2	40	8.6	0.44	4.36	4.00	8.80	8.4	25.6	11	Small capacity but can be increased
2.	Diamond Head																		Site eliminated by Special Consideration, See II-6
3.	Ewa No. 1	6	6	2	2	5	5	2	2	30	1.7	0.72	2.07	0	2.79	1	4.4	1	On Prime Agricultural Land
4.	Ewa No. 2	8	4	3	2	4	3	3	2	29	1	0.84	2.44	2.00	5.28	4.1	6.1	2	On Prime and Other Important Agricultural Lands
5.	Halawa A & B																		Site eliminated by Special Consideration, See II-18
6.	Honouliuli	10	10	3	4	3	5	4	2	41	9.3	0.89	2.89	0	3.78	2.2	20.8	7	Protection against leachate contamination may be required
7.	Kaena	4	10	3	5	2	2	4	4	34	4.5	2.82	3.23	3.00	9.05	8.7	17.7	4	Site is remote
8.	Kahe	6	10	3	5	5	5	3	3	40	8.6	0.64	2.41	2.00	5.05	3.8	21.0	8	Needed for Hawaiian Electric Co. expansion
9.	Kaloi																		Site eliminated by Special Consideration, See II-33
10.	Keekee	4	10	3	5	2	2	4	4	34	4.5	2.86	4.32	3.00	10.18	10	19.0	5	Site is remote
11.	Koko Crater	10	10	2	3	3	2	4	4	38	7.2	3.06	2.79	2.00	7.85	7.2	21.6	9	In Koko Head Natural Park
12.	Kunia A & B																		Site eliminated by Special Consideration, See II-43
13.	Maili																		Site eliminated by Special Consideration, See II-45
14.	Makua																		Site eliminated by Special Consideration, See II-47
15.	Ohikilolo	4	10	5	5	4	3	4	3	38	7.2	1.90	2.52	2.00	6.42	5.5	19.9	6	Site remote. Has substantial rest & recreation area on site
16.	Pearl Harbor Swamplands																		Site eliminated by Special Consideration, See II-56
17.	Sand Island																		Site eliminated by Special Consideration, See II-57
18.	Waianae Expansion	10	10	5	4	2	3	5	3	42	10	1.54	2.68	1.00	5.22	4.0	24.0	10	Site remote; bad access
19.	Waimanalo Gulch	4	10	5	4	2	3	3	4	35	5.2	0.56	3.22	3.00	6.78	5.9	16.3	3	Steep sides; narrow
20.	Waipio																		Site eliminated by Special Consideration, See II-70

* Numbers in this column (12) have been doubled, then added to Column 17 to arrive at the Sum in Column 18.

NB'S

IV. DISCUSSION AND RECOMMENDATIONS

IV. DISCUSSION AND RECOMMENDATIONS

The matrix shows the following ranking of sites for the three different conditions of HPOWER:

	Without HPOWER	With HPOWER at Waipahu	With HPOWER at Campbell
1.	Ewa No. 1	Ewa No. 1	Ewa No. 1
2.	Ewa No. 2	Ewa No. 2	Ewa No. 2
3.	Kaena	Waimanalo Gulch	Waimanalo Gulch
4.	Waimanalo Gulch	Kaena	Kaena
5.	Koko Crater	Keekee	Keekee
6.	Keekee	Honouliuli	Ohikilolo
7.	Honouliuli	Ohikilolo	Honouliuli
8.	Ohikilolo	Koko Crater	Kahe
9.	Kahe	Kahe	Koko Crater
10.	Waianae Expansion	Waianae Expansion	Waianae Expansion
11.	Barbers Point	Barbers Point	Barbers Point

Other listed sites have been eliminated by Special Considerations.

The three tables show that the Ewa No. 1 and Ewa No. 2 sites were always first and second in potential regardless of whether the HPOWER project was implemented or at which of the two sites the HPOWER project was located. The third ranked site was always a poor third. Therefore, it is recommended that the City select either one of the top two for landfill development.

The following discussion generally summarizes the site data and considers other intangible data that were not included in the evaluation matrix but were used to make the final site recommendations.

BARBERS POINT

The Barbers Point site is a very small site with a life expectancy of 1.5 years. The City will be faced with the same problem of selecting another landfill site after this landfill is completed.

This site is immediately upwind of a housing area in Barbers Point Naval Air Station and the Department of the Navy will object to the selection of this site.

A well and pump system of Oahu Sugar Co. and an auto junk dealer will be displaced.

Size of this site can be increased by taking cane land. However, the Ewa No. 2 and No. 1 sites are more suitable when considering cane land for landfilling.

This site is not recommended for landfill development.

EWA NO. 1

The Ewa No. 1 site is on prime agricultural land leased by Oahu Sugar Co. from Campbell Estate. It contains about 210 acres and has an estimated life of 25 years. The high elevation (130' above sea level) provides a potential for reducing the area by 50% or more by using greater depth of landfill. Cover material is available on site and the site is not over BWS groundwater zone. Annual rainfall is about 25 inches and leachate generation is not likely with proper design and operation. The site is surrounded by canefields and will be visible to the public only during periods when cane has been harvested.

Its distance from Honouliuli, Ewa, Makakilo and Barbers Point N.A.S. will keep general landfill nuisances to a minimum. The nearby residents and communities have been exposed to the nuisances of cane production and harvesting operations by Oahu Sugar but they will still object to landfill development at the site.

This site is located in the institutional and commercial area of Campbell Estate's long range Development Plan and they will also object. The Oahu Development Plan shows this site in agriculture.

This site has low environmental and social impact and is number 1 in economical ranking, but the taking of agricultural land for landfill purposes will be opposed by Oahu Sugar Co., citizen groups and individuals. The displacement of this acreage of prime agricultural lands must be weighed against the need for a sanitary landfill for the public good when a final decision on site selection is made.

This site ranks first in all tables of the matrix and is recommended for final selection for development as a landfill site.

EWA NO. 2

The Ewa No. 2 site is on prime and other important agricultural land leased by Oahu Sugar Co. from Campbell Estate. It contains about 200 acres and has an estimated life of 14 years. About one-half of the cover material is available on site. The site is not over BWS groundwater supply. Annual rainfall is about 25 inches and leachate generation is not likely with proper design and operation.

The site is surrounded by canefields on three sides and will not be visible to the public except during periods when cane is harvested. Navy facilities are on the fourth (east) side. Fernandez Village is about 4,000 feet west and a wildlife habitat is approximately 1,000 feet north. Nearby residents and communities have been exposed to the nuisances of cane production and harvesting operations by Oahu Sugar, but they will still object to landfill development at the site.

The selection of this site will be opposed by Oahu Sugar, citizen groups and individuals.

The site is within the Navy Blast Clearance Zone for ammunition handling operations. The Navy is presently negotiating with Campbell Estate to purchase the land so that activities within the area can be controlled by them. Navy ownership does not preclude the site's use as a landfill, as the use of the land will not change. Cane production will be allowed to continue and landfill can also be a compatible use within the Blast Clearance Zone. The Navy will require certain design controls if this site is selected.

The Navy now uses the private landfill at Palailai to dispose of their refuse and it may be advantageous to them to jointly develop this site with the City.

This site has nominal development cost and least environmental impact which can be further minimized to a great extent with proper operations. It may be more acceptable to Campbell Estate than Ewa No. 1 since it is located in the potential recreational area of Campbell Estate's long range development plan. This site can fit in as a park for the future development or revert back to cane land after use as a landfill. The Oahu Development Plan shows this site in agriculture.

The displacement of this acreage of Prime and Other Important Agricultural Land must be weighed against the need for a sanitary landfill for the public good when a final decision on site selection is made.

This site can be developed in small increments, possibly 20 to 30 acres at a time. The cane land can be planned to be taken out of production as the cane is harvested.

This site may pose the least problems for landfill site development when all factors are considered.

This site ranks second under all the different conditions of the matrix.

This site is recommended for final selection for development as a landfill site.

HONOULIULI

The Honouliuli site is located off Fort Weaver Road about 1700 feet northwest of the business and residential area of Honouliuli Village. It contains about 22 acres of land owned by Campbell Estate and leased to Oahu Sugar Co. Part of the site (20%) is in cane and the remainder (80%) is a gully. Access to the site can also be provided from Farrington Highway. It has an estimated life of 3.4 years.

Oahu Sugar Company operates two pump sites in the area, one each for domestic water and irrigation water. However, according to Oahu Sugar, both have been used for domestic water when needed. Site is outside the BWS groundwater zone. Average annual rainfall is about 25 inches and the generation of leachate is not likely with proper design and operation. The wells will have to be sealed and replacement sources must be established for Oahu Sugar Co.

This site is located in the residential area of Campbell Estate's long range development plan.

The short life of 3.4 years can be extended by using adjacent cane land (prime agricultural land) to increase the area to about 52 acres. The high elevation (140 ft. above sea level) provides a potential for greater depth of landfill and this could extend the life to over 10 years. However, the Ewa No. 2 and No. 1 sites are more suitable when considering cane land for landfilling.

This site is not recommended for final selection for development as a landfill site.

KAENA

The Kaena site is far removed from the refuse generation centers. The short life span (3.0 years) and the unstable and rising fuel prices make this site unattractive.

Most of the required cover material must be imported.

This site is not recommended for landfill development.

KAHE

The Kahe site is located in the northern portion of Hawaiian Electric Company's Kahe Power Plant site about 1 mile south of Nanakuli. It contains about 70 acres of usable landfill area and has an estimated life of 15 years. About one-half of the required cover material must be imported.

The site is presently open space and the landfill will utilize about half of the valley floor. It is outside the BWS groundwater zone. The area has about 20 inches of average annual rainfall and the generation of leachate is not likely with proper operation.

The site is very visible from Farrington Highway. It is owned and masterplanned as an expansion area for power generation by HECo. According to HECo, the site was acquired for and is committed to the future expansion of HECo's Kahe Power Plant. This is HECo's only electric power generation station on Oahu with adequate area to accommodate future expansion and their studies indicate that no other viable site is available. HECo cannot jeopardize their capability for future expansion by relinquishing any portion of the valley for landfill construction. Using this land for a landfill would severely limit HECo's ability to increase its power-generating capacity. Power generation is an environmentally sensitive activity and finding another economical power generation site that is environmentally acceptable would be extremely difficult.

The land is presently zoned and general planned for industrial use by the City and it should continue to be committed to this highest and best use. Utilizing portions of Kahe Valley for landfilling will remove land committed to power generation facilities and will unfairly transfer the site selection process and costs of a major facility required for the public welfare from the City to HECo.

This site is not recommended for landfill development.

KEEKEE

The Keekee site is far removed from the refuse generation centers. The short life span (2.5 years) and the unstable and rising fuel prices make this site unattractive.

Most of the required cover material must be imported.

This site is not recommended for landfill development.

KOKO CRATER

The Koko Crater site is located in the southeast tip of Oahu in Koko Head Natural Park. It contains about 75 acres of usable landfill area and is an open area owned by the City and County of Honolulu. It has an estimated life of 11 years.

The site is well buffered from urbanized areas on all sides except at the entrance. Foster Botanical Gardens maintains a garden of succulent plants in a small portion of the crater. Any landfill will have to be constructed around the garden with adequate buffer areas or the garden should be relocated. Koko Crater Stables uses the crater as a riding trail area on a concession from the City. This business activity would be displaced. Bishop Estate deeded the land to the City on the premise that this land be used only for park purposes. Environmental impacts are moderate.

The selection of this site will be opposed by Koko Crater Stables, Foster Botanical Garden, citizens of Hawaii Kai community and other groups.

The site is not over BWS groundwater zone. Average annual rainfall is about 25 inches and leachate generation is not likely with proper design and operation. Surface runoff will be difficult to handle due to the steepness of the crater walls; this may create some difficulties in wet weather operations.

The site can be used as a landfill site but is not recommended for landfill development. When viewed from an island wide standpoint, this site's location in southeast Oahu may place it too close to the existing Kapaa Landfill. With most of the population growth potential centered more toward Central Oahu area and the HPOWER project cited in Waipahu or Campbell Industrial Park, this site may become an economical burden in the future.

OHIKILOLO

The Ohikilolo site is far removed from the refuse generation centers. This could become a major economical burden in the future due to unstable and rising fuel prices.

The upper areas are over the BWS groundwater zone. First Hawaiian Bank has a substantial rest & recreation facility at the site. Also, three residences may be displaced.

This site is not recommended for landfill development.

WAIANAE EXPANSION

The Waianae Expansion site appears to be a good potential site. There are sufficient open lands adjacent to the existing landfill for the expansion. However, to convert this site into a major landfill, the access road will have to be improved considerably. Additional right-of-way will be required. Some homes may be located too close to the access route and may require relocation. With the improvements, the atmosphere of the rural type roadway or the country style living will be severely disrupted. The roadway would divide the existing residential community. The distance from the major refuse generation centers could become a major economical burden in the future due to unstable and rising fuel prices.

This site is not recommended for expansion as a major regional landfill development. This site should be closed after the existing capacity is utilized.

WAIMANALO GULCH

The Waimanalo Gulch site is located about 2 miles southeast of Nanakuli and a mile northwest of Honokai Hale. It contains about 80 acres of usable land and has an approximate life of 7.5 years. It is owned by Campbell Estate, the Au families and Hawaiian Electric Co.

The site is presently open space but the Kahe Theme Park is proposed on the lower portion of the site adjacent to an agricultural subdivision. It is outside the BWS groundwater zone. Average annual rainfall is 20 inches, and leachate generation is not likely with proper operation.

The site is very visible from Farrington Highway and the proposed West Beach development. It is long and narrow with steep sides, causing development and operation to be difficult. Cover material is not available on site. Most of it must be imported.

This site is recommended for landfill development only if other higher ranked sites are unavailable.

SUPPLEMENT

TO

APPENDIX E

SOILS CLASSIFICATION

SUPPLEMENT TO

APPENDIX E

SOILS CLASSIFICATION

(From U. S. Soil Conservation Service)
(Soil Survey of State of Hawaii)
(August 1972)

CORAL OUTCROP

Coral outcrop (CR) consists of coral or cemented calcareous sand on the island of Oahu. The coral reefs formed in shallow ocean water during the time the ocean stand was at a higher level. Small areas of coral outcrop are exposed on the ocean shore, on the coastal plains, and at the foot of the uplands. Elevations range from sea level to approximately 100 feet. The annual rainfall amounts to 18 to 40 inches. Coral outcrop is geographically associated with Jaucas, Keaau, and Mokuleia soils.

Coral outcrop makes up about 80 to 90 percent of the acreage. The remaining 10 to 20 percent consists of a thin layer of friable, red soil material in cracks, crevices, and depressions within the coral outcrop. This soil material is similar to that of the Mamala series.

This land type is used for military installations, quarries, and urban development. Vegetation is sparse. It consists of kiawe, koa haole, and fingergrass.

EWA SILTY CLAY LOAM, MODERATELY SHALLOW, 0 TO 2 PERCENT SLOPES (EmA)

This soil occurs on alluvial fans on the island of Oahu and developed in alluvium derived from basic igneous rock. The surface layer is dark reddish-brown silty clay loam about 18" thick. The subsoil is dark reddish brown. The substratum is coral limestone about 20 to 50 inches below the surface. Runoff is very slow, and the erosion hazard is no more than slight.

This soil is used for sugarcane, truck crops, and pasture. The natural vegetation consists of fingergrass, kiawe, koa haole, kiu and uhaloa.

FILL LAND

This land type consists of areas filled with material from dredging, excavation from adjacent uplands, garbage, and bagasse and slurry from sugar mills. The areas are on the islands of Kauai, Maui, and Oahu.

a. Fill land, mixed (FL): This land type occurs mostly near Pearl Harbor and in Honolulu, adjacent to the ocean. It consists of areas filled with material dredged from the ocean or hauled from nearby areas, garbage, and general material from other sources. Included were a few areas that have been excavated.

This land type is used for urban development including airports, housing areas, and industrial facilities.

HONOULIULI SERIES

This series consists of well-drained soils on coastal plains on the island of Oahu in the Ewa area. These soils developed in alluvium derived from basic igneous material. They are nearly level and gently sloping. Elevations range from 15 to 125 feet. The annual rainfall amounts to 18 to 30 inches and occurs mainly between November and April. The mean annual soil temperature is 74°F. Honouliuli soils are geographically associated with Ewa, Lualualei, Mamala, and Waialua soils. These soils are used for sugarcane, truck crops, orchards, and pasture. The natural vegetation consists of kiawe, koa haole, fingergrass, bristly foxtail, and bermudagrass.

a. Honouliuli Clay, 0 to 2 percent slopes (HxA): This soil occurs in the lowlands along the coastal plains. There are areas of fine-textured alluvial soils that have a stony subsoil. There are also some areas of shallow, red, friable soils that are underlain by reef limestone.

In a representative profile, the soil is dark reddish-brown, very sticky and very plastic clay throughout. The surface layer is about 15 inches thick. The subsoil and substratum have subangular blocky structure, and they have common to many slickensides. The soil is neutral and mildly alkaline.

Permeability is moderately slow. Runoff is slow, and the erosion hazard is no more than slight. The available water capacity is about 1.8 inches per foot of soil. In places roots penetrate to a depth of 5 feet or more. Workability is slightly difficult because of the very sticky and very plastic clay. The shrink-swell potential is high.

JAUCAS SERIES

This series consists of excessively drained, calcareous soils that occur as narrow strips on coastal plains, adjacent to the ocean. These soils occur on all the islands. They developed in wind- and water-deposited sand from coral and seashells. They are nearly level to strongly sloping. Elevations range from sea level to 100 feet. The annual rainfall amounts to 10 to 40 inches. The mean annual soil temperature is 75°F. Jaucas soils are geographically associated with Pulehu, Mokuleia, Kaloko and Lualualei soils.

These soils are used for pasture, sugarcane, truck crop, alfalfa, recreational areas, wildlife habitat, and urban development. The natural vegetation consists of kiawe, koa haole, bristly foxtail, bermudagrass, fingergrass and Australian saltbush.

a. Jaucas sand, 0 to 15 percent slopes (JaC): The slope range of this soil is 0 to 15 percent, but in most places the slope does not exceed 7 percent. Included are narrow strips of Beaches and areas of Pulehu, Mokuleia, and Keaau soils.

   In a representative profile, the soil is single grain, pale brown to very pale brown, sandy, and more than 60 inches deep. In many places the surface layer is dark brown as a result of accumulation of organic matter and alluvium. The soil is neutral to moderately alkaline throughout the profile.

   Permeability is rapid, and runoff is very slow to slow. The hazard of water erosion is slight, but wind erosion is a severe hazard where vegetation has been removed. The available water capacity is 0.5 to 1.0 inch per foot of soil. In places roots penetrate to a depth of 5 feet or more. Workability is slightly difficult because the soil is loose and lacks stability for use of equipment.

   This soil is used for pasture, sugarcane, truck crops, and urban development.

KOKO SERIES

This series consists of well-drained soils on fans and volcanic spurs on the island of Oahu. These soils developed in alluvium washed from deposits of volcanic ash, cinders, and tuff. They are gently sloping to moderately steep. Elevations range from nearly sea level to 200 feet.

The annual rainfall amounts to 15 to 25 inches, most of which occurs between November and April. The mean annual soil temperature is 74°F. Koko soils occur near Koko Head, Koko Crater, and Diamond Head. They are geographically associated with Lualualei soils.

These soils are used for homesites, pasture and truck crops. The natural vegetation consists of kiawe, klu, koa haole, fingergrass, and bristly foxtail

a. Koko silt loam, 6 to 12 percent slopes (KsC): On this soil, runoff is medium and the erosion hazard is moderate. Workability is slightly difficult because of the slope. This soil is used for homesites and pasture.

KUNIA SERIES

This series consists of well-drained soils on upland terraces and fans on the island of Oahu. These soils developed in old alluvium. They are nearly level to moderately sloping. Elevations range from 700 to 1,000 feet. The mean annual rainfall amounts to 30 to 40 inches, most of which occurs from November to April. The mean annual soil temperature is 71°F. Kunia soils occur on the foot slopes of the Waianae Range, near Schofield Barracks. They are geographically associated with Kolekole, Lahaina, and Wahiawa soils.

These soils are used for sugarcane, pineapple, homesites, and military reservations. Most areas are cultivated, and the natural vegetation is not significant.

a. Kunia silty clay, 0 to 3 percent slopes (KyA): This soil occurs on broad, smooth slopes. Included are small areas of Kolekole soils and small areas of red, clayey soils at lower elevations.

   In a representative profile the surface layer is dark reddish-brown silty clay about 22 inches thick. The subsoil, 40 to 71 inches thick, is dark reddish-brown silty clay and silty clay loam that has subangular blocky structure. The substratum is dark reddish-brown gravelly silty clay. Manganese concretions occur throughout the profile. The surface layer is medium acid to extremely acid, and the subsoil is slightly acid to strongly acid.

   Permeability is moderate. Runoff is slow, and the erosion hazard is no more than slight. The available water capacity is about 1.7 inches per foot of soil. In places roots penetrate to a depth of 5 feet or more.

   This soil is used for sugarcane, pineapple, homesites, and military reservations.

MOKULEIA SERIES

This series consists of well-drained soils along the coastal plains on the islands of Oahu and Kauai. These soils formed in recent alluvium deposited over coral sand. They are shallow and nearly level. Elevations range from nearly sea level to 100 feet. The annual rainfall amounts to 15 to 40 inches on Oahu and 50 to 100 inches on Kauai. The mean annual soil temperature is 74°F. Mokuleia soils are geographically associated with Hanalei, Jaucas, and Keaau soils.

These soils are used for sugarcane, truck crops, and pasture. The natural vegetation consists of kiawe, klu, koa haole, and bermudagrass in the drier areas and napiergrass, guava, and joee in the wetter areas.

a. Mokuleia clay (Mtb): This soil is nearly level. Permeability is slow in the surface layer. Workability is difficult because of the sticky, plastic clay. This soil is used for sugarcane and pasture.

ROCK OUTCROP

Rock outcrop (rRO) consists of areas where exposed bedrock covers more than 90 percent of the surface. It occurs on all five islands. The rock outcrops are mainly basalt and andesite. This land type is gently sloping to precipitous. Elevations range from nearly sea level to 10,000 feet. Included in mapping were a small area of lithified coral sand on Molokai and small areas of coral outcrop along the coasts of other islands.

This land type is not suited to farming. It is used for water supply, wildlife habitat, and recreation.

STONY LAND

Stony land (rST) occurs in valleys and on side slopes of drainageways on the island of Oahu. It is mainly between Barbers Point and Kaena Point. It consists of a mass of boulders and stones deposited by water and gravity. The slope ranges from 5 to 40 percent. Elevations range from nearly sea level to 500 feet. The annual rainfall amounts to 18 to 60 inches. Stony land is geographically associated with Lualualei and Ewa soils.

Stones and boulders cover 15 to 90 percent of the surface. The soil among the stones consists of reddish silty clay loam that is similar to Lualualei soils. In most places there is enough soil among the stones to provide a foothold for plants.

This land type is used for wildlife habitat and recreation. The natural vegetation consists of kiawe, lantana, koa haole, bermudagrass, and annuals.

WAIPAHU SERIES

This series consists of well-drained soils on marine terraces on the island of Oahu. These soils developed in old alluvium derived from basic igneous rock. They are nearly level to moderately sloping. Elevations range from nearly sea level to 125 feet. Rainfall amounts to 25 to 35 inches annually; most of it occurs between November and April. The mean annual soil temperature is 75°F. Waipahu soils are geographically associated with Hanalei, Honouliuli, and Waialua soils.

These soils are used for sugarcane and homesites. The natural vegetation is fingergrass, bermudagrass, bristly foxtail, and kiawe.

a. Waipahu silty clay, 0 to 2 percent slopes (WzA): This soil is nearly level and occurs on dissected terraces adjacent to the ocean. Included are small areas of Hanalei, Honouliuli, and Waialua soils. Also included are small areas of clay, where permeability is moderately slow.

In a representative profile the surface layer is dark grayish-brown silty clay about 12 inches thick. The subsoil, about 58 inches thick, is dark brown silty clay that has prismatic structure. It is very sticky and very plastic in the lower part. The substratum is clayey alluvium. The soil is slightly acid in the surface layer and subsoil.

Permeability is moderately slow. Runoff is slow or very slow, and the erosion hazard is none to slight. The available water capacity is about 1.4 inches per foot in the surface layer and about 1.6 inches per foot in the subsoil. Roots penetrate to a depth of 5 feet or more.

This soil is used for sugarcane and homesites.

b. Waipahu silty clay, 2 to 6 percent slopes (WzB): On this soil, runoff is slow and the erosion hazard is slight.

This soil is used for sugarcane and homesites.

1705230

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU
? SOUTH BERETANIA
HONOLULU, HAWAII 96843

RECEIVED
DEPT. OF PUBLIC WORKS
AUG 1 3 ... PM '79
DIR
DEP
Repre

July 30, 1979

TO : MR. WALLACE MIYAHIRA
DIRECTOR AND CHIEF ENGINEER
DEPARTMENT OF PUBLIC WORKS

FROM : KAZU HAYASHIDA
BOARD OF WATER SUPPLY

SUBJECT: YOUR LETTER OF JUNE 27, 1979, REQUESTING COMMENTS ON YOUR PROPOSED LEEWARD DISTRICT SANITARY LANDFILL EIS

Of the proposed landfill sites under consideration, we find the following sites acceptable to us:

Site	Comment
1. Barbers Point	
2. Diamond Head	
3. Ewa No. 1	3. Thin alluvial cover
4. Ewa No. 2	4. Well on site must be sealed
5. Honouliuli	5. Well on site must be sealed
6. Kaena	
7. Kahe	
8. Keekee	
9. Koko Head	9. Bare rock; should have impermeable membrane
10. Pearl Harbor Swamp Lands	
11. Sand Island	
12. Waimanalo Gulch	
13. Waipio	

All of the remaining sites are not acceptable in that they may affect both existing and potential water sources.

Mr. Wallace Miyahira
Page 2

July 30, 1979

The water requirements for fire protection at each site should be addressed. Consideration should be given to using waters from non-potable sources.

Should you have questions or require additional information, please call Lawrence Whang at 548-5221.

KAZU HAYASHIDA
Manager and Chief Engineer

File

BOARD OF WATER SUPPLY

CITY AND COUNTY OF HONOLULU

"0 SOUTH BERETANIA

HONOLULU, HAWAII 96843

August 30, 1979

Mr. Wallace K. Endo
Vice President
Stanley S. Shimabukuro &
Associates, Inc.
1126 12th Avenue
Honolulu, Hawaii 96816

Dear Mr. Endo:

Subject: Your Letter of August 20, 1979 on
<u>Leeward District Sanitary Landfill</u>

Enclosed is a map showing the potential areas where brackish water could be developed. The proposed landfill sites within this area are not anticipated to have adverse effects on our plans to develop brackish water in that area.

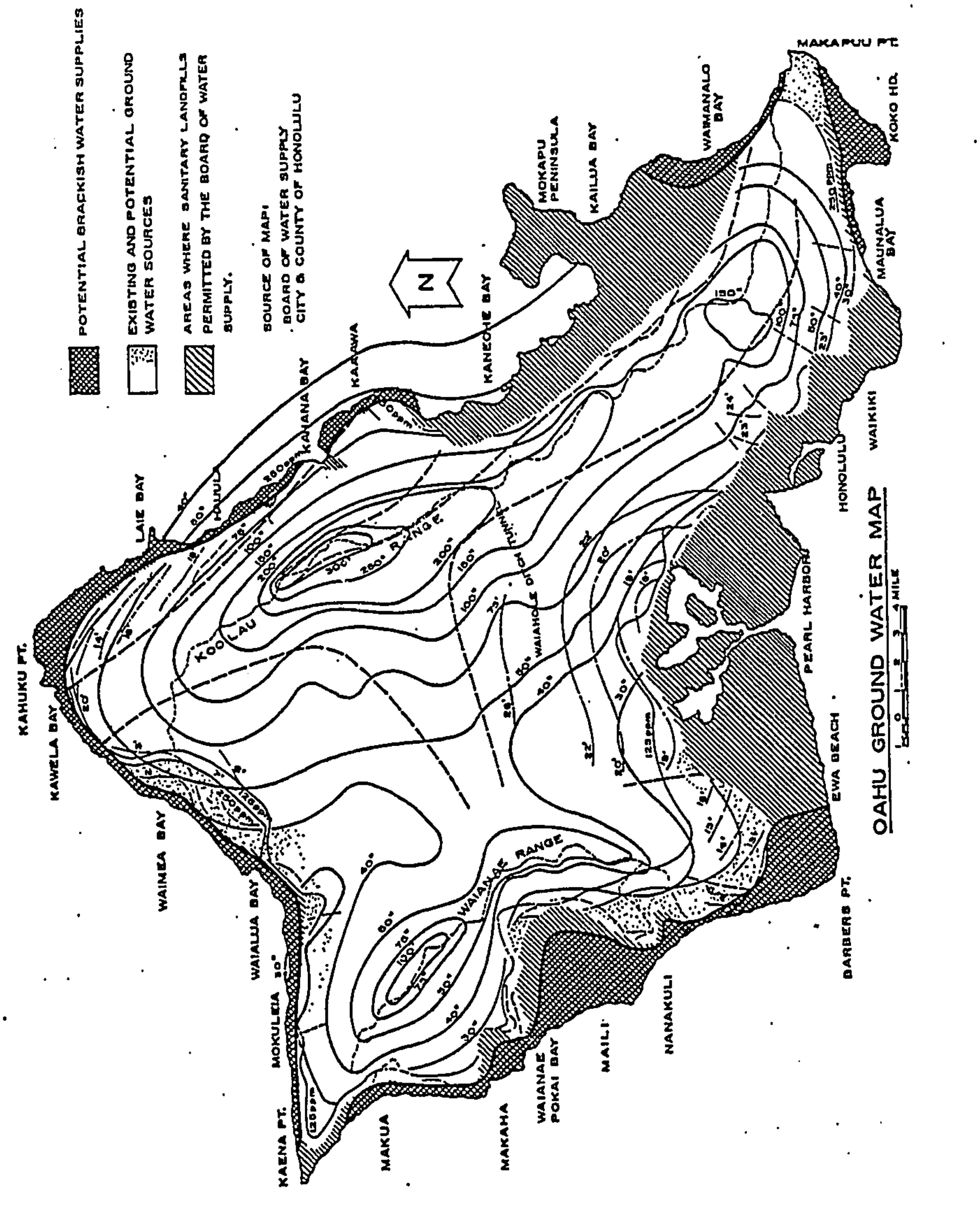
Should you have questions or require additional information, please call Lawrence Whang at 548-5221.

Very truly yours,

L.G. Lambert

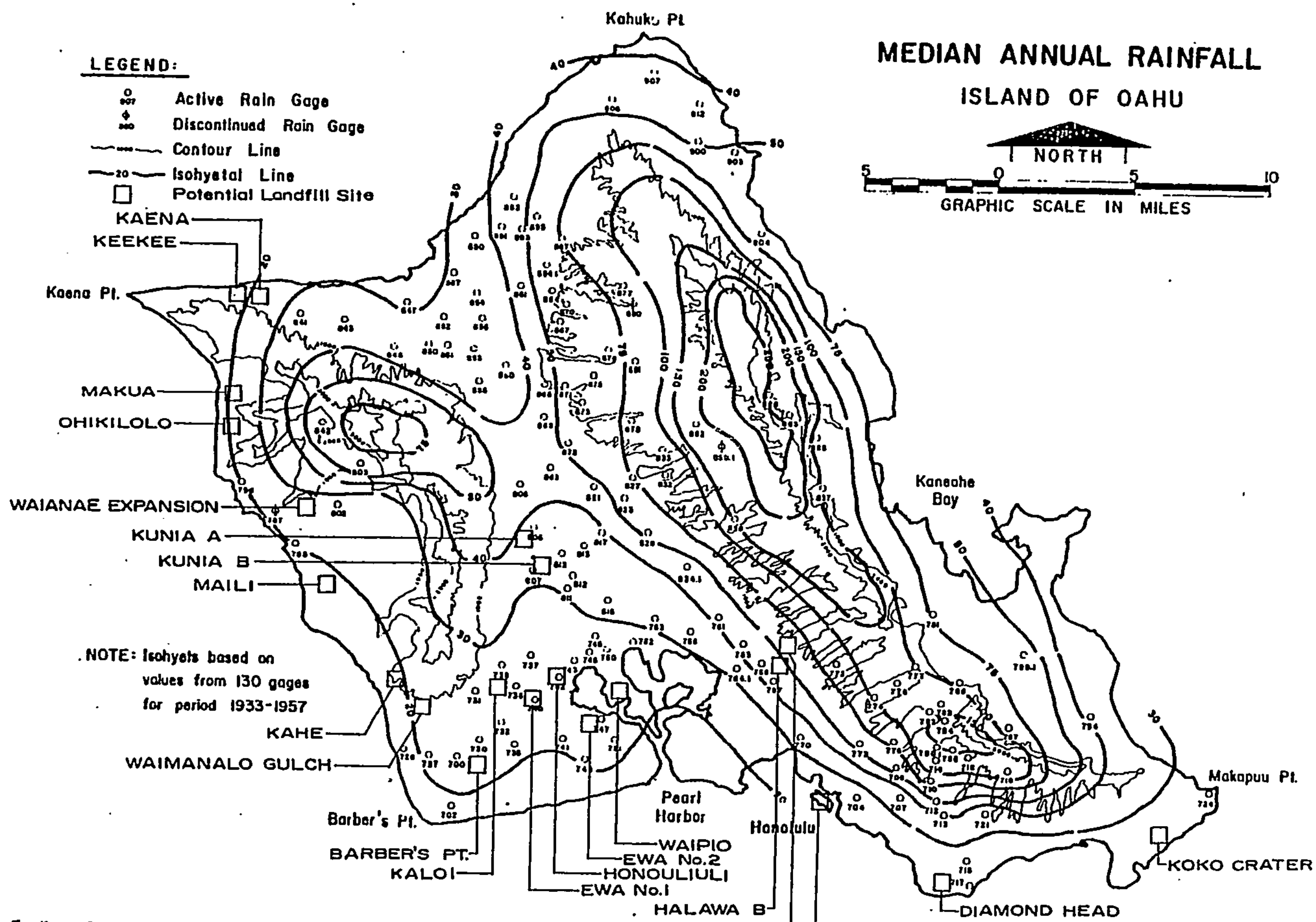
For KAZU HAYASHIDA
Manger and Chief Engineer

Encl.



SUPPLEMENT TO
APPENDIX F

LEEWARD DISTRICT
SANITARY LANDFILL



LEEWARD DISTRICT

APPENDIX E

Solid Waste Integrated Management Plan
(Chapter 10)

City and County of Honolulu
Department of Public Works
1995

10 Sanitary Landfilling and Combustion

SECTION 10
SANITARY LANDFILLING AND COMBUSTION

10.1 PURPOSE

Pursuant to Chapter 26(h) of Act 324, this component of the Plan shall:

(1) Evaluate current sanitary landfill capacity during the plan year and identify life expectancy based on current waste stream assessment;

(2) Evaluate expansion potential of existing sanitary landfill sites including changes to site operations and design, potential for lateral and/or vertical expansion, and extension of site life due to waste reduction considerations;

(3) Conduct sanitary landfill candidate area screening including regional and area specific exclusionary, site evaluation, environmental, and site selection criteria.

(4) Quantify and characterize existing solid waste disposal through combustion;

(5) Evaluate excess incinerator capacity during the plan year and identify future impacts as a result of source reduction, recycling, bioconversion, and other waste reduction efforts;

(6) Quantify and characterize the combustion residue for the plan year and planning period which will require disposal. Assess the potential for reuse/recycling; and

(7) Assess current combustion residue management practice and develop plans for future disposal modifications.

10.1.1 Overview

The currently operating sanitary landfills on Oahu can provide disposal capacity during the present plan period and for some portion of the next decade, depending on the extent to which diversion goals are met. However, expansion of existing sanitary landfill sites or establishment of new sanitary landfill site(s) should be accomplished within this plan period to provide future waste containment facilities.

The existing capacity and expansion potential of operating sanitary landfills will be affected by the degree of implementation of waste reduction and diversion programs in the City. The significance of the degree of program implementation on landfill expansion will be discussed in this section.

Disposal sites to accommodate non-combustible municipal solid waste diverted at H-POWER and construction/demolition debris should be addressed within the current planning period.

Existing incineration capacity, type and operational practices will be discussed herein. Incinerator residue and ash quantities, handling and disposal practices will also be discussed.

10.2 CURRENT LANDFILL CAPACITY

Existing municipal solid waste (MSW) sanitary landfills currently operating on Oahu include the Kapaa Sanitary Landfill on the Windward side and the Waimanalo Gulch Sanitary Landfill on the Leeward side of the island. These sites are addressed with regard to existing and potential additional capacity.

The Nanakuli Construction and Demolition Debris Landfill is permitted and operates on the Leeward side. Additional unpermitted construction and demolition landfills are discussed. The Kalaheo Sanitary Landfill, which was closed in 1989, is also discussed concerning potential capacity as a construction and demolition debris landfill. Kapaa Site No. 1 has been selected as a landfill site, and the City will add it to the Public Facilities Map. Planning for the permitting process will begin in 1993.

Descriptions of the sites are given in Section 2 of this document. Information regarding waste types and quantities delivered to each facility is included in Section 3.

The following table gives specific data pertinent to each site.

TABLE 10-1: EXISTING SANITARY LANDFILLS ON OAHU

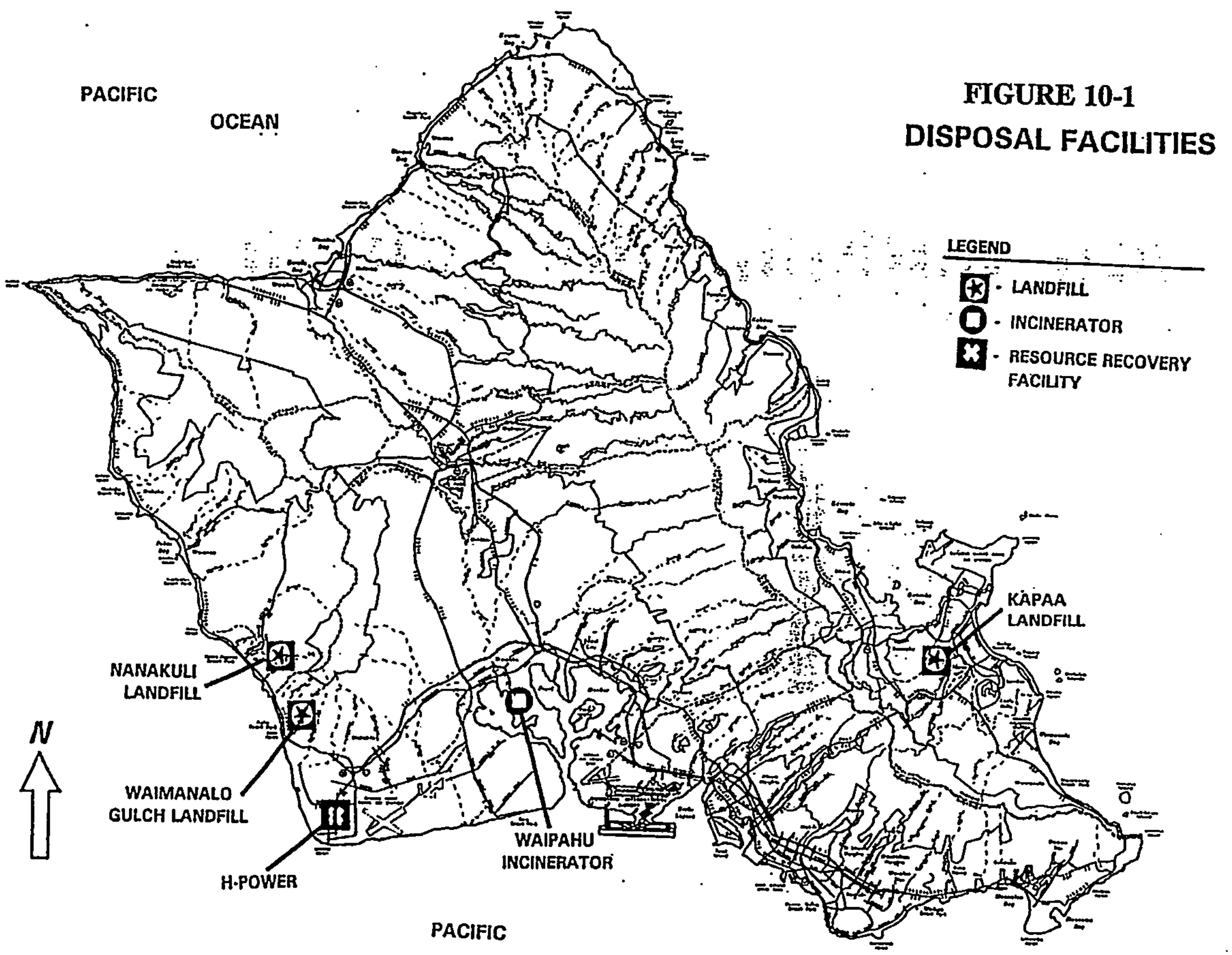
Site	Type	Waste Received in 1991 (Tons)	Estimated Closure under Current Conditions	Estimated Closure under Projected Diversion
Kapaa	MSW	101,054	1995	1998
Nanakuli	C&D	201,766	Beyond 2000	Beyond 2000
Waimanalo Gulch	Ash/MSW	392,627	2003	2017
Kaneohe M.C.A.S.	C&D	11,200	1998	1998
Other Landfills*	C&D	200,000	N/A	N/A

MSW - Municipal Solid Waste C&D - Construction and Demolition Debris
* Waste receipts estimated from several unofficial sources

Other municipal sanitary landfills that are now closed include the Kalaheo, Kawailoa, and Waianae sites. The Palailai Landfill, a private disposal site, is also closed.

Figure 10-1 shows the location of waste disposal facilities on Oahu.

FIGURE 10-1
DISPOSAL FACILITIES



10.2.1 Kapaa Sanitary Landfill

The Kapaa Sanitary Landfill site was developed in three phases, the original Central Site, Site No. 2, and Site No. 3. The Central Site has been closed for several years and has been graded and vegetated. Major landfill activities on Site No. 3 ceased in 1982 leaving current landfill operations limited to Site No. 2. The site is estimated to have two to four years of capacity remaining within the currently used area. Kapaa Site No. 1 is a planned site and is discussed later in this section.

The City has considered closing the existing Kapaa Sanitary Landfill by October 1993 due to pending regulations. However, due to the difficulty in siting a new landfill, the City will decide on a closure date later. On October 9, 1991, the United States Environmental Protection Agency (EPA) promulgated Solid Waste Disposal Facility Criteria in Parts 257 and 258 of 40 CFR, based on RCRA Subtitle D. The federal government has required all states to adopt sanitary landfill design, operation and closure standards pursuant to these standards or accept EPA's enforcement of the standards. By closing this site before October 9, 1993, the existing Kapaa site will only be subject to the standards for final closure as stated in the guidelines. Other requirements concerning environmental monitoring, post-closure care, and financial assurances will not be applicable. While not required to do so, the City has been monitoring through an environmental monitoring program as a part of the landfill operations since 1980.

10.2.2 Nanakuli Construction and Demolition Landfill

The Nanakuli Landfill is owned and operated by a private company, PVT, Inc. The site receives approximately 200,000 tons per year of construction and demolition debris. The site is permitted and has approximately 200 acres of land that are suitable for expansion. This site has a potential capacity to dispose of the currently received tonnage through the planning period. The site owners indicate an intent to continue operations through the year 2000.

10.2.3 Waimanalo Gulch Sanitary Landfill

The Waimanalo Gulch Sanitary Landfill is owned by the City and operated under contract by Waste Management of Hawaii, Inc. The present site design has approximately 8.3 million cubic yards of available volume as of May 1992, giving the site sufficient capacity through 2003 under the current waste loading conditions. If proposed waste diversion goals are met, the current estimated volume should provide capacity through the year 2017.

Table 10-2 shows the estimated site life for the current waste diversion rate and for the proposed diversion goals of this plan. The estimate is based on increasing waste generation rates related to population projections as described in Section 3 and using volume-to-weight conversion factors provided by the site operator.

TABLE 10-2: WAIMANALO GULCH SANITARY LANDFILL SITE LIFE ESTIMATE

MSW Diversion		Conversion Factors		Site Life Capacity Through
1995	2000	Density	Cover Ratio	
13%	13%	Ash = 2000 PCY SW = 1100 PCY	Ash 10:1 SW 3.5:1	2003
25%	50%	Ash = 2000 PCY SW = 1100 PCY	Ash 10:1 SW 3.5:1	2017

Conversion Factors estimated by Waste Management, Inc. of Hawaii
Cover Ratio is volume of waste to volume of daily/intermediate cover
SW - Solid Waste
PCY - Compacted waste density in pounds per cubic yard

10.2.4 Waipahu Incinerator Ash Landfill

The Waipahu Incinerator Ash Landfill site received ash from the nearby solid waste incinerator until the landfill operations ceased in November 1991. The ash disposal landfill is located on Navy-owned land. The City has engaged a consultant to design a final closure plan for this landfill.

10.2.5 Kaneohe Marine Corp Air Station Landfill

The Kaneohe Marine Corp Air Station (M.C.A.S.) Landfill reportedly receives 11,200 tons of waste per year. This commercial and industrial waste is generated on base and is the portion that is not collected by private refuse haulers. Base staff estimates that this tonnage is expected to remain constant throughout the life of the landfill and that the site has adequate capacity to remain open through 1998.

10.2.6 Other Landfills

Other non-permitted sites are known to receive construction and demolition debris. It is estimated that as much as 200,000 tons per year are received at these sites. Those sites have unused capacity and will continue operation throughout the plan period, according to the owners. Under the rules proposed by the State Department of Health, these sites would have to be permitted or closed.

The unpermitted sites may continue to accept waste, making estimation of the construction and demolition debris disposal needs difficult. These sites are illegal and unpermitted so that the amount of material they accept cannot be accurately reflected in estimates of the City's waste generation. The estimates provided in this Plan are based on information from individuals who appear knowledgeable about the amount of these construction and demolition waste being disposed.

10.3 EXPANSION POTENTIAL OF EXISTING SANITARY LANDFILLS

Vertical or lateral expansions of any of the existing sanitary landfills currently operating will require revisions to the Solid Waste Permits for each site in question. Environmental clearance will be required for lateral expansions beyond permit limits.

Under new federal sanitary landfill regulations mandated for adoption by the State before October 1993, sites with lateral expansions of existing sanitary landfills will require liners. Vertical expansions over currently permitted areas will not require lining in most instances, but stringent closure and monitoring will be required.

The cost of establishing and operating a new landfill will be greater than the existing sites. Cost increases are a result of the siting process and the requirements of RCRA Subtitle D relating to liners, monitoring, and operations. The requirements of RCRA Subtitle D are more fully discussed in Section 10.4.

10.3.1 Kapaa Site No. 1

Kapaa Site No. 1 was identified in the 1977 landfill siting study, "*Inventory Study of Potential Sanitary and Demolition Landfill Sites,*" Stanley S. Shimabukuro and Associates, Inc. This area is not contiguous with the existing landfill. The previous study contained a site design for the 58-acre unit, which has approximately 3 million cubic yards of landfill capacity. The proposed site location is shown on Figure 10-2.

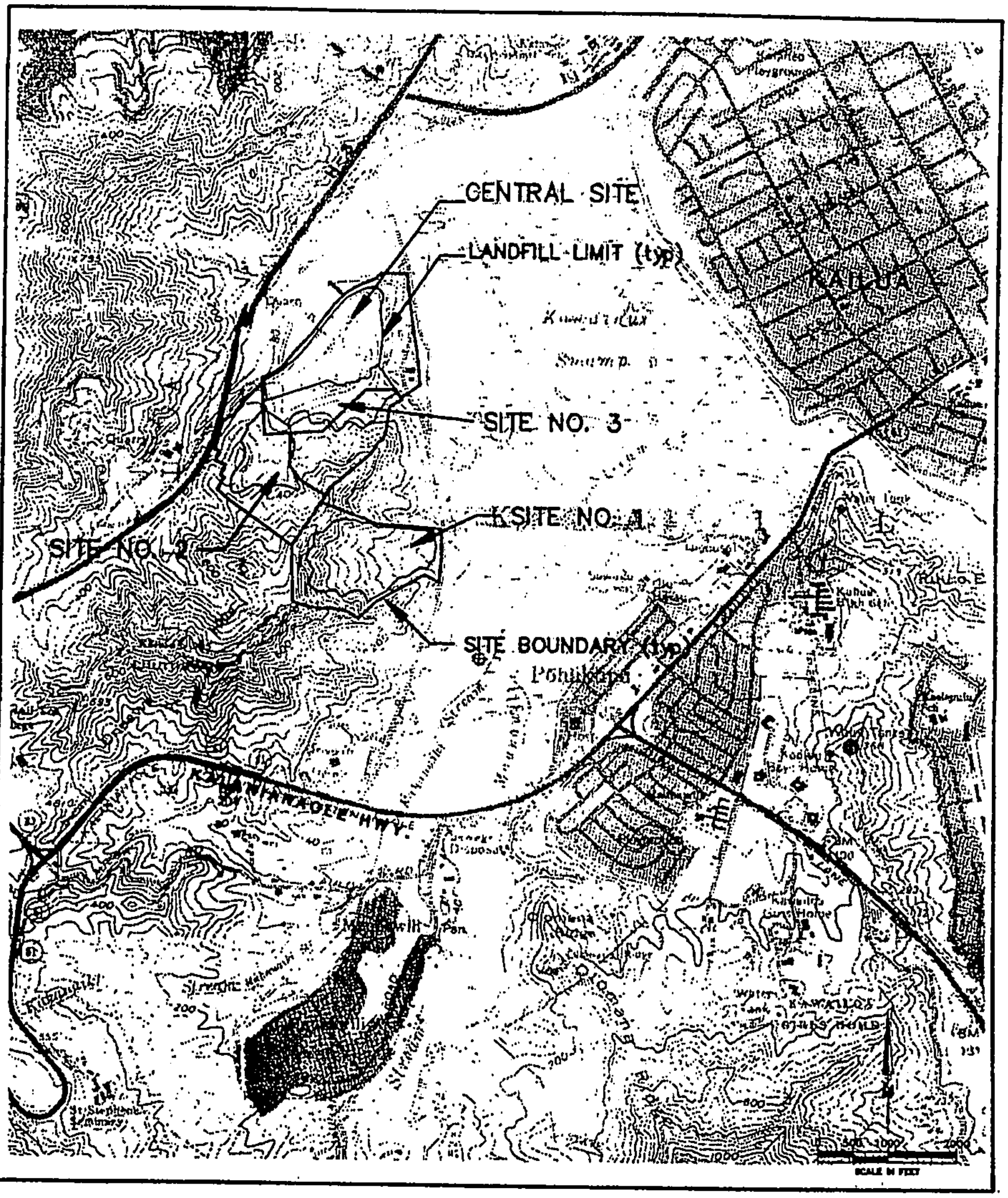
The City has an approved Environmental Impact Statement for Kapaa Site No. 2, although it may have to be amended. The City intends to begin the preliminary engineering and environmental studies for the Kapaa Site No. 1 in 1993 and plans to have this facility operational by 1995.

10.3.2 Kalaheo Sanitary Landfill

The Kalaheo Sanitary Landfill, now closed at the permitted elevation of 250 feet msl (mean sea level), could be reopened and filled to a higher elevation. The site was originally designed to a larger configuration, but a height limit was imposed by the State Department of Land and Natural Resources under a Conservation District Use Permit.

Reopening of Kalaheo will likely require environmental documents and a new Solid Waste Management Permit to expand laterally and vertically. Additionally, new federal guidelines will require that a lateral expansion of the Kalaheo site be lined over the area outside the current limits of waste fill.

When the Kalaheo site was operating, complaints concerning odor were received. If this site is to be considered for future expansion, it would be prudent to consider incorporating an effective odor control system or using it only for construction and demolition debris. Use as a



CITY AND COUNTY OF HONOLULU
INTEGRATED SOLID WASTE MANAGEMENT PLAN
KAPAA SANITARY LANDFILL

FIGURE 10–2
DECEMBER 1992
368SHT.DWG

construction and demolition disposal site would be beneficial to the City because it would extend the existing site capacity of Kapaa and will not present the odor problems associated with a sanitary landfill handling municipal solid waste and sludge. Because it is closer to the point of generation of construction and demolition waste on the windward side of Oahu, the facility could provide more convenient disposal and reduce illegal dumping.

It is estimated that approximately 7 million cubic yards of additional capacity can be obtained at the Kalaheo site, depending on the ultimate height of the final configuration. A reasonable design scenario to a height below the surrounding ridges can accommodate the construction and demolition debris from the region for many years.

10.3.3 Waimanalo Gulch Sanitary Landfill

The currently permitted area of the Waimanalo Gulch Sanitary Landfill is limited to a self-imposed maximum fill elevation of 400 feet msl. Expansion of this site beyond the currently permitted configuration could occur by raising the height of the fill and/or by expanding the existing footprint laterally.

Vertical expansion over the existing site would be limited by constraints on the current landfill configuration and overhead power lines. It is estimated that a vertical expansion scenario could provide approximately 500,000 cubic yards of additional capacity.

Vertical expansion may require a revised Solid Waste Management Permit from the State, a revised Conditional Use Permit from the City Department of Land Utilization, and environmental documents.

A lateral expansion of the site, however, will provide a significant volume increase and can be accomplished by the following methods:

- Expand along the east perimeter of the fill, raise the maximum fill height and maintain the current by-pass drainage pattern; and/or

- Realign and extend the current drainage by-pass ditch to catch run-off at a point farther up the gulch. This would allow for expansion farther up and across the width of the canyon and provide significant additional capacity.

Potential capacity for expansion within the current landfill property could be as high as 4 million cubic yards, depending on earthmoving efforts and ultimate height of the expansion area.

Problems inherent in a lateral expansion are that new permits and environmental documents may be required. Also, the physical features of the upper region of the Waimanalo Gulch (within the current property limits) would require extensive excavation and quarrying of rock materials.

10.4 REGULATORY REQUIREMENTS

Regulations affecting solid waste management and landfills have changed dramatically in recent years and are likely to continue to evolve over the next several years. The State of Hawaii passed Act 324 that provided goals for integrated solid waste management planning. The City enacted Ordinance 89-114 on May 10, 1989, which established diversion goals of 50% by 1995 and 75% by 2000 to reduce reliance on landfills and incineration by emphasizing waste diversion strategies such as reuse, recycling, and composting.

On October 9, 1991, the EPA adopted Solid Waste Disposal Facility Criteria (RCRA Subtitle D). States can either adopt similar regulations or let EPA enforce the Subtitle D regulations. If a state wishes to enforce its own regulations, it must develop criteria for sanitary landfills equal to or more stringent than the federal guidelines by October 9, 1993. A permitted state may implement area-specific design and plans specific to the conditions in the state. The State of Hawaii has drafted Act 245 amending Chapter 342 of the Hawaii Revised Statutes to address the Subtitle D requirements and to become a permitted state. The requirements include location restrictions and criteria for facility design, operations, groundwater monitoring, corrective action, financial assurance, and closure and post-closure care.

10.4.1 Federal Guidelines

RCRA Subtitle D includes restrictions on landfill location, facility design standards, operating requirements, groundwater monitoring and corrective action, closure and post-closure care, and financial assurance. The regulations governing location, restrict siting municipal solid waste landfills near airports or in ecologically or geographically sensitive areas (e.g., floodplains, fault lines, seismic zones, and unstable terrain). Operating requirements include prohibiting regulated hazardous wastes, applying a daily cover, controlling disease vector populations, monitoring methane gas, restricting public access, controlling storm water run-off, protecting surface water from pollutants, and keeping appropriate records. Design standards require landfills to have a composite liner made of a synthetic flexible membrane over a compacted clay layer. All landfills must have groundwater monitoring wells, and landfill operators are responsible for cleaning up any contamination if it does occur. Upon closure, the landfill owner/operator is responsible for capping the landfill and monitoring groundwater, methane gas, and leachate for 30 years. Landfill owners/operators must also prove financial capability to cover the costs of closure, post-closure, and, if necessary, clean-up activities.

10.4.2 State and Local Regulations

Current regulations affecting sanitary landfills in the City are regulated by both the local and state government. The following agencies have specific authority or responsibilities over the location, design and/or operation of sanitary landfills.

10.4.2.1 State of Hawaii Department of Health

A Solid Waste Management Permit is required from the State Department of Health Office of Solid Waste Management as set forth in Title 11, Chapter 58, Hawaii Administrative Rules on Solid Waste Management Control. These regulations establish standards for the design, construction, installation, operation, and maintenance of solid waste disposal sites. Besides sanitary landfills, Title 11, Chapter 58, also has standards for reclamation facilities, incinerators, and transfer stations. These standards are also proposed for modification in response to RCRA Subtitle D.

10.4.2.2 City and County of Honolulu Department of Land Utilization

A Conditional Use Permit is required for solid waste disposal sites under the City and County of Honolulu Land Use Ordinance (December 1990). Approval must be obtained from the State Department of Health, the Fire Department, the Board of Water Supply and the Department of Public Works to obtain a Conditional Use Permit.

The term of a Conditional Use Permit for a waste disposal facility is limited to no more than five years, and a public hearing is required as part of the permit process.

The conditional use of a waste disposal facility is limited to the following zoning districts.

- P-2, General Preservation
- AG-2, General Agriculture
- I-2, Industrial Intensive

Siting a proposed sanitary landfill in an area outside these zoning district designations requires an amendment to the General Plan.

10.4.2.3 City and County of Honolulu Board of Water Supply

The Board of Water Supply has concerns for potential contamination of water supply sources from waste disposal practices. The Board of Water Supply will review each proposed sanitary landfill site and must grant approval to the City Department of Land Utilization in order for the landfill applicant to obtain a Conditional Use Permit.

10.5 FUTURE SANITARY LANDFILL SITE AVAILABILITY

Suitable areas for future sanitary landfill sites are very limited on the island. Even with achievement of optimistic diversion goals and continued incineration of solid waste, the availability of significant sanitary landfill capacity will always be necessary. Oahu's current sanitary landfill capacity is limited to some point beyond this decade, depending on diversion efforts. Therefore, the process of siting new sanitary landfills or expanding existing sites should be a continuous effort throughout the current planning period.

The siting process outlined in this section is intended to describe siting criteria and a method of analysis to follow to locate a new sanitary landfill site. Four locations that could potentially be used as sanitary landfill were identified while preparing this Plan. The features of those four locations are reviewed in this siting discussion. The mention of these four locations does not suggest that the City is proposing any of them as sanitary landfill sites or is actively investigating the use of those sites. Before the City proposes use of a specific location for a sanitary landfill, it will follow a siting, environmental, permitting, and public review process.

10.5.1 Siting Goals

Leeward Oahu

A major expansion or large new regional sanitary landfill on the Leeward side of the island, sited and permitted within this plan period, is viewed as a best case scenario to replace the Waimanalo Gulch Sanitary Landfill and allow for continued solid waste disposal capacity on the island. Siting of a major sanitary landfill on the Leeward side is necessary since most of Oahu's future non-divertable waste (primarily ash from the H-POWER facility) will be generated on this side. Additionally, the Leeward side is significantly more arid and therefore more suitable for sanitary landfilling.

A secondary goal for the Leeward side is to maintain a construction and demolition debris landfill to divert these materials from costly sanitary landfills constructed to RCRA Subtitle D standards.

Windward Oahu

A replacement site on the Windward side is needed to replace the Kapaa Sanitary Landfill to minimize transportation costs. The Kapaa Site No. 1 is expected to fulfill this need.

10.5.2 Previous Sanitary Landfill Siting Studies

The following studies have been conducted to identify and site landfill facilities on the island of Oahu:

(1) *Hydrogeologic and Soils Study of Proposed Sanitary Landfills for the Leeward and Windward Oahu*, Stephen P. Bowles & John F. Mink, July 1977;

(2) *Inventory of Potential Sanitary and Demolition Landfill Sites on the Island of Oahu*, Stanley S. Shimabukuro and Associates, Inc., August 1977;

(3) *Environmental Impact Statement for the Proposed Leeward District Sanitary Landfill*, (Kaloi, Makaiwa, Nanakuli) Oahu, Hawaii, Environment Impact Study Corporation, October 1977;

(4) *Supplement to Inventory of Potential Sanitary and Demolition Landfill Sites on the Island of Oahu*, Stanley S. Shimabukuro and Associates, Inc., November 1979;

(5) *Waipahu Ash Disposal Site Feasibility Study*, Belt, Collins & Associates, November 1983;

(6) *Revised Environmental Impact Statement for the Kalaheo Sanitary Landfill*, Environment Impact Study Corporation, August 1983;

(7) *Revised Environmental Impact Statement for Leeward District Sanitary Landfill, at Waimanalo Gulch Site and Ohikilolo Site*, Environment Impact Study Corporation, May 1984;

(8) *Final Addendum to Revised Environmental Impact Statement for Leeward District Sanitary Landfill at Waimanalo Gulch Site*, Diane S. Hirsch, August, 1985.

The objective of the 1977 *Inventory Study of Potential Sanitary and Demolition Landfill Sites* was to identify potential sites, rank each potential site, and make recommendations for preferred landfill site selections. This study was also based on the earlier 1977 hydrogeologic and soils study. After review of the site recommendations, the City selected five sites for which conceptual plans were prepared for sanitary landfill site development, along with cost estimates for development, operations and maintenance, and environmental assessments. The study ranked the Kapaa sites (1, 2, & 3) and the Kalaheo site as the best candidates for the Windward side of Oahu. On the Leeward side, the Makaiwa, Nanakuli, and Kaloi sites were ranked highest. Following this study an Environmental Impact Statement (EIS) was prepared for the selected Leeward sites.

The 1979 *Supplement to Inventory of Potential Sanitary and Demolition Landfill Sites* developed new site selection criteria, added new sites and re-evaluated the Leeward sites to recommend sites for further study. The study ranked sites allowed by the Board of Water Supply (sites not in areas that could affect either existing and potential water sources). The study concluded that the top candidates were two sites near Ewa with relatively flat topography. The Waimanalo Gulch Sanitary Landfill site was ranked third under scenarios that included a waste-to-energy facility.

The 1983 *Waipahu Ash Disposal Site Feasibility Study* looked at the possibility of disposing of incinerator ash as part of reconstruction of the adjacent golf course. The study considered economic effects and physical characteristics. This proposal, if revisited, would have to examine potential environmental impacts.

10.5.3 Sanitary Landfill Siting Process

The site selection process for identifying new sanitary landfill sites on the island of Oahu should be initiated within this planning period. The recommended approach for a siting study involves the following steps:

(1) Define Project Requirements;

(2) Identify Exclusion Criteria;

(3) Apply Exclusion Screening;

(4) Identify Potential Sites and Perform Initial Ranking;

(5) Conduct Site Evaluations and Perform Secondary Screening;

(6) Rank Potential New Landfill Sites based on Evaluation Criteria;

(7) Develop Approach to Permit Selected Site and/or Alternatives; or

(8) Revise Exclusionary Criteria and Identify New Potential Sites (if a preferred site is not identified).

Steps 1 through 4 above are addressed in this Plan using the previous siting studies discussed in Section 10.5.2. The remaining steps should be followed in the plan period until one or more landfill sites are located. This process can be iterative; the exclusionary criteria may need to be modified if the process does not result in identification of suitable sites.

The methodology for a successful site selection process should include:

- Accountability to the public;
- A logically sequenced and organized approach;
- A clear identification of goals;
- Establishment of environmental performance standards;
- A comprehensive approach;
- A clear presentation of information; and
- Distinction of fact from judgment.

10.5.3.1 Project Requirements

Growth on the island is predicted to increase through the planning period and beyond. Even assuming highly successful measures to reduce the amount of waste being deposited in the current sanitary landfills, there is a clear need to secure additional sanitary landfill capacity for future planning periods.

Since siting and permitting a sanitary landfill requires an extensive amount of time and effort, the process should begin early in the planning period to realize successful completion before current sanitary landfill capacity is exhausted.

Disposal Requirements

Adequate sanitary landfill disposal capacity, resource recovery facilities, or alternative disposal technology is needed for the following waste categories:

- Municipal solid waste residuals and incinerator ash;
- Special wastes, such as asbestos, sewage sludge, medical wastes; and
- Construction and demolition debris.

Existing permitted sanitary landfills and new sites or expansion units that are constructed to RCRA Subtitle D standards can accommodate these waste categories. However, construction and demolition debris which is not recycled or reused could potentially be disposed in unlined facilities, depending on the solid waste regulations finally adopted by the State and approved by the EPA. Other special wastes, MSW residuals (non-combustible, non-recoverable), and incinerator ash should be recycled or reused. If not, they will require disposal in existing permitted facilities, in new sanitary landfills, or in lined expansion units of existing sites.

The specific needs for siting new sanitary landfills on the island are as follows:

(1) Municipal Solid Waste Residuals, Special Wastes and Incinerator Ash

Develop a major sanitary landfill expansion or new site on the Leeward side to accommodate ash and residue from H-POWER and handle the remainder of wastes that will not be diverted through source reduction, recycling, composting, or resource recovery.

Most of the combustible waste from the Windward side of the island is transferred to the H-POWER facility, and composting could eventually divert a large amount of organic material from disposal. However, a new site, such as Kapaa Site No. 1, is needed on the Windward side to provide continuing flexibility in the solid waste management system. For example, if the Leeward facilities were to become overloaded due to a natural disaster, the Windward site would then be available.

(2) Demolition and Construction Debris

Develop additional landfill capacity for disposal of inert construction and demolition debris. Organic materials in the construction and demolition waste category, such as wood, could be separated for other recovery processes. It would be advantageous to have landfills for inert materials on both sides of the island to keep transportation of heavy debris to a minimum. These landfills should separate and reuse soil, rocks and concrete rubble to conserve capacity as long as there is a viable market for the materials.

Although significant reductions in quantities and waste types are possible, the need for landfill sites constructed to modern standards with adequate capacity will likely never end.

Proposed Site Capacity

Identification of sites with sufficient capacity to achieve a minimum active life of ten years is appropriate. This minimum period is chosen to reflect the current level of effort required to develop similar projects. Projects with shorter life spans would require nearly continuous effort to maintain adequate disposal capacity. A longer minimum site life would be preferable, but is unlikely due to the physical limitations of previously identified potential landfill sites.

10.5.3.2 Exclusion Criteria

An initial screening is conducted to identify potential areas where sanitary landfills can be located outside exclusion zones. Exclusion criteria were selected based on RCRA Subtitle D siting restrictions and additional criteria pertinent to local conditions. Only criteria with data available on a regional basis are used in the initial exclusion screening. Criteria that require site specific investigations or research should be applied after the field work has been conducted. According to Subtitle D, no proposed solid waste disposal facilities or practices associated with the operation of such facilities shall be sited in areas with the following designations:

(1) Floodplains and Tsunami Zones;
(2)* Wetlands and Sensitive Habitats;
(3) Areas of Existing or Potential Water Sources;
(4) Areas of Incompatible Land Use;
(5)* Known Areas of Historical or Archaeological Significance; and
(6)* Geologic Fault Areas, Unstable Areas and Areas of Volcanic Activity.

* These criteria require site specific investigations or research and should be applied in subsequent screenings.

(1) Flood Plains and Tsunami Zones

Proposed sanitary landfill sites should not be located within 100-year floodplain. Site exclusion is based on inspection of Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps. Sites with significant areas inundated by 100-year flooding should be excluded. However, sites with minimal areas of flooding, which could be mitigated with drainage improvements, should be considered.

Landfill sites should also not be sited within zones susceptible to tsunamis (seismic waves).

Tsunami zones have been established by the State of Hawaii Civil Defense Tsunami Evacuation Maps.

Since flood plain and tsunami zone areas are relatively small and/or located near shorelines, this criterion should be examined when considering specific areas for potential landfill sites.

(2) Wetlands and Sensitive Habitats

Areas designated as wetlands should not be considered. Each potential new landfill site should also be examined for the occurrence of sensitive plant or animal species, or of sensitive habitats, on or near the candidate site. Each area should be investigated using data from existing publications, files and data bases. Site investigations should be done to decide whether the site should be excluded because of the presence of species listed (or identified as candidate species) as threatened or endangered by the State and Federal governments.

Sensitive habitat areas should be identified through site examination by an expert for each potential site to be considered. Exclusion of sites based on this criterion should be made with subsequent screenings after appropriate field investigations have been performed.

If landfill development on identified sites does not jeopardize threatened or endangered species or their habitats, the sites should be rated with respect to potential impact on the general biotic system. This rating can eventually be used in comparing the candidate sites during secondary ranking based on site specific data.

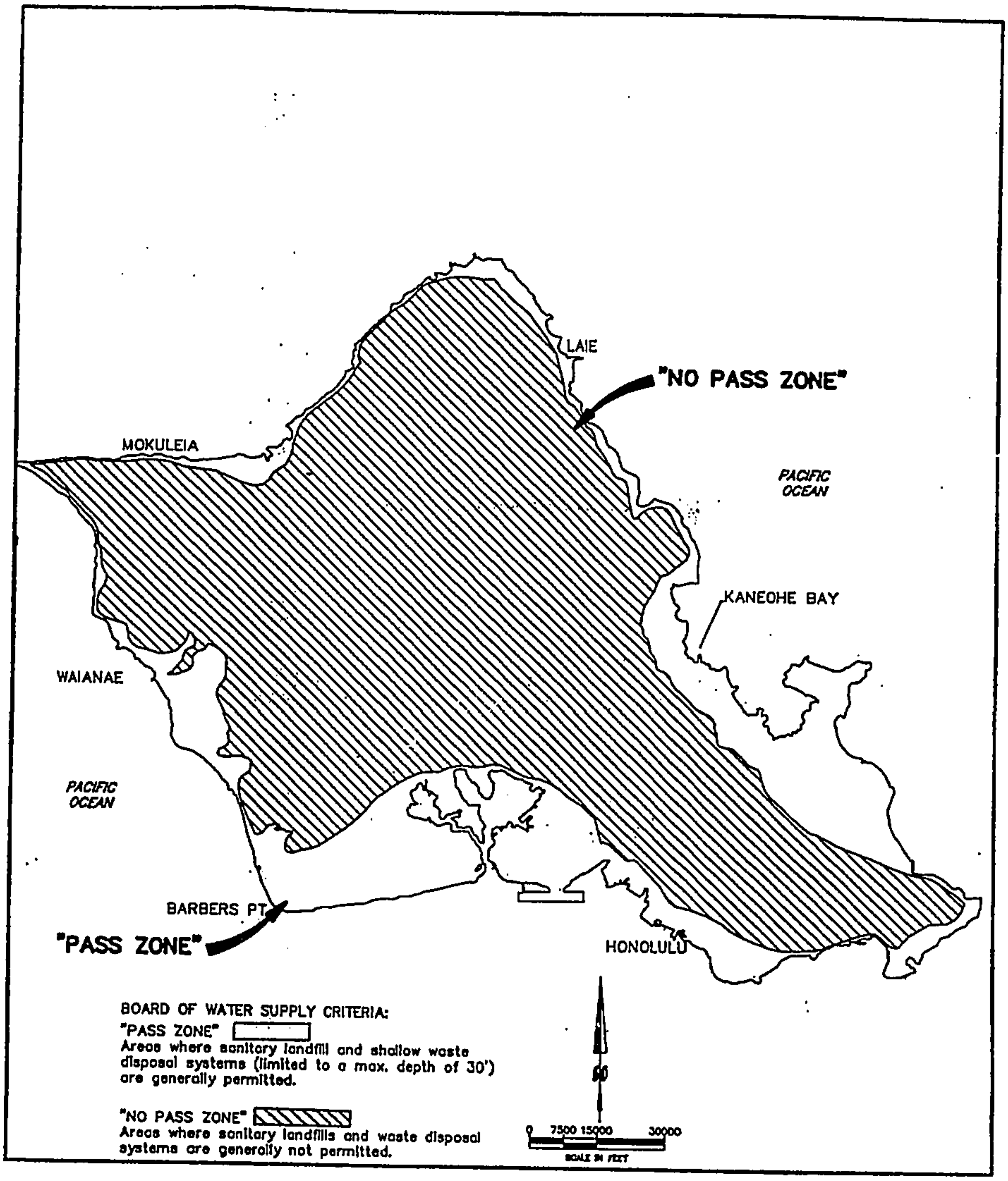
(3) Location in an Area of Potential or Existing Water Sources

Potential sites that are in recharge areas as defined by the Board of Water Supply should not be considered. Areas of groundwater recharge are situated over much of the island of Oahu. Figure 10-3 shows areas of brackish water supplies and additional areas identified by the Board of Water Supply (1987) which may be acceptable for sanitary landfill development. This criterion is subject to change if water source protection can be assured based on site specific technical data.

(4) Areas of Incompatible Land Use

a) Proximity to Airports:

RCRA Subtitle D requires that no landfill shall be located closer than 5,000 feet from airport runways used by piston-type aircraft or closer than 10,000 feet from runways used by turbojet aircraft. The purpose of this requirement for civilian airports regulated by the Federal Aviation Administration (FAA) is to protect aircraft from colliding with birds that may be attracted to the landfill operation. Additionally, the FAA and the affected airport must be notified if any new landfill unit is constructed within a five-mile radius of a runway.



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POTENTIAL OR EXISTING WATER SOURCES

FIGURE 10-3

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For purposes of the preliminary exclusion process, the criteria stated above should also be applied to military airfields. Figure 10-4 shows airport locations and the resulting exclusion zones.

b) Land Preserved for Natural or Recreation Purposes:

Areas designated as forest preservation or for recreation purposes should be excluded from consideration as potential landfill sites. Local, state and national parks and recreation areas are shown on area specific maps for potential landfill sites.

c) Land Used or Designated for Residential or Commercial Development:

The 1990 Land Use Plan will form the basis for determination of current and planned zoning. The Kapolei Area Long Range Master Plan for the Estate of James Campbell will be used for land use for the area from Ewa to Kahe Point. Land used for commercial and residential areas is shown on area specific maps for identified potential sanitary landfill sites.

(5) Areas of Historical and Archaeological Significance

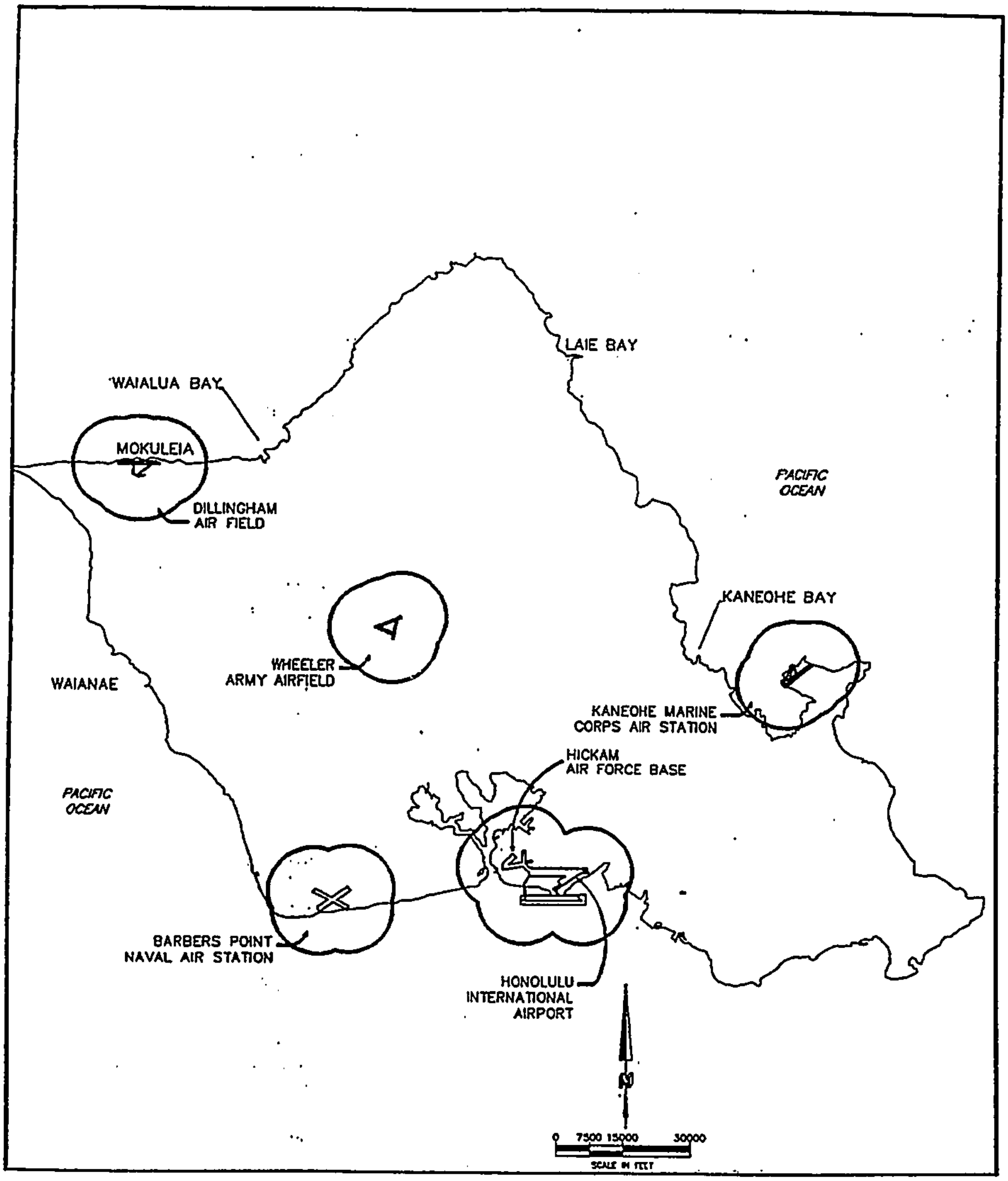
Areas of historical and archaeological significance should be avoided in siting a disposal facility. Historical resources refer to material remains of human activities that characterized the post-contact or historic period. Archaeological resources refer to the material remains (artifacts, structures, etc.) produced by prehistoric human societies. Landfill construction and operation would probably be incompatible within such areas, unless the archaeologically significant site was preserved as required by the Historic Preservation Division of the State Department of Land and Natural Resources.

This criterion should require site specific investigations or research and should be applied in subsequent screenings.

(6) Geologic Fault Areas, Unstable Areas and Areas of Volcanic Activity

To protect containment structures (liners, leachate collection systems, and landfill covers) from damage from earthquakes, fault displacement, and landslides, landfills should not be located in areas that have a high potential for severe ground motion or rupture.

This criterion should require site specific investigations or research and should be applied in subsequent screenings.



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AIRPORT EXCLUSION AREAS

FIGURE 10–4

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10.5.3.3 Potential New Sanitary Landfill Sites

Previous siting studies have been reviewed and potential new landfill sites identified in the previous work were analyzed. The following sites were reviewed at this time:

- Ewa No. 1
- Ewa No. 2
- Kahe
- Maili

The locations of these sites are shown on Figure 10-5.

Other sites in the previous studies were ranked lower or are considered inappropriate at this time. The Makaiwa Gulch site was ranked favorably in the previous siting studies, and the site has since been given approval by the Board of Water Supply. However, the Kapolei Long Range Master Plan now proposes residential development for this area.

10.5.3.4 Initial Ranking

The following criteria are used in evaluating the potential new sanitary landfill sites. Each criterion is given a weighted factor from 1 to 5 depending on importance. The weighted factors were decided by the Advisory Committee. Higher weighted factors are assigned to criteria judged most important. The sites selected for evaluation are then scored based on their ability to meet the various criteria. Individual site scores are assigned for each criterion. Each score, from 0 to 10, reflects the ability of the potential site to mitigate any impacts associated with the criterion in question. The score for each criterion is then multiplied by the weighted factor. The totals of the weighted scores are summed for each site, and the sites are ranked by the highest score.

(1) Compatibility with Area Land Use (judgement based on current use, adjacent use, proposed development, future general plans). Examples of scores are:

Score 0 - In an area of use by many people, no available buffer zone, highly visible, possibly upwind.

Score 5 - Moderate adjacent land use, 1000 foot buffer zone, somewhat visible with possible screening.

Score 10 - Little or no adjacent residential or commercial uses, substantial buffer zone, limited visibility or completely screened.

(2) Technical Viability (semi-quantitative judgement based on engineering feasibility, cover availability, need for engineered alternatives, site access, proximity of utilities). Examples of scores are:

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POTENTIAL LEEWARD SANITARY LANDFILL CANDIDATE SITES
(EWA 1, EWA 2, KAHE, MAILI)

FIGURE
10–5

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Score 0 - Natural slopes are steeper than 2:1 (horizontal to vertical), no adequate soils available, requires hard rock excavation, requires more than one mile of new access road, more than one mile from existing utilities.

Score 5 - Natural slopes are not steeper than 3:1, some soils exist on-site for daily cover, no potential clay sources on-site, less than one-half mile from existing roads and utilities.

Score 10 - Natural slopes are flatter than 5:1, adequate soils for daily cover and clay layers, potential earthwork balance, close to major roads and utilities.

(3) Economic Issues (numerical scoring reflecting position relative to other sites based on long run costs of operations and transportation compared to short run costs for site acquisition and development, cover material, haul distance, and import costs). Examples of scores are:

Score 0 - Cost of site is highest of candidates being considered.

Score 5 - Cost of site is equal to median of highest and lowest cost sites.

Score 10 - Cost of site is lowest of candidates being considered.

(4) Landfill Capacity (numerical scoring reflecting position relative to other sites). Examples of scores are:

Score 0 - Estimated site capacity is least of candidates being considered.

Score 5 - Estimated site capacity is equal to median of largest and smallest sites.

Score 10 - Estimated site capacity is greatest of candidates being considered.

Table 10-3 shows an initial ranking of the four sites reviewed.

TABLE 10-3: INITIAL RANKING OF IDENTIFIED POTENTIAL SANITARY LANDFILL SITES

Criteria	Weight	Site Score			
		Ewa No.1	Ewa No.2	Kahe	Maili
Land Use Compatibility	2.30	6.15	0.00	10.00	9.65
Technical Viability	2.70	10.00	6.71	0.00	6.77
Economic Issues	2.40	10.00	3.99	7.28	0.00
Landfill Capacity	2.50	3.78	1.59	10.00	0.00
Total Weighted Score*	-	74.61	37.07	65.47	40.48

*The total score is for example only. Before the City recommends a specific site, it will complete additional studies.

10.5.3.5 Environmental and Technical Site Evaluations

It is recommended that at least the three top-ranked sites from the initial screening process be selected for further evaluation. Site specific information should be gathered for each site selected. This information may include, but not be limited to, the following tasks:

- Conduct a hydrogeologic investigation to determine subsurface conditions and groundwater depth, flow direction, quality, and quantity;
- Sample on-site soils to determine physical properties for use in landfill construction and operation and estimate available quantities;
- Conduct a preliminary environmental study for each site to identify impacts on land use compatibility, noise, visual aesthetics, traffic and cultural resources;
- Conduct a biotic study for each site to identify wildlife and habitat and look for the existence of rare, threatened, or endangered species; and
- Prepare a preliminary engineering design based on site specific data and a seismic analysis for the proposed design. This work would also include drainage and flood control design and detailed estimates of excavation and landfill volumes.

During the site specific evaluations it may be appropriate to remove sites from further consideration because of exclusionary factors identified during the field and design work.

10.5.3.6 Secondary Screening

Based on future site specific field investigations and preliminary design work conducted for the remaining candidate sites, a secondary screening should be conducted on an expanded list of criteria. The additional criteria were not used in the preliminary screening because site specific information is needed to adequately assess these issues.

The secondary screening should include the following criteria:

(1) Ability to Protect Natural Resources (Groundwater, Surface Water, Air Quality)

(2) Compatibility with Area Land Use (Current Use, Adjacent Use, Proposed Development, Future General Plans)

(3) Destruction of Natural Habitat (Displacement of Species, Loss of Biotic Diversity)

(4) Potential Destruction of Cultural Resources

(5) Technical Viability (Engineering Feasibility, Cover Availability, Need for Engineered Alternatives, Site Access, Availability of Utilities)

(6) Economic Issues (Updated Development Costs, Haul Distance, Material Import Costs)

(7) Anticipated Site Life

(8) *Land Acquisition Issues*

The secondary screening would be conducted much like the initial screening, using weighted factors for the expanded criteria and scoring each site based on the field investigations.

With the results of the secondary screening, the remaining sites should be ranked by highest score. During the siting process, a public information program should be conducted so that the public will understand the selection process.

If a preferred selection is apparent after the secondary screening, it would be appropriate to prepare an environmental document and initiate the permitting process for the selected site. If a preferred site is not identified, then the initial exclusionary criteria can be modified to open new areas to potential landfill sites.

10.5.4 Preliminary Analysis of Potential Municipal Solid Waste Landfill Sites

Preliminary site designs have been prepared for the four sites identified in previous siting studies and selected for further analysis in this section. Maps showing the extent of the landfill designs are included in the analysis of each site.

Table 10-4 shows the acreage, capacity and elevations and estimated site life for each site design.

TABLE 10-4: LEEWARD SANITARY LANDFILL CANDIDATE SITES

Site	Area (acres)	Refuse Capacity (cubic yards)	Maximum Landfill Elevation (feet msl)	Adjacent Ground Elevations (feet msl)	Site Life Estimate (Years)*
Ewa No. 1	229	22.4 million	250	110 - 155	23
Ewa No. 2	200	16.5 million	110	30 - 40	17
Kahe	323	42.7 million	1300	100 - 1300	44
Maili	180	12.4 million	120	20 - 56	13

* The site life estimate was based on the amount of capacity used in 1991. New diversion programs are expected to reduce the need for landfill capacity, thereby extending site life beyond the estimate provided here.

In the area fill method of sanitary landfill design and operation, waste is spread and compacted over the natural surface of the ground and covered with soil or another material. In the trench method, an area is first excavated. The waste is spread and compacted in the excavated area and then covered with the soil removed from the trench. The area method is useful for large volumes of waste and in areas where excavation below the earth surface is not desired. The trench method provides for a smaller working face (the surface on which the waste is dumped) making for easier operations in wet weather and more efficient land use. The trench method is suitable for smaller volumes of waste.

10.5.4.1 Ewa No. 1

Location

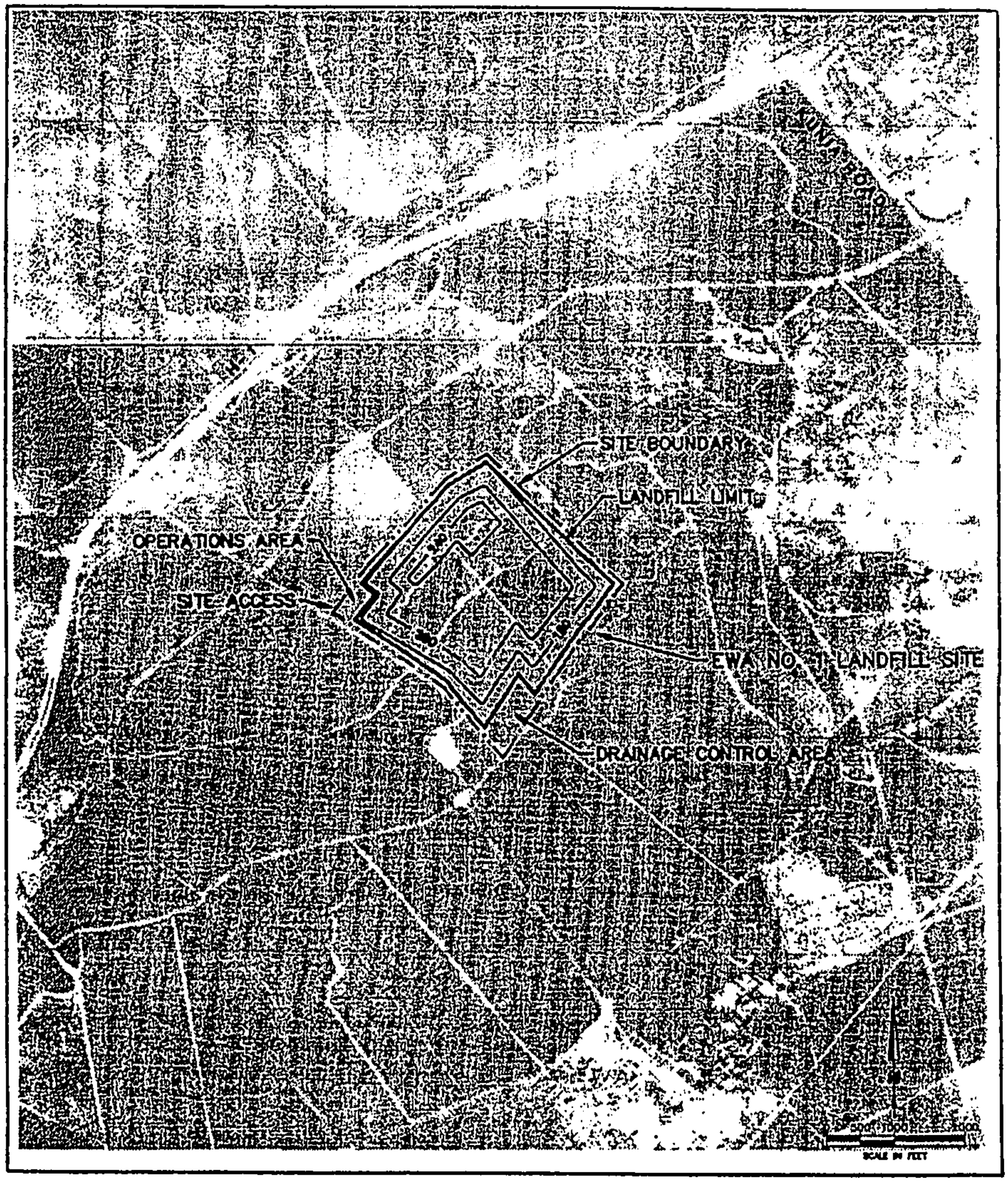
The Ewa No. 1 site, originally presented in the 1979 Shimabukuro supplemental siting study, is located on a 229-acre portion of the Ewa plain. The site is located 1,200 feet south of Farrington Highway and approximately 1 mile north of Ewa on relatively flat agricultural land.

Site Design

The Site Plan shown on Figure 10-6 uses a combination area fill and trench fill method. The design has a gross waste volume of 24.3 million cubic yards.

The maximum elevation of the landfill is shown at 250 msl. Ground elevations range from 105 to 150 feet msl and the slopes are approximately 1% to 2% to the southeast. Final side slopes around the perimeter of the site are shown at 5:1 (horizontal to vertical) and should not require any special preparation or erosion control measures. The top of the fill is designed with a 3% slope to the south to allow surface runoff.

The liner basin is designed with 10:1 side slopes and bottom slope of 2%. The low point of the



CITY AND COUNTY OF HONOLULU
INTEGRATED SOLID WASTE MANAGEMENT PLAN
EWA 1 SITE PLAN

FIGURE 10–6

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liner subgrade is shown at elevation 70 msl.

This site is in an area that has suitable soils for landfill construction. Because of the relatively flat terrain and an adequate separation from groundwater, onsite excavation would generate sufficient quantities of soil materials for daily cover, liner construction and final capping of the site. Soils on the site are clay and silty clay and can provide adequate cover material. Additionally, the fines within the onsite soils will allow construction of barrier layers with relatively low permeability.

Ownership, Zoning and Surrounding Land Use

The property is owned by the James Campbell Estate and is currently used for open space and cane fields. The site is in the City Zone District designated Agriculture AG-1. Surrounding land use is agriculture with some residential and commercial uses within one-half mile of the site.

Site Constraints

Although this site is the most suitable in terms of technical viability and environmental protection, it may receive strong opposition from the land owner and from the local community due to its proximity, future development potential, and use as prime agricultural land.

10.5.4.2 Ewa No. 2

Location

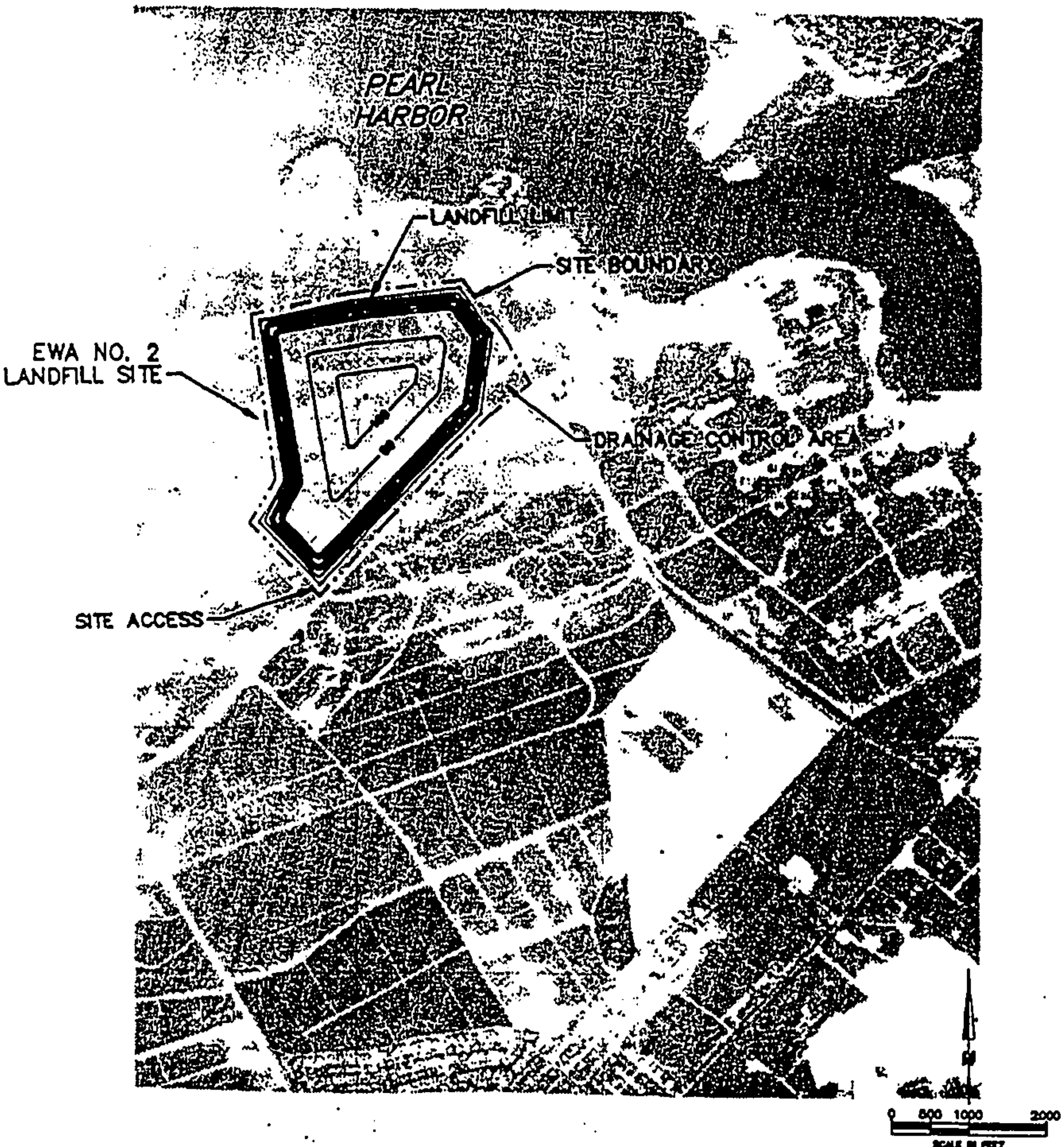
The Ewa No. 2 site as presented in the 1979 supplemental study is shown on a 200-acre portion of the Ewa plain. The site is located approximately 2 miles north of Ewa Beach by the West Loch of Pearl Harbor on relatively flat agricultural land used for sugar cane. Ground elevations range from approximately 30 to 40 feet msl.

Site Design

The Site Plan shown on Figure 10-7 uses a combination area fill and trench fill method. The design has a total waste volume of 18.6 million cubic yards.

The maximum elevation of the landfill is shown at 110 msl. Final side slopes around the perimeter of the site are shown at 3:1 and should not require any special preparation or erosion control measures. The top of the fill is designed with 3% slopes that drain toward the perimeter from a central high point.

Since this site is relatively low in elevation and groundwater in the area is near sea level, the total depth of excavation should be limited to 20 to 25 feet to maintain adequate separation from groundwater to the liner subgrade.



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INTEGRATED SOLID WASTE MANAGEMENT PLAN
EWA 2 SITE PLAN

FIGURE
10–7
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The liner basin is designed with 10:1 (horizontal to vertical) side slopes. Construction of the liner bottom will require special grading to create positive drainage over the entire basin. The low point of the liner subgrade is shown at elevation of 10 msl.

Ownership, Zoning and Surrounding Land Use

The property is owned by the James Campbell Estate and is currently used for open space and cane fields. The site is in the City Zone District designated Agriculture AG-1. Surrounding land use is agriculture and military. The northeast corner of the site is 1,000 feet from the West Loch of Pearl Harbor. Fernandez Village is within one mile of site.

Site Constraints

Physically, the site is restricted in depth of excavation due to shallow groundwater and will therefore require some importation of daily cover material. The relatively flat terrain will also create difficult perimeter drainage conditions and will affect the performance of the leachate collection system.

The site is located within the Pearl Harbor Blast Zone. Use of the site for a landfill would require negotiations with U.S. Department of Defense, who may impose unique conditions related to design, construction, or operation practices. The location of the site within the Pearl Harbor Blast Zone has a beneficial aspect. Home construction is also restricted within the zone, so the zone would provide a natural buffer area for the landfill.

10.5.4.3 Kahe

The Kahe site was identified in the 1979 *Supplement to Inventory of Potential Sanitary and Demolition Landfill Sites* and ranked as eighth. The previously identified site was intended to fill two gulches, the Limaloa Gulch and the Keoneoio Gulch. Based on forthcoming standards that require lining the site, the Limaloa Gulch has been excluded at this time because of steep side slopes in that gulch.

Location

The site is located on approximately 323 acres north of Kahe Point by the Hawaiian Electric Company (HECO) Kahe Power Plant. The proposed site is also within 1000 feet of Waimanalo Gulch Sanitary Landfill.

Site Design

The maximum elevation of the sanitary landfill is shown at 1300 msl. Final slopes of the site are shown at 3:1 and would require benching for site access and stability and erosion considerations. The site would rise approximately 100 to 200 feet above the surrounding terrain. The design shown on the Site Plan on Figure 10-8 has a total waste volume of 45.4 million cubic yards. The area selected is above the current HECO Kahe Power Plant. The landfill would be constructed in the Keoneoio Gulch and extend across a broad slope above the power plant.

The Board of Water Supply has indicated that the Kahe site is in a suitable sanitary landfill location with regard to avoiding groundwater recharge areas.

Ownership, Zoning and Surrounding Land Use

The potential site is partly on property owned by the HECO, which is in a City Zone District designated Industrial I-1. The remainder of the potential site is shown on Agricultural land. Surrounding land uses include the Waimanalo Gulch Sanitary Landfill, the HECO Kahe Power Plant and open space. The site is approximately one mile south of Nanakuli, and some residences and the Kahe Beach Park are approximately one-half mile from the site.

Site Constraints

The sanitary landfill liner and final cover will require special considerations in the design and construction because of the relatively steep slopes at this site. Excavation onsite will likely have to be made in hard rock similar to the adjacent Waimanalo Gulch Sanitary Landfill.

Other conditions that are likely to make this site difficult to construct are the proximity to the ocean and the plans for expansion of the HECO Power Plant. Limited availability of flat ground at the bottom of the site will make it difficult to control sedimentation and construct leachate containment facilities.

10.5.4.4 Maili

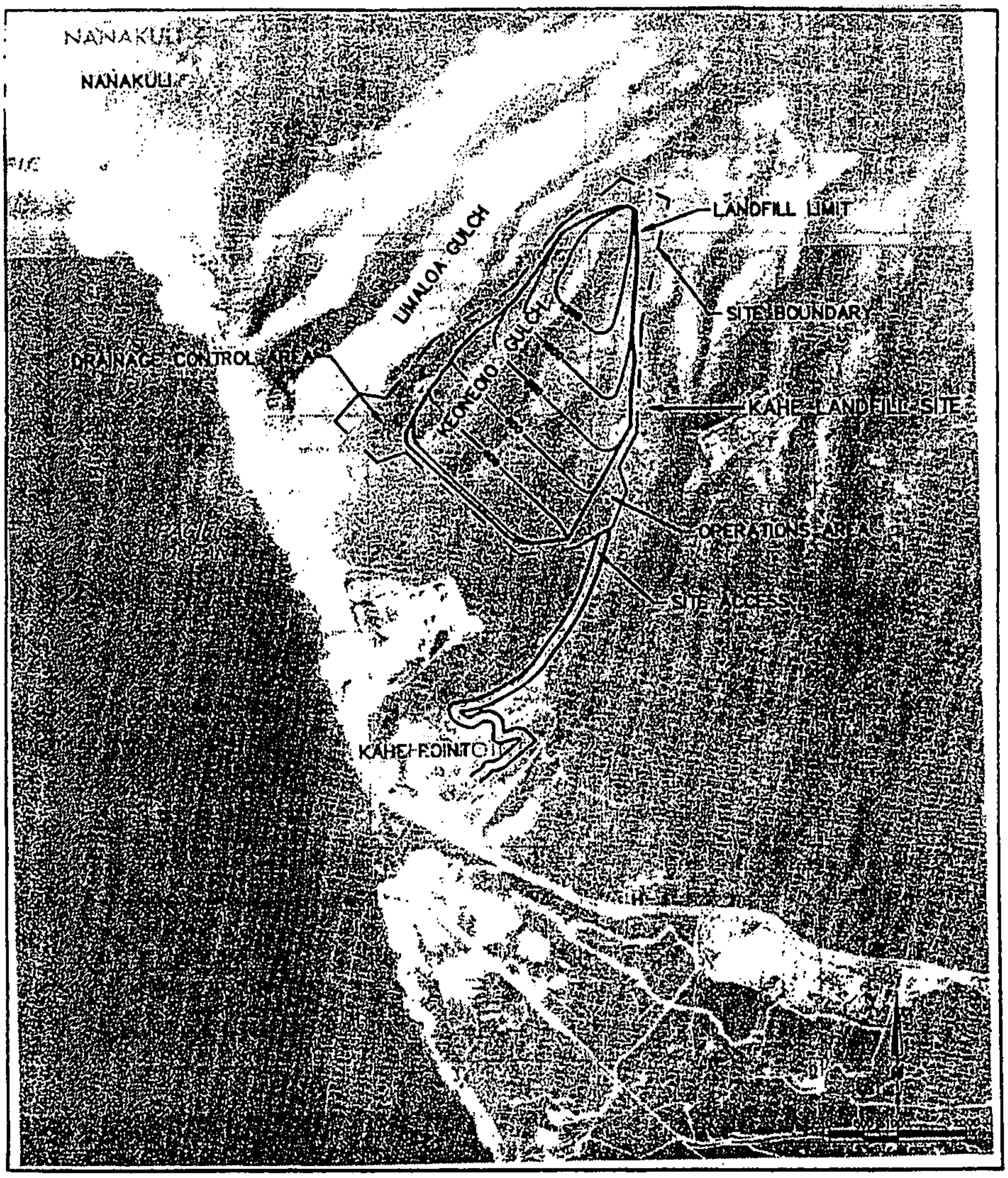
The Maili site was originally identified in the 1977 *Inventory of Potential Sanitary and Demolition Landfill Sites on the Island of Oahu.* The site was rejected in the 1979 supplemental study because it was committed to limestone quarry operations. The site is now added for reconsideration because the need for its use as a landfill may not occur until after complete production of the quarry.

Location

The site is located near the community of Maili, approximately one-half mile inland from the Farrington Highway.

Site Design

The maximum elevation of the sanitary landfill is shown at 120 msl. Final side slopes around the perimeter of the site are shown at 5:1 and should not require any special preparation or erosion control measures. The top of the fill is designed with 3% slopes that drain toward the perimeter from a central high point. The Site Map shown on Figure 10-9 uses a combination



CITY AND COUNTY OF HONOLULU
INTEGRATED SOLID WASTE MANAGEMENT PLAN
KAHE SITE PLAN

FIGURE
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CITY AND COUNTY OF HONOLULU
INTEGRATED SOLID WASTE MANAGEMENT PLAN

MAILI SITE PLAN

FIGURE 10-9

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area fill and trench method. The design has a total waste volume of 14.1 million cubic yards.

The liner basin is designed with 10:1 (horizontal to vertical) side slopes. The liner bottom will require careful grading to create positive drainage over the entire basin. The low point of the liner subgrade is shown at elevation of 10 msl.

Ownership, Zoning, and Surrounding Land Use

The site is owned by the Kaiser Cement & Gypsum Corporation. The City Zone District is Agriculture AG-1. Adjacent land uses include agriculture, military and residential.

Site Constraints

The urban area of Maili is within about 1,000 feet of the potential sanitary landfill site and includes residences, businesses, schools and parks. Some homes are within about 200 feet of the property boundary.

Refuse haulers will pass through the communities of Nanakuli and Maili to access the site. Refuse truck traffic would be using the road the existing quarry trucks now use.

10.6 COMBUSTION

There are six incinerators on Oahu; three of which are currently in use. The H-POWER and Waipahu facilities accept MSW from commercial customers and City residential routes. The incinerator at the Queens Hospital accepts medical waste from that hospital and from other medical facilities. There is a small medical incinerator at Castle Hospital. Two sewage sludge incinerators are being reopened as this Plan is being prepared. In total, incineration provides disposal capacity for about half the waste generated on the island.

There are two general types of facilities that burn MSW: refuse derived fuel (RDF) and mass burn. RDF is fuel that has had non-combustible and some recyclable materials removed. The remainder is reduced in size to particles no greater than six inches. The H-POWER facility is an RDF plant. A mass burn facility removes oversize non-combustible materials and may have some waste separation capability, but generally burns the MSW without processing. The Waipahu Incinerator is a mass burn facility.

The discussions in this section are limited to review of the H-POWER and Waipahu facilities. These facilities handle MSW, which is the focus of this Plan.

10.6.1 Applicable Air Emissions Regulations for Existing Municipal Waste Combustors

The following discussion summarizes the present and pending federal air emissions requirements for existing municipal waste combustors in the United States. The Clean Air Act regulates emissions from new, modified, or reconstructed municipal waste combustors. The New Source

Performance Standards (NSPS) applies to any unit having a capacity greater than 250 tons per day for which construction, modification or reconstruction commenced on or after December 20, 1989. The other, Emission Guideline Standards, is to control the emissions from existing municipal waste combustors. The Emission Guideline is the focus of this discussion. The regulations became effective with their publication in the Federal Register on February 11, 1991.

States were required to adopt and submit to the EPA a plan to implement and enforce the Subpart Ca guidelines by February 11, 1992. On April 27, 1992, a Conference Committee of the State Legislature approved House Bill No. 3838, which added a new chapter relating to air pollution control to state law. The purpose of the bill is to enable the Department of Health to meet the requirements of the Federal Clean Air Act Amendments of 1990.

The Hawaii Department of Health is responsible for preparing the State's plan and has not completed its preparation as of September 1, 1992. The plan is expected to conform to the Emission Guideline Standards. If the Department of Health does not submit an approved plan within the required period, the EPA has authority to implement and enforce its own plan. The EPA is required to act within two years after the Emission Guideline promulgation date, or by February 11, 1993. Such a plan is to assure compliance with the Emission Guideline Standards by February 11, 1996.

The NSPS and Emission Guideline Standards are to require new and existing municipal waste combustor units to control emissions to a level achievable by applying the best demonstrated technology (BDT) considering costs, non-air-quality health and environmental impacts, and energy requirements. The emission levels specified in the Emission Guideline Standards are based on the conclusion that BDT for existing MSW combustors is different for *very large* and *large* facilities. *Very large* plants have an aggregate capacity to burn more than 1,100 tons per day. A *large* plant has the aggregate capacity to burn between 250 tpd and 1,100 tpd. The Waipahu Incinerator is classified as a *large* plant and H-POWER is classified as a *very large* plant. The Emission Guideline Standards require compliance within 36 months of the effective date of State emissions standards. The period of compliance is presently unclear if a State has not submitted a plan to the EPA. In any event, compliance must be achieved not later than February 11, 1996.

10.6.2 Pending Revisions

Section 129 of the Clean Air Act Amendments of 1990 directs that both the NSPS and Emission Guideline Standards be broadened so that they are fully consistent with Section 129 within one year of its publication. Specific numerical emission limits that are described in Section 129 for toxic metals, mercury, cadmium, and lead must be added. Siting requirements for new municipal waste combustors and nitrogen oxides emission standards for existing municipal waste combustors are also to be addressed.

10.6.3 Municipal Waste Combustion Residue

Section 306 of the Clean Air Act Amendments of 1990 regulates the management and disposal of residue from MSW combustors. Under Section 306 MSW combustor ash would not be regulated as a hazardous waste pursuant to RCRA Subtitle C for two years after the date of enactment. MSW combustor ash would not be regulated as a hazardous waste under 40CFR261, Subpart D, since it is not listed therein. The residue from units burning MSW includes fly and/or bottom ash. During the two-year moratorium, however, MSW combustor residue would be subject to:

1) Regulations governing the disposal of solid waste under 40CFR257.

2) Applicable State regulations governing solid waste disposal.

3) Any applicable State regulations governing MSW combustion residue disposal or utilization/reuse.

Congress may resolve this issue when re-authorization of the Resource Conservation and Recovery Act is considered again. In the interim, the EPA Administrator has issued a letter finding that MSW combustion ash is not a regulated waste under Subtitle C and can be disposed in landfills designated for MSW.

The State Department of Health is presently developing new solid waste landfill regulations, which may specifically address MSW combustor residue, and will file for EPA approval of this program under the Federal Subtitle D landfill regulation, as previously discussed.

10.7 WAIPAHU INCINERATOR

10.7.1 General

The Waipahu Incinerator is a mass burn facility located near the Farrington Highway off-ramp of the H-1 Freeway. The 600 tpd facility is owned and operated by the City and has been operational since October 1970. It has two combustion units that are operating continuously for the five and one-half days per week the facility is open. The facility is shut down for maintenance on Saturday afternoons and Sundays. This facility incinerates but does not generate steam or power. There is no separation of waste materials (other than non-permitted waste) before combustion.

The Waipahu Incinerator currently is taking waste from the airplanes and ships that visit Oahu. Such material is defined as "foreign waste" by federal regulations, which require the waste to be handled to avoid contact with plants or animals. Since the Waipahu Incinerator is a mass burn facility, the foreign waste can be disposed directly in the furnace feed chute.

The facility also combusts residential and some commercial waste materials. During 1991 it handled 56,000 tons of waste, of which about 10,000 tons was foreign waste. When operating at its 600 tpd design capacity, this facility has processed as much as 134,000 tons of waste per year.

The incinerator is currently being evaluated to decide the economic feasibility of upgrading the emissions control equipment to comply with new regulations. The results of that evaluation are anticipated to be available during 1993. The City should then decide whether to continue operating the incinerator with the upgraded control equipment or dispose of the waste handled by this facility in other ways.

10.7.2 Process Description

The waste receiving building has a tipping floor for trucks to discharge collected waste into a 1,200-ton storage pit (equivalent to 2 storage days at facility design capacity). Two 5.5-ton overhead traveling bridge cranes, each with a 3-cubic-yard, mechanically-operated, clamshell bucket, charge solid waste to the two furnaces. Refuse trucks are weighed by a 60-ton, 60-foot-long platform scale.

Each incinerator includes a charging hopper and chute, a refractory-lined furnace with three traveling grate stokers, auxiliary fuel burners, under-fire combustion air, wall cooling air systems, and a refractory-lined fly ash chamber. A series of wetted baffles and arches and a three-field electrostatic precipitator remove particulate matter from the combustion air. The cleaned gases are drawn by an induced draft fan through a 90-foot-high, refractory-lined stack, which exhausts to the atmosphere.

A drag conveyor in a water-filled concrete trough, parallel and underneath each incinerator, collects, dewaters, and discharges the combustion residue into a dump truck for transport to the Waimanalo Gulch Sanitary Landfill. Oversized bulky waste separated at the charging level is hauled to the same landfill.

Future improvements at the incinerator include plans to computerize the scale operation.

10.7.3 Regulatory Statutes

The Waipahu Incinerator has been subject to several Hawaii State regulatory activities, most of which have resulted from modifications to the facility or maintenance-related reconstructions. However, none of these activities have been sufficient to subject the facility to the revisions to the NSPS regulations as a modified or reconstructed facility.

While exempt from the federal NSPS requirements, the Waipahu Incinerator has been subject to the State Administrative Rules, Title 11, Chapter 60. These regulations provide incinerator emission limits for particulate matter and opacity. The facility currently operates under a Permit to Operate issued by the Department of Health. This permit contains the following special conditions:

- The facility must be operated with the wet-wall scrubbers and electrostatic precipitators.

- An annual performance test must be conducted to decide the mass rate of discharge of sulfur dioxide (SO_2) and particulate matter from each unit.

- An annual emissions report must be submitted for each unit.

On August 9, 1990, the facility was issued an Authority To Construct for extensive repairs to the furnaces and replacement of the electrostatic precipitators. The Department of Health has approved two extensions to the Authority to Construct Permit, which included the following conditions:

- Compliance with any new federal emission guidelines for municipal waste combustors when completed.

- Compliance with a more stringent opacity limitation than under the existing operating permit.

- If it is determined that the visible emissions are over the applicable standard, the Department of Health may require the installation, operation, and maintenance of a transmissometer system for the continuous measurement and recording of stack opacity emissions.

- A source test for SO_2 and particulate matter must be completed within 60 days after achieving the maximum production rate for the facility, but not later than 180 days after start-up.

While the Department of Health does not currently require the City to test the combustion residue from the Waipahu Incinerator, the City does test the ash.

10.7.4 Upgrade of Air Emissions Control

The Waipahu Incinerator will be subjected to the Subpart Ca Emission Guideline Standards for municipal waste combustors under the Clean Air Act Amendments of 1990. The Refuse Division has retained a consultant to prepare a study to assess the impacts of these regulations on the Waipahu Incinerator. Phase I of the study completed as a draft report in April 1992, addressed the applicability of the Clean Air Act Amendments to the facility. Phase II of the study is to be completed in 1993 and will address the adequacy of existing data to characterize the air emissions from the facility and the impact of the new regulations on operation of the facility. The results of the study should be used to analyze the City's options for the Waipahu Incinerator.

10.8 H-POWER

10.8.1 General

The H-POWER facility is located in the Campbell Industrial Park and is operated by Honolulu Resource Recovery Venture. It has been operational since May 22, 1990. The City has a 20-year contract with the facility operator to provide 561,600 tons of processible MSW per year. Hawaiian Electric has a contract with the facility operator to purchase the net electrical output of the facility.

In 1991 the facility accepted 602,418 tons of waste and burned a total of about 396,201 tons. The remainder was recycled materials, non-combustibles, and bypassed material. Combustion of that refuse produced 320,038,000 megawatt-hours of power for sale. The plant had an availability of about 83 percent, including allowance for time it was not operational due to either scheduled or unscheduled maintenance. A total of 175,980 tons of bottom and fly ash and RDF process residue were disposed of in 1991 in the Waimanalo Gulch Sanitary Landfill, along with the materials that were removed from the waste before preparation of the fuel and the materials that were bypassed when the facility was down for maintenance in February 1991.

The H-POWER facility consists of two 100-ton per hour waste processing lines and two combustion trains. The waste processing capacity of the facility is 2,016 tpd. It produces about 45 megawatts of electrical energy for sale.

10.8.2 Process Description

The facility is divided into two basic sections:

(1) solid waste processing; and
(2) power generation.

The processing section receives solid waste from collection and transfer vehicles and produces RDF. The power block section uses the RDF to produce steam from two 242,700-pound per hour boilers, which in turn drive a single turbine generator to generate electricity that is the facility's sole energy product.

The solid waste processing section consists of an automated weigh station, receiving, processing, and RDF storage buildings. The automated weigh station consists of two, 60-ton platform scales (one inbound and one outbound) with a scale house. The receiving building encloses flail mills for coarse size reduction; rotating magnetic drum for separation of ferrous metal; two stages of rotating trommel screening to remove fine, non-combustibles; and shredders for finer size reduction (less than 6 inches in length) of primary trommel overflow.

The RDF storage building has a large enclosed floor with a capacity of 3,000 tons (which is equal to two days of RDF firing capacity) and an elevating transport conveyor leading to the power generator section.

The power generation section includes RDF metering bins and air swept vibrating feeders; two tangentially fired 36-ton per hour traveling grate boilers producing superheated steam; combustion residue drag flight conveyors for quenching dry fly ash; semi-dry acid gas absorbers for acid gas removal; a five-field electrostatic precipitator for particulate removal; and a three-flue (one for future use) stack exhausting to the atmosphere. In addition, the turbine-generator, condenser, and cooling tower comprise the balance of the power generation section.

The site has sufficient space to add a third processing unit.

10.8.3 Overview of Project Agreements

The H-POWER project included the following contractual agreements:

- Contract for Design, Construction, Testing of a Solid Waste Disposal and Resource Recovery Facility between the City and County of Honolulu and Honolulu Resource Recovery Venture;
- Contract for Waste Processing and Disposal Services (Service Contract) between the City and Honolulu Resource Recovery Venture;
- Purchase Power Contract (Energy Contract) between the City and the Hawaiian Electric Company;
- Landfill Agreement between the City and Waste Management, Inc.; and
- Various transacting documents that define the arrangements under which the City approved the facility to be financed by Ford Motor Credit Corporation.

Honolulu Resource Recovery Venture, an affiliate of ABB Resource Recovery Systems, operates and maintains H-POWER under the Service Contract with the City.

This contract obligates the City to deliver, or cause to be delivered by private haulers and by City transfer trucks, a minimum of 561,600 tons of combustible solid waste per year to H-POWER unless unavailable due to force majeure; provide a landfill for disposal of bypassed waste and residues; adjust the fees paid to Honolulu Resource Recovery Venture to compensate for certain changes in H-POWER; and continue payment to Honolulu Resource Recovery Venture in the event of a shutdown or non-compliance due to force majeure. The City will likely continue to pay an established fee in the event that less tonnage is received than guaranteed. In addition, the City has the responsibility to deliver or cause to be delivered any solid waste in excess of the guaranteed waste supply (provided a more economical disposal alternative is not available).

The Purchase Power Contract between the City and Hawaiian Electric Company specifies the terms and conditions for the purchase and sale of electrical capacity and the net energy to the utility's system.

10.8.4 Process Modifications

10.8.4.1 Ferrous Metal Separation from Incoming Waste

Honolulu Resource Recovery Venture is selling ferrous, aluminum, and mixed non-ferrous metal recovered from the incoming waste. Until recently, the recovered metals had a high level of contamination, and sale of the material on the local markets did not provide sufficient revenue to support the recovery operation. As a result, the metal had been disposed of at Waimanalo Gulch Sanitary Landfill. Improvements to the recovery equipment became operational during the third quarter of 1992. By achieving a higher recovered-material quality, Honolulu Resource Recovery Venture can now sell the recovered metals. The company estimates that an additional 18,000 tons of ferrous metal will be diverted from the waste stream annually because of this program.

10.8.4.2 Metals Recovery from the Ash

During mid-1992, the Honolulu Resource Recovery Venture conducted a full-scale demonstration test for recovery of metals from ash. The combustion residue passes through a vibrating screen to remove large ferrous metal, a magnetic separator to remove smaller ferrous metal, and eddy current separation to remove mixed non-ferrous metals (aluminum, brass, and copper). Honolulu Resource Recovery Venture predicts an additional 10,000 tons per year of metal can be diverted from the waste stream with this system.

10.8.5 Air Emissions

10.8.5.1 Continuous Emissions Monitoring System

Under its air permit, the air emissions from the units at H-POWER are to be tested continuously for NO_X and CO_2. In addition, emissions are tested annually for a variety of gaseous pollutants and heavy metals. On May 11-14, 1992, Clean Air Engineering performed the air emission tests, and the results indicated full compliance with the permit requirements.

10.8.6 Combustion Residue

Under its solid waste management permit, Honolulu Resource Recovery Venture is required to analyze combustion residue samples quarterly. To date, testing of the combustion residue has indicated compliance with the EPA standards.

The City and ABB are investigating the following combustion residue reuse:

1. Pelletization and use as road base or fill material.
2. Use as an additive in concrete.
3. Use as an aggregate in asphaltic concrete for road clays.
4. Use as an additive to stabilize clay soil.
5. Use as a daily landfill covering in a mixture with dewatered sewage sludge.

Recently, Honolulu Resource Recovery Venture has suggested that the City investigate reuse of the fly ash and bottom ash fractions. Use of fly ash in cement manufacturing is a favorable option. Use of bottom ash as an aggregate in road paving or mixed with wastewater sludge as landfill cover appear to offer the highest potential based on the limited test results available.

10.9 EXPANSION OF COMBUSTION CAPACITY

10.9.1 Waipahu Incinerator

There is a study in progress that should provide the City with information concerning the control of air emissions from the Waipahu Incinerator. If the incinerator is found not to meet Federal emission standards, then the City must decide whether to add more control equipment or find an alternate means of disposing of the material that is currently incinerated there.

10.9.2 H-POWER

This facility is currently operating at design capacity. With the diversion programs implemented to achieve the State's goals, the City will continue to be able to provide sufficient waste to satisfy the 561,600 tpy contractual requirement, except for one year at the end of the planning period. However, if the waste diversion goals are not achieved, maximizing waste disposal in the H-POWER facility will be essential to extending landfill life.

H-POWER could be expanded to accommodate additional waste from other islands that need the additional disposal capacity. The addition of a third unit should be considered if the waste diversion programs do not achieve the waste diversion goals.

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APPENDIX F

Evaluation of Selected Technology Alternatives to Landfill Disposal

City and County of Honolulu
Environmental Services Department

Evaluation of Selected Technology Alternatives to Landfill Disposal

September 2001

Report prepared by
Pacific Waste Consulting Group

Pacific Waste
CONSULTING GROUP

Evaluation of Selected Technology Alternatives

To Landfill Disposal

September 2001

Prepared for

The City and County of Honolulu

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Executive Summary

This report summarizes the evaluation of alternative technologies to process the waste material disposed at the Waimanalo Gulch Landfill. The landfill receives 800 TPD (tons per day) of MSW (municipal solid waste), 600 TPD of ash from H-POWER, and 30 TPD of sewage sludge.

The Review Team anticipated that the City would use the recommendations in this report to determine a course of action to address the alternatives to landfill disposal that are technically and economically feasible and do not subject the City (City & County of Honolulu) to financial risk. The Review Team acknowledges that a landfill will be required for the foreseeable future.

The most important criterion that a process must meet to make the technical and economic risk potentially acceptable to the City is:

The process must have been used with MSW as a feedstock operating at a reasonable capacity for the amount of waste proposed. The process must be financeable.

None of the three processes evaluated in this report meet this test. None of them have any plants in any size that process MSW and the financeability of anything but a demonstration project is questionable.

A Review Team consisting of City staff and a consultant evaluated the processes. Meetings were held at the offices of the vendors that would supply the plasma arc technologies, with financial representatives of one of the plasma arc proposers, and with representatives of the companies proposing.

The three proposals that were evaluated were:

1. A proposal by Waste to Energy delivered to Mayor Jeremy Harris July 3, 2001. They proposed the use of a plasma arc system provided by SUI (Scientific Utilization, Inc.). They proposed processing the solid waste and sludge being taken to the Waimanalo Gulch Landfill.

2. A proposal dated September 7, 2001, from Hawaii Medical Vitrification (whose parent firm is Asia Pacific Environmental Technologies, Inc.). They would use the plasma arc system provided by IET (International Environmental Technologies LLC) in operation at their facility. They suggested a demonstration with 10 tons of H-POWER ash and 10 tons of MSW. They recommend proceeding to larger size units after successfully testing the waste processing on the smaller unit.

3. A proposal by Hydromex that was delivered to City staff on August 24, 2001. They have proposed paying for a full size test plant in Campbell Industrial Park to process 100 tons

per day of H-POWER ash and auto fluff (the waste from shredding automobiles at Hawaii Metal Recovery). If the plant operates as Hydromex expects, they would transfer its ownership to the City.

Each of the three proposals was evaluated considering the evaluation criteria and the fundamental requirement shown earlier.

None of the processes achieved this fundamental requirement.

The flaws in three proposals are summarized below. The comments reflect the nature of the proposals. Waste to Energy made a proposal that the City invest $275,000,000 in an unproven process. APET proposed demonstrating its process using its existing plant in Campbell Industrial Park. Hydromex proposed that they would invest the funds needed to construct a demonstration project on land provided by the City.

WASTE TO ENERGY

Financability - The plant must be municipally financed, as taxable financing is not available at any price. The support for the municipal financing is a Performance Bond. Waste to Energy has not provided information showing the Performance Bond is available. Waste to Energy's investment banker has stated that the plant could not be financed without a Performance Bond. The availability of a Performance Bond must be demonstrated.

Operational History – There is no operational experience on any size MSW project for any period with the Waste to Energy process.

Operator's Experience – Waste to Energy proposes to operate the plant itself. The company has not demonstrated any experience operating any solid waste management facility.

Energy Production – The energy production from the process to be used by Waste to Energy is claimed to be very high. No support has been provided for the claim. The amount of energy that is sold from the plant is the largest of the three sources of revenue to the plant. Without demonstration of the energy production, the revenue to the plant cannot be evaluated.

Sale of Material Produced – The plant will produce a glass material, a market for which has been claimed, but not demonstrated. The sale of glass is an important source of revenue to the plant and must be demonstrated.

HMV

Proposal Details – HMV did not include details of the cost of the demonstration project, the City's responsibilities, or the schedule. These details are needed.

HYDROMEX

Lease – The lease document provided with the proposal needs to be updated to reflect the current project.

Product Sales – The letter relating to product sales needs to be updated.

Disposal Fee – The project proforma needs to be updated to reflect the fee for disposal of the H-POWER ash.

Two of the proposals are for no-cost demonstrations of the technology for a portion of the waste stream. The proposal submitted by Waste to Energy could be reformatted into a similar demonstration project. The City may wish to consider demonstration projects, as they would provide data on the waste stream and the disposal process for evaluation and comparison before using the technologies further.

IN SUMMARY:

- The time required to finance a full-scale process and the time to permit it will extend well beyond the deadline for re-permitting the Waimanalo Gulch Landfill for the expansion. None of these processes should be considered a replacement for the landfill, AT THIS TIME.
- The City should consider establishing an Alternative Technology Demonstration Park near to H–POWER for alternative technologies.
- The City should consider public/private partnerships to facilitate demonstration projects.
- The City should consider starting with small demonstration projects, such as the four TPD HMV facility, and, if they are successful, consider expanding to larger 10 or 50 TPD projects before considering unproven technologies.

1 Introduction

This report summarizes the evaluation of technology alternatives to landfill disposal of MSW (municipal solid waste). The evaluation conducted was an extension of the City's (City & County of Honolulu) review of alternative technologies that was reported in a document titled *New Systems Research for Refuse Disposal* dated April 2000. This report expands on one of the recommendations from the earlier report. That report suggested further consideration be given to the plasma arc process for waste conversion, metal recycling equipment, and drywall recycling equipment. Both of the drywall and metal technologies have been used before and can be considered without further evaluation.

This report includes a section describing the scope of the evaluation, a description of the evaluation criteria, a summary of the meetings with the process vendors, and the conclusions of the review.

1.1 Responsibility for Recommendations

This report was prepared with the input of all of the members of the Review Team. The contributions of the Review Team members were critical to getting the data needed for the evaluations and providing the process vendors and proposers with a broad range of questions and concerns to address.

The report was reviewed by the staff of the City's Refuse Division and by others in the City. Their overall direction and comments are reflected throughout the report.

While direction was provided by the City staff, the observations and conclusions are the author's and reflect the author's opinion and judgment, independent of the City staff's opinions, regarding the current viability of the processes evaluated.

1.2 The Proposals

The City has received the following three proposals to use alternative technologies for all or a portion of the waste going to the Waimanalo Gulch Landfill.

1. A proposal to Mayor Jeremy Harris delivered on July 3, 2001, by Waste to Energy. They proposed the use of a plasma arc system provided by SUI (Scientific Utilization, Inc.).

2. A proposal made verbally at a meeting on August 28, 2001, by APET (Asia Pacific Environmental Technologies) to use the plasma arc system provided by IET (International Environmental Technologies LLC). They currently have a plant operating in Campbell Industrial Park to process medical waste and suggested a test with 100 tons of H-POWER ash over one week.

3. A proposal by Hydromex that was delivered to City staff on August 24, 2001, that uses a proprietary chemical to mix with the ash to form building materials. They have proposed constructing a full size test plant in Campbell Industrial Park to process 100 TPD of H-POWER ash.

It is anticipated that the City would use the recommendations in this report to determine a course of action to address the alternatives to landfill disposal that are technically and economically feasible without subjecting the City to financial risk. The City may also consider a process if the proponent is able to demonstrate it on one or more test segments of the waste stream at low or no cost to the City and with no risk to the City.

1.3 Process Evaluations

This report was prepared to evaluate the claims made by the three proposers using information they provided, supplemented by information gathered from visits to the plasma arc process vendors. The visits to vendor sites occurred on:

1. August 2 and 3, 2001, to the financial team for Waste to Energy in Atlanta, Georgia, and to SUI in Huntsville, Alabama.

2. August 13, 2001, to the offices of IET located in Richland, Washington.

3. August 28, 2001, at the HMV (Hawaii Medical Vitrification) facility owned by APET. While this visit was not to a vendor's site, it was to an operational facility that uses the plasma arc process.

Each of the plasma arc process vendors and the financial people were given a list of questions relating to the process or the proposals that the City received. The questions provided to SUI regarding the Waste to Energy proposal are in Appendix A. The questions provided to IET are in Appendix B. The IET questions were not the same as for SUI because they did not have the financial aspects included as SUI did. Some of the IET questions were provided to the Hydromex representative. Those questions are in Appendix C.

The City sent each of the plasma arc vendors a letter confirming the time of the visit. The letter included the following comment regarding the purpose of the trip:

> Gather facts and observations that would enable the officials in the City & County of Honolulu to determine if the plasma arc process was far enough along in its development to offer an opportunity to treat the waste being taken to the Waimanalo Gulch Landfill. One test to be applied is whether the process was used on MSW, the existence of at least one plant in the size range needed for this waste stream, and how long the plant(s) had been operating.

1.4 The Review Team

Each of the proposers and vendors was interviewed by a Review Team that included Tim Houghton, Executive Assistant in the City's Department of Environmental Services, and Mark White an employee of PWCG (Pacific Waste Consulting Group), the firm that prepared this evaluation. The meetings held by the Review Team and the members of the Team that participated were:

1. August 2, 2001, the Review Team, including Malcolm Tom, Deputy to the Managing Director of the City met with the staff of SAMCO, a member of the financial team for Waste to Energy.

2. August 3, 2001, the Review Team, including Malcolm Tom, met with the staff of SUI and toured their facility.

3. August 13, 2001, the Review Team, met with the staff of IET, and toured an operating plant that uses their process for mixtures of hazardous and radioactive wastes.

4. August 24, 2001, the Review Team met with The Environmental Group, which represents Hydromex.

5. August 28, 2001, the Review Team, including Colin Jones, Energy Recovery Administrator at H-POWER, met with representatives of APET, and toured their HMV plant. They have verbally proposed to process some H-POWER ash.

6. August 30, 2001, the Review Team, met with the staff of Waste to Energy to ask some questions about their proposal and to review some of the information gathered at the August 4, 2001, meeting.

1.5 Existing Conditions

The City is in process of seeking permission to expand its Waimanalo Gulch Landfill. As part of that process, the City prepared a Supplemental EIS (Environmental Impact Statement) that summarized its earlier evaluation of technologies that could be alternatives to landfilling. Some of the public has requested that the City expand that evaluation. This report summarizes the expanded evaluation.

This evaluation is only the first step in what may be a long-term process. The time provided to make this evaluation is limited by the schedule for the EIS. Further consideration of any of these processes will depend on exhaustive evaluation of the technical and economic factors related to the cost for disposal, environmental considerations, and changes needed to the waste management system. In addition, City and State procurement requirements will need to be considered. The environmental and land use permits will add to the time needed to implement a new technology. The permitting process alone would require 12 to 24 months after the technology is selected. The procurement process for selecting a new technology on the scale that Waste to Energy is proposing would require at least 24 months, assuming all time lines were met.

One must acknowledge that the time required to install a new process to replace landfill disposal will extend well beyond the time that the landfill expansion must be operational. As a result, it is clear that a new technology to eliminate the need for a landfill will not be available until some time in the future, even assuming one or more processes met the evaluation criteria. None of the processes met the evaluation criteria.

1.6 Prior Evaluation

The *New Systems Research for Refuse Disposal* report evaluated over 50 different methods of managing the waste. The evaluation compared the technologies to the following criteria:

The report authors reduced the 50 technologies to seven by comparing each to the evaluation criteria. The seven short-listed technologies, as identified in the earlier report, were:

- Plasma Oxidation/Vitrification followed by Conversion of Heat to Electricity in a Boiler.
- Plasma Gasification/Vitrification. This technology has two alternatives with different energy recovery options: production of a synthetic gas and conversion to electricity in a turbine generator or conversion of the synthetic gas to methanol.
- Rotary Kiln Gasification/Slagging followed by Methanol Recovery.
- Low–Temperature Pyrolysis followed by Oil Recovery.
- Conversion of Wood and Plastic Waste to ECO–Lumber.
- Metals Recovery.
- Gypsum Recycling.

These seven technologies were further evaluated and reduced to the following three:

- Plasma Gasification/Vitrification Followed by Converting Syngas to Electricity.
- Metals Recovery.
- Gypsum Recovery.

Two of the processes reviewed for this report (SUI and IET) use plasma arc and vitrification. The third (Hydromex) was not included in the New Systems Research effort. It uses a chemical to bind the waste material and produce a building material. Metal recovery and gypsum recycling were not reviewed, as they are already being used. In addition, they would address only 7.0 percent of the waste (gypsum process) or 12.3 percent (metals recovery).

1.7 Material to be Processed

The City currently has a waste-to-energy plant, the H-POWER facility, which processes 2,000 TPD. H-POWER accepts residential refuse collected by the City and some commercial waste. From a fuel perspective, the material accepted at H-POWER is the best available. The waste materials delivered to the Waimanalo Gulch Landfill is the ash from H-POWER and other noncombustible waste from commercial collection and the convenience centers. It is not expected to have the heating value that the fuel accepted at H-POWER does. The City does not have an evaluation of the chemical makeup of the waste being accepted at the Waimanalo Gulch Landfill, but does have an evaluation of the types of waste materials that are disposed. The approximate composition of the waste material is shown in the table in Appendix D, titled *Composition of the Waste Disposed at the Waimanalo Gulch Landfill.*

1.8 Limitations on Information Included in this Evaluation

Proposals have been submitted to the City at different times over the last year. In some cases, the proposer has significantly modified them. The data gathering for this evaluation was started on August 1, 2001, and completed on September7, 2001. This report is based on the data gathered during this time.

There will probably be statements made in this evaluation that do not reflect the most current information available to the proponent. This situation is unfortunate, but the report cannot be completed if new information is continually included in it.

1.9 Usage to Process MSW

One of the best ways to understand the technical and financial risk of a process is to evaluate operating projects that use the process to manage MSW. It is also important to have a project that is in the size range needed for Honolulu. While it is important to demonstrate the process at small scale, there can be unforeseen problems in processing waste at full scale. Significant technical and financial risk exists if a process is used that is not proven on the waste stream in question.

The duration that a process has been used on MSW can also be important. When refuse derived fuel processes were first used, many of the problems did not become apparent until after the first year of operation. In some cases, the problems were so severe that the process was abandoned, leaving the jurisdiction unable to recover the cost of the project.

2 Evaluation Criteria

The general criteria to be used to evaluate the processes were provided to each firm that the Review Team met with.

1. The alternative technology must have significantly fewer and/or less severe environmental impacts than the current disposal methods.

2. Costs must be comparable to the existing system, although some additional expense may be justified for a particularly beneficial technology.

3. The technology must be feasible on the scale required by the City for disposal of municipal solid waste and ash. A table listing the approximate type and quantity of materials landfilled at Waimanalo Gulch Landfill was attached for each firm's information and use. The landfill accepts approximately 800 TPD of municipal solid waste and 600 TPD of ash from the H–POWER waste–to–energy plant; annual intake is about 410,000 tons.

A copy of the table that was provided to the recipient of the letters is in Appendix D. The evaluation criteria were compared to the information provided by the process vendors. In many cases, the data needed were not available or were unproven. In those cases, the report uses the data provided and makes some qualitative comments about it.

A summary of the types of information reviewed for each of the evaluation criteria follows. The results of the evaluation are summarized in Section 7, Summary of Observations.

2.1 Environmental Impacts

The process must have less environmental impact than the existing system. This criterion is evaluated through the permitting that has been done for existing projects and using data provided by the vendor. It considers the air emissions from the project and the leachability of the material produced from the process.

All of the processes evaluated claim to have no or extremely low emissions. However, they have either not been subject to permitting agency review in the size needed for the City or have not processed either MSW or ash. Some of the process vendors claim that the process has no emissions. However, they use the gas produced to generate electricity with a gas turbine, which will have to be permitted. In any case, the permitting agency will need to make a finding regarding the permit requirements, and that finding will take technical information and time.

No data is available on the leachability of the glass since no product has been produced with any of the three processes using MSW or ash. Those tests can take a significant amount of time and can be expensive. The regulatory agency will need to see the results of the tests to confirm that the leachability claim is valid.

2.2 Cost

The cost of the plant to process the Waimanalo Gulch Landfill waste stream must be similar to the current costs. The cost includes the capital cost for the plant and the cost of operating the plant. These cost elements are summarized as a cost per ton to process the waste that can be compared to the current disposal cost.

The vendors all had different approaches to providing the City with a process. One offered to provide a small operating plant for a short-term test of the ash. Another offered to construct and operate a small plant to process some of the ash. The cost of these operations can be evaluated as they proceed.

The other process offered to construct a full-scale plant to process all of the MSW and ash (later modified to include only the MSW). The cost of this plant is less assured, as the vendor has not constructed a plant of the size needed to process such quantities. The proforma provided for this process included critical assumptions about revenue and capital cost that are detailed later in this report. In general, the vendor did not supply sufficient information to justify the assumptions, so the economics of the process cannot be verified. Since no projects have been built using this process on MSW, all of the assumptions related to the technology are open to question.

2.3 Feasibility

The feasibility of the process focuses on the technical and financial risk. The key indicator of feasibility of the process *on the amount and type of material the City has to be processed* is the existence of more than one project continuously operating for a time. The number of projects and period would be specified in a request for proposals for an alternative technology, but, as a point of comparison, the City has required two or more plants operating for more than two years in its search for innovative technologies to process sewage sludge.

None of the processes evaluated have any plants operating on MSW or ash. None have built a plant on any feedstock in the size needed for the City's waste.

3 Scientific Utilization Inc. Process

The meetings with people associated with this process were held on August 2, 3 and 30, 2001. On August 2, the Review Team met with principles of SAMCO, a financial firm that is supporting the proposals made by Waste to Energy. They provided information about the financial aspects of the proposal. On August 3, the Review Team met with staff of SUI, which would provide the technology. On August 30, the Review Team met with principals of Waste to Energy to discuss their proposal. The Waste to Energy proposal would use the SUI process.

3.1 Process Description

The technology they would propose for Honolulu is an AC plasma arc with a molten glass bed. The waste would be injected into the molten bed with a feeder and injection mechanism. The waste would be gasified in the molten bed, which would minimize particulates. The noncombustible material will be entrained in the glass slag to be removed from the process chamber. The gasses will pass through the plasma arc located above the molten bed, and will be dissociated to form the clean synthetic gas. The synthetic gas will be used in a gas turbine powered generator. The waste heat from the process and the heat from the turbine will be used to heat water for a steam generator.

SUI has built and tested the plasma arc on contraband material from the US Customs Service. That material includes drugs and is packaged in grease, oil, coffee, tape, and other materials. The system grinds the waste so that it will pass a 150- to 200-mesh screen and destroys it without any ash. The unit was designed to process 15 tons per day. According to Mr. Bucher, the change in administration in January 2001 resulted in the Customs Service not accepting the unit and has since been sold to an entity in Switzerland for use in Taiwan processing contraband there. At the time of our meeting, it was being shipped to Taiwan. They expect it will be modified to produce synthetic gas rather than having complete destruction of the contraband material. The synthetic gas is expected to have 250 to 500 BTUs per cubic foot. That unit has not been operated to recover energy, so the company has no operational experience recovering energy in a full-scale unit.

IET has tested the plasma arc on a number of waste streams, including "simulated MSW." The SUI representative commented that the test of simulated MSW was done at Georgia Tech and involved selected sources of mixed MSW (generally from a residential waste stream), not selected waste materials (such as only paper and plastic).

They are working on the process controls now. The controls are essential to maximize the synthetic gas formation. They need to control for changes in the BTU content of the fuel. The controls adjust for variations in feed by modifying the flow of working fluid for the plasma arc, the fuel feed rate, and other parameters as needed. The control system is one of the key components of the process.

They are also developing the apparatus for inserting the fuel into the molten bed and an apparatus for stirring the molten bed. These elements are key to controlling the process.

3.2 Meeting Summaries

This section summarizes a meeting held with the vendor of the SUI process and members of a financial firm that is working with a proponent of the process that is located in Honolulu.

These three meetings were to discuss technical and financial questions about recent proposals from Waste to Energy and to identify the current proposal. This summary includes the discussions with each of the three companies in separate sections, followed by comments on the Waste to Energy proposal to the City.

3.2.1 Meeting with SAMCO

This meeting was held on August 2, 2001, at the SAMCO offices in Atlanta, Georgia. The participants were Patricia Newman and Diane Harmon of SAMCO, Ken Burns of New South Capital (he noted that he was the financial advisor for Waste to Energy), John Theberge of Holland & Knight, a Washington DC law firm (which would be a special tax counsel for SAMCO and participated by telephone), and the Review Team. We have been advised by Waste to Energy that Ken Burns no longer is associated with the project.

The three ways the project could be municipally financed

1. Government bonds where the City would issue the bonds but the ownership could be either with the City or with a separate "governmental instrumentality." The use of a separate governmental instrumentality would insulate the City from operational costs/liabilities of ownership of the facility. The bonds could be solely secured by the revenues of the project so there would be no tax reason why the City would have ultimate responsibility to repay the bonds. The City, or the "governmental instrumentality," could hire SUI or some other entity to manage the facility through a qualified management contract. The duration/terms of qualified management contracts are somewhat limiting, but many financings are done each year using qualified management contracts. Since a qualified management contract is somewhat inflexible and limiting, the benefits to the City are less than they are in a lease transaction described below.

2. Traditional private activity bonds to pay for the facility. The private party would own/operate the facility. The bonds would have to be included in the state's volume cap, which could be problematic with a transaction of this size.

3. The third structure is a mix of the other two structures. The City would issue the bonds, and ownership would be either with the City or with a "governmental instrumentality." The reason to use the governmental instrumentality would be to insulate the City from

operational costs/liabilities of ownership of the facility. The City would issue revenue bonds, and the City would not have ultimate responsibility for repaying the bonds. The facility would be leased to SUI or some other entity. This alternative differs from the first in its use of a lease. The use of a lease, rather than a qualified management contract, provides increased flexibility in the actual business deal and is usually a better way to do the project. Because of a special rule that only applies to airports and to solid waste disposal facilities, the financing would not be included in the state bond cap.

They recommended using the third alternative with the "government instrumentality" being a non-profit company. They were not aware of any other solid waste projects that have been financed with such an arrangement, although they indicated that it is common with airports and sewage treatment facilities. With this arrangement, the bond purchasers would be secured by a priority mortgage lien and security interest in the proposed project and all revenues it generates, together with any certification and/or performance or surety bonds relating to the SUI technology. The only recourse the bond holders would have if the system did not operate as guaranteed is the performance bond that SUI would get, the price of which should be reflected in SUI's cost of the project. The "moral obligation" of the City is implied, but not expressed. That is, the "essentiality" of the project would determine whether the City might assume any financial responsibility in the event of a default on the proposed bonds in an effort to assure continued operation of the project.

Ms. Newman assumed that the project would be financed with municipal bonds. She used an 8 percent interest rate in her calculations. The bonds would not be rated by any national organization. The extra cost due to the lack of rating is reflected in the assumed interest rate. Ms. Newman agreed that these bonds would be "nonrated, high-yield debt securities–issued primarily for start-up projects for which no municipal and/or insurance or corporate guaranty is available." They have also been termed "junk bonds."

The most critical aspect of the financing is the performance bond. The cost of the bond will add directly to the cost of the project, and the requirements of the bond are important to the protection afforded to the bondholders.

The City had asked some questions of the Waste to Energy proposal. The following question was one of those:

> "With the net profit levels projected why is government backed financing necessary? Profit levels would seem to sustain an entirely private operation."

Ms. Newman responded that the project would have to be municipally financed, as she felt the market for taxable bonds would be extremely limited. One of the proformas provided to the City by Waste to Energy included the retiring of the 20-year bonds after six years of payment. Even with that expectation, Ms. Newman felt there would be no market for the bonds if they were a taxable issue.

Mr. Thebarge indicated that the municipal bonds are needed because the interest rate for the taxable bonds would not be adequate to market the bonds. He also stated that the municipal bonds avoided the need for complying with certain Securities and Exchange Commission requirements. The municipal bonds also had the advantage of the City's "moral" obligation to work to make the project successful.

Another key point in the discussion of financing with the non-profit company is the support for the project the City might have to provide though future tip fee increases. She expected that there would be no allowance for increasing in the tip fee beyond the schedule provided in the RFP. The project would be financed without the possibility of increases in the City tip fees being used to support unanticipated costs.

3.2.2 Meeting with SUI

We met with SUI at their offices in Huntsville, Alabama, on August 3, 2001. The meeting was attended by Keith Bucher (President and CEO), Igor Polovtsev (Chief Scientist), Charles Ingram (Senior Engineer), Malcolm Tom and Tim Houghton of the City, and Mark White of Pacific Waste Consulting Group.

SUI is a systems engineering and integration company that is commercializing and marketing technologies. This privately held company has been in business since 1992 and now has 16 employees. They began marketing the technology about one year ago after spending several years commercializing it. According to Mr. Bucher, the company is transitioning from product development to commercialization.

They are also working on the mechanism to feed the waste to the molten bed unit. They intend to use a system that does not just drop the fuel into the bed from the top. They also have plans for other changes to the molten bed to make it more efficient. The fuel will not have to be sized for this process, but does need to be fed in a closely packed, continuous stream (similar to a garbage compactor). They want to minimize the air entrained with the fuel to better control the waste conversion process.

The largest unit they have built is for 15 tons per day of a mixed waste stream material (the Customs Service equipment), and they acknowledge that the size needed for Honolulu waste has not yet been built and operated. They believe the equipment used for the Customs Service has a theoretical maximum size of 500 TPD. For the Waimanalo Gulch Landfill waste, they would recommend three 500 TPD units with two of them operating at any one time. They would each be operating at 400 TPD.

In the prior discussions of financing for the project, the bond counsel identified the need for a performance bond to assume the technical and economic risk of using a new technology. Mr. Bucher stated that they had not gotten performance bonds before because they add so much to the cost of the project. Rather, they would build the components of the system and test each of them exhaustively. After each has satisfied the performance tests, they pay the contractor (SUI uses many outside contractors). This phase of the project results in a finished process, and the technical risk is minimized. The risk of the components not working together as designed exists until the entire process is assembled and applied to the design waste stream. SUI has proposed this approach for its other project (one for auto fluff). Mr. Bucher also stated that SUI would provide its corporate guarantee that the technology would operate as stated.

Following the approach Mr. Bucher outlined and the financing ideas discussed with SAMCO leaves the proposal without a performance bond, the key element to finance it and minimize risk to the City.

On August 9, 2001, Mr. Bucher called to advise that he did not intend to leave the impression that the company did not use performance bonds. If they use them at the start of the project, they are very costly and complex. That is why he recommended the phased approach.

The next step recommended by Mr. Bucher is an evaluation of the waste stream and other conditions in Honolulu for the technology. SUI can do that evaluation for a cost of $370,000. Having SUI do the evaluation may eliminate them from competition to provide the plasma arc system if the City chose to pursue the project due to a conflict of interest or procurement law issues.

Two other waste streams in Honolulu, auto fluff and tires, may benefit from the plasma arc. SUI is in final discussions to provide a system to a large iron foundry that uses wrecked autos as feedstock. They have auto fluff to dispose of. The system being proposed would destroy that material and produce a significant amount of excess energy. The host is considering mining the auto fluff waste from its current landfill and processing that material. The system costs $0.04 to $0.45 to produce a kilowatt-hour of energy with a breakeven cost of about $0.03.

The proposal that was provided to the City for using the plasma arc as an alternative to the landfill included processing the ash from H-POWER. Since the ash has little heating value remaining, SUI suggested that the value of vitrifying the ash is to bind up constituents that may leach in a landfill. According to SUI, it would require 19 MW of power to process the ash stream from H-POWER. Mr. Bucher agreed that it did not seem to make sense to process the ash. At $0.08 per kilowatt-hour (the price the utility pays for electricity, not the price the project would pay) the annual cost in lost energy revenue alone for processing the ash would be over $13,000,000. The capital cost of the equipment and the other operations and maintenance costs would have to be included.

Later, Waste to Energy stated that ash processing was no longer a part of their proposal.

3.3 Comments on the Waste to Energy Proposals

This section summarizes observations about the Waste to Energy proposal to the City. It includes comments on the proposal itself and on Waste to Energy and SUI responses to questions.

3.3.1 Summary of the Proposal

This evaluation identifies the key elements of the proposal and raises some issues the City should consider before proceeding. During the Review Team's discussions with the members of the Waste to Energy team, several statements were made and information was provided to respond to questions about Waste to Energy's proposal. This summary addresses the provisions of the Waste to Energy proposal as amplified by the comments made to the Review Team in discussions.

Waste to Energy would provide the City with a project to process all of the MSW that is taken to the Waimanalo Gulch Landfill and produce electrical energy and a glass slag to be used for construction aggregate and sand blasting media. The cost of the equipment and installation will be paid with a bond issue the City sponsors. The City would form a municipal corporation to contract for the project and its operations. The municipal corporation would insulate the City from risk; the bondholders would be protected from the technical risk by the performance bond that would be obtained by SUI.

The cost of operations would be paid from revenues. The revenues are from sales of electricity and the glass slag and from the tip fees paid for disposal. The bonds would be repaid from project revenues.

The technology proposed has never been tested for any period on MSW, has not been built any larger than 15 TPD, and has not operated continuously for longer than a few months. The existence of at least one project that had been processing as much MSW as is taken at the Waimanalo Gulch Landfill was one of the basic criteria for this review. The process proposed by Waste to Energy does not meet this criterion.

3.3.2 City Insulated from Risk by Municipal Corporation

Proposal: Waste to Energy's investment banker suggested that the City form a municipal corporation, as is allowed by IRS provisions, to contact for the plasma arc equipment and for its operation. The municipal corporation would be the responsible entity so the purchasers of the bonds for the project would have recourse only to that corporation, not the City, if the project failed. This approach has been used to finance airports, water, and sewer facilities but has not been used for MSW projects.

The investment banker stated that while the City would not be directly liable for repaying the bonds, it would have a "moral obligation" to make the project work.

Comment: While in some applications the use of a municipal corporation may insulate the host jurisdiction from risk of action by bondholders, no information was provided to illustrate where this approach has been used with a *new, unproven technology*. It is difficult to believe, without further substantiation, that bondholders would not seek to recover a financial loss from the City if it financed an unproven process and that process failed. It seems reasonable that that bondholders would expect that the City has done sufficient due diligence to assure that the process would work.

Without a project that has been operating for several years using this process with MSW as a fuel, it is not possible for the City to do any due diligence evaluation. Without a complete understanding of the process, its risks, operational experience, and cost, it would seem that the City would have a problem expressing its confidence in the operation.

3.3.3 Waste to Energy will Operate and Manage the Facility

Proposal: Waste to Energy would be the facility operator and would manage it.

Comment: Waste to Energy has not indicated that it has any experience in any aspect of the operation or management of any solid waste disposal facility. The City, as do most other government agencies, requires that an operator of a solid waste facility have significant operational experience. For example, the City is in process of negotiating with parties to build and operate a facility to process green waste and sewage sludge. The RFP (Request for Proposals) for this composting project specified that the operator would be required to have a minimum of two years experience operating such facilities.

Since processing waste started many years ago, it has been clear that managing waste materials is much more challenging than most other materials. Past solid waste project failures and significant reconstruction of costly process features argue for the City to be conservative in its requirements for operating experience.

The Waste to Energy proposal does not meet the usual minimum requirements for operational experience. If the City decides to proceed with this project by issuing an RFP, it should require at least two years of operational experience as a qualification to propose.

3.3.4 Performance Bond Guarantee for the Performance of the Facility

Proposal: The proposal states that there is "NO financial liability" for the City. In conversations with Waste to Energy and its advisors (primarily SAMCO, the investment banker and financing specialist), the Review Team was told that the Performance Bond would provide the bondholders with the necessary protection from the technical risk of the project. SAMCO stated that the bonds would be "non-rated by any bond rating agency because the technology was unproven." The Performance Bond is needed to enable the bonds to be sold.

During conversations with SUI, the Review Team was told that Performance Bonds were too expensive to get and that SUI would guarantee the technology through a phased development approach that mitigated the technical risk. The phased development approach would have a first phase during which the local conditions would be identified that are necessary for the process to be designed and configured for the waste stream. The first phase would also use a competitive process to identify contractors to build components of the system. The second phase would have the process constructed and tested as components. SUI would prepare computer simulations to test the interface between components. The goal of the second phase is to avoid or eliminate the technical risk of the components not working together. The extensive computer-based testing is to ensure that the process will work as described when assembled as the operational plant. SUI expects that having that data and experience will reduce the cost and need for a Performance Bond.

During the Review Team's evaluation, SAMCO stated that the Performance Bond would be very expensive. SUI also stated that the bond would add significantly to the cost of the equipment so they recommended the phased development approach to reduce that cost.

Later, Waste to Energy and its partners stated that the Performance Bond would add only one to three percent to the cost of the equipment and provided a list of companies that could issue the bond. Waste to Energy was asked to provide the names and phone numbers of contacts at those companies. The contact information was not provided so the cost of the bond could be confirmed.

Comment: The Waste to Energy team has stated that the Performance Bond was the key to providing bondholders (and the City) confidence that the technical risk of the SUI process would not be assumed by either. As a result, it is clear that the Performance Bond must be adequate to recover the full cost of the equipment, as financed (the equipment cost has been stated to be $183,750,000 and the financed cost to be $284,772,619).

The cost of the Performance Bond is critical to confirm so the cost of the process and the debt service are accurately stated. The willingness of companies to issue a Performance Bond is critical to confirm the availability of the Performance Bond for this *untested and unproven process.*

The cost stated for the Performance Bond (one to three percent) is what would be expected for a construction bond, not what is anticipated for a bond for a process that has never been operated on a waste feedstock.

The lack of confirmation of the availability of a firm to issue a Performance Bond for the SUI process and confirmation of the cost of that bond are critical defects in this proposal.

3.3.5 Power Production

Proposal: SUI stated that its plasma arc process, with the generation technology that it proposes, would produce 1,500 kWh (kilowatt hours) of electricity per ton of waste processed.

A point of comparison is the plasma arc process provided by IET. Their process uses a plasma arc with a molten glass bed similar to the SUI process. The IET arc is powered by alternating current, and the SUI arc is powered by direct current. The processes are different in execution and in the number of operating units they have. SUI has no units in operation and IET has two. IET claims that its process will produce a gross of 1,200 kWh per ton, a number similar to the one SUI uses and much greater than the gross power production at H-POWER (630 kWh).

The net power available for sale to the utility is the key factor in the economics of the process, not the gross. SUI has stated that its in-plant usage is eight to ten percent, with the expectation that it will be closer to eight. IET has stated that its in-plant usage is 50 percent.

For comparison, the H-POWER plant and has an in-plant usage of 15 percent for a net output of 534 kWh per ton. Of course, the H-POWER process and the plasma arc processes are entirely different, so there are many reasons why the power production and net output would be different. But the H-POWER plant provides a reality check. The net output for the SUI process would be 1,350 kWh per ton and the IET process would be 600 kWh per ton.

The Review Team asked SUI why its gross power production is so much greater and in-plant usage is so much less than IET. They responded that the information is proprietary and we would have to agree to keep the response confidential, which is not of any value to this review. In addition, SUI stated that "maybe they (IET) do not know how to operate the plasma arc as well as we do." One must remember that IET has two operational plants (one of which is located in Honolulu) and SUI has none. The IET Honolulu plant (the owners of which also made a proposal that is included in this review) produced energy from the waste they process.

SUI has not operated a plant that produced energy; the one they have operated for a short time was for complete destruction of the feed, not energy production.

Comment: The net energy production is crucial to the project economics. According to the proforma provided by SUI and Waste to Energy, the project would produce sufficient revenue to "generate $30-$40 million/year to be put back into the community." The availability of those funds directly depends on the large amount of net energy available to be sold.

The energy production claimed by SUI was not substantiated in any way, so the economic promises made by Waste to Energy cannot be substantiated.

SUI also stated that it could produce so much more electricity because it would use gas turbine generation technology that was superior to the generators used at H-POWER. They also stated that it would achieve an overall efficiency of 45 to 50 percent. That is, of the total energy available in a unit of fuel entering the process, the plasma arc, gas fuel production, heat recovery, and electricity generation equipment working together will recover 45 to 50 percent. While the process used at H-POWER is different, the efficiency there is about 25 percent, and large steam power plants achieve about 35 percent.

In later conversations with SUI staff, they stated that General Electric of ABB would provide the generators they would use and that equipment was not generally available now. The Review Team asked for names and phone numbers of contacts at those companies to verify the efficiency of the equipment and verify it has been tested on gas from processing MSW. The contact information was not provided.

Even if the generation efficiency can be verified, the lack of experience producing power for sale to a utility using the SUI process with MSW as a fuel is a critical defect in this proposal.

3.3.6 Availability

Proposal: The Project Overview section of the Waste to Energy proposal states that the plant will operate 345 days per year, 24 hours per day. That schedule corresponds to an availability (the amount of time the project is operating to process MSW) of 97 percent.

As a point of comparison, the IET process is expected to have availability of 85 percent. The availability of the H-POWER plant is between 80 and 85 percent.

Comment: The SUI projection of availability is not based on performance of the process on MSW. The methods for introducing the MSW into the process, the maintenance that will be needed on the waste processing equipment, the plasma arc operating on MSW, and the gas cleanup equipment have not been subjected to any long-term testing to demonstrate reliability.

The availability of the equipment directly affects the amount of power sold and the amount of waste processed. Those revenue streams are crucial to the financial feasibility of the project. Before any financial feasibility can be established, the availability needs to be demonstrated.

The lack of demonstrated availability is a critical defect with the Waste to Energy proposal.

3.3.7 *Fuel Handling*

Proposal: The SUI process would not reduce the size of the MSW before injecting it into the plasma arc vessel. The as-received waste would be tightly compacted and inserted directly into the molten glass bed with a mechanism that is under development. Since the molten bed is kept at a very high temperature, the insertion of the fuel will be difficult. In addition, the molten bed will need to be agitated so assure adequate mixing of the waste and glass. The mixing mechanism is also under development.

Comment: It is difficult to understand how as-received MSW (which will vary in size from small bits of grass to large pieces of wood or metal) can be tightly compacted and moved from atmospheric conditions into a high temperature environment without the size being consistent. The approach that SUI would use has not been identified or proven.

One of the larger costs of operating H-POWER is the waste processing. Waste processing equipment has undergone significant refinement since first introduced decades ago. Many costly failures resulted after significant investment by large, well-financed, technically competent firms. It is not clear how SUI will perfect the means for introducing unprocessed MSW into a high temperature environment.

The lack of proven technology for this aspect of the process introduces significant technical risk. Even if the plasma arc process can convert the waste to gas fuel with significantly greater efficiency, it is of little use if the material cannot be fed to the process.

Until the method for introducing the fuel and the apparatus for mixing the MSW in the molten glass bed are designed, tested, and proven, and the results disclosed to the City, the City should not consider the SUI process.

3.3.8 Warranty

Proposal: Waste to Energy provided a contract in July 2001 that it wants the City to execute for the project. The contract does not reflect the current project. For example, the contract is for a project to process waste, ash, and sewage sludge. The current proposal does not include the ash. The contract identified the Seller as SUI and the Buyer as the City.

The contract included a warranty for 30 days from plant startup, providing the plant is maintained according to Seller's instructions and manuals. Waste to Energy and SUI are to operate and maintain the plant. The Seller and Waste to Energy are responsible for training all operations and maintenance personnel.

Comment: A 30-day warranty on a new process that is neither proven nor tested for any length of time processing the amount of fuel proposed is unacceptable. The operations warranty provided for a technology such as used at H-POWER included a 90-day acceptance period during which the contractor demonstrates that the process will operate as specified. In addition, a warranty of at least three years was provided for major components. This warranty protection was provided for a technology and its components that had been proven for many years on many other MSW applications of the size needed here.

Any proposal for use of the plasma arc at full scale should provide at least as much warranty coverage. The Waste to Energy proposal has critical defects.

3.3.9 Operating Staff

Proposal: The proposed contract provided by Waste to Energy includes a Project Overview in the Executive Summary. That document states that it will take five people per shift (15 total over 24 hours) to operate the plant with additional personnel coming from the unneeded landfill staff. In the section titled "Jobs and Income Created by the City & County of Honolulu Project," the proposal states that 48 permanent plant jobs will be created, meaning that 48 people will be needed to operate the plant.

Comment: The anticipated availability of surplus 33 personnel coming from unneeded landfill staff (48, minus the 15) is unrealistic. The landfill staff is employed by a private contractor and would not be available to this project. There are not that many people working at the landfill.

The proforma for the Waste to Energy project needs to be revised to reflect the total number of staff needed.

3.3.10 Financing the Generating Equipment

Proposal: The proposal includes a finance model for determining the annual debt service. That model includes financing with tax-free bonds all of the equipment needed. The law limits that type of financing to equipment that is associated with processing the MSW, not with generating electricity.

Comment: The cost of the generating equipment needs to be eliminated from the tax exempt financing and the annual cost of financing that equipment with taxable bonds needs to be calculated. It is expected that this change will add to the annual debt service, but not significantly change the financial performance of the project.

The proforma for the Waste to Energy project needs to be revised to reflect the taxable financing of the generating equipment.

3.3.11 The Plasma Arc Technology has Passed the California EPA Standard

Proposal: Based on conversations with the SUI staff, the standards met were the air quality standards in the San Diego Air Quality Management District, which are consistent with the ones established by the California Air Resources Board, a California EPA agency. The standards passed were for a test of customs contraband (drugs and packaging materials).

Comment: For a process or project to be considered as having passed a "California EPA Standard" it would have to be tested on the material to be processed. The SUI process has not been tested on MSW. Until it has been tested, Waste to Energy cannot make a valid claim that the process has passed any standards when processing MSW.

4 IET Process

International Environmental Technologies LLC is located in Richland, Washington. The Review Team met with Jeff Sumra, President of IET on August 13, 2001, in Richland. On August 28, 2001, the Review Team met with Sam Lui, President and CEO of Hawaii Medical Vitrification, and Donald-Michael Bradford, a member of the Company's Board of Directors. This section provides a description of the IET process and a summary of the meetings.

4.1 Description

The IET system uses two sets of graphite rods. One set uses AC power, is inserted in a bed of molten glass, and heats the glass using the electrical resistance of the glass. The other set is powered by DC current and is placed at the surface of the glass. It preheats the waste material being processed.

The waste needs to be sized to four-inch nominal and is moved into the processing chamber with a screw conveyor. It drops onto the surface of the molten glass, where it is converted to energy and slag. The process can also be fed with a pipe for liquid waste and a batch feeder for containerized materials (the medical waste at HMV is placed in six-gallon buckets and the entire bucket processed). The fuel is introduced through a set of air locks that prevent large amounts of oxygen being introduced into the process.

The waste pile is heated with the DC plasma arc. Gasses are driven off from the organic material. Some of the inorganics are combined with the glass and removed as the glass is extracted from the vessel. The metal in the waste is liquefied and flows to the bottom of the vessel where it is drained off.

The gas flows from the conversion vessel to a thermal residence chamber, which provides time for the reactions to be completed. The gas stream is then passed through a counterflow quench tank to reduce its temperature to 400 F. It is then passed through a baghouse to remove particulate matter. A packed tower scrubber removes the other contaminants. After the gas cleanup, the gas stream, often consisting of hydrogen and carbon monoxide, is directed to the gas turbine generator to produce electricity.

When they are not using the system, they can shutdown the DC plasma arc and use the AC system to maintain a minimum temperature in the glass bed. Doing so decreases the startup time required to bring the process up to full production. The refractory brick that lines the reactor vessel helps maintain the temperature.

The process requires heat to operate. It should not be overfed because the temperature will decrease and the destruction of the waste will not be complete. They have a control system that slows the feed if the temperature drops too low.

The equipment is estimated to be available 85 percent of the time.

The amount of energy they estimate will be produced from the conversion of the organic fraction in an "average" sample of MSW is 1,200 kWh per ton (assuming the generation efficiency is 40 percent). Their process uses 600 kWh per ton, making 600 available for sale. The other major revenue streams are the tip fees and the product made of the glass slag. They have not yet had a project that has sold glass slag.

By varying the temperature of the reactions and the other materials (such as trace metals) injected into the process with the waste, the equipment can produce a glass slag with specified properties. The glass is one to five percent of the original waste volume. The Company has done extensive work to identify the conditions needed to produce a glass slag that can be put to beneficial use. They can produce a glass particle with sharp corners that can be used for sand blasting without releasing silica as sand does. They have also used a proprietary process to make a foam glass that is light and strong, but can be brittle. They have made it into a light building material. They had samples of a building block and a brick. The brick costs about $0.10 each to produce. They have used the same process to produce a lightweight replacement for roof shingles and tile. The foam glass has very good insulating properties and is impervious to water and pest damage.

4.2 Meeting Summary

These meetings were held to review the IET process and the APET proposal.

4.2.1 IET

This meeting was held with Jeff Surma (President and CEO) and Mike Elliott (Director of Engineering) of IET, Tim Houghton, and Mark White. The meeting was to discuss the potential for using the IET plasma arc technology, which is used at APET's HMV plant in Honolulu. The meeting at the IET location was followed up with a phone conference to discuss some questions about the process. The phone conference is summarized at the end of this section.

The company has been in business since 1995 and has 36 employees. They are privately held and, with the exception of last year, have been profitable. Last year they participated in an expensive testing program that reduced profitability. They design the entire system and use fabrication contractors to manufacture the units to their specifications. They act as construction manager, with the contractor selected by the customer.

They could provide treatment for the ash. They would vitrify the ash and make it into a glass material. The glass would be used as sand blasting media. IET has a contact in California that is willing to buy the material on a long-term contact (20 years) at a current price of $100 per ton in California. The cost of shipping to California is estimated to be $7.00 per ton. They have been told that the company sells the material for $200 to $300 per ton. Sand blasting media is also purchased at Pearl Harbor. They use about six tons per day and pay $2,000 per ton for it.

The company is in process of designing a 50 TPD unit for a utility customer in the East that wants to process the ash from its coal fired power plant. The 15 TPD units are a round configuration. The 50 TPD unit is rectangular. They believe it can be expanded into a 100 TPD unit by extending the long axis of the rectangle.

The company had a proforma for the 50 TPD ash project. They calculated the total operating cost would be $91 per ton (assuming $0.04 per kWh purchased). The price for glass was assumed to be $65 per ton. The net loss is $26 per ton, not including the cost of capital. The cost of the plant was $10,000,000, which is $36 per ton, for a total cost of $62 per ton. The current cost of disposal of the ash is $59 per ton. They did not provide a copy of the proforma.

The company provides process guarantees. They guarantee for one year that the throughput, emissions, and usage of consumables will not exceed the guaranteed amount. If the plant does not operate as guaranteed, the company will reduce the capital cost of the equipment to equal compensation. They do not provide additional guarantees on the plant equipment or its operations. The City would be at risk for the cost of the plant if it did not operate as guaranteed after the first year.

A conference call was held September 24, 2001, with Jeff Surma from IET, Frank Doyle, John Lee, and Wilma Namumnart, all with the City's Refuse Division, and Mark White. The call was to review the energy production expected with the IET equipment and to obtain Mr. Surma's input and recommendations for proving their process on MSW.

IET has claimed that its process will produce a net of 600 kWh per TPD of waste processed. The electrical production directly affects the revenue to the plant and thus the economic viability of the project.

IET has test data from conversion of MSW that it used with theoretical calculations to project the amount of gross energy expected and the amount needed to operate the plasma arc process. The MSW used for the tests was a prepared fuel comprised of paper, wood, and plastic. The tests were done on a 10 TPD unit, which was de-rated to 6 TPD for this test. The gas produced was used to power a reciprocating engine.

The IET process produces more energy from the waste than H-POWER because they use much less air and because the conversion of waste to gas is more efficient that the conversion of waste to steam at H-POWER. The gas is produced in similar quantities to pyroloysis, but is much cleaner due to the hotter temperatures in the reaction chamber (1,000C with the IET process compared to 600 to 700C with pyrolosis). In addition, the generation of the power with a gas turbine is more efficient than with the boilers used at H-POWER. The turbine generators IET would use have been used many times on similar fuels, so the efficiency of the generating equipment is well understood.

IET would not recommend going from the 10 TPD unit they have to a 600 TPD unit. Their company is not large enough to provide the guarantees that would be required. Rather, they would operate the 4 TPD plant at HMV for three to six months to prove the concept and gather data on the operations. If the test were successful, it would take 12 to 18 months to install the 50 TPD unit that would follow and another six months of operations to gather the necessary data to prove the technology at that size. If those tests were favorable, they would add 50 TPD modules to get to 300 TPD. None of these time frames include the period to obtain local permits.

4.2.2 Hawaii Medical Vitrification (APET)

On August 28, 2001, the Review Team met Sam Liu, President of HMV, and Don-Michael Bradford, a member of the HMV Board of Directors. For this meeting, the Review Team included Colin Jones, the City's Energy Recovery Administrator at H-POWER as wells as Tim Houghton and Mark White. The meeting was to discuss the approach that company has suggested for testing their process on the H-POWER ash.

This company is operating a 4 TPD plasma arc plant in Campbell Industrial Park. They primarily treat medical waste, but are permitted for metals, grease, tires, and soil. They have an interest in processing the ash from H-POWER to better understand the cost of processing, the appropriateness of the glass product from the process for a currently available market for sand blasting media, and the environmental impacts. They have been working with the State Department of Health (DOH) on the permitting and environmental issues, the US Navy on the applicability of the glass product for use as sand blasting media, and the University of Hawaii on use of the syngas produced for power generation with a fuel cell. These parties, with HMV and the City, would be the group that would test processing of the ash.

The test suggested would use 100 tons of ash to produce about one to five tons of glass. In addition to the ash, the company wants to include sewage sludge in the process to see the impact it has on the process.

The test would be conducted over a one-week period. The company would get approval from DOH to hold the medical waste that would otherwise be processed during that period. It would also work with the US Navy to arrange for testing of the glass as sand blasting media.

4.3 Comments on the HMV Proposal

This section summarizes observations about the Waste to Energy proposal to the City. It includes comments on the proposal itself and on Waste to Energy and SUI responses to questions.

4.3.1 Summary of the Proposal

This proposal is for a demonstration of their plasma arc on the ash and waste. They would start with a one to four TPD demonstration (the capacity of their existing equipment) and move to a 10 TPD.

The larger demonstration would be conducted if justified by the results of the first demonstration. Following a successful second demonstration, they would recommend larger units

4.3.2 Cost to the City

Proposal: The proposal suggests a demonstration project, but does not provide any details regarding the cost, schedule, or the City's responsibilities.

Comment: Before proceeding with this proposal, the City may want to provide a Request for Proposals (to this company and to others that may wish to provide a demonstration project) to clarify the information they will need to proceed with a demonstration project.

5 Hydromex Process

5.1 Description

The Hydromex process combines waste material with a chemical in the presence of heat and pressure to extrude cross sections that can be used in construction. The waste material needs to be sized to enable the chemical reaction to have sufficient surface area to be complete. The building materials have been suggested for use as railroad ties and replacements for cement blocks.

5.2 Meeting Summary

On August 24, 2001, Tim Houghton and Mark White met with Larry Leaf of The Environmental Group, the local representative of Hydromex. The company has made a proposal to the City to provide a plant to process the ash from H-POWER and the contaminated (treated) wood from the Waimanalo Gulch Landfill.

Hydromex has made other proposals to the City. In the August 24 meeting, they proposed to provide the City with the services of one 50-ton-per-shift (eight hours) plant. Since the plant would be operated for two shifts per day, the daily capacity would be 100 TPD. The $4,000,000 cost for the plant would be paid through a leasing arrangement that The Environmental Group or Hydromex would have with an offshore leasing company. The cost of permitting the facility and all costs of operations would be the responsibility of Hydromex.

The City's obligation would be to provide the 100 TPD of ash and contaminated wood to the plant. A period of time would be provided during which the Hydromex staff would prove that the plant can process the ash and contaminated wood, that the process will produce the building products claimed, and that there is a market for the building products. At the end of that time, the City could assume ownership of the plant and equipment. During the meeting, an estimate of at least 12 months was discussed as that time period.

They want to locate the plant on H-POWER land or near the H-POWER plant. They are prepared to begin constructing the plant when the City agrees to the terms of an agreement.

A proposed agreement was provided to the City on about August 24, 2001 that outlines some of the details of the project. Additional details need to be specified. The next section of this report reviews the information that has been provided and identifies some of the additional information that is needed.

5.3 Comments on the Hydromex Proposal

5.3.1 Summary of the Proposal

Hydromex would provide the City with a demonstration unit to process H-POWER ash, auto fluff, and treated wood to produce railroad ties and building blocks. The cost of the equipment and installation will be paid with a lease they have arranged. The cost of operations will be paid from revenues. They would operate the project for a period (one year has been discussed) and then sell it to the City. During the time they operate the project, they would prove that it can process the ash and treated wood and that they can sell the entire production of building materials. If they are unable to either demonstrate that the process works on the waste stream or that they can sell the product, the City will be under no obligation with respect to the project.

This evaluation identifies the key elements of the proposal and raises some issues the City may wish to consider before proceeding with this proposal.

5.3.2 Lease

Proposal: The proposal included the statement that the lease to finance the equipment had been approved through a local bank and a leasing company. A letter from a leasing company was included to support the comment.

Comment: The letter from the leasing company is dated October 21, 1999. It is not clear whether the situation with the leasing company, Hydromex, or the project then envisioned have changed. A document should be provided from the leasing company that clearly expresses its willingness to finance the current Hydromex proposal.

The proposal contains an August 9, 1999, letter that refers to leasing the Hydromex facility to the City. An August 11, 1999, letter to the City that is attached to the lease identifies the conditions of the lease, including the City being the owner of the facility. The August 9, 1999, lease commitment letter and August 11, 1999, letter should reissued based on the current proposal.

5.3.3 Distribution of All Products Produced

Proposal: The proposal states, "After acceptance of the Hydromex waste system capability and distribution of all products produced the C&C would purchase the pilot system..."

Comment: One of the key aspects of the proposal is that the cost of the technology would be similar to the current cost of disposal. For that claim to be true, the building materials produced need to be marketable for a price that returns significant revenue after production and shipping expenses.

The proposal includes a letter several years old from a railroad agreeing to buy the railroad ties Hydromex produces. The agreement needs to be restated to reflect current conditions.

5.3.4 Revenue from Disposal Fees

Proposal: The proposal includes a proforma that is based on $70 per ton disposal fees.

Comment: The disposal fee for the ash is $11.48 per ton and the disposal cost for the auto fluff is $36.00. The project proforma needs to reflect these smaller revenue streams.

6 Summary of Recommendations

6.1 Overall

None of the three processes has a plant that has been operating on MSW, so all three fail the primary evaluation criterion.

However, the proposals by HMV and Hydromex are for them to provide a demonstration project to the City to prove their technology. Those two proposals deserve further consideration.

The proposal from Waste to Energy is for the City to invest about $300,000,000 in a process that is unproven and untested with MSW. The process has several areas with questions that are not answered, and the proposal has several critical defects. If the proponent is able to propose a no cost test for the City, that approach may prove to be worth investigating further.

6.2 Waste to Energy

Fundamentally, the SUI process does not meet the primary operations and MSW processing criteria and should not be further considered for that reason. In addition, several areas of the Waste to Energy proposal and the SUI process have flaws that need to be corrected.

Risk to the City – The approach suggested by Waste to Energy's financial representatives regarding avoidance of risk has not been used on an MSW project or on a new and unproven technology. There has been no showing that the City is insulated from significant financial risk by proceeding as described in the Waste to Energy proposal.

Waste to Energy will Operate – The Waste to Energy proposal has that company as the operator and manager of the facility. They do not identify any experience they have with operating solid waste facilities. Lack of operating experience is a critical defect in this proposal.

Performance Bond – The Waste to Energy financial representatives stated that a Performance Bond was necessary to mitigate the risk of the unproven technology. SUI, the process vendor, stated that they would reduce the cost of the Performance Bond by phasing development of the project, but did not identify the City's financial commitment at phases II or III. The cost of the Performance Bond identified by the Waste to Energy financial representatives appears more like the cost of a construction bond, not a performance bond for an unproven technology. The lack of resolution of the Performance Bond questions makes the risk to the City unacceptable.

Power production –SUI claims its process will produce much more power for sale than other technologies. The revenue from sale of power is crucial to the financial performance of the project. SUI did not provide information to verify the high net output and has not built any projects using

MSW to prove its claims. The lack of supporting data is a critical defect to this proposal.

Availability – The SUI process availability was claimed to be 97 percent, much higher than other plasma arc processes. The high availability results in higher revenue from sale of power and from disposal fees. SUI has no operational projects to gather data to support its claim. This is a critical defect for this proposal.

Fuel handling – SUI has not developed the equipment for introducing the fuel into the process. This part of the process is critical, as many solid waste technologies have had major problems with fuel handling. The lack of a proven method to introduce the fuel is a critical defect.

Warranty – SUI offers a 30-day warranty with its equipment. That is much less than is usual with large solid waste processing plants. The warranty is unacceptable, and may reflect the unproven nature of the process.

Operating staff - The proforma provided by Waste to Energy includes using unnecessary staff from the Waimanalo Gulch Landfill to supplement their staff. The proforma needs to reflect the full cost of the staff and should not rely on staff from the landfill, as they may not be available.

Generating equipment – The proforma reflects financing the generating equipment with the rest of the solid waste processing equipment, a practice that is not allowed by Federal law. The proforma needs to be revised to reflect the correct financing.

Passed California EPA Standards - The data provided by SUI states that their process has passed the California EPA Standards. Those standards need to be assessed with the fuel that is proposed to be used. Since that was not the case, that claim is not valid.

6.3 HMV (APET)

The proposal from HMV needs to be expanded to identify the cost, schedule, and City responsibilities.

6.4 Hydromex

The Hydromex proposal has several areas that are critical to the project economics that need to be updated to reflect the proposed project.

Availability of Lease Funds – The lease commitment is several years old and does not reflect conditions Hydromex now proposes. It needs to be updated.

The letters expressing interest in purchasing the product are several years old and need to be updated.

Appendix A – Questions Sent to Scientific Utilization, Inc.

Questions Related to the Scientific Utilization, Inc

Plasma Arc Technology

July 25, 2001

The questions are divided into those that refer to the proposal made recently to the City and County of Honolulu by Waste to Energy and to general questions about the technology. The first questions relate to the information provided in the proposal that Waste to Energy made to the City & County.

1. What is the status of other Waste to Energy projects? Which have broken ground?

2. The proposal seems optimistic regarding the time provided for permitting the project. What experience does the team have getting the various environmental and other permits (e.g., zoning and use permit) for projects in Hawaii?

3. The original proposal indicated extruder/feeder systems were being developed. What is status of development of those systems?

4. What is your experience with "self-power" generation? What power source is used when cogen facility is not producing energy?

5. Please reconfirm the amount of power needed for the plasma arc operation and for the remainder of the facility.

6. The cogen plant is identified as operating 24 hours per day, 354 days per year, leaving 11 days when it is down. How is system powered during this 11-day period?

7. The proposal states there will be "No Residual Ash" or "slag". Other parts of the proposal indicate residuals of five percent by weight. Please clarify.

8. Is there a clear market identified for the glass. We understand that the glass could be provided to sand blasting companies but it must be granulized first. Glassphalt has been proposed for many years in Hawaii, but still has not taken off otherwise the market for recycled glass would be greater.

9. The guaranteed processing is indicated as 83 tons per hour. Is this guarantee on a continuous or variable basis? What is peak processing capacity?

10. What is the composition of solid waste did you use as a basis for your conclusions regarding the project feasibility? Has that composition been compared to the composition of the waste being accepted by the Waimanalo Gulch Landfill? What BTU value for the waste did you use?

11. The Georgia test provided with the initial proposal was on "simulated" MSW. Have there been any tests on actual MSW? If so, what were the results?

12. If the unit is to process the H–POWER ash, will methanol be required to create slurry for feed? It is very unclear as to how the ash will be fed into the unit. What kind of additional reduction in volume will the unit obtain?

13. What BTU value do you expect in the ash? How much syngas will be produced through your processing of that material. we understand that a potentially beneficial by product is carbon. Will this product be produced and what will be done with it?

14. What is the down time required to change electrodes? How frequently do they need to be changed? What is impact on operational performance?

15. What kind of material are you using for the rods; inconel or carbon?

16. The staffing levels appear high for a highly automated facility. What is rationale for staffing?

17. What is status on "major subscale Prototype Reactor" identified in proposal?

18. What is basis for the:

    a. Proposed tip fee,

    b. Selling price for slag,

    c. Selling price for metals,

    d. Marketability of slag and metals. Have markets in Hawaii been identified?

    e. Electric rate.

19. The operating costs for electricity seem low. What rate is being used? How has standby requirement for peak power been addressed?

20. Please explain the statement that there is "no" cost related to fuel consumption.

21. Water costs do not appear to be shown; yet there appears to be significant need for

water for cooling. Please explain.

22. What is basis for construction costs? Are they based on national or regional averages? Have they been adjusted for Hawaii conditions?

23. Where is site cost included in the proforma?

24. Who is intended to be "end user" as relates to Guarantor portion of performance bond?

25. How is performance bond paid for?

26. The term "Governmental Bonds" is used frequently. Please define this term. Who is ultimately responsible for repayment of "Governmental Bonds"?

27. The project is defined at one point as a private activity financed with tax-exempt revenue bonds. Yet it the facility is also identified as owned by a governmental agency. Which is it?

28. What are benefits and risks to a governmental entity if it owns this project? What guarantees are provided that the financial institution, WTE, or SUI will be capable of making good on their insurance if the facility does not meet expected performance levels.

29. With the net profit levels projected why is government backed financing necessary? Profit levels would seem to sustain an entirely private operation.

30. If the governmental entity is the owner, how is there no liability to the City?

31. Please explain in detail how, and which, IRS codes require the City and County to own the facility and lease it to the operator.

The following questions apply to the technology in general.

1. What is the range of daily throughput that the technology is appropriate to process?

2. What is the daily throughput of the existing facilities?

3. What is the daily throughput of the facilities that have been contracted for?

4. What waste materials have been processed in the technology?

5. What operational availability (number of days per year) is the technology expected to achieve? In your proposal you state that the equipment would be down 11 days per year. Is this the expected down time for the entire plant, including any waste processing and

power generation equipment?

6. What product(s) are expected to be produced that can be beneficially used? For the amount and composition of the waste feedstock expected to be available to the technology from the Waimanalo Gulch Landfill, what amount of product is expected?

7. How much of each type of waste material(s) is the technology expected to produce, given the amount and composition of the expected waste feedstock?

8. What is the potable water usage per ton of material processed?

9. Provide the following information for the operational projects that are using this technology.

   a. Size of the project in tons (US) per day.

   b. Starting date for operations.

   c. Amount of material processed since start of operations.

   d. Cost of processing in dollars per ton (US) of material processed.

   e. Revenue from sale of materials in dollars per ton (US) of material processed.

   f. Revenue from sale of energy in dollars per ton (US) of material processed.

   g. The total amount of materials sold since the start of the project.

   h. The total amount of energy sold since the start of the project.

   i. The total amount of materials disposed since the start of the project.

   j. Number of days the facility has been out of service since start of operations. What were the reasons for the facility being out of service?

   k. Location of project.

   l. Name and telephone number of the primary contact with the host jurisdiction.

Appendix B – Questions Sent to International Environmental Technologies LLC

Questions Related to the Plasma Arc Technology

July 25, 2001

10. What is the range of daily throughput that the technology is appropriate to process?

11. What is the daily throughput of the existing facilities?

12. What is the daily throughput of the facilities that have been contracted for?

13. What waste materials have been processed in the technology?

14. What operational availability (number of days per year) is the technology expected to achieve? In your proposal you state that the equipment would be down 11 days per year. Is this the expected down time for the entire plant, including any waste processing and power generation equipment?

15. What product(s) are expected to be produced that can be beneficially used? For the amount and composition of the waste feedstock expected to be available to the technology from the Waimanalo Gulch Landfill, what amount of product is expected?

16. How much of each type of waste material(s) is the technology expected to produce, given the amount and composition of the expected waste feedstock?

17. What is the potable water usage per ton of material processed?

18. Provide the following information for the operational projects that are using this technology.

    a. Size of the project in tons (US) per day.

    b. Starting date for operations.

    c. Amount of material processed since start of operations.

    d. Cost of processing in dollars per ton (US) of material processed.

    e. Revenue from sale of materials in dollars per ton (US) of material processed.

f. Revenue from sale of energy in dollars per ton (US) of material processed.

g. The total amount of materials sold since the start of the project.

h. The total amount of energy sold since the start of the project.

i. The total amount of materials disposed since the start of the project.

j. Number of days the facility has been out of service since start of operations. What were the reasons for the facility being out of service?

k. Location of project.

l. Name and telephone number of the primary contact with the host jurisdiction.

Appendix C – Questions Sent to Hydromex

Questions Related to the Hydromex Technology
August 24, 2001

19. What is the range of daily throughput that the technology is appropriate to process?

20. What is the daily throughput of the existing facilities?

21. What is the daily throughput of the facilities that have been contracted for?

22. What waste materials have been processed in the technology?

23. What operational availability (number of days per year) is the technology expected to achieve? In your documentation you state that the equipment would be down 110 days per year. Is this the expected down time for the entire plant for maintenance.

24. For the amount and composition of the waste feedstock expected to be available to the technology from the Waimanalo Gulch Landfill, what amount of product is expected?

25. How much of each type of waste material(s) is the technology expected to produce, given the amount and composition of the expected waste feedstock?

26. What is the potable water usage per ton of material processed?

27. Provide the following information for the operational projects that are using this technology.

    a. Size of the project in tons (US) per day.

    b. Starting date for operations.

    c. Amount of material processed since start of operations.

    d. Cost of processing in dollars per ton (US) of material processed.

    e. Revenue from sale of materials in dollars per ton (US) of material processed.

    f. Revenue from sale of energy in dollars per ton (US) of material processed.

    g. The total amount of materials sold since the start of the project.

    h. The total amount of energy sold since the start of the project.

i. The total amount of materials disposed since the start of the project.

j. Number of days the facility has been out of service since start of operations. What were the reasons for the facility being out of service?

k. Location of project.

l. Name and telephone number of the primary contact with the host jurisdiction.

Appendix D – Composition of the Waste Disposed at the Waimanalo Gulch Landfill

The table included in this Appendix was taken from a report titled Waste Composition Analysis for the City & County of Honolulu.

There are four important caveats to understand about this table.

1. The waste composition data on was taken in 1998.
2. Disposal tonnage from 2000 was used to estimate of the amount of each constituent of the waste stream.
3. All composition calculations are based on the sorted materials' weight (as opposed to volume). The results were derived using a 90% confidence interval. This means there is a 90% certainty that the actual composition is within the calculated range. This table shows the average composition from within that range.
4. The table shows the approximate composition of the waste going to the Waimanalo Gulch Landfill. The composition data is for commercial waste. In addition, self-haul customers deliver waste and material is brought to the site from the City's Convenience Centers. These two waste streams have not been included in the composition results.

Material	(Mean %)	Tons/Day
Paper	8.9%	71.2
Newspaper	0.2%	1.6
Cardboard	5.2%	41.6
High Grade	0.5%	4
Low Grade	2.2%	17.6
Compostable	0.3%	2.4
Non-Recyclable Paper	0.5%	4
Plastics	4.9%	39.2
PET #1	0.0%	0
HDPE #2	0.0%	0
Other Bottles	0.0%	0
Rigid Plastic	1.4%	11.2
Film Plastic	2.5%	20
Other Plastic	1.0%	8
Wood	31.2%	249.6
Treated Wood	13.9%	111.2
Pallets/Crates	7.6%	60.8
Untreated Lumber	5.8%	46.4
Untreated Plywood	2.6%	20.8
Stumps	1.3%	10.4

Metal	12.3%	98.4
Aluminum Cans	0.2%	1.6
Tin Cans	0.2%	1.6
Ferrous	6.7%	53.6
Non-ferrous	0.4%	3.2
Mixed/Other	4.8%	38.4
Glass	0.5%	4
Yard Waste	6.0%	48
Other Inorganics	20.0%	160
Wallboard	7.0%	56
Asphalt Roofing	1.4%	11.2
Asphalt Paving	1.9%	15.2
Concrete	2.9%	23.2
Other	6.8%	54.4
Other Wastes	16.0%	128
Furniture/Mattresses	5.1%	40.8
Carpet	4.5%	36
Other	6.4%	51.2
Total	99.8%	800

Appendix E – Information Submitted by Waste to Energy

EXHIBIT A
Page 1 of 5

CITY AND COUNTY OF HONOLULU, HAWAII
Revenue Bonds, Series 2001
(SUI Plasma Technology Plant)

Estimated Sources and Uses of Funds

	Series 2001 Tax-Exempt Revenue Bonds	Total
SOURCES OF FUNDS:		
Bond Proceeds	$252,665,000	$252,665,000
Equity Contribution (Project Site) (1)	0	0
Interest on Available Funds (2)	12,107,519	12,107,519
TOTAL	$264,772,519	$264,772,519
USES OF FUNDS:		
Acquisition and Construction Fund:		
Acquisition and Construction Costs	$183,750,000	$183,750,000
Development Coordinator's Fee	8,750,000	8,750,000
Performance Bond Premium (2)	5,250,000	5,250,000
Equity Contribution (Project Site) (1)	0	0
Acquisition Related Expenses	198,401	198,401
Capitalized Interest (2), (3)	30,319,800	30,319,800
Debt Service Reserve Fund (4)	25,266,500	25,266,500
Working Capital (5)	1,000,000	1,000,000
Cost of Issuance	10,237,818	10,237,818
TOTAL	$264,772,519	$264,772,519

(1) [TO BE DETERMINED]
(2) Estimated interest earnings on Acquisition and Construction Fund, Debt Service Reserve Fund, Capitalized Interest Accounts, and Working Capital Fund during eighteen-month construction period.
(3) Capitalized Interest period of 18 months calculated at the respective interest rates for the Bonds; calculation includes interest on Available Funds.
(4) A debt service reserve equal to 10% of the face amount of the bond issue or maximum annual debt service, whichever is less.
(5) Working capital estimated at $1,000,000, approximately ___ Days-Cash On-Hand.

EXHIBIT A
Page 2 of 5

CITY AND COUNTY OF HONOLULU, HAWAII
Revenue Bonds, Series 2001
(SUI Plasma Technology Plant)

Estimated Cost of Acquisition and Construction Budget

ACQUISITION AND CONSTRUCTION FUND:

(a) Construction Costs (SUI Plasma Technology Plant)		$175,000,000
(b) Contingency (5% of Construction Costs)		8,750,000
		$183,750,000
Development Coordinator's Fee (1)		8,750,000
Performance Bond Premium (2)		5,250,000
Acquisition Related Expenses	(see below)	198,401
Capitalized Interest		30,318,800
	TOTAL	$228,268,201

ACQUISITION RELATED EXPENSES:

Construction Monitor	$50,000
Development Coordinator's Counsel Fee & Expenses	50,000
Environmental Report	3,000
Site Appraisal	5,000
Real Estate Counsel Fee and Expenses	30,000
Title Insurance and Recording Fees	50,000
Site Survey/Topographic Study	8,500
Contingency	1,901
TOTAL	$198,401

(1) Development Coordinator's Fee calculated at 5% of Construction Costs.
(2) Performance Bond Premium calculated at 3% of Construction costs.

EXHIBIT A
Page 3 of 5

CITY AND COUNTY OF HONOLULU, HAWAII
Revenue Bonds, Series 2001
(SUI Plasma Technology Plant)

Estimated Cost of Debt Issuance Budget

Bond Counsel Fee and Expenses	$1,263,325
Bond Purchaser's Counsel Fee and Expenses	50,000
Lessee's Counsel Fee and Expenses	50,000
Closing, Travel, Hotels, and Meals	25,000
CUSIP, MSRB, Clearance, etc.	75,800
Financing Team Expenses	50,000
Financial Feasibility/Market Studies	126,000
Investment Bankers' Counsel Fee and Expenses	631,663
Investment Bankers' Fee	7,579,950
Issuer's Administrative Fee	315,831
Issuer's Counsel Fee and Expenses	25,000
Printing and Binding of Documents	15,000
Trustee's Acceptance/Counsel Fee and Expenses	27,500
Contingency	3,750
	$10,237,818

EXHIBIT A
Page 4 of 5

CITY AND COUNTY OF HONOLULU, HAWAII
Revenue Bonds, Series 2001
(SUI Plasma Techonolgy Plant)

REVENUE BONDS SERIES 2001 -- 20-YEAR TERM; SEVEN YEARS CALL PROTECTION

Issue Size:	$252,665,000	Average Debt Service:	26,942,350
Interest Rate:	8.000%	Maximum Debt Service:	31,492,800
Term:	20	Delivery Date:	12/01/01

December 1	BEG BAL	PRIN	INT	DEBT SVC
2002	252,665,000	0	20,213,200	20,213,200
2003	252,665,000	0	20,213,200	20,213,200
2004	252,665,000	0	20,213,200	20,213,200
2005	252,665,000	5,000,000	20,213,200	25,213,200
2006	247,665,000	7,000,000	19,813,200	26,813,200
2007	240,665,000	8,000,000	19,253,200	27,253,200
2008	232,665,000	8,750,000	18,613,200	27,363,200
2009	223,915,000	9,500,000	17,913,200	27,413,200
2010	214,415,000	10,500,000	17,153,200	27,653,200
2011	203,915,000	11,670,000	16,313,200	27,983,200
2012	192,245,000	12,650,000	15,379,600	28,029,600
2013	179,595,000	13,700,000	14,367,600	28,067,600
2014	165,895,000	14,800,000	13,271,600	28,071,600
2015	151,095,000	16,000,000	12,087,600	28,087,600
2016	135,095,000	17,285,000	10,807,600	28,092,600
2017	117,810,000	18,650,000	9,424,800	28,074,800
2018	99,160,000	21,000,000	7,932,800	28,932,800
2019	78,160,000	23,000,000	6,252,800	29,252,800
2020	55,160,000	26,000,000	4,412,800	30,412,800
2021	29,160,000	29,160,000	2,332,800	31,492,800
TOTALS		252,665,000	286,182,000	538,847,000

EXHIBIT A
Page 5 of 5

CITY AND COUNTY OF HONOLULU, HAWAII
Revenue Bonds, Series 2001
(SUI Plasma Technology Plant)

Assumptions

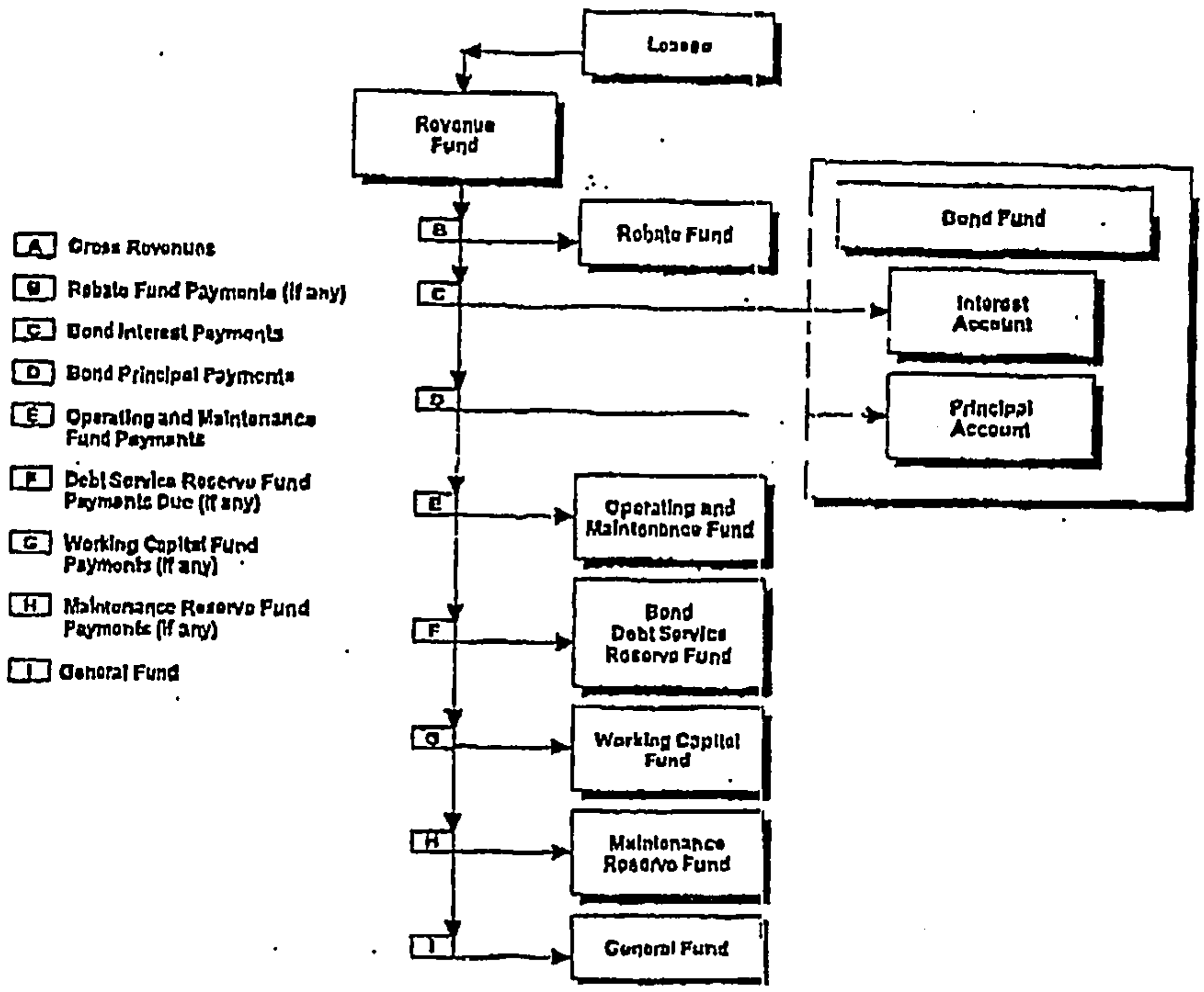
Construction period		
First six months	6	
Second six months	6	
Third six months	6	
Fourth six months	0	
Fifth six months	0	
Sixth six months	0	
Seventh six months	0	
Total construction period	18	months
Capitalized interest period	18	months
Interest only period	18	months
Amortization period tax-exempt bonds	20	years
Amortization period taxable Bonds	0	years

	% Items	$ Amounts
Interest Earnings Rate for DSR	0.00%	0
Interest Earnings Rate During Construction	5.00%	0
Estimated interest rate on tax-exempt Bonds	6.00%	0
Estimated interest rate on taxable Bonds	0.00%	0
Acquisition/Renovation	0.00%	0
Acquisition Related Expenses	0.00%	0
Architectural/Engineering Fees	0.00%	0
Bond Counsel Fee and Expenses	0.00%	0
Bond Purchaser's Counsel Fee and Expenses	0.00%	60,000
Bond Commission Fee	0.00%	0
Lessee's Counsel Fee and Expenses	0.00%	50,000
Lessee's Expenses	0.00%	0
Special Tax Counsel Fee and Expenses	0.00%	0
Closing, Travel, Hotels, and Meals	0.00%	25,000
Capitalized Interest	0.00%	0
Construction Costs	0.00%	183,750,000
Construction Monitor	0.00%	80,000
CUSIP, MSRB, Clearance, etc.	0.03%	0
Debt Service Reserve	0.00%	20,250,500
Development Coordinator's Fee	0.00%	8,750,000
Development Coordinator's Counsel Fee & Expenses	0.00%	50,000
Manager's Expenses	0.00%	0
Manager's Counsel Fee and Expenses	0.00%	0
Management Consulting Fee	0.00%	0
Environmental Report	0.00%	5,000
Equity Contribution	0.00%	0
Site Appraisal	0.00%	6,000
Facilities Inspection	0.00%	0
Facilities License Fee	0.00%	0
Financial Feasibility/Market Studies	0.00%	125,000
Financing Team Expenses	0.00%	60,000
Financial Advisor's Fee and Expenses	0.00%	0
Furniture, Fixtures & Equipment	0.00%	0
Investment Bankers' Counsel Fee and Expenses	0.25%	0
Investment Bankers' Expenses	0.00%	0
Investment Bankers' Fee	0.00%	7,879,950
Issuer's Administrative Fee	0.15%	0
Issuer's Counsel Fee and Expenses	0.00%	25,000
Land Acquisition Cost/Site Work	0.00%	0
Performance Bond Premium	0.00%	5,250,000
Printing and Binding of Documents	0.00%	15,000
Real Estate Counsel Fee and Expenses	0.00%	30,000
Retirement of Existing Debt	0.00%	0
Site Survey/Topographic Study	0.00%	8,500
Title Insurance and Recording Fees	0.00%	60,000
Trustee's Authentication and Acceptance Fee	0.00%	0
Trustee's Acceptance/Counsel Fee and Expenses	0.00%	27,500
Working Capital	0.00%	1,000,000
Contingency	0.00%	42,651

EXHIBIT B

CITY AND COUNTY OF HONOLULU, HAWAII
Revenue Bonds, Series 2001
(SUI Plasma Technology Plant)

FLOW OF FUNDS SUMMARY



Mayor .71

CONTRACT OFFER TO THE CITY AND COUNTY OF HONOLULU

TO: Mayor Jeremy Harris

FROM: Waste To Energy (WE) – Development Coordinator/Operator/Management
Scientific Utilization, Inc. (SUI) – Designer/Builder/Operator/Management
SAMCO CAPITAL MARKETS(PHN) – Investment Bank/Financing

1) Waste To Energy – Development Coordinator – A Hawaiian business will coordinate this offer to:
   - Design, build, operate, manage
   - Finance

2) Scientific Utilization, Inc. – Designer/Builder/Operator/Management and Maintenance

   Contract to build Plasma Technology processing facility to process 1,400 tons – 800tons/msw, 600tons/H-Power ash, and 32 tons dry sewage sludge with 36% moisture. This contract comes with an insurance surety bond guarantee for the performance of this facility.
   - This plasma technology has passed the California EPA Standard.
   - This facility makes it unnecessary to expand Waimanalo Gulch Landfill.
   - This facility will cost $190,000,000 to build, at NO COST to the City.
   - A requirement of 3-5 acres is needed. Ben Lee suggested a site adjacent to H-Power at Campbell Park.
   - No land, air, or water pollution.
   - This facility will not require fossil fuel.
   - This facility will take 18 months to build.
   - This facility will generate its own power and an excess of 40mgwt m/l.of saleable electricity.
   - This facility will generate $30-$40 million/year to be put back into the community.

2) SAMCO CAPITAL MARKETS/PHN – Investment bank

   A Letter of Intent has been provided to finance this facility:
   - At NO COST to Honolulu or Hawaii.
   - NO financial liability.

This offer qualifies as a "No Bid" offer but if Honolulu must RFP for a solution to process this 1,400 tons and 32 tons dry sewage sludge, WE recommends instead of a Limited RFP as been discussed, that the City puts out a RFP for the TOTAL TONNAGE Currently being dumped into Waimanalo Gulch Landfill.

Should there be a proposal that is environmentally and economically feasible, then the City is obligated to the people to issue such a contract for this proposal. One that has the possibility of eliminating Waimanalo Gulch Landfill or an expansion to that and any dumping of Municipal Solid Waste (MSW) and toxins into the aina. Studies show that the expansion of the landfill will cost millions of dollars to build and operate.

This is an offer to the City and County of Honolulu and to the people of Honolulu.

This is the only WIN-WIN solution on the table. The City should at least give this offer an opportunity to solve this problem. Should it not solve the problem, then the surety bond will reimburse the investment and Honolulu will still have the Waimanalo Landfill.

The City and County of Honolulu has **NOTHING** to lose with this offer.

Sincerely,

Waste To Energy

Equipment and Services Purchase Contract Between City and County of Honolulu, HI And Scientific Utilization Inc.

THIS CONTRACT is entered into by the City and County of Honolulu, HI and (herein after referred to as the Buyer) and by Scientific Utilization, Inc., an Alabama Corporation, located at 201 Electronics Boulevard SW, Huntsville, AL 35824, (herein after referred to as the Seller). Collectively referred to as the parties below.

RECITALS

A. Buyer desires to purchase from Seller a specifically configured SUI Waste to Energy Plant (herein after referred to as the Plant) for the purpose of destroying municipal solid waste and generating electrical power as outlined in the attached Scope of Supply and Plant Specification (Appendix 1). This contract will be executed in five Phases as follows:

B. Phase 1: Design and Specification of plant equipment, components and parts and permitting.
C. Phase 2: Procurement of plant equipment, components and parts.
D. Phase 3: Construction of plant inclusive of site work, physical plant erection, tie-ins to supporting utilities and construction testing.
E. Phase 4: Plant commissioning, inclusive of necessary integrated testing, staffing and training of plant personnel, development of necessary operations and maintenance procedures and direct support for the first thirty (30) days of operation.
F. Phase 5: Operation and Maintenance of the plant jointly by Waste to Energy, LLC a Hawaiian Corporation and SUI.

NOW, THEREFORE, in consideration of the mutual promises and covenants herein contained and other good and valuable consideration, it is agreed between the parties as follows:

1. SCOPE OF WORK. The Seller agrees to perform all services and provide all goods required to complete each Phase of the Contract as defined herein in a reasonable and timely manner. Specific work details and schedules will be developed by the Seller and reviewed and approved by the Buyer for each Phase. Seller shall notify Buyer of any problems concerning meeting the approved schedule milestones regardless of causing party or conditions. Seller shall implement the best available "work around"plan to minimize and/or recover any potential schedule delays. Buyer and his development team will support Seller in the timely and cost effective preparation of the designated site to insure that all required site interfaces, facilities and equipment are installed and fully operational, prior to delivery of Sellers equipment and/or Plant to the site.

2. COMPENSATION. In consideration of the design, engineering, purchase of equipment, construction and training efforts of each Phase, the Buyer shall pay the Seller the sums listed in Appendix 2 according to the terms and conditions of Appendix 2. All transactions shall be in United States of America (USA) dollars executed by wire transfer to the Sellers designated bank in the USA or by certified check mailed directly to Seller.

3. CHANGES. Upon prior approval of the Seller, the Buyer may at certain times direct changes, or cause the Seller to make changes, to drawings, specifications or manuals for the Plant or to otherwise change the scope of work covered by this contract, including work with respect to such matters as inspection, testing or quality control. Any difference in price or time for performance resulting from such changes shall be reviewed in good faith and approved by the Buyer and Seller, prior to implementation of such changes.

4. FORCE MAJEURE. Any delay or failure of the either party to perform its obligations under this Contract shall be excused if, and to the extent that it is caused by, an event or occurrence beyond the reasonable control of the party and without its fault or negligence, including, but not limited to, acts of God, actions by any governmental authority (whether valid or invalid), fires, floods, windstorms, explosions, riots, natural disasters, wars, sabotage, labor problems (including lockouts, strikes and slowdowns), inability to obtain power, material, labor, equipment or transportation, or court injunction or order, provided that written notice of such delay (including the anticipated duration of the delay) shall be given by the party as soon as possible after the event or occurrence. When involved in site preparation activities or local import/export procedures, or other Contract activities supported by either party, throughout the delay period, each party will fully assist the other party in resolving all local problems as quickly as possible.

5. WARRANTY. Seller warrants that Plant equipment will meet the performance and configuration/operational requirements of Appendix 1 for a period of 30 operating days from Plant start up, provided that the Plant is maintained according to Seller's instructions and manuals. Seller also warrants the cost of all parts for equipment designed and built by Seller to be free of defects in workmanship and performance for a period of one year from Plant start up. Seller also passes on to the Buyer, at no cost, all existing warranties for equipment obtained by Seller from third party vendors.

6. . OPERATION AND MAINTENANCE (O & M). The Seller jointly with Waste to Energy, LLC shall be responsible for training of the O & M personnel for the supplied Plant for the life of the Plant. The design life of the Plant is 20 years with proper maintenance. The Seller will continuously work with the Buyer and its development team to minimize O & M costs and maximize Plant performance, throughout the life of the Plant.

7. . TERMINATION FOR BREACH OR NONPERFORMANCE. Either party reserves the right to terminate all or any part of this contract, without liability to the other party, if the offending party: (a) repudiates or breaches any of the terms of this Contract; (b) fails to perform services, payment or delivery of goods as specified in this Contract; (c) fails to make progress so as to endanger timely and proper completion of this Contract and does not correct such failure or breach within 40 working days after receipt of written notice from the injured party specifying such failure or breach.

8. .INTELLECTUAL PROPERTY. The Buyer understands and agrees that Seller claims ownership in all technology and technical information disclosed to Buyer and/or inherently contained in Seller's equipment, manuals or other data or information (including verbal) disclosed to Buyer. Buyer agrees that, to allow Seller time to fully file its pending patent applications, all information disclosed from Seller to Buyer shall be kept strictly confidential for the life of the plant and shall not be disclosed to any third parties during that period without first obtaining approval from Seller. By entering into this Contract, the Seller does not grant to the Buyer any license to use the Seller's technology for any other purpose. No granting of a license to manufacture the Seller's technology is made or implied by this Contract. If Buyer or a third party associated with the Buyer wishes to obtain licensing rights for use of Seller's technology, the Seller agrees to negotiate in good faith for a royalty bearing license to Buyer or to the third party associated with Buyer, to make, use of and/or market Seller's technology or products for use in an appropriate market segment.

9. INDEMNIFICATION.

(a) Seller agrees that it will indemnify, defend and hold harmless Buyer from and against any and all claims, liabilities, obligations, suits, judgments, damages, expenses or costs (including reasonable attorneys' fees) (the following being individually and collectively referred to herein as "Liabilities") which may be asserted against or incurred by Buyer to the extent that such Liabilities result from third party claims arising out of (i) the negligent act or omission or willful misconduct of Seller in performing services herein, or (ii) the breach by Seller of this Agreement.

(b) Buyer agrees that it will indemnify, defend and hold harmless Seller from and against any and all Liabilities which may be asserted against or incurred by Seller to the extent that such Liabilities result from third party claims arising out of (i) the negligent act or omission or willful misconduct of Buyer in performing services herein or (ii) the breach by Buyer of this Agreement.

10. INSURANCE. Seller shall maintain insurance coverage as usual and customary for Seller's industry and Contract value of equipment. Copies of Insurance Certificates of both Buyer and Seller shall be made available upon request.

11. LIMITATION OF LIABILITY. Under no circumstances shall either party be liable for indirect, special, incidental, consequential, punitive or exemplary damages arising out of breach or nonperformance of this Contract except as determined by a governing Alabama Court or arbitrator.

12. REMEDIES. The rights and remedies of the parties in this contract shall be cumulative with and additional to all other or further remedies provided in law or equity.

13. CUSTOMS; EXPORT & IMPORT CONTROLS. Any tax incentives or savings attributable to this project, in this location, shall be made available to the Seller.

14. ADVERTISING. Both parties shall be allowed to include the other parties' name and address on its routine client list as a matter of reference. Each party shall also be allowed to use any general promotional material provided by the other party for the purpose of describing that parties' equipment and/or capabilities. However, neither party shall, without first obtaining the written consent of the other party, engage in any manner of advertising or publish the fact that the other party has contracted to furnish specific goods or services covered by this Contract, or use any trademarks or trade names of the other party in advertising or promotional materials. Neither party shall use, in its external advertising, marketing programs, or other promotional efforts, any data, pictures, or other representation of the other parties equipment, services or capabilities except on the specific written authorization of both parties.

15 MARKETABILITY AND COMPLIANCE The Seller shall fully support the Buyer and his development team in efforts to insure that any and all, goods or services supplied by either party, shall be fully marketable and comply with all applicable laws, rules, regulations, orders, conventions, ordinances or standards of the country or that relate to the design, engineering, manufacture, labeling, transportation, importation, exportation, operation, licensing, approval or certification of the goods or services, including, but not limited to, those relating to environmental matters, wages, hours and conditions of employment, subcontractor selection, discrimination, occupational health/safety and operational safety. Seller represents that it will supply the Buyer with all requested information necessary for the Buyer and his development team to insure such full and complete marketability and compliance.

16. NO IMPLIED WAIVER The failure of either party at any time to require performance by the other party of any provision of this contract shall in no way affect the right to require such performance at any time thereafter, nor shall the waiver of either party of a breach of any provision of this contract constitute a waiver of any succeeding breach of the same or any other provision.

17. NON-ASSIGNMENT. Neither party may assign or delegate its obligations under this Contract without the other party's prior written consent.

18. GOVERNING LAW; JURISDICTION: This Contract is to be construed according to the laws of the State of Alabama, of the United States of America. Any action or proceeding by either party must be brought in state or federal court in Alabama having jurisdiction over Seller.

19. SEVERABILITY. If any term(s) of this Contract is invalid or unenforceable under any statute, regulation, ordinance, execution order or other rule of law, such term(s) shall be deemed referred or deleted, as the case may be, but only to the extent necessary to comply with such statute, regulation, ordinance, order or rule, and the remaining provisions of this Contract shall remain in full force and effect.

20. ENTIRE AGREEMENT. This Contract together with the attachments, exhibits, supplements or other terms specifically referenced, constitutes the entire agreement between Seller and Buyer with respect to the matters contained in this Contract and supersedes all prior oral or written representations and agreements. This Contract may only be modified in written form signed by duly authorized personnel of both Buyer and Seller.

21. COUNTERPARTS. This Contract may be executed in any number of counterparts, each of which shall be an original, but all of which together shall constitute one instrument. The authentic signature of any party received by facsimile transmission shall constitute a valid and binding signature of such party. Both Buyer and Seller certify that the person(s) signing this Contract below are fully authorized to commit their Company to this Contract.

IN WITNESS WHEREOF, the parties have executed this Contract as of the date below.

BUYER:	SELLER:
City and County of Honolulu, HI	SCIENTIFIC UTILIZATION, INC.
By:	By:
Name:	Name: Keith Bucher
Title:	Title: President and COO
Date:	Date:

APPENDIX 1

Waste to Energy Plant

Performance Specification and

Scope of Supply

Performance Specifications

1. **Throughput:** Up *to fourteen hundred thirty tons per 24 hour day* based upon characteristics of waste (to be specified by Buyer). Buyer specifies chemical analysis of each waste stream for evaluation and approval by Seller.

2. **Hazardous Waste Capability:** not applicable

3. **Material Processing:** Unique, *custom designed solids material processing Plant* transforms most solid waste into a synthesis gas (SYN-Gas) for direct use as a fuel for electrical turbine generator units.

4. **Plant Waste Streams:** Air emissions will meet all applicable local emissions standards. Local air emissions standards to be provided by Buyer.

5. **Advanced Thermal Process:** For each approved waste stream, the Thermal Conversion System shall be able to process up to 800 tons/hr MSW, 30 tons/hr dried sludge and 600 tons/hr ash.

6. **Electrical Power Systems:** Turbine-generators will provide plant operational power, after plant start-up. Total electrical power produced is anticipated to be forty three (43) megawatts/hr (MW/hr). Electrical power available for sale to "the grid" is projected at greater than thirty-eight (38) MW/hr.

I. Scope of Supply

1. **Seller Scope of Supply:**
   a. Site work including, roads, fencing, plant office and maintenance buildings, as typical for an electrical generation plant and waste handling plant.
   b. Thermal Conversion Plant
   c. Waste Heat Recovery Steam Generators and associated electrical Turbine Generator and support sub-systems.
   d. SYN-Gas processing equipment
   e. SYN-Gas powered electrical Turbine Generator
   f. Exhaust Gas Treatment subsystems
   g. Plant Utilities Support Equipment
   h. Plant Motor Control Units and Switchgear
   i. Plant Controller, Control Room and Software
   j. Plant Data Recording Unit and Software
   k. Exhaust Gas Monitoring sub-systems
   l. Plant Structure
   m. Plant Piping and Instrumentation
   n. Plant Interface Support Equipment and Hookups
   o. Waste Staging and Transfer Equipment
2. **Buyer Scope of Supply:**
   Site property and support for coordination and sale of excess electrical power.

Appendix 2

Compensation

Terms and Conditions

Terms and Conditions for Plant Deployment and Revenue Sharing Operations (All Amounts Below are in U.S. Dollars)

Deployment Payment Terms*

Payment Milestone		
Signing of Contract	10%	$19,000,000
Start of Engineering and Detailed Design	10%	$19,000,000
Start of site work and civil Construction	10%	$19,000,000
Completion of Equipment Specifications	10%	$19,000,000
Start of Purchasing for Equipment, etc.	20%	$38,000,000
Construction – Incremental Payments	30%	$57,000,000 *
Start-up and Commissioning Complete	10%	$19,000,000 **
Total Installed Cost	100%	$190,000,000

- * Monthly Construction payments incrementally made according to the agreed to schedule. The 30% payment will be divided by the planned number of months for construction.
- ** Upon the completion of start-up and electrical generation to "the local electrical grid" *the full amount for final 10% is due and payable.*

Revenue Sharing Payment Terms

1. A target fee of ten (10%) per cent of plant net revenues per year shall be paid jointly to the Seller and Waste to Energy LLC, a Hawaiian Corporation, for life of plant. This fee shall be paid monthly.
2. Actual fee paid based upon level of success in achieving approved plant performance and operational efficiency criteria.

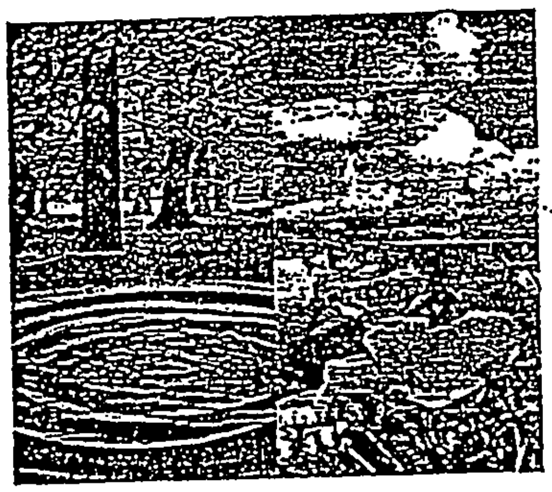
Operation and Maintenance Contract Option
Payment Terms

1. The Seller with Waste to Energy LLC, a Hawaiian corporation, jointly agree to provide full services for operations and maintenance. Full payment for O & M costs are made monthly to Seller and Waste to Energy, LLC.
2. This fee for O & M is included in the 10% net revenue sharing as previously stated. However, if the revenue sharing is pro-rated, due to lack of plant performance, the 1% O & M fee is still payable on a regular monthly basis.
3. O & M operations fees of one (1) per cent of the 10% of revenue sharing shall be paid monthly within thirty (30) days after the end of each month.
4. Seller will provide training to selected plant staff for operation and management.

Proposal for City and County of Honolulu, Hawaii
Plasma Waste to Energy Plant
Fourteen Hundred tons / day,
Municipal Solid Wastes

- EXECUTIVE SUMMARY -

Waste Reduction



Clean Emissions

Proposal for SUI Plasma
Waste to Energy Plant for City and County of Honolulu, Hawaii

1.0 Project Overview

Scientific Utilization, Inc. will design and install a Municipal Solid Waste (MSW) processing plant that will utilize the latest thermal disassociation technology for conversion of waste to energy. SUI will be the project manager for design, construction and test certification of the specially designed Pyro-Electric Thermal Conversion (PETC) reactor. The reactor is sized for receiving and converting Fourteen Hundred (1430) tons per day of waste (800 tons per day of MSW, 600 tons per day of Ash, and 30 tons per day of dry sewage sludge), into a high temperature, combustible synthesis gas (Syn-gas). Heat from the plasma reaction process and the gas turbine exhaust will convert water to steam to power a steam turbine power generator unit. The Syn-gas will be the fuel for a gas turbine power generator unit. This combined cycle system, in conjunction with the patented SUI thermal conversion process, will make the most efficient and cost effective cogeneration plant available today. The system can provide electrical power to operate internal co-generation plant equipment while providing substantial excess power for sale to the electrical distribution network.

The Co-generation Plant design will operate 24 hours per day, 354 days per year. System design life is 20 years with proper maintenance. This Plant will be capable of full, fail-safe, computer control with built-in-test software and system operational.performance and safety lockouts. Five qualified technicians per shift are required to operate the Thermal Conversion Plant and Power Generator Units. Material Handling and Processing equipment associated with the existing Landfill provides additional personnel positions. New jobs are created as outlined in subsequent Sections. Upon completion of engineering and construction, SUI will train all candidate operating personnel and / or contract for operations and maintenance assistance.

Critical System lockouts include real time monitoring and control of:

1. Thermal Balance and Destruction Rate
2. Emissions Quality
3. Mechanical Integrity and Leak Detection
4. Electrical Integrity, with Voltage and Current Level Lockouts

Plant assembly on-site can begin in the tenth month from contract authority to proceed. Full Plant assembly and certification testing is scheduled for month 18. Included is a top-level schedule for your review.

SUI guarantees Plant performance and electrical output for the specified MSW feed-stream. We provide a 24-hour per day hot line for Plant operation and maintenance questions.

Major Equipment List and Scope of Supply:

Scope of Supply by SUI:
- PETC Reactor
- Power Supplies / Controllers
- Heat Recovery Steam Generator for energy recovery from Syn-gas
- Heat Recovery Steam Generator for energy recovery from Turbine
- Gas Scrubber with exhaust stack
- Feed System
- Structural steel equipment supports and access platforms
- System Controller including industrial computer
- Power Supply cabinets, breakers, and cable
- Instrumentation, wiring and conduit
- Miscellaneous pumps, heat exchangers, fans, valves, piping, etc.
- Engineering and Design including Equipment manuals and procedures
- Installation, Integration and Testing
- Building to house electrical panels and controls and / or complete system
- Permits, if needed (SUI will provide engineering support)
- Environmental testing contractor (SUI to provide coordination)
- Process water supply
- Electrical power supply
- NaOH for Scrubber start-up operation
- Tipping floor / storage building for staging waste

Scope of Supply by Client:
Site with access roads, parking, office building, control building, etc.

Economic Analysis of City and County of Honolulu Plant Operation.

Design-Build Construction Cost	$190,000,000
Plant Capacity for Conversion of MSW	1400 tons per day
Number of SUI Reactor Units	4
Assumed Tipping Fee	$65.00 per ton (1% escalation)
Electricity Rate	$80.00 per Mega-watt
Total Electrical Capacity	43.23 Mega-Watts / hour
Net Electricity available to sale to "the Grid"	38.91 Mega-Watts / hour

Preliminary Schedule

Months 1-4:
- Signing of contracts
- Engineering & Permits
- Site work, roads, office and service buildings construction
- Plant structure started
- Procurement started

Months 5,6:
- Complete engineering drawings and specifications
- Expedite equipment, components, parts and construction materials.
- Start construction.

Months 7-16
- Construction

Months 17-18
- Plant Start-up Testing

Projected Cash Flow

Contract Milestone	Amount of Payment	
1. Sign Contract and Start Engineering:	20% =	$ 38,000,000
2. Complete Equipment Spec's, start Procurement:	30% =	$ 57,000,000
3. Complete Procurement Start On-site Installations:	20% =	$ 38,000,000
4. Completion of Installations:	20% =	$ 38,000,000
5. Completion of Certification Testing:	10% =	$ 19,000,000
	100% =	$190,000,000

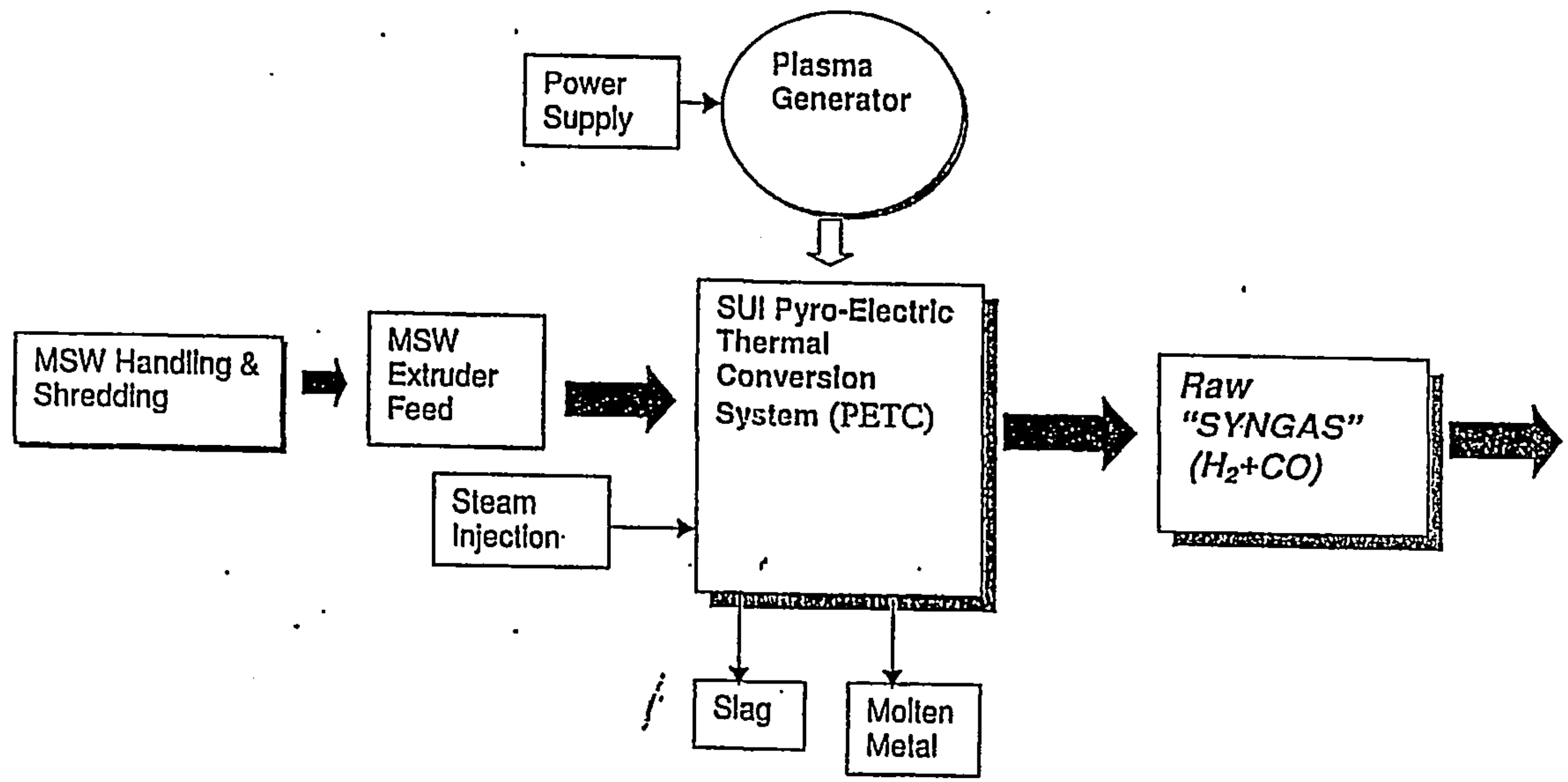
Jobs and Income Created by the City and County of Honolulu Project:

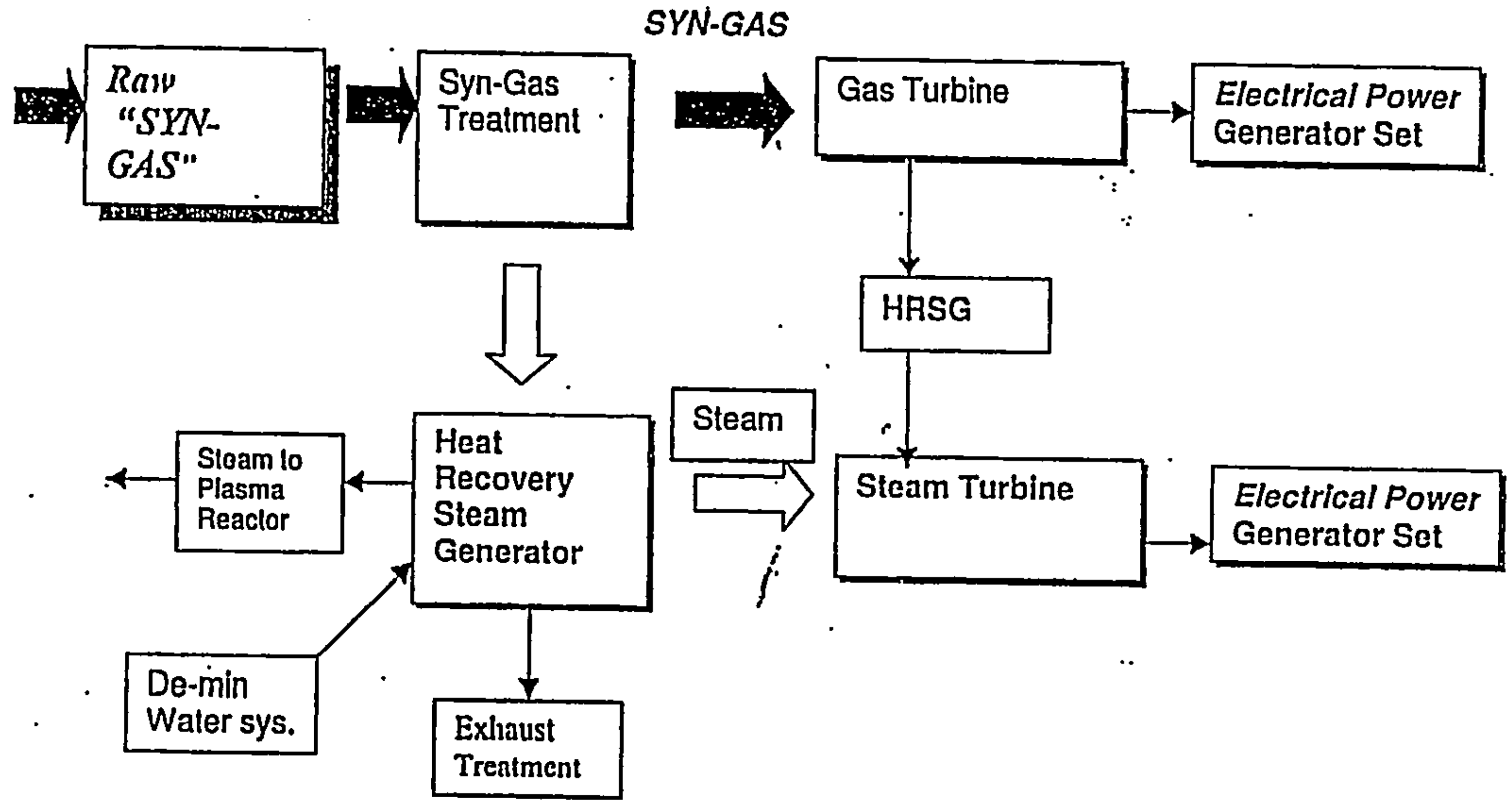
TEMPORARY JOBS DURING CONSTRUCTION = 300
PERMANENT PLANT JOBS = 48

Description of Construction Contracts for the City and County of Honolulu Plant (Additional Income for the area)

Civil Engineering and Surveying:	$ 15,000
Site Preparation, grading, roads, drainage, etc.	$ 300,000
Paving, fencing, lighting, Utilities	$ 450,000
Administration and shop buildings (separate)	$ 150,000
Landscaping	$ 175,000
Temporary Construction Power	$ 150,000
Plant Electrical tie-ins	$ 500,000
Structure and Concrete for Tipping Area	$ 950,000
Local Trades and Labor (200,000 man-hours)	$10,000,000
Local Supply of Construction Materials	$4,500,000
LOCAL CONSTRUCTION CONTRACTS:	$17,190,000

SUI Waste to Energy Plant – Simplified Block Diagram – page 1




SYN-GAS
Raw "SYN-GAS"
Syn-Gas Treatment
Gas Turbine
Electrical Power Generator Set
HRSG
Steam
Steam Turbine
Electrical Power Generator Set
Steam to Plasma Reactor
Heat Recovery Steam Generator
De-min Water sys.
Exhaust Treatment

PROJECT NAME: **City and County of Honolulu, 1400 Tons per day Cogen Plant**
PROJECT NUMBER:
DATE: 06/01/01

6.5m eq. for aid

SOURCE OF FUNDS:

Debt			$0

USE OF FUNDS

Turnkey construction cost			$100,000,000
Development cost			$0
Soft costs (ins, legal, underwrtg, etc)			$0
Interest during construction			$0
Working Capital			$0
Maintenance reserve			$0
Contingency reserve			$0
TOTAL			$190,000,000
Debt per annum interest rate	8%		

ASSUMPTIONS

1. Design plant throughput in tons/day	>	830	
2. Hourly design throughput of MSW for plant		34.58333333	
3. Average yearly availability per reactor	>	97%	
4. Average hourly throughput per reactor, incl. downtime		8.645833333	
5. Average daily throughput per reactor		207.5	
6. Average yearly throughput per reactor		71251.35	
7. Number of online reactors in plant		4	
8. Total Average hourly throughput for this plant	>	34.58333333	
9. Total average daily throughput for this plant		830	
10. Total average yearly througput for this plant		285005.4	
11. guaranteed MSW tonnage		830	
12. Heat content of MSW in BTU/lb		4500	
13. Tipping fee - per ton		$65.00	
14. Tipping fee escalator		1%	1.01
15. Electric Rate	>	$80.00	
16. Electric/Commodity rate escalator		1%	1.01
17. Percentage of slag in waste		15%	
18. Percentage of metal in waste		5%	
19. Selling price per ton of slag	>	$10.00	
20. Selling price per ton of metal	>	$50.00	
23. Gas production - per ton of waste in cu. ft.	>	30000	
24. BTU content per SCF of gas	>	300	
25. Total gas production- per hour		1037500	
26. Total Electrical production in MW/hr		43.23	
27. Electricity available for sale		38.01	
28. Tons of CO2 produced per ton of MSW (normal= 0.15)		0.15	
29. Resale price per ton of CO2		$0.00	
30. Heat rate for elect. prod. in BTU/KW	>	7200	
31. Power available for resale as % of total	>	90%	
32. CPI escalator - estimated fixed rate	>	3%	1.03

CASHFLOW ANALYSIS

Tons per day	830	Tipping fee - price per ton:		tons/day	
Electric rate per MegaWatt	$80.00		> MSW	$65	830
Tipping Fee per ton of waste	$65.00		> sludge	$25	0
Net MegaWatts for sale	39		> biomed	$30	0
Sale price for residual slag	$10.00		> hazwaste	$50	0
Sale price for iron pig	$50.00		> tires	$25	0
Sale price for CO2	$0.00		Average/ton	$65	

REVENUES	YEAR	FIRST	SECOND	THIRD	FOURTH	FIFTH	SIXTH	SEVENTH
Sale of electricity		$26,443,800	$26,708,238	$26,975,320	$27,245,074	$27,517,524	$27,792,700	$28,070,627
Tipping fees		$19,008,300	$19,289,283	$19,482,176	$19,676,998	$19,873,768	$20,072,505	$20,273,230
Sale of slag		$440,730	$445,137	$449,589	$454,085	$458,625	$463,212	$467,844
Sale of pig		$734,550	$741,896	$749,314	$756,808	$764,376	$772,019	$779,740
Sale of CO2		$0	$0	$0	$0	$0	$0	$0
TOTAL REVENUES		$46,717,380	$47,184,554	$47,656,399	$48,132,963	$48,614,293	$49,100,436	$49,591,440
OPERATING COSTS								
Total plant wages - 3 shifts		$1,210,000	$1,246,300	$1,283,689	$1,322,200	$1,361,866	$1,402,722	$1,444,803
Office expenses		$95,000	$97,850	$100,786	$103,809	$106,923	$110,131	$113,435
Reactor plant maintenance		$100,000	$103,000	$106,090	$109,273	$112,551	$115,927	$119,405
Electric plant maintenance		$200,000	$206,000	$212,180	$218,545	$225,102	$231,855	$238,810
Insurance, Legal, Acct		$150,000	$154,500	$159,135	$163,909	$168,826	$173,891	$179,108
Natural Gas, Diesel Fuel		$100,000	$103,000	$106,090	$109,273	$112,551	$115,927	$119,405
TOTAL Operating Costs		$1,855,000	$1,910,650	$1,967,970	$2,027,009	$2,087,819	$2,150,453	$2,214,967
GROSS OPERATING CASHFLOW		$44,862,380	$45,273,904	$45,688,430	$46,105,955	$46,526,474	$46,949,982	$47,376,473
INTEREST ON DEBT		$15,200,000	$14,440,000	$13,680,000	$12,920,000	$12,160,000	$11,400,000	$10,640,000
NET CASHFLOW AFTER INT. PYMT:		$29,662,380	$30,833,904	$32,008,430	$33,185,955	$34,366,474	$35,549,982	$36,736,473
PRINCIPAL PAYMENT								
Beginning Balance		$190,000,000	$180,500,000	$171,000,000	$161,500,000	$152,000,000	$142,500,000	$133,000,000
Payment		$9,500,000	$9,500,000	$9,500,000	$9,500,000	$9,500,000	$9,500,000	$9,500,000
Ending Balance		$180,500,000	$171,000,000	$161,500,000	$152,000,000	$142,500,000	$133,000,000	$123,500,000
NET AFTER PRINCIPAL CASHFLOW:		$20,162,380	$21,333,904	$22,508,430	$23,685,955	$24,866,474	$26,049,982	$27,236,473
Cummulative cash		$20,162,380	$41,496,284	$64,004,714	$87,690,668	$112,557,143	$138,607,125	$165,843,598

EIGHT	NINTH	TENTH	ELEVENTH	TWELVTH	THRTNTH	FORTNTH	FIVTNTH	SIXTEEN	SVNTEEN
$28,351,333	$28,634,846	$28,921,195	$29,210,407	$29,502,511	$29,797,536	$30,095,511	$30,396,466	$30,700,431	$31,007,435
$20,475,963	$20,680,722	$20,887,529	$21,096,405	$21,307,369	$21,520,442	$21,735,647	$21,953,003	$22,172,533	$22,394,259
$472,522	$477,247	$482,020	$486,840	$491,709	$496,626	$501,592	$506,608	$511,674	$516,791
$787,537	$795,412	$803,367	$811,400	$819,514	$827,709	$835,986	$844,346	$852,790	$861,318
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$50,087,355	$50,588,228	$51,094,110	$51,605,052	$52,121,102	$52,642,313	$53,168,736	$53,700,424	$54,237,428	$54,779,802
$1,488,147	$1,532,792	$1,578,776	$1,626,139	$1,674,923	$1,725,171	$1,776,926	$1,830,234	$1,885,141	$1,941,695
$116,838	$120,343	$123,953	$127,672	$131,502	$135,447	$139,511	$143,696	$148,007	$152,447
$122,987	$126,677	$130,477	$134,392	$138,423	$142,576	$146,853	$151,259	$155,797	$160,471
$245,975	$253,354	$260,955	$268,783	$276,847	$285,152	$293,707	$302,518	$311,593	$320,941
$184,481	$190,016	$195,716	$201,587	$207,635	$213,864	$220,280	$226,888	$233,695	$240,706
$122,987	$126,677	$130,477	$134,392	$138,423	$142,576	$146,853	$151,259	$155,797	$160,471
$2,281,416	$2,349,859	$2,420,354	$2,492,965	$2,567,754	$2,644,786	$2,724,130	$2,805,854	$2,890,030	$2,976,730
$47,805,939	$48,238,370	$48,673,756	$49,112,087	$49,553,348	$49,997,527	$50,444,606	$50,894,570	$51,347,398	$51,803,072
$9,880,000	$9,120,000	$8,360,000	$7,600,000	$6,840,000	$6,080,000	$5,320,000	$4,560,000	$3,800,000	$3,040,000
$37,925,939	$39,118,370	$40,313,756	$41,512,087	$42,713,348	$43,917,527	$45,124,606	$46,334,570	$47,547,398	$48,763,072
$123,500,000	$114,000,000	$104,500,000	$95,000,000	$85,500,000	$76,000,000	$66,500,000	$57,000,000	$47,500,000	$38,000,000
$9,500,000	$9,500,000	$9,500,000	$9,500,000	$9,500,000	$9,500,000	$9,500,000	$9,500,000	$9,500,000	$9,500,000
$114,000,000	$104,500,000	$95,000,000	$85,500,000	$76,000,000	$66,500,000	$57,000,000	$47,500,000	$38,000,000	$28,500,000
$28,425,939	$29,618,370	$30,813,756	$32,012,087	$33,213,348	$34,417,527	$35,624,606	$36,834,570	$38,047,398	$39,263,072
$194,269,537	$223,887,907	$254,701,663	$286,713,750	$319,927,098	$354,344,624	$389,969,231	$426,803,800	$464,851,199	$504,114,270

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EIGTEEN	NINTEEN	TWNTY
$31,317,510	$31,630,685	$31,946,991
$22,618,201	$22,844,383	$23,072,827
$521,958	$527,178	$532,450
$869,931	$878,630	$887,416
$0	$0	$0
$55,327,600	$55,880,876	$56,439,685
$1,999,946	$2,059,944	$2,121,742
$157,021	$161,731	$166,583
$165,285	$170,243	$175,351
$330,570	$340,487	$350,701
$247,927	$255,365	$263,026
$165,285	$170,243	$175,351
$3,066,032	$3,158,013	$3,252,754
$52,261,568	$52,722,863	$53,186,931
$2,280,000	$1,520,000	$760,000
$49,981,568	$51,202,863	$52,426,931
$28,500,000	$19,000,000	$9,500,000
$9,500,000	$9,500,000	$9,500,000
$19,000,000	$9,500,000	$0
$40,481,568	$41,702,863	$42,926,931
$544,595,838	$586,298,701	$629,225,632

BASIC COSTS		
System design and detailed engineering	>	$190,000,000
plasma system		$0
Reactor, feeder, extractors, etc.		$0
Gas treatment system		$0
Installation - does not include land costs		$0
Misc. (Add'l equpmt)		$0
Co-generation equipment	>	$0
TOTAL		$190,000,000

OVERHEAD		
Operations	>	$850,000.00
Engineering Mgt		$100,000.00
Telephone		$10,000.00
Benefits		$195,000.00
Expendables		$35,000.00
misc		$20,000.00
TOTAL		$1,210,000

SAMCO CAPITAL MARKETS
A Division of Service Asset Management Company

VIA FACSIMILE 808-732-9751
and U.S. POSTAL SERVICE

July 2, 2001

Mr. Bryan H. K. Ha'o
Managing Director, Hawaiian Group
Waste to Energy
916 21st Avenue
Honolulu, Hawaii 96839

RE: [ISSUER TO BE DETERMINED]
Revenue Bonds, Series 2001A
(Municipal Solid Waste Cogeneration Plant)

Dear Mr. Ha'o:

This letter constitutes a commitment of SAMCO Capital Markets, a Division of Service Asset Management Company (SAMCO), and PHN Capital Funding Inc. (PHN) to purchase or place an issue of debt securities (the Bonds) proposed to be issued by a to-be-determined issuer qualified to issue tax-exempt and/or taxable debt securities under the Constitution and laws of the State of Hawaii (the Issuer) for the hereinafter described project.

The interest on the Series 2001 Bonds will be tax-exempt to the owners thereof for federal income tax purposes and from State of Hawaii income taxes for qualified investors.

The proceeds from the sale of the Bonds will be used (1) to finance the design, development, construction, and equipping of: (1) a combined municipal solid waste cogeneration plasma facility with an auxiliary ash destruction unit designed to process 800 tons/msw, 600 tons/H-Power ash and dried sewage sludge for the benefit of the City of Honolulu, Hawaii, and located in Honolulu County, Hawaii (collectively, the Project); (2) to fund capitalized interest during the 18-month construction period and start-up of operations of the Project; (3) to fund certain reserves; and (4) to pay related costs of issuance. It is our understanding that the Project will be developed by Scientific Utilization, Inc. (SUI) and the Waste to Energy, Hawaiian Group (the Development Coordinator), owned by the Issuer, and leased and managed by the Development Coordinator, each of which entities has expertise in the development and management of the respective components of the Project.

The Development Coordinator will be responsible for the overall development of the Project and will, therefore, be responsible for the selection of various professionals to serve as advisors/consultants to the Issuer (including specifically the investment bankers).

Closing of the financing shall take place as soon as practicable after all conditions for closing (as hereinafter described) have been met to the satisfaction of SAMCO, PHN, the Issuer, and the Development Coordinator.

The Bonds will be issued pursuant to the terms of a bond resolution to be adopted by the Issuer and shall conform in all respects to the Constitution and laws of the State of Hawaii. The Issuer's liability with respect to the Bonds will be limited to the revenues received by it from the operation of the Project. In addition, the Issuer's interest in the Project will be pledged to a trustee bank for the benefit of the bond owners pursuant to the terms of a mortgage and security agreement. NEITHER THE ISSUER, THE CITY OF HONOLULU, THE COUNTY OF HONOLULU, OR THE STATE OF HAWAII SHALL BE RESPONSIBLE FOR THE REPAYMENT OF THE PRINCIPAL OF OR THE INTEREST ON THE BONDS, OR FOR THE COST OF OPERATIONS RELATING TO THE PROJECT.

The Bonds will be registered bonds in minimum denominations of $100,000 each and integral multiples in excess thereof and marketed to qualified institutional investors. The interest rate or rates on the Bonds and maturity schedule for the Bonds shall be determined by SAMCO and PHN based upon their judgment under prevailing market conditions. At this time, the interest rate or yield on the proposed tax-exempt Bonds should not exceed 8.50% for a non-rated, high-yield transaction with a 30-year stated maturity. SEE preliminary estimated sources and uses of funds with supporting schedules and flow of funds summary attached hereto as Exhibits A and B, respectively—for discussion purposes only.

The obligation of SAMCO and PHN to purchase or place the Bonds shall be subject to the satisfaction at or prior to closing of the following conditions:

A. The information provided to SAMCO and PHN by the Issuer, SUI, and the Development Coordinator relating to the Project shall have been accurate in all material respects.

B. The Issuer shall have duly authorized:

(i) the form, terms, and issuance of the Bonds and the offering documents relating thereto,
(ii) the indenture of trust between the Issuer and the trustee (the Indenture),
(iii) the lease agreement between the Issuer and the Development Coordinator (the Lease), and
(iv) related security documents.

C. The Issuer shall have received an unqualified opinion of nationally recognized bond counsel to the effect that:

(i) the issuance of the Bonds is exempt from registration under the provisions of the Securities Act of 1933, as amended, and under the provisions of all other applicable Federal and state securities laws, and
(ii) the Indenture is exempt from qualification under the Trust Indenture Act of 1939, as amended.

D. SAMCO, PHN, and their counsel shall have approved the Indenture, the Lease, and all related security, financing, and offering documents and legal opinions.

E. SAMCO, PHN, and their counsel shall have received an environmental assessment report (Phase I) for the Project site addressed to the trustee by an environmental consultant or engineer acceptable to SAMCO, PHN, the Issuer, SUI, and the Development Coordinator.

F. *SAMCO, PHN, and their counsel shall have received an appraisal relating to the Project site addressed to the trustee by an MAI appraiser acceptable to SAMCO, PHN, the Issuer, SUI, and the Development Coordinator.*

G. *SAMCO, PHN, and their counsel shall have received a financial feasibility report and market analysis from a financial feasibility consultant acceptable to SAMCO, PHN, the Issuer, SUI, and the Development Coordinator, to the effect that the net revenue generated from the Project, after deduction of operating expenses, will be at least a sufficiently high multiple to enable:*

(i) *SAMCO and PHN to market or place the Bonds, and*
(ii) *the Project to adequately service the debt on the Bonds over the life of the Bonds.*

SAMCO and PHN expect to be in a position to close the proposed financing within one hundred twenty (120) days following the appointment of the Development Coordinator's design/build/finance team by representatives of the City of Honolulu and the Issuer to undertake the Project, with the cooperation of the Issuer, SUI, and the Development Coordinator..

Yours sincerely,

Patricia Hewitt Newman
On Behalf of
SAMCO Capital Markets, a Division of
SERVICE ASSET MANAGEMENT COMPANY, and
PHN CAPITAL FUNDING INC.

/PHN
Attachments
Exhibit A: *Estimated Sources and Uses of Funds with Supporting Schedules*
Exhibit B: *Flow of Funds Summary*

pc: *Keith Bucher, President & COO, Scientific Utilization, Inc., Huntsville, AL*
Kenneth N. Burns, President, Industrial Capital Funding, Inc., Marietta, GA
Roger J. Engemoen, Jr., President, SAMCO Capital Markets, Austin, TX
Diane M. Harmon, Vice President, SAMCO Capital Markets, Atlanta, GA
John E. Theberge, Esq., Holland & Knight LLP, Washington, DC
Donald P. Ubell, Esq., Parker, Poe, Adams & Bernstein, L.L.P., Charlotte, NC
Michael G. Wadsworth, Managing Director, SAMCO Capital Markets, Dallas, TX

CITY OF HONOLULU, HAWAII
Revenue Bonds, Series 2001
[ISSUER TO BE DETERMINED]

Estimated Sources and Uses of Funds

	Series 2001 Tax-Exempt Revenue Bonds	Total
SOURCES OF FUNDS:		
Bond Proceeds	$269,975,000	$269,975,000
Equity Contribution (Project Site) (1)	0	0
Interest on Available Funds (2)	12,801,982	12,801,982
TOTAL	$282,776,982	$282,776,982
USES OF FUNDS:		
Acquisition and Construction Fund:		
Acquisition and Construction Costs	$199,500,000	$199,500,000
Development Coordinator's Fee	9,500,000	9,500,000
Equity Contribution (Project Site) (1)	0	0
Acquisition Related Expenses	202,059	202,059
Capitalized Interest (3)	32,397,000	32,397,000
Debt Service Reserve Fund (4)	26,584,400	26,584,400
Working Capital (5)	1,000,000	1,000,000
Cost of Issuance	13,593,524	13,593,524
TOTAL	$282,776,982	$282,776,982

(1) [TO BE DETERMINED]
(2) Estimated interest earnings on Acquisition and Construction Fund, Debt Service Reserve Fund, Capitalized Interest Accounts, and Working Capital Fund during eighteen-month construction period.
(3) Capitalized interest period of 18 months calculated at the respective interest rates for the Bonds; calculation includes Interest on Available Funds.
(4) A debt service reserve equal to 10% of the face amount of the bond issue or maximum annual debt service, whichever is less.
(5) Working capital estimated at $1,000,000, approximately ___ Days-Cash On-Hand.

DEBT SERVICE:

THE AMOUNT ALLOCATED TO REPAY THE FUNDING AGENCY FOR THE $4,000,000.00 INITIAL INVESTMENT OR LOAN. FOR THIS PROJECTION THE PRINCIPLE AND INTEREST PAYMENT WOULI BE APPROXIMATELT $__________ PER MONTH CACULATED WITH AN INTEREST RATE OF ______ PERCENT FOR A TERM OF __ YEARS. THE PAYMENT HAS BEEN STARTED IN THE _____ MONTH IN THE SPREADSHEETS AND WILL FLUCTUATE WITH DIFFERENT INTEREST RATES.

TOTAL OPERATING EXPENSE:

ALL EXPENSES INCURRED IN SETTING UP AND OPERATING THE PLANTS. INITIALLY THE TOTAL OPERATING EXPENSE INCLUDES THE COSTS FOR CONSTRUCTING THE PLANTS AND OTHER ITEM: WHICH WILL NOT BE ONGOING COSTS. AFTER MONTH TWELVE THE TOTAL EXPENSES REMAIN STABLE AND ARE ANTICIPATED TO BE $1,187,150 PER YEAR.

GROSS PROFIT:

THE AMOUNT OF MONEY LEFT EACH MONTH AFTER ALL INCOME IS RECEIVED AND EXPENSES ARE PAID WITH THE EXECPTION OF TAXES, AND LOAN PAYMENT. IN THE FIRST YEAR THE GROS: PROFIT OF $1,028,747 REFLECTS ONLY AMOUNT EARNED FROM TIPPING FEES AND PRODUCTS SOLD. THIS NUMBER CAN BE OBTAINED BY SUBTRACTING THE TOTAL EXPENSE LINE FROM THE TOTAL REVENUE LINE.

NOTE!

ALL ITEMS ARE SUBJECT TO CHANGE THROUGH FINAL NEGOTIATIONS. SOME ITEMS ARE ALSO SUBJECT TO CONDITION BEYOND THE CONTROL OF THE ENVIRONMENTAL GROUP SUCH AS INFLATION, NATURAL DISASTERS, GOVERNMENT INTERVENTION ETC. INFORMATION INCLUDED IN THESE DOCUMENTS ARE CONSIDERED CORRECT AS OF JULY, 2001.

CHEMICALS:

CHEMICALS IN MOST CASES ARE POLYMERS USED IN THE PROCESS. IT IS NOT ANTICIPATED THAT OTHER CHEMICALS WOULD BE PURCHASED, SINCE THEY WILL BE OBTAINED IN THE WASTE STREAM NORMALLY. IN SOME CASES IT IS POSSIBLE FOR THE PLANT TO BE PAID TO TAKE POLYMERS. AN AMOUNT OF $714,000.00 HAS BEEN ALLOCATED PER YEAR STARTING IN MONTH TWO AND CONTINUING FOR THE DURATION OF THE PROJECT.

OTHER ADDITIVES:

IN SOME SITUATIONS IT WILL BE NECESSARY TO PURCHASE ADDITIVES TO INSURE CERTAIN CHARACTERISTICS OF THE FINISHED PRODUCTS.

INSURANCE / LEGAL:

ALL INSURANCE NEEDS OF THE PLANT INCLUDING LIABILITY, FIRE AND ANY OTHER INSURANCE THAT THE OWNER OR OTHER PEOPLE OR AGENCIES INVOLVED WITH THE PLANT REQUIRE THE PLANT TO HAVE IN FORCE.

QUALITY CONTROL:

EXPENSES INCLUDING SALARY FOR MAINTAINING A QUALITY CONTROL PROGRAM FOR THE PLANTS TO MAKE SURE THAT NOTHING TOXIC IS USED IN THE PLANTS WITHOUT PROPER TREATMENT. ALSO THESE QUALITY CONTROL PERSONS WILL MAKE SURE THAT THE PLANTS ARE PROPERLY MAINTAINED IN ACCORDANCE WITH HYDROMEX PROCEDURES FOR MAINTENANCE. THIS AMOUNT IS INCLUDED IN THE LABOR FIGURE.

MATERIAL HANDLING EQUIPMENT:

INCLUDED IN THE MATERIAL HANDLING EQUIPMENT ROW IS THE RENTAL OR PURCHASE OF THE EQUIPMENT FOR HANDLING MATERIAL NOT INCLUDED IN THE EQUIPMENT PURCHASE SECTION ABOVE, IN ADDITION TO FUEL OIL, OIL, GREASE, MAINTENANCE AND WEAR PARTS WHICH WILL HAVE TO BE REPLACED ON THE PLANTS PERIODICALLY. AN AMOUNT OF $38,250.00 HAS BEEN ALLOCATED PER YEAR STARTING IN MONTH TWO AND CONTNUING FOR THE DURATION OF THE PROJECT.

MISCELLANEOUS:

INCIDENTAL EXPENSES NOT FORSEEN IN THE ITEMS ABOVE. AN AMOUNT OF $14,000.00 HAS BEEN ALLOCATED PER YEAR STARTING IN MONTH ONE AND CONTINUING FOR THE DURATION OF THE PROJECT.

SCALES SERVICE:

SCALES ARE NEEDED FOR WEIGHING THE WASTE BEING DELIVERED TO THE PROJECT FOR BILLING PURPOSES, AND FOR MAINTAINING LEGAL WEIGHT LIMITS OF THE TRUCKS HAULING PRODUCTS FROM THE PROJECT. SCALES EXIST CURRENTLY ON THE PROJECT AND ARE OPERABLE.

EQUIPMENT PURCHASE:

ALL EQUIPMENT FOR DAY TO DAY OPERATIONS OF THE PLANT INCLUDING COMPLETE HYDROMEX PLANTS, ELECTRICAL EQUIPMENT AND SERVICE, PRODUCT FORMS, AND FINISHING EQUIPMENT FOR PRODUCTS BEING PRODUCED BY THE HYDROMEX PLANTS. THE TOTAL PRICE FOR THIS EQUIPMENT DELIVERED TO THE PROJECT IN HONOLULU, HI. U.S.A. WILL BE $4,000,000.0

ADMINISTRATIVE:

ALL EXPENSES FOR SALARIES THROUGHOUT THE PROJECT INCLUDING ACCOUNTING, BOOKKEEPING, EXECUTIVE SALARIES, CLERICAL SALARIES AND OTHER COSTS DIRECTLY INVOLVED FOR THE ADMINISTRATIVE PREFORMANCE OF THE PROJECT.

SALES AND MARKETING:

SALES AND MARKETING FOR EITHER TRYING TO SELL THE PRODUCT, OR FOR TRYING TO GET MORE PEOPLE TO BRING IN THEIR WASTE AND PAY TIPPING FEES. ALSO INCLUDED IN THIS CATEGORY IS ANY ADVERTISING OR OTHER SALES RELATED EXPENSES DURING THE NORMAL PROJECT EFFORT TO BRING IN REVENUE.

PLANT OPERATING COSTS:

PLANT OPERATING COSTS INCLUDE THE UTILITIES, MAINTENANCE OF THE FACILITY AND OTHE ITEMS THAT ARE DIRECTLY INCLUDED IN THE OPERATION OF THE PLANT.

LABOR:

DIRECT LABOR FOR THE HYDROMEX PLANTS AND RECYCLING FACILITYS INCLUDING MACHINE OPERATORS TECHICIANS AND ANY OTHER PERSONAL DIRECTLY INVOLVED IN THE OPERATION OF THE PLANTS.

PRODUCT SALES:

PRODUCT SALES ARE THE MONIES COLLECTED FROM THE SALE OF THE VARIOUS PRODUCTS MANUFACTURED BY THE HYDROMEX PLANT. FOR THESE SPREADSHEETS THE PRICE IS $40.00 PER TON BEING USED FOR THE INITIAL PRODUCTS TO BE PRODUCED. OTHER PRODUCTS WILL BE ADDED AS NEEDED BY CUSTOMER REQUEST.

TOTAL REVENUE:

ALL MONEY RECEIVED BY THE OWNERS OF THE FACILITY AS INCOME FROM TIPPING FEES, PRODUCT SALES OR ANY OTHER SOURCE OF INCOME.

TOTAL AVAILABLE CASH:

AMOUNT OF CASH IN THE BANK ACCOUNTS OF THE PROJECT EACH MONTH BEFORE EXPENSES ARE PAID.

EXPENSES:

FACILITIES AND LAND:

THE PROPERTY LOCATED IN HONOLULU, HI. U.S.A. AT CAMPBELL INDUSTRIAL PARK IN CONJUCTION WITH H - POWER.

BUILDING AND IMPROVEMENTS:

THE IMPROVEMENTS NEEDED WILL BE A COVERED AREA FOR THE HYDROMEX SYSTEM; ODOR CONTROL DEVICES AND POWER SOURCE IMPROVEMENTS.

PERMITS ETC.

BASED ON THE INFORMATION AVAILABLE REQUIRED PERMITS ARE IN PLACE WITH A SITE SPECIFIC REVIEW FOR THE HYDROMEX SYSTEM BY THE STATE DEPT. OF HEALTH, PERMIT DIVISION.

NEW VISIONS FOR A CLEANER TOMORROW

50 TON PER SHIFT WASTE
TRANSFORMATION FACILITY
HONOLULU, HI. U.S.A.

7/27/2001

EXPLANATIONS AND ASSUMPTIONS

THE FOLLOWING INFORMATION IS A COMPILATION OF THE ITEMS FOUND IN THE PROCEEDING SPREADSHEET FOR THE HONOLULU, HI. U.S.A. PROJECT. THIS PROJECTION IS BASED ON A 50 TON PER SHIFT HYDROMEX FACILITY OPERATING 16 HOURS A DAY OR TWO SHIFTS RECEIVING MSW ASH AND DEMO MATERIAL, THEN MAKING VARIOUS BUILDING MATERIALS AND RAILROAD TIES. PRICES MAY VARY DUE TO TIPPING FEES, PRODUCT PRICES, STATUS OF THE PLANT, OR OWNER CLIENT NEGOTIATIONS. THE SPREADSHEETS AS WELL AS ALL OF THE ASSUMPTIONS LISTED, ARE BASED ON THE MOST CURRENT INFORMATION AVAILABLE AS OF AUGUST, 2000.

INCOME:

CASH:

THE AMOUNT OF MONEY LEFT OVER FROM MONTH TO MONTH. IN THE FIRST AND SECOND MONTH WE ARE ASSUMING ZERO CASH. IN THE THIRD MONTH THE AMOUNT OF CASH IS DETERMINED BY TAKING THE TOTAL AVAILABLE CASH AND SUBTRACTING THE TOTAL EXPENSES FROM THE PREVIOUS MONTHS AND IS REPEATED IN THE FOLLOWING MONTHS.

PROJECT INVESTMENT:

THE TOTAL PRICE FOR THE PROJECT IS $4,000,000.00
THE $4,000,000.00 IS LISTED IN THE INCOME SECTION DUE TO THE FUNDS BEING ACCEPTED FROM THE FUNDING AGENCY AND THEN REPAID BY THE PURCHASER OF THE PLANT.

TIPPING FEES:

TIPPING FEES ARE THE FEES COLLECTED BY THE OWNER OF THE PLANT FROM VARIOUS ENTITIES TO ACCEPT WASTE. FOR THE PURPOSE OF THE SPREADSHEETS THESE FEES ARE AS FOLLOWS:

A) 100 TONS OF MIXED DEMO (C&D) AND MSW ASH AT $70.00 PER TON

ONTH 7	MONTH 8	MONTH 9	MONTH 10	MONTH 11	MONTH 12	TOTAL
233,750	233,750	233,750	233,750	233,750	233,750	2,018,750
						4,000,000
85,000	85,000	85,000	85,000	85,000	85,000	680,000
148,750	148,750	148,750	148,750	148,750	148,750	1,338,750
233,750	233,750	233,750	233,750	233,750	233,750	6,018,750

2,125	2,125	2,125	2,125	2,125	2,125	25,500
3,187	3,187	3,187	3,187	3,187	3,187	38,244
5,993	5,993	5,993	5,993	5,993	5,993	56,935
1,594	1,594	1,594	1,594	1,594	1,594	15,143
2,125	2,125	2,125	2,125	2,125	2,125	21,252
43,520	43,520	43,520	43,520	43,520	43,520	435,200
1,594	1,594	1,594	1,594	1,594	1,594	17,534
600	600	600	600	600	600	7,200
200	200	200	200	200	200	2,400
500	500	500	500	500	500	6,000
2,084	2,084	2,084	2,084	2,084	2,084	18,754
6,375	6,375	6,375	6,375	6,375	6,375	57,376
29,750	29,750	29,750	29,750	29,750	29,750	282,625
584	584	584	584	584	584	5,840
						4,000,000
100,231	100,231	100,231	100,231	100,231	100,231	4,990,003

HONOLULU HYDROMEX WASTE MANAGEMENT SYSTEMS

INCOME	MONTH 1	MONTH 2	MONTH 3	MONTH 4	MONTH 5	MONTH 6
ASH			74,375	74,375	233,750	233,750
OAN	4,000,000					
TOTAL REVENUE (SALES)@ $40.00					85,000	85,000
OTAL REVENUE (TIP FEE)			74,375	74,375	148,750	148,750
OTAL AVAILABLE CASH	4,000,000	0.00	74,375	74,375	233,750	233,750

EXPENSES						
ADMINISTRATIVE	2,125	2,125	2,125	2,125	2,125	2,125
VERHEAD	3,187	3,187	3,187	3,187	3,187	3,187
TILITIES		2,997	2,997	2,997	5,993	5,993
MAINT. & REPAIR		797	797	797	1,594	1,594
NSUR. /LEGAL	1,063	1,063	1,063	1,063	2,125	2,125
AYROLL (TAX INCLUDED)	21,760	21,760	21,760	21,760	43,520	43,520
MATERIAL HANDLE EQUPT.		1,594	1,594	1,594	1,594	1,594
TRAVEL	600	600	600	600	600	600
NTERTAINMENT	200	200	200	200	200	200
ODGING	500	500	500	500	500	500
TESTING / R+D			1,041	1,041	2,084	2,084
ALES & MARKETING			3,188	3,188	6,375	6,375
LANT FABRICATION						
LOAN PAYMENT (EST.) ?						
EMICALS		14,875	14,875	14,875	29,750	29,750
SCELLANEOUS	292	292	292	292	584	584
PLANT PURCHASES	4,000,000					
OTAL EXPENSES	4,029,727	49,990	54,219	54,219	100,231	100,231

- YEAR 2001 PROJECTION
- ONE 50 TON HYDROMEX SYSTEM

FINANCIAL PROJECTIONS FOR A 50 TON HYDROMEX PLANT
OPERATING TWO SHIFTS IN HONOLULU, HAWAII.

INCOME	PER YEAR
TIPPING FEES (C)	$ 1,785,000
PRODUCT SALES (D) (CONSERVATIVE)	1,020,000
TOTAL INCOME	$ 2,805,000

OPERATING EXPENSE	
ADMINISTRATIVE (E)	25,500
OVERHEAD (F)	38,250
LABOR (G)	522,240
SALES & MARKETING (H)	76,500
INSURANCE / LEGAL (I)	25,500
TESTING (J)	25,000
UTILITIES (K)	71,910
MAINTENANCE & REPAIRS (L)	19,125
MATERIAL HANDLE EQUIPMENT (M)	19,125
CHEMICALS (N)	357,000
MISCELLANEOUS	7,000
TOTAL OPERATING EXPENSE	$ 1,187,150

ASSUMPTIONS

a) TWO 8 HOUR SHIFTS
b) 255 / DAYS PER YEAR OPERATION.
c) $70 / TON MUNICIPAL SOLID WASTE (MSW) AND CONSTRUCTION DEBRIS.
d) BLOCKS, 25 WT., 50 CENTS @, 80 / TON PLUS OTHER PRODUCTS INCLUDING RAILROA[illegible] CROSS TIES @ 194.00 / TON.
e) INCLUDES OFFICE AND WORKER.
f) OFFICE MISC.
g) BASED ON 8 PEOPLE @ 32.00 / HOUR TOTAL WAGES AND BENEFIT PACKAGE.
h) EQUALS 15% OF PRODUCT SALES. THIS NUMBER COULD VARY WITH TYPE OF CONTRACTS, ETC.
i) VARIES BY COMPANY AND AREA.
j) PROCESS CONTROL.
k) EITHER DIESEL FOR GENERATORS OR ELECTRICITY, GAS OR OIL.
l) ROUTINE MAINTENANCE.
m) PAYMENTS ON FORKLIFTS, FRONT END LOADERS, ETC.
n) AGENTS USED IN THE PROCESS ARE PRESENT IN WASTE STREAM. ON OCCASION PURCHASE OF SOME AGENTS MAY BE REQUIRED. WE EXPECT THIS COULD COST $14.00 / TON.

RECAP

a) TOTAL TONS PER YEAR		25,500
b) OPERATING EXPENSE PER TON		$ 46.5[illegible]
c) TOTAL INCOME PER TON		$ 110.[illegible]
d) TOTAL GROSS PROFIT PER TON $ 63.45	OR	$1,617,975.00 / Y[illegible]

Lessee hereby authorizes Leasepoint to investigate the accounts and financial condition of the Lessee and also authorizes any credit bureau, bank, finance company, creditor, supplier, or other similar entity contacted by Leasepoint to release any and all information pertinent to such accounts and financial condition.

Lessee agrees to cooperate fully with Leasepoint in the closing and funding of this proposed transaction. If there is a Lessee misstatement, or if the Lessee has omitted to state any material fact in connection with financial condition and representations; or if the Lessee frustrates the closing of the transaction; or if the Lessee does not allow the complete due diligence process to be completed by Leasepoint; or if Lessee changes its mind about the funding; Leasepoint will retain and not refund the commitment fee submitted herewith.

Commitment By:
Leasepoint Corporation

Ronald J. Lister

Accepted By:
County City Of Hawai

By________________________
Title:

Date_______________19_____

23276 South Pointe, Suite # 210, Laguna Hills, California 92653
Toll Free (888) 258-1845 • Local (949) 454-9205 • Fax: (949) 454-9259

Additional Collateral:	None.
Purchase Option:	There is no residual value.
Insurance:	Prior to the closing and funding of the transaction, Lessee shall furnish a Certificate of Insurance evidencing primary insurance acceptable to Lessor/Secured Party, including "All Risk" Physical damage coverage with appropriate Loss-Payee and Additional Insured endorsements in favor Lessor/Secured Party.
Net terms:	This Lease shall be absolutely net, whereby all expenses for documentation and processing, maintenance, insurance and all other items of a similar nature shall be for the Lessee's account.
Documentation:	All documentation shall be provided by Lessor/Secured Party.
Waivers of Lien:	None required.
Tax Exemptions:	This transaction must be designated as tax-exempt under section 103 Of the internal revenue code.
Payment Rate Adjustment:	The payment rate quoted in this commitment is relative to current financial market conditions as of this date. Any subsequent change in market conditions prior to the commencement date of this lease Agreement may then result in a corresponding change in the payment rate for such a lease.
Commitment Fee:	Upon Lessee acceptance of this commitment, a commitment fee In the amount of 1% of the equipment cost equaling $59,000.00 shall be due Leasepoint Corporation. Upon execution of all documentation this commitment fee shall be fully applied against initial payment under the Lease agreement.
Expiration:	This commitment shall expire on September 15, 1999, unless a signed copy is received by Lessor/Secured Party, along with the commitment fee on or prior thereto.

Upon acceptance of this commitment, Lessee hereby agrees to furnish Leasepoint such financial reports and other information, which Leasepoint may reasonably request in order to complete this transaction. Additionally, Lessee hereby warrants that all such financial reports and other information submitted to Leasepoint are true and accurate as of the dates thereof, and that no material items regarding financial and/or legal matters have been omitted from such reports, information and/or discussions with Leasepoint which might otherwise impact Leasepoint's consideration of this financial request. Furthermore, all information submitted becomes the property of Leasepoint Corporation and will not be returned.

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LEASEPOINT CORPORATION

EQUIPMENT LEASING

August 11, 1999

Ms. Marlu Oliphant West
City & County Of Honolulu
Honolulu, Hawaii

Dear Ms Oliphant West:

Leasepoint Corporation is pleased to present the following finance/ownership lease commitment to the City & County Of Honolulu. This commitment may contain verbiage relative Equipment Lease structures. Be advised that where this proposal refers to "Lessor" and "Lessee," it shall infer "Secured Party" and "Debtor" depending on which finance structure is being addressed within that specific text.

Lessor/Secured Party:	Leasepoint Corporation (Leasepoint), its nominees or assigns.
Lessee/Debtor:	City & County Of Honolulu.
Guarantors:	City & County Of Honolulu
Equipment:	Waste Recycling Facility
Equipment Supplier:	Hydromex Hawaii, Inc
Equipment Cost:	$5.9million
Location:	Honolulu
Type Financing:	Finance/Ownership lease. There is no residual value.
Commencement Date:	Initial funding to occur prior to September 11, 1999.
Terms:	84 months.
Monthly Payment:	84 equal payments payable monthly in advance at $87084.
Base Interest Rate:	6.315%
Rate Factor:	0.01476
Advance payments:	First months, due upon documentation.

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LEASEPOINT CORPORATION

EQUIPMENT LEASING

August 09, 1999

Hydromex Hawaii, Inc.
Ms. Marlu Oliphant-West

Per our conversation earlier this date.

Hydromex of Hawaii is approved for leasing of a waste recycling facility that would be acceptable for the County/City of Honolulu, Hawaii. The lease plan can be structured as a municipal lease directly through the City/County government.
This approach would save substantial monies in leasing and interest costs.
The interest rate alone is approximately 50% of a conventional lease plan.

The lease could be structured through a private Corporation that was set-up to conduct primary business for the County/City of Honolulu.
This would allow the Corporation to service other parts of the private sector as well as the public municipality. A Corporation serving both private and public sectors would be quite profitable, if their sole business was devoted to operating a Hydromex waste recycling facility. Disposing of waste and manufacturing building materials from the same source is a business that will be very much part of the future.

See attached documents re: costs of lease structure via Municipal lease or Conventional Capital equipment lease plan.

Sincerely,

Ron Lister

Ron Lister- leasePoint Corporation.

23276 South Pointe, Suite # 210, Laguna Hills, California 92653
Toll Free (888) 258-1845 • Local (949) 454-9205 • Fax: (949) 454-9259

CONCORD LEASING CORPORATION
4F. 121. SUNG CHIANG ROAD. TAIPEI 104 TAIWAN R. O. C.
TEL: 886-2-501-4-600
FAX: 886-2-508-0985

DATE: 21 Oct 99
TO: The Enviromental Group. Mr. Larry Leaf
SUBJ: LOI for Hydromex 50 ton machine.

This is a letter of intent for a 50 ton Hydromex waste recycle machine. We have looked at the plan and we would like to proceed with this program for installation in Hawaii. We would like more information from City & County on the volume of waste and placement of the machine.

Sincerely,

PETER HUANG
President, Hawaii Region

The Environmental Group

"Serving the World with"
Environmental Products and Services

Since 1989

HYDROMEX SYSTEM
SUGGESTED RETAIL PRICE LIST
U.S.A. ONLY

EFFECTIVE DATI
6/1/99

PLANT SIZE PER DAY	SUGGESTED RETAIL
50 TON	$ 4,000,000
100 TON	5,000,000
200 TON	6,400,000
400 TON	10,500,000

NOTE:

THE ABOVE SUGGESTED PRICE IS A "BASE LINE" QUOTE. CUSTOMER SPECIFIC CONFIGURATIONS MAY VARY THE COST OF A GIVEN SYSTEM.

LARGER SYSTEMS WILL BE QUOTED ON AS NEEDED BASIS, DEPENDING ON END USERS SIZE NEEDS AND CONFIGURATION.

PRICES DO NOT INCLUDE LOCAL TAXES, IF APPLICABLE.

SHIPPING IS ..... F.O.B. PALM SPRINGS, CA. USA

350 Ward Ave. Suite 106 . Honolulu, HI. USA 96814. Tele (808) 591-7722. Fax 1(808) 395-7265

ADDENDUM # 1

HYDROMEX 50 TON PLANT FOR THE CITY AND COUNTY OF HONOLULU, HI. (BYR)

NON PERFORMANCE RETURN POLICY

Hydromex Hawaii, Inc. AGREES TO DESIGN, BUILD AND BRING TO OPERATIONAL LEVEL A 50 TON HYDROMEX WASTE PROCESSING PLANT PURCHASED BY BYR AND INSTALLED AT HONOLULU, HI. THIS PLANT WILL INCLUDE ALL THE EQUIPMENT NECESSARY TO PRODUCE PRODUCTS AGREED UPON BY BOTH PARTIES AND SHALL INCLUDE ALL ENGINEERING, LABOR, AND SUPERVISION DURING THE CONSTRUCTION OF THE PLANT, QUALITY CONTROL BEING PERFORMED ON THE PLANT DURING CONSTRUCTION.

AFTER SIX MONTHS (6 MONTHS) AND AFTER THE SYSTEM IS OPERATIONAL, IF THE SYSTEM IS NOT MECHANICALLY OPERATING AND/OR NOT PRODUCING THE AGREED UPON PRODUCTS, THEN Hydromex Hawaii Inc. WILL RELOCATE THE SYSTEM TO ANOTHER OPERATOR AND COMPENSATE THE ORGINAL OWNER FOR ANY AMOUNTS DUE FROM HYDROMEX SYSTEM LEASE/LOAN OR PAYMENTS PAID AT TIME OF SYSTEM TRANSFER.

THE ABOVE CONSIDERED COMPENSATION WILL BE PAID ONLY AFTER A NEW OWNER IS FOUND AND THIS NEW OWNER PURCHASES THE USED Hydromex SYSTEM DESCRIBED ABOVE AND AUDITED DOCUMENTATION OF PAYMENTS MADE ON THE SYSTEM BEING PURCHASED BY BYR IS PRODUCED TO Hydromex Inc.

THIS AGREEMENT IS CONTINGENT UPON A SIGNED PURCHASE AGREEMENT NO LATER THAN 90 DAYS FROM ABOVE DATE.

8.6 NOTIFICATION. All notices which are required or permitted to be given pursuant to the terms of this Agreement shall be sufficient in all respects if given in writing and delivered by registered or certified mail, postage prepaid, or private mail service, attention to the parties whose signatures are set forth below, to the respective addresses of the parties hereof set forth at the top of this Agreement. The addresses and addressees for the purpose of this Section may be changed by giving written notice of such change in the manner provided herein for giving notice. Unless and until such written notice is received, the addresses and addressees as stated by prior written notice, or provided herein if no written notice of change has been received, shall be deemed go continue in effect for all purposes herein.

IN WITNESS WHEREOF, the parties duly authorized representatives hereto have executed this Agreement on the first date written above.

_______________ Attest _______________

_______________ Attest _______________

_______________ Attest _______________

Initials________ Initials________ Initials________

infringement action. Each party warrants to the other that it will indemnify and hold the other harmless from any and all claims, costs and reasonable attorney fees resulting from the actions of that party or from the actions of anyone whose actions have incurred claims against that party.

ARTICLE VIII:
MISCELLANEOUS PROVISIONS

8.1 ENTIRE AGREEMENT. This Agreement constitutes the entire agreement between the parties hereto relating to the subject matter of this Agreement. Any and all oral or written agreements, understandings, promises, or representations relating to the subject matter of this Agreement, not expressly set forth in this Agreement are of no force and effect. No usage of the trade shall be relevant to supplement or explain any term used in this contract. Acceptance or acquiescence in a course of performance rendered under this contract shall not be relevant to determine the meaning of this contract even though the accepting or acquiescing party has knowledge of the nature of the performance and opportunity for objection.

8.2 AMENDMENTS. Unless explicitly provided for in this Agreement, this Agreement cannot be amended or modified except by written instrument executed by both parties hereto.

8.3 ATTORNEY'S FEES. If any legal action or proceeding arising out of or relating to this Agreement is brought by either party to this Agreement, the prevailing party shall be entitled to receive from the other, in addition to any other relief that may be granted, the reasonable attorney's fees, costs, and expenses incurred in the action or proceeding by the prevailing party.

8.4 ASSIGNMENT. Neither party shall assign this Agreement without the prior written consent of the other this contract to a third party.

8.5 GOVERNING LAW. This Agreement shall be governed by and construed in accordance with the laws of the state in which TEG's Corporate Offices are located.

event beyond TEG's control that restricts, prevents or interferes with the orderly or economically efficient production or distribution of the Services, or which otherwise adversely effects a substantial part of TEG's business.

6.2 DISPUTES. Any dispute or claim arising under this Agreement shall be resolved in accordance with the Rules of Commercial Arbitration of the American Arbitration Association before a panel of three arbitrators, such arbitration to be held in a venue mutually agreed upon by the parties. Likewise, venue of any legal action other than enforcement of an arbitration award shall be the state in which TEG Corporate Offices are located currently, or a mutually agreed upon location.

6.3 DEFAULT. If either party should default under the provisions of this Agreement, notification of default should be sent by Certified Mail, return receipt requested. If such default is able to be cured in ten days then the default must be cured, or if the default is not capable of being cured within ten (10) days, then the defaulting party must commence the cure within ten (10) days of receiving the notice specifying the matters constituting default and diligently complete the cure as soon as it is reasonable to do so. If BYR materially fails to prosecute its undertakings under this Agreement, or if a petition of any chapter of condition of bankruptcy is filed by or against BYR and remain undismissed for more than thirty (30) days, or if governmental action results in BYR being no longer permitted to do business as contemplated under this Agreement in a substantial portion of the world, then BYR's rights under this Agreement, shall expire ten (10) days after such event.

ARTICLE VII:
INDEMNITIES

7.1 HYDROMEX warrants that there are no infringements or violation of any patent or any other intellectual property rights relating to the Technology described herein and agrees to indemnify and hold BYR and BYR's contractors harmless from all claims and costs, including reasonable attorney's fees, relating to any claims of infringement or violation, provided that HYDROMEX shall have the right to represent BYR and its contractors in the defense of any such disclosure is made. This agreement shall not apply to any item of Confidential Information after such item of Confidential Information becomes generally known or available to the public through no act or failure to act on the part of BYR. BYR shall have the burden of establishing that any item of information furnished to it by or on behalf of HYDROMEX is not Confidential Information.

5.4 REMEDIES FOR BREACH OF CONFIDENTIALITY. Upon breach of any covenant or condition of this Article to this Agreement by BYR, HYDROMEX shall be entitled to injunctive relief, either perdente lite or permanently or both, as a remedy at law would be inadequate and insufficient. In addition, HYDROMEX shall be entitled to such damages as it can show it has sustained by reason of said breach. Nothing in this Agreement shall be construed as limiting any of HYDROMEX'S remedies at law or equity in any way, and HYDROMEX may obtain all legal and equitable remedies through the courts of competent jurisdiction.

ARTICLE VI:
INTERPRETATIONS AND ENFORCEMENT

6.1 FORCE MAJEURE. Neither party shall be responsible for any resulting loss by the other if the fulfillment of any of the terms and provisions of this Agreement is delayed or prevented by Force Majeure events. "Force Majeure events" include, without limitation, the passage and/or enforcement of a statute, law, ordinance, regulation, order, judgment, or decree, whether legislative, executive, or judicial and whether or not valid; and act of God including, without limitation, earthquake, flood, or fire; epidemic; accident; explosion; casualty; lockout, boycott or other labor controversy (including but not limited to threat of walkout); civil disturbance; war or armed conflict (whether or not there has been an official declaration of war or official statement as to the existence of a state of war); invasion; occupation intervention of military forces; and act of a public enemy embargo; delay of a common carrier; changed economic conditions; inability without fault on TEG's part to obtain sufficient materials, labor transportation, power or other essential commodities required by TEG and any

5.1 BYR does hereby warrant that BYR, their owners or any of their agents will not disclose any confidential and proprietary information to anyone nor compete with HYDROMEX in any way during the term of this agreement or for seven (7) years after the termination of this agreement. Should this happen, BYR agrees to pay all legal fees, loss of sales, and any other cost incurred by HYDROMEX to correct such occurrence.

5.2 DEFINITION. "Confidential Information" shall mean all: ideas and concepts; client, customer, vendor, distributor, or supplier lists, names, addresses, and amounts purchased from or sold to or by clients, customers, vendors, distributors, and suppliers and the prices of such purchases and sales, financial information; budgets; professional, marketing, merchandising, demographic, technical, scientific, engineering, or similar information, including without limitation all designs, photographs, plants, data, formulae, patterns, and related information; computer programs, drawings, samples, devices, inventions, requirements, sketches, memoranda, processes, specifications, and procedures; distribution methods or processes know how; business relationships; and copyrightable materials, in each case which are useful in or relevant to the businesses of HYDROMEX and disclosed by or on behalf of HYDROMEX to BYR either directly or indirectly, in writing, orally, by samples, drawings or inspection of offices, equipment, documents, or otherwise.

5.3 CONFIDENTIALITY. BYR agrees to keep the Confidential Information confidential and not to disclose it to any party except in accordance with the terms of this Agreement. BYR may disclose such information to those or its employees of BYR who must have such information in connection with the business relationship described in the Agreement, and BYR agrees to limit access to the Confidential Information only to those persons. BYR agrees to use the Confidential Information only as designated by and upon the prior written approval of HYDROMEX, and to use its best efforts to prevent the Confidential Information from being disclosed to any unauthorized third party. If requested to do so by HYDROMEX,

BYR will obtain appropriate confidentiality agreements from any third party or employees, attorney, accountant, agents, or servants of BYR to whom the Confidential Information is to be disclosed pursuant to this Agreement before

Initials________ Initials________ Initials________

ARTICLE IV:
WARRANTEES AND GUARANTEES

4.1 HYDROMEX will supply BYR with the proper operation and maintenance manuals for the facility when it is operable. At that time it will be the responsibility of BYR to maintain the equipment and operate the equipment in accordance with the two documents provided. Should BYR not provide proper care for the facility as outlined in the above documents, the warranties for parts and labor shall cease to be in force.

4.2 With the exception of wear parts such as shredder blades, mixer blades, and any other parts which would wear as a result of being in constant contact with the waste, all parts of the facility are guaranteed for one year. This includes electrical motors, hydraulic motors, bearings and other moving parts of the facility normally used in the operation of the facility.

4.3 In most cases the equipment purchased by HYDROMEX to erect the plant will be guaranteed by the suppliers for a period of one (1) year or more if the equipment breakdown is a result of faulty workmanship of the supplier or manufacturer. When the plant is turned over to BYR for operation they will be supplied with a complete list of all suppliers and manufacturers used for the erection of the facility. At BYR's discretion they may purchase parts and supplies directly from the manufacturer or from HYDROMEX. The purchasing of parts from any other source without the purchase being approved by HYDROMEX shall result in the warrantee becoming void.

ARTICLE V:
CONFIDENTIAL & PROPRIETARY

ARTICLE III:
TECHNOLOGY USE

3.1 This agreement covers only the rights to own and operate the HYDROMEX Processing Facility for the use in BYR's locations of the plants. HYDROMEX is the sole owner of the technology, patents, and trade and service marks. The rights to use the technology in each plant is incorporated in the selling price of the plant; ownership of the technology is not transferred or implied.

3.2 All changes to the HYDROMEX plant or formulas made by BYR for the duration of this agreement shall be in writing signed by both parties before changes are made. Any changes not performed under this procedure will result in the Warrantees and Guarantees of this agreement becoming null and void.

3.3 As a part of this Agreement HYDROMEX will supply to BYR new technologies developed by either HYDROMEX or other Facility owners operating HYDROMEX facilities at no charge. HYDROMEX will continually update the facilities owned by BYR. Should BYR or the combination of HYDROMEX and BYR working together develop new technology at the operating facility it will become the property of HYDROMEX, INC.

Initials________ Initials________ Initials________

PRICE AND TERMS

2.1 The total price of the HYDROMEX (1) 50 Ton Facility will be $4,000,000 U.S. and will include all parts, labor, construction and training for BYR personnel. This price will include bringing the plant to an operational level and remaining at the site for a period of sixty (60) to ninety (90) days for consulting and additional training if necessary. The $4,000,000 U.S. shall be paid by BYR as follows:

2.2 The Total Amount of Purchase: The $4,000,000 U.S. is to be transferred to a TEG escrow account at time of_______________. The banking routing information will be by separate document.

2.3

2.4

2.5 A non-performance return policy will be in effect and is attached as addendum # 1

Initials__________ Initials__________ Initials__________

ARTICLE I:
SALE OF PLANT

1.1 HYDROMEX agrees to design, build and bring to operational level (1) 50 ton per shift HYDROMEX Processing Plant. The plant will include all of the equipment necessary to produce a product agreed upon by both parties and shall include all engineering, labor, supervision during the construction of the plant, quality control of the work being performed on the plant during construction and payment to individual contractors performing work directly relating to the construction of the plant.

1.2 BYR will provide the land for the site and buildings suitable, with improvements, to hold all of the equipment needed for safe and efficient operation in addition to any protection needed for the plant. Specifications for the buildings will be given to BYR by HYDROMEX within 15 working days from the signing of this Agreement. At this time it is anticipated by both parties to locate the facility in the County of Honolulu, Hawaii.

1.3 BYR will be responsible for obtaining all permits and any other requirements for locating the plant in the area they may choose.

1.4 HYDROMEX will be responsible for insuring all parts included with the plant are in accordance to, and accepted by all local, regional and governmental codes for safety and quality, as well as any other standards required by various agencies in the location where the plant is to be built. HYDROMEX will whenever possible, hire local contractors and personnel as well as local suppliers to be a part of the erection of the plant..

ARTICLE II:

Initials________ Initials________ Initials________

AGREEMENT

ONE (1) 50 TON PER SHIFT HYDROMEX PLANT PURCHASE

This Agreement for the purchase of one (1) 50 ton per shift waste transformation facility dated ______________________is between The Environmental Group (hereinafter known as TEG), with main office located in Honolulu, Hawaii, U.S.A.,and City and County of Honolulu (hereinafter known as Buyer or BYR) located at: Honolulu, Hawaii, U.S.A., and collectively known as "Parties".

WITNESSETH THAT:

WHEREAS, HYDROMEX has developed certain technology that converts waste materials into usable products hereinafter referred to as the HYDROMEX Technology.

WHEREAS, the parties have exchanged information regarding their respective capabilities in certain business and market segments, and

WHEREAS, BYR has performed adequate due diligence, on HYDROMEX, and the HYDROMEX Technology allowing BYR to knowledgeably enter into this contract understanding the potential risks and rewards.

NOW THEREFORE, in consideration of the mutual covenants, provisions and benefits contained herein the parties hereby agree as follows, intending to be legally bound.

PROPOSAL

1. THE ENVIRONMENTAL GROUP IS WILLING TO BRING TO AN OPERATIONAL LEVEL AND OPERATE A HYDROMEX 50 TON PER SHIFT WASTE TREATMENT SYSTEM. THIS WOULD BE A PILOT PROGRAM TO PROVE CAPABILITY AND PRODUCT OUTPUT TO THE C&C HONOLULU, DES.

2. THE INITIAL "FEED STOCK" OR WASTE TO BE DIVERTED FROM THE LANDFILL (APROX. 100 TONS PER DAY), WOULD BE H-POWER ASHES AND HMR'S RESIDUAL WASTE FROM THE METAL RECYCLING SYSTEM PLUS WASTE MATERIAL DISPOSED IN THE LANDFILL BY THE COMPOSTING COMPANY AT CAMPBELL INTRUSTRIAL PARK.

3. THE IDEAL LOCATION FOR THIS SMALL PILOT SYSTEM SHOULD BE ON THE GROUNDS OF THE H-POWER FACILITY AS A CONVIENENCE. IMAGINE RUNNING THIS HYDROMEX SYSTEM WITH ELECTRICITY GENERATED BY WASTE PROCESSED BY H-POWER! (REF: SECTION ____8____ FOR MAXIMUM AREA NEEDED) 50TON SYSTEM.

4. AFTER ACCEPTANCE OF THE HYDROMEX WASTE SYSTEM CAPABILITY AND DISTRIBUTION OF ALL PRODUCTS PRODUCED, THE C&C WOULD PURCHASE THE PILOT SYSTEM AND CONTINUE THE OPERATIONS AT THE EXISTING LOCATION OR RELOCATE TO ANOTHER AREA. STAFFING CAN BE PRIVATE OR COUNTY EMPLOYES FOR CONTINUED OPERATIONS. (REF: AGREEMENT IN SECTION__2___.)

4a. LEASE HAS BEEN APPROVED THROUGH A LOCAL BANK AND A LEASING COMPANY.

5. THE NEXT LOGICAL STEP WOULD BE TO PURCHASE AND INSTALL, AT SOME LOCATION, HYDROMEX SYSTEMS LARGE ENOUGH TO PROCESS ALL 600 TONS PER DAY OF H-POWER ASH (APROX. 50% OF TOTAL LANDFILL USAGE). THESE SYSTEMS WOULD BE SIZED AND PRICED WHEN THE ACTUAL ASH MIX RATIO IS TESTED DURING THE INITIAL PILOT SYSTEM.

6. ENCLOSED ANALYSIS REPORT AND TESTS IN SECTION ____5____ OF THIS BOOK SHOWS MIXTURE RATIOS OF 40% ASH AND 60% OTHER WASTE. FOR THIS <u>EXAMPLE</u> <u>ONLY</u> TO PROCESS ALL THE H-POWER ASH THE TOTAL INPUT FEED STOCK WOULD BE 1500 TONS PER DAY OF MIXTURE. THIS WOULD TAKE TWO HYDROMEX SYSTEMS RUNNING TWO SHIFTS EACH AT 750 TONS PER DAY OR 375 TONS PER SHIFT.

7. THE FORCASTED HYDROMEX SYSTEMS, USING THE ABOVE ANALYSIS, THAT WOULD EVENTUALLY BE NEEDED FOR TOTAL OAHU WASTE DISPOSAL AND DIVERSION FROM THE EXISTING LANDFILL WOULD BE: TWO (2) – 400 TON HYDROMEX SYSTEMS @ <u>$10,500,000</u> EACH. (REF: TO SECTION____8____ FOR SIZE/DIMENTIONS) USE 500 TON SYSTEM LAYOUTS.

8. FOR BUDGETING OR LEASING PROJECTIONS, FOR FY03 AND FY04, WOULD BE FOR <u>EQUIPMENT</u> <u>COSTS</u> <u>ONLY</u> <u>$21,000,000.00.</u>

9. OPERATIONAL COST CAN BE MADE AVAILABLE, UPON REQUEST, DEPENDING ON PRIVATE OR COUNTY STAFFING.

REFERENCES AND DETAIL INFORMATION ENCLOSED.

MAHALO,

The Environmental Group

"Serving the World with"
Environmental Products and Services

Since 1989

FORWARD

THE ENVIRONMENTAL GROUP IN CONJUNCTION WITH HYDROMEX, INC., IS PLEASED TO OFFER A PROGRAM TO EVENTUALLY ELEMINATE WASTE DISPOSAL IN A LANDFILL ENVIRONMENT AS WE KNOW IT TODAY!

THIS HYDROMEX WASTE SYSTEM CAN VERTUALLY DIVERT THE MAJOR DAILY VOLUME OF WASTE PLACED IN THE WAIMANALO GLUTCH LANDFILL WITHIN 3 YEARS! ALONG WITH CONTINUED RECYCLE PROGRAMS AND NEW TECHNOLOGY AVAILABLE OR ON THE HORIZON, OAHU COULD BE THE FIRST MUNICIPALITY TO BE A "ZERO WASTE" COUNTY IN THE WORLD BY 2010!

WHAT A GREAT LEGACY FOR ALL RESPONSIBLE PARTIES TO LEAVE FOR GENERATIONS TO COME....

350 Ward Ave. Suite 106 . Honolulu, HI. USA 96814. Tele (808) 396-4108. Fax 1(808) 395-7265

Table of Contents

HYDROMEX INC.

A COMPLETE WASTE MANAGEMENT SYSTEM

**PROTECTING THE ENVIRONMENT
FOR FUTURE GENERATIONS**

Book № 7026

Appendix G – Information Submitted by Hydromex

Increment No. 3: Test 10 tons of H-Power glass, in one to four tons per day increment. This would include adding alumina to the mix for use in the shipyards.

If these test prove that the Plasma Enhanced Melter is capable of meeting the independent standards of the City and County for volume reduction, commercial fuel sourcing (i.e. hydrogen gas) and vitrified glass for sandblasting grit, then a further large scale test could be arranged using the Ten-Ton per Day PEM unit.

Hawaii Medical Vitrification also proposes to the City and County of Honolulu that the vitrified glass produced in all the incremental tests be given to the United States Navy Ship Repair Facilities laboratory in order they could determine if the vitrified glass could be used as a commercial grade sandblasting grit. The United States Navy has offered to do this testing for Hawaii Medical Vitrification as part of their Presidential Executive Order regarding the purchase of recycled products.

The Hawaii Medical Vitrification plant is in Campbell Industrial Park located across the street from the H- Power industrial site. It will be easy to bring the ash, glass and RDF to the HMV operations. We also believe it is extremely important that other sites be considered for the building of the Plasma Enhanced Melter would also be in the proximity of H-Power.

If the Plasma Enhanced Melter system is built in the future, a much larger site to accommodate a multiple series of Ten-Ton PEM Units will be necessary. When scale ability can be achieved 25 Ton and 50 Ton PEM units will replace the existing smaller units. In this case, HMV would highly recommend that the City and County of Honolulu build incrementally over a period of years instead of constructing one large, massive unit.

Hawaii Medical Vitrification is prepared to establish a cost-per-day and mobilization costs for the above stated Incremental Demonstration Tests. Please contact HMV to discuss our mutual interest in the testing and evaluation of the Plasma Enhanced Melter application for Municipal Solid Waste disposal.

Sincerely,

Samuel Y. K. Liu
President and CEO

September 7, 2001

Mr. Frank J. Doyle, P.E.
Chief, Refuse Division
Department of Environmental Services
City and County of Honolulu
650 South King
Honolulu, Hawaii 96813

RE: Demonstration of HMV's Plasma Enhanced Melter Technology on Materials Going to the Waimanalo Gulch Landfill in Kapolei

Hawaii Medical Vitrification

1088 Bishop Street

Suite 1133

Honolulu, HI 96813

808 532 0512

Fax: 808 532 0515

Dear Mr. Doyle:

As an environmental professional, you are aware that medical waste is the most complex of all waste streams to be disposed of permanently.

Let me introduce the concept of Hawaii Medical Vitrification, the company that was founded to provide a complete environmental solution to medical waste management and disposal. HMV has a commercial, fully operational Plasma Enhanced Melter that has the capacity to destroy one to four tons of hazardous medical waste per day.

Hawaii Medical Vitrification (HMV) is a company wholly owned by Asia Pacific Environmental Technology, Inc. The HMV operation, after three years in the concept, development, financing, design, construction and installation phases, has been underway since February, 20, 2001.

In trying to make a public-private partnering effort and demonstrate the capabilities of the 4-Ton Plasma Enhanced Melter (PEM™), HMV proposes to the City Officials to take its Plasma Enhanced Melter off-line from its commercial operations and make it available for a series of incremental test so that the City and County, University of Hawaii, Pearl Harhour Naval Shipyard and the Dept. of Health, State of Hawaii could independently judge the capabilities of this new and important technology.

The Incremental Demonstration Test would be as follows:

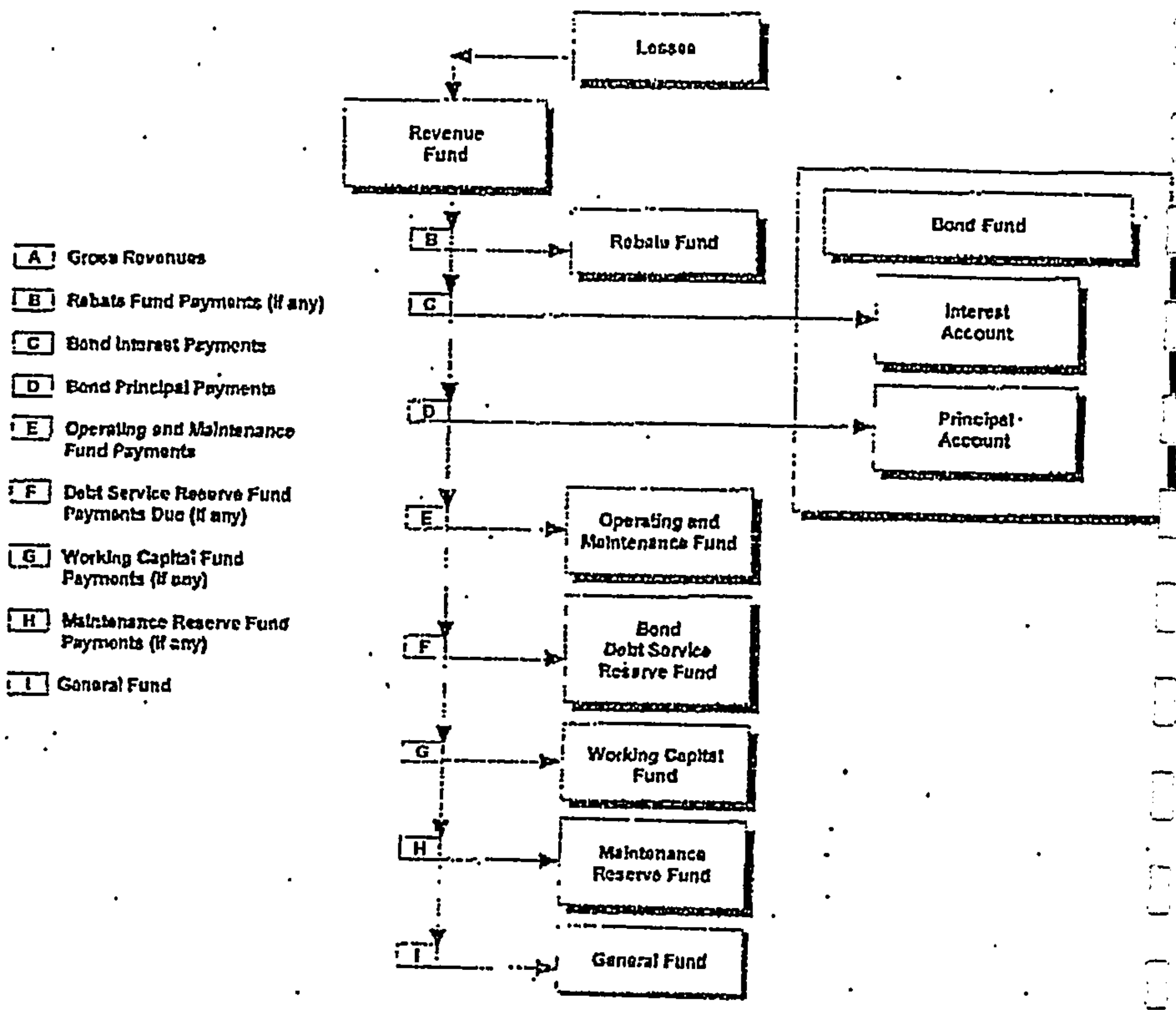
Increment No. 1: Test 10 tons of H-Power Ash, in the same mixture as taken to the Waimanalo Gulch Landfill site, in one to four ton per day increment.

Increment No. 2: Test 10 tons of H-Power Refuse Derived Fuel (RDF), in one to four ton per day increment. This would be similar to the Municipal Solid Waste that is being taken to the Landfill but in shredded form.

Appendix F – Proposal Submitted by HMV

CITY OF HONOLULU, HAWAII
Revenue Bonds, Series 2001
[ISSUER TO BE DETERMINED]

FLOW OF FUNDS SUMMARY



CITY OF HONOLULU, HAWAII
Revenue Bonds, Series 2001
[ISSUER TO BE DETERMINED]

Assumptions

Construction period		
First six months	6	
Second six months	6	
Third six months	6	
Fourth six months	0	
Fifth six months	0	
Sixth six months	0	
Seventh six months	0	
Total construction period	18	months
Capitalized interest period	18	months
Interest only period	36	months
Amortization period tax-exempt Bonds	25	years
Amortization period taxable Bonds	0	years

	% Items	$ Amounts
Interest Earnings Rate for DSR	6.88%	0
Interest Earnings Rate During Construction	5.60%	0
Estimated interest rate on tax-exempt Bonds	6.00%	0
Estimated interest rate on taxable Bonds	0.00%	0
Acquisition/Renovation	0.00%	0
Acquisition Related Expenses	0.00%	0
Architectural/Engineering Fees	0.00%	0
Bond Counsel Fee and Expenses	0.50%	0
Bond Purchaser's Counsel Fee and Expenses	0.00%	50,000
Bond Commission Fee	0.00%	0
Lessee's Counsel Fee and Expenses	0.00%	30,000
Lessee's Expenses	0.00%	0
Special Tax Counsel Fee and Expenses	0.00%	0
Closing, Travel, Hotels, and Meals	0.00%	25,000
Capitalized Interest	0.00%	0
Construction Costs	0.00%	193,500,000
Construction Monitor	0.00%	60,000
CUSIP, MSRB, Clearance, etc.	0.03%	0
Debt Service Reserve	0.00%	26,684,400
Development Coordinator's Fee	0.00%	9,600,000
Development Coordinator's Counsel Fee & Expenses	0.00%	60,000
Manager's Expenses	0.00%	0
Manager's Counsel Fee and Expenses	0.00%	0
Management Consulting Fee	0.00%	0
Environmental Report	0.00%	3,000
Equity Contribution	0.00%	0
Site Appraisal	0.00%	5,000
Facilities Inspection	0.00%	0
Facilities License Fee	0.00%	0
Financial Feasibility/Market Studies	0.00%	125,000
Financing Team Expenses	0.00%	50,000
Financial Advisor's Fee and Expenses	1.00%	0
Furniture, Fixtures & Equipment	0.00%	0
Investment Bankers' Counsel Fee and Expenses	0.25%	0
Investment Bankers' Expenses	0.00%	0
Investment Bankers' Fee	0.00%	8,039,250
Issuer's Administrative Fee	0.13%	0
Issuer's Counsel Fee and Expenses	0.00%	25,000
Land Acquisition Cost/Site Work	0.00%	0
Owner's Contingency	0.00%	0
Printing and Binding of Documents	0.00%	15,000
Real Estate Counsel Fee and Expenses	0.00%	30,000
Retirement of Existing Debt	0.00%	0
Site Survey/Topographic Study	0.00%	8,500
Title Insurance and Recording Fees	0.00%	50,000
Trustee's Authentication and Acceptance Fee	0.00%	0
Trustee's Acceptance/Counsel Fee and Expenses	0.00%	27,500
Working Capital	0.00%	1,000,000
Contingency	0.00%	51,309

CITY OF HONOLULU, HAWAII
Revenue Bonds, Series 2001
[ISSUER TO BE DETERMINED]

REVENUE BONDS SERIES 2001 – 25-YEAR TERM; TEN YEARS CALL PROTECTION

Issue Size:	$269,975,000	Average Debt Service:	25,891,208
Interest Rate:	8.000%	Maximum Debt Service:	26,584,400
Term:	25	Delivery Date:	09/01/01

September 1	BEG BAL	PRIN	INT	DEBT SVC
2002	269,975,000	0	21,598,000	21,598,000
2003	269,975,000	0	21,598,000	21,598,000
2004	269,975,000	0	21,598,000	21,598,000
2005	269,975,000	4,780,000	21,598,000	26,378,000
2006	265,195,000	5,250,000	21,215,600	26,465,600
2007	259,945,000	5,680,000	20,795,600	26,475,600
2008	254,265,000	6,080,000	20,341,200	26,421,200
2009	248,185,000	6,650,000	19,854,800	26,504,800
2010	241,535,000	7,110,000	19,322,800	26,432,800
2011	234,425,000	7,780,000	18,754,000	26,534,000
2012	226,645,000	8,280,000	18,131,600	26,411,600
2013	218,365,000	9,050,000	17,469,200	26,519,200
2014	209,315,000	9,680,000	16,745,200	26,425,200
2015	199,635,000	10,480,000	15,970,800	26,450,800
2016	189,155,000	11,380,000	15,132,400	26,512,400
2017	177,775,000	12,280,000	14,222,000	26,502,000
2018	165,495,000	13,280,000	13,239,600	26,519,600
2019	152,215,000	14,280,000	12,177,200	26,457,200
2020	137,935,000	15,380,000	11,034,800	26,414,800
2021	122,555,000	16,780,000	9,804,400	26,584,400
2022	105,775,000	17,980,000	8,462,000	26,442,000
2023	87,795,000	19,480,000	7,023,600	26,503,600
2024	68,315,000	20,980,000	5,465,200	26,445,200
2025	47,335,000	22,780,000	3,786,800	26,566,800
2026	24,555,000	24,555,000	1,964,400	26,519,400
TOTALS		269,975,000	377,305,200	647,280,200

CITY OF HONOLULU, HAWAII
Revenue Bonds, Series 2001
[ISSUER TO BE DETERMINED]

Estimated Cost of Debt Issuance Budget

Bond Counsel Fee and Expenses	$1,349,875
Bond Purchaser's Counsel Fee and Expenses	50,000
Lessee's Counsel Fee and Expenses	30,000
Closing, Travel, Hotels, and Meals	25,000
CUSIP, MSRB, Clearance, etc.	80,993
Financial Advisor's Fee and Expenses	2,699,750
Financing Team Expenses	50,000
Financial Feasibility/Market Studies	125,000
Investment Bankers' Counsel Fee and Expenses	674,938
Investment Bankers' Fee	8,099,250
Issuer's Administrative Fee	337,469
Issuer's Counsel Fee and Expenses	25,000
Printing and Binding of Documents	15,000
Trustee's Acceptance/Counsel Fee and Expenses	27,500
Contingency	3,750
	$13,593,524

CITY OF HONOLULU, HAWAII
Revenue Bonds, Series 2001
[ISSUER TO BE DETERMINED]

Estimated Cost of Acquisition and Construction Budget

ACQUISITION AND CONSTRUCTION FUND:

(a) Construction Costs (SUI Plasma Technology Plant)		$190,000,000
(b) Contingency (5% of Construction Costs)		9,500,000
		$199,500,000
Development Coordinator's Fee (1)		9,500,000
Acquisition Related Expenses	(see below)	202,059
Capitalized Interest		32,397,000
	TOTAL	$241,599,059

ACQUISITION RELATED EXPENSES:

Construction Monitor		$50,000
Development Coordinator's Counsel Fee & Expenses		50,000
Environmental Report (3)		3,000
Site Appraisal		5,000
Real Estate Counsel Fee and Expenses		30,000
Title Insurance and Recording Fees		50,000
Site Survey/Topographic Study		8,500
Contingency		5,559
	TOTAL	$202,059

(1) Development Coordinator's Fee calculated at 5% of Construction Costs.

HYDROMEX 50 TON WASTE SYSTEM

OPERATIONS PERSONNEL PER 8 HOUR SHIFT

I. 1- SUPERVISOR: TRAINED IN ALL ASPECTS OF THE HYDROMEX SYSTEM OPERATION AND CAPABLE OF MANAGING THE COMPLETE OPERATION. ALSO RESPONSIBLE FOR MIXING FORMULAE AND COMPUTER LITERATE INCLUDING QUALITY CONTROL TESTING AND REPORTS.

II 2- HYDROMEX EQUIPMENT OPERATORS: CAPABLE OF OPERATING ALL COMPONENTS OF THE HYDROMEX SYSTEM INCLUDING ROUTINE PREVENTATIVE AND CORRECTIVE MAINTENANCE. SHOULD BE MECHANICALLY INCLINED AND ABLE TO WORK ON HEAVY EQUIPMENT WITH TOOLS AND MONITORING DEVICES.

III 2- EQUIPMENT OPERATORS: TRAINED AND ABLE TO OPERATE AND REPAIR FORKLIFTS AND FRONT END LOADERS. OTHER DUTIES WOULD INCLUDE INPUT FEEDSTOCK INSPECTION AND CONTROL AS WELL AS LIGHT SUPPORT DUTIES TO THE HYDROMEX EQUIPMENT OPERATORS.

IV 2-GENERAL MATERIAL HANDLERS: CAPABLE OF DISASSEMBLE OF INCOMING MATERIALS FOR RECYCLE PRIOR TO HYDROMEX SHREDDING. ABLE TO USE SMALL TOOLS AND POWER SAWS, ETC. ALSO GENERAL OVERALL HELPERS..

NOTE: THE TOTAL PERSONNEL FOR EACH 8 HOUR SHIFT SHOULD BE AT LEAST 7 PEOPLE OR 14 STAFF FOR TWO SHIFTS TO PRODUCE AND PROCESS APROX. 100 TONS OF WASTE PER DAY...

CITY COUNCIL

CITY AND COUNTY OF HONOLULU
HONOLULU, HAWAII 96813-3065 / TELEPHONE 547-7000

STEVE HOLMES
Councilmember
Phone: (808) 547-7002
Fax: (808) 523-4220
E-mail: holmes@co.honolulu.hi.us

December 6, 1999

Mr. Larry Leaf
President
The Environmental Group
350 Ward Avenue
Suite 106
Honolulu, Hawaii 96814

Dear Mr. Leaf:

Thank you for the information and briefing on the plans for Hydromix Waste Treatment System. I understand that this is a private venture and that the City and County of Honolulu are not obligated in any way financially for the operation of this system.

As the Chair of the Public Works and Environmental Services Committee at the Honolulu City Council, I am aware that the capacity at our H-Power Facility and the Waimanalo Landfill are reaching a critical level and alternate modes of disposal will be critical in handling our waste stream in the coming years. Diversion of waste from these facilities is an important component in long-term management of waste disposal issues. I believe that, priced competitively, this system could assist the city in the reuse/disposal of a portion of our solid waste stream

Thank you for the information you provided, and I look forward to your participation in this waste reuse effort.

Sincerely,

Steve Holmes

STEVE HOLMES
Councilmember

The Environmental Group

"Serving the World with" Environmental Products and Services

Since 1989

COMPANY GENERAL INFORMATION

1. INCORPORATED IN HAWAII SINCE 1989
   INCORPORATED IN MISSISSIPPI SINCE 1997

2. DIRECTION .... ENVIRONMENTAL CONCERNS, AIR AND WATER QUALITY, WATER CONSERVATION, SOLAR HEAT AND ENERGY CONSERVATION, DESALINATION, WASTE MANAGEMENT.

3. MANUFACTURE REP., COMMERCIAL SALES, WHOLESALER, INDEPENDENT SALE ASSOCIATE.

4. WORLDWIDE MARKETING OF WATER / AIR FILTRATION DEVICES AND WASTE MANAGEMENT SYSTEMS WITH FOREIGN ASSOCIATES FROM ASIA, SAUDI ARABIA, KUWAIT, FRANCE, GERMANY, PACIFIC BASIN, ETC.

5. CONCENTRATION EFFORTS HAWAII .... ENERGY AND WATER CONSERVATION, COMMERCIAL AIR FILTRATION, SOLAR HEAT/AIR CONDITION, WATER CONDITION FOR SWIMMING POOLS, HVAC COOLING TOWERS AND WASTE MANAGEMENT SYSTEMS.

6. FUTURE PLANNING .... RECYCLE CENTER HAWAII, JOINT VENTURE EFFORTS WITH OTHER ENVIRONMENTAL COMPANIES, EXPANSION INTO THE PACIFIC AREA FOR QUALITY DRINKING WATER TO AID THIRD WORLD NATIONS IN THEIR ON GOING FIGHT WITH WATER BORN DISEASE AND WASTE MANAGEMENT SYSTEMS TO THIRD WORLD NATIONS.

7. HIGHLIGHTS .... AFTER THE GULF WAR, WE HAD AIR FILTRATION DEVICES IN THE KUWAIT HOSPITALS TO HELP WITH THE SMOKE PROBLEM DURING THE OIL FIRES .... ASSISTED THE CITY AND COUNTY OF HONOLULU IN THEIR PASSING OF THE WATER CONSERVATION ORD.-92-01 TO HAVE COMMERCIAL PROPERTIES CHANGE OUT TOILETS TO THE LOW FLOW UNITS WITHIN THE NEXT 4 YEARS .... INTRODUCTION OF WASTE MANAGEMENT SYSTEMS WORLDWIDE.

8. IN 1997 THE COMPANY EXPANDED ITS OPERATION TO THE GULF COAST AREA OF THE UNITED STATES. THIS LOCATION WILL MAINLY CONCENTRATE ON THE MARKETING AND OPERATION OF THE HYDROMEX WASTE MANAGEMENT SYSTEM IN THE SOUTHEASTERN PART OF THE US. THIS PROPRIETARY TECHNOLOGY RECLAIMS WASTE AND PRODUCES ENVIRONMENTAL SAFE PRODUCTS FOR USE IN HOMES AND INDUSTRY, AND AN ALTERNATE TO LANDFILL PROBLEMS. THE HONOLULU OFFICE WILL BE THE BASE LOCATION FOR THE HYDROMEX SYSTEM IN THE PACIFIC RIM REGION. 1998 EXPANDED AND OPENED ANOTHER OFFICE IN THE PHILIPPINES, MARKETING OF ALL THE COMPANY'S PRODUCTS AND SERVICES. 2000 WILL INCLUDE ADDITIONAL LOCATIONS IN NEVADA AND CONNECTICUT CONCENTRATING ON HYDROMEX DEVELOPMENT IN THE WESTERN AND NORTHEAST AREAS OF THE U.S. OTHER LOCATIONS ALREADY ESTABLISHED IN CHINA AND SOUTH AFRICA WITH ASSOCIATES CONCENTRATING ON WASTE MANAGEMENT PROJECT.

350 Ward Ave. Suite 106 . Honolulu, HI. USA 96814. Tele (808) 591-7722. Fax 1(808) 395-7265

HYDROMEX INC.

A COMPLETE WASTE MANAGEMENT SYSTEM

THE HYDROMEX INC. COMPANY PROFILE 1998

HYDROMEX AG completed research on an innovative System/ Process to convert waste, both in solid and liquid form, to inert materials which after conversion can be transformed into building materials or other products with commercial value. In December of 1991 a patent was filed on the process titled: " ECOLOGICALLY HARMLESS MATERIAL PRODUCED FROM WASTE". In December of 1992 a second patent was filed titled "FUEL FROM INDUSTRIAL WASTE". Research and development work was assisted by a number of scientists from Germany, Switzerland, Austria and the USA

The system was further developed by Gene Pridemore an original founder of the System/ Process. The U.S. company formed by Gene Pridemore, also one of the Hydromex patent holders, is know as Hydromex Inc. The company, Hydromex, Inc., incorporated in Nevada and filed a further patent in June of 1994. The company owns proprietary technology that transforms a wide variety of waste into usable consumer products. The Company is run by Gene Pridemore and has no financial indebtedness.

The company has been financed by the owners and by the sales of Selling Agreements to Independent Contractors. The company is also offering for sale the exclusive rights to specific geographical territories still available, World wide.

Gene Pridemore has spent the last five years further developing the Hydromex Process. He is a consultant to the companies working with the World Bank on environmental issues throughout the world. He has extensive expertise in concrete structural engineering, construction and development of mines and operating mineral processing plants for major international corporations.

The Environmental Group

Since 1989

"Serving the World with"
Environmental Products and Services

DATE: 8/24/01

COMPANY NAME: C&C ENV / DES

TO: Tim Ho

FROM: Larry Lett

NUMBER OF PAGES: 3 (INCLUDES COVER)

MESSAGE: Tim,

Attached stuff for Mark per our meet this A.M.

Aloha,

Larry

350 Ward Ave. Suite 106 . Honolulu, HI. USA 96814 . Telephone (808) 591-7722 . Fax 1(808) 395-7265

496

The plant you are about to see is our Hydromex Model 50-T-01. This system is a 50 Ton Per Shift transportable plant. Our plants are rated based on the production of 50 tons of extruded, cast and loose products per eight hour shift.

The following is a breakdown of the major components and their location by skid for easy identification during your tour:

<u>Skid #1</u> <u>SHREDDER SKID</u>

Skid #1 has a dual stage shredder with a 36" feed conveyor and a 30" discharge conveyor. The top (primary) rotor is powered by a 60HP Lincoln motor, assisted by a 400 lb flywheel that is attached to the shaft opposite the motor. This rotor reduces the incoming waste material to less than 1 inch in diameter.

The bottom (secondary) rotor is powered by a 40HP Lincoln motor, assisted by a 250 lb flywheelat the opposite end of the shaft and reduces the material from 1 inch to 3/8 of an inch in diameter or smaller. These motors operate on 480 volts at 132 amps.

The shredder was designed by **Shred-O-Lator Corporation.** The feed and discharge conveyor parts were purchased from **Motion Industries Corporation** and assembled by **Hydromex.**

All augers are 12 inches in diameter and turn at 33 rpm (revolutions per minute). Materials were purchased from. **Martin Conveyor** and assembled by **Hydromex.**

The auger feeds the waste material from the shredder into two 5 cubic yard silos equipped with two 30 inch wide conveyors powdered by two 3HP motors. Motors and material for the conveyors supplied by **Motion Industries Corporation** and **Martin Conveyor Systems.** Located in front of and to the left of the silos you will find a 25HP air compressor.

This air compressor is a screw type silent model made by Ingersoll Rand and purchased from **U. S. Equipment Company** of Los Angeles, California.

The cabinet on the other side of the skid is the electrical panel. The panel is rated at 480 Volts with 600 amp service and contains 31 motor starters and the main disconnect for all the power to the plant. The panel and all the equipment was supplied by **Mag-Trol Corporation** of Newport Beach and **Associated Electric Company** of Los Angeles.

<u>Skid #2</u> <u>EXTRUDER SKID</u>

The two large green vessels being fed by the silos are ribbon blenders or mixing tanks. They are powered by two 5HP motors and are chain driven. Each mixer has a capacity of 2 cubic yards and are equipped with air operated doors. The mixers were made by **Hydromex,** powered by **Motion Industries** and the air system was purchased from **Santa Fe Industrial Plastics** of Santa Fe Springs, California.

In front of and to the left of the two mixers are components of the extruding system for the plant. The components for the system are:

2 each 75HP Lincoln motors
1 each 8 inch x 16 inch x 144" extruder head
1 each 8 inch bore ram with a capacity of 150 tons of pressure
2 each Vickers Hydraulic Pumps
1 each component mixer
1 each 300 gallon hydraulic fluid reservoir

All parts for the extruder system were supplied by **Motion Industries Corporation** with exception of the component mixer and extruder head fabricated by **Hydromex.**

On the right side of the skid is a 12 inch conveyor for transporting loose material (mulch, compost, etc.) for storage from the second mixer.

Skid #3 LIQUID AND CONTROL SKID

Starting from the end closest to the shredder you will see the Control House. This is a 6 foot x 6 foot metal structure enclosed in glass allowing the operator to have visibility. It is air tight and air conditioned to prevent dust from accumulating inside the room. This room has all the valves and electrical controls for the entire plant. It also houses the PLC computerized unit for automatic operation of the plant. The house was built by **Hydromex** and the computer by **Alpha Environmental Controls** of Walnut California. All other items located in the house were supplied by **Santa Fe Industrial Plastics** of Santa Fe Springs, California.

Next is a green vessel with two pumps and a blower attached, this is a two compartment scrubber which cleans the air from the plant before emitting it into the atmosphere. The scrubber was designed and built by **Hydromex**, parts were supplied by **Santa Fe Industrial Plastics** of Santa Fe Springs, California.

Next are two cone bottom tanks which are the mixing tanks for all the liquids and have a series of blue air actuated valves mounted on them which are controlled by the computer. These tanks have a capacity of 250 gallons each. Behind them are six 550 gallon storage tanks which hold liquids until pumped into the mixing tanks. All pumps used for transporting liquids are Graco double air diaphragm pumps. All of the 2400 feet of pipe, 137 valves, 8 tanks, 8 pumps and all fittings were supplied by **Santa Fe Industrial Plastics** of Santa Fe Springs, California.

The three skids are all identical 8 feet wide and 35 feet long and were made by **Balboa Pacific Corporation** of Santa Fe Springs, California.

All steel supplied throughout the entire plant was supplied by **Tell Steel Corporation** of Long Beach, California.

I would like to acknowledge the efforts and hard work of the Hydromex team in constructing this plant.

Carol Batrus - CEO
Administration/Financials

Gene Pridemore - President
Engineering/Development

Jim Walraven
Computer Design/Engineering

Sheri Walraven
Documentation/Publications

John Childs
Operation/Fabrication Consultant

Fred DeCann
Fabrication/Assembly and Piping

Teresa Gorseth
Fabrication/Assembly and Painting

Most of all, we would like to give thanks to someone who was unable to see this dream come true. Mr. Albert Butler was a cherished supporter of Hydromex from October, 1994 until May 1996, when he suffered a heart attack and died on May 26th. Our gratitude, love and loss cannot be put into words. This plant and all the rest, are dedicated to you, Al.

Gene Pridemore
Hydromex Inc.
President

HYDRO MEX. 6/24/01

BRING IN 50 TPD AT NO COST TO THE CITY.
EXPORT ALL PRODUCT OFF TO PANAMA CITY &
DEMO FACILITY FOR ASIA.

ASH + FLUFF. NOT WANT A 50% MIX. USE 2 SITE
INCLUDE TREATED LUMBER
THEY DO. P

PART OF CHEMICAL IS RECYCLED.
WHY NOT PAY - HAVE LEASE AGENT TO PAY HUCS WITH
EXPECTATION THAT IT WILL SELL TO CITY. SAID 90 DAYS
BUT OK TO DO FOR 12 MONTHS.

SELL PRODUCT - FEAR OF HAVING PRODUCT TO DEAL WITH -
RR IN PANAMA CITY - MAKE INTO TIES. ALSO TEST IN A AGING
CHAMBER TO TEST THEM. ALSO 2 SAWMILLS IN MISSIPPI TO MAKE NON-LOAD BEARING.
ADVANCE DISPOSAL PROJECT - GOT ONLY THE WASTE W/O ©
SHARE THE POWER & NOT GET ENUF. PRIVATE SYSTEM, SO MOVED
TO KAUI. THINK MACHINE IS IN NEVADA.
HAD NO DEMO FOR 3 YEARS. OWNER SAYS TO GO INT + GET
LOCALS TO FUND IT. MUST HAVE DEMO TO SELL OTHERS.

★ SITE UNSEEN. LEASE ARRANGED.
SELLING THE PRODUCT - PLAN TO SELL HERE.
IDEAS FOR
HAVE A LEVEL OF INTEREST / COMMITMENT FROM LOWES + WEST.

LEASE AGREEMENT IS KEY ITEM - FRANK CHIN FROM TAIWAN
QUESTIONS - HOW LONG - 10 YR, LIFE 25 YEARS
EXTRUDING SIZE OF A RAILROAD TIE + THE CINDER BLOCK
EPA ~~HAS TO~~ SAYS IT IS OK IF PASSES TCLP TESTING.
EXPECT TO EXPORT TO ASIA. TOLD HIM ABOUT PERCEPTION
OF EXPORTING WASTE BASED PRODUCT.
AIR PERMIT - HE HAS A GUY IN DOH
WILL HAVE A BIG SHREDDER + A SMALL ONE THAT GETS 3/8"
ALL ELECT USE IS ~~FAR~~ FOR

MAINT OF SHREDDERS - SEE THE Q + A BOOK.
SHREDDERS ARE OFF THE SHELF

★ IF THE FIRST UNIT IS IN NEVADA OR UTAH - HE IS NOT
SURE. HE IS CHECKING WITH GENE. WHERE IS IT?

(Ash / cons'( )

1) Any translation on test - ?? Dioxin test. (1)

2) TLCP TEST - FOR EPA

3) 12 month TEST Program - -

4) contaminated wood? MIX-TEST?

5) Clean Air Compliance -

    1) AIR scrubber -

    2) Shredder ~~at~~ 3/8"

6) Permiting - !!

7) Name - D.O.H.

8) Power Demand O.K. -

* 9) Equipment Brand/type sheets -

* 10) Copy of Hesperia (Permit) - SCAQMD -

    total File. Permit Engineer at site

11)

The Environmental Group

Since 1989

"Serving the World with"
Environmental Products and Services

DATE: 9/12/01

COMPANY NAME: PACIFIC WASTE CONSULTING GROUP

TO: MARK WHITE

FROM: LARRY LEAF, PRESIDENT

NUMBER OF PAGES: 2 (INCLUDES COVER)

MESSAGE: DEAR MIKE,

CLEAR TYPED DOCUMENT OF NOTES (REF. YOUR E-MAIL 9/12/01

MEETING NOTES

1) ANY TRANSLATIONS OF TESTS? REFER TO TEST 11 AND 12. ALL OTHERS ARE NOT AT THIS TIME. APROX. $70.00/PAGE IN HAWAII!!

2(TLCP TESTS? REFER QUESTION AND ANSWER BOOK (Q & A) PAGES 9; 15-16; 17.

3(~~XSXXMMXEXXBXXXXBXXMX~~ 12 MONTH TEST PERIOD VERSUS 6 MONTH? O.K. WITH A C & C B.O.T. AGREEMENT OF SOME KIND IN PLACE..

4) CONTAMINATED WOOD MIX TEST? REFERE TO TEST BOOK #7,11,12,13..

5) CLEAN AIR COMPLIANCE? REFER TO Q & A BOOK 4(A-7); 7(B-1)..

6) PERMITS? WILL NEED TEMP. PERMIT UNTIL OPERATIONAL FOR "LIVE TEST" AND SITE SPECIFIC LOCATION..

8) POWER DEMAND? THIS IS WHAT WE USE..

9) EQUIPMENT BRAND/TYPE/ THESE SHEETS WERE FORWARDED TO YOU VIA TIM? IF YOU DO NOT HAVE, LET ME KNOW..

10)COPY OF HESPERIA PERMIT? SCAQMD? INFO PENDING 9/4/01. WEB SITE RESEARCH GOT ME TO FRANK AT PERMIT ASSIST.,SACRAMENTO, 800-353 2672, BUT NO CALL BACK AS OF YET. 9/12/01..

11)KAUAI PERMIT? NOT SURE THE SYSTEM PLAN GOT THAT FAR.. WE ARE IN CONTACT WITH HYDROMEX TO DIG UP WHAT THEY CAN FIND...

350 Ward Ave. Suite 106 . Honolulu, HI. USA 96814 . Telephone (808) 591-7722 . Fax 1(808) 395-7265

ANSWERS TO YOUR QUESTIONS TYPED SHEETS 24 AUG 01

1) 100 - 2000 TONS PER DAY.

2) 50 TONS/SHIFT

3) REFER TO TEST BOOK..

5) 255 DAYS/YR; BACK SHIFT NOT USED FOR P.M./C.M.; DOWN TIME ARE DAYS NOT USED FOR HEAVEY P.M./C.M...

6) TON FOR TON THROUGHPUT; 100 TON IN/ 100 TON OUT PRODUCTS..

7) 40% H-POWER ASH (OR MORE) AND 60% OTHER FEEDSTOCK - 100% OUT PUT PRODUCTS..

8) RE-USE OUR WATER IN PROCESS PLUS H-POWER "GREY WATER".

9) 9D-- 25,500 TONS PER YEAR - $46.55 PER TON COSTS..
9E-- APROX $110.00/TON INCLUDE TIP FEES.. GROSS PROFIT $63.45/T

HOPE THIS HELPS...

ALOHA,

LARRY

APPENDIX G

Hawaii Medical Vitrification Tests of H-POWER Residue on January 11-12, 2002

HAWAII MEDICAL VITRIFICATION TESTS OF HPOWER RDF OF JANUARY 11-12, 2002

By: T. W. Vorfeld, PE
Hualalai Engineering, Inc.
75-5259C Mamalahoa Hwy.
Holualoa, HI, 96725
Telephone 808-326-9058

June 26, 2002
(Revised July31, 2002)

INDEX

1.0 INTRODUCTION AND SCOPE

The first phase of testing refused derived fuel destruction in the "plasma assisted melting" system at the Hawaii Medical Vitrification plant at Kapolei took place on January 11 and 12, 2002. The purpose of these tests was to demonstrate the claim by the owners that the process was more energy efficient than the nearby HPOWER facility. This phase of the testing was to be a simplified Input/Output test where the input material feed was weighed, the electric energy consumption measured and the synthetic gas output analyzed and measured. More detailed testing was to be performed later, once the plant's Syngas engine generators were replaced.

This phase was completed and a report was to be issued by Hawaii Medical Vitrification personnel for review and comment by the City of Honolulu representatives shortly thereafter.

The initial scope of services was to witness the testing and assist the City in reviewing the results. That scope changed when no report was issued by Hawaii Medical Vitrification and City representatives asked that a review of available data be made and a short report on the outcome of the testing be prepared by this consultant.

The following report and conclusions are based on data obtained during testing, interviews with operating personnel and observations made by this consultant.

2.0 SUMMARY OF CONCLUSIONS

The testing observed during January 11 and 12, 2002 did not demonstrate that the "plasma-enhanced melter" system is more energy efficient than HPOWER. Further, the tests indicated the system is an inefficient producer of hydrogen gas.

The **thermal gasification** efficiency during the selected runs varied between 47% and 49%, excluding the inefficiency of utilization of the Syngas to produce electric energy or the inefficiency of producing the electric energy used for gasification. This compares to some other biomass gasification systems which project a thermal efficiency of 60%, maximum.

If gas turbines in a reasonably high efficiency combined cycle mode of operation (9,000 BTU/kWh) had burned the Syngas, the overall **process conversion** efficiency would have been 17.8-18.4 %, excluding any penalty for producing the electric energy used for gasification (See Figure A). HPOWER, which uses no external electric energy input, has an overall process conversion efficiency of approximately 24.3 %. Energy to separate and prepare MSW into RDF is not included in these figures.

A better comparison would be the net electric energy produced per ton of RDF. The tests indicate the plasma-enhanced-melter would have produced a **negative** 3,366 kWh per ton of RDF if the Syngas had been burned in an efficient combined cycle generating system. By comparison, the HPOWER process produced a **positive** 712 kWh per ton of RDF in 2001. Both figures exclude the energy required to prepare the RDF from MSW.

Another way of looking at the overall conversion efficiency of this process is that the plasma-enhanced-melter system consumed electric energy during the testing at the rate of approximately 303.2 kW and produced Syngas capable of generating electric energy at the rate of 94.4 kW. Therefore, this process, at the tested conditions, consumed more three times the electric energy than it was capable of producing.

As a producer of hydrogen, the test results indicate this process used 89% more electric energy input than conventional electrolyzing of water would have required for the same amount of hydrogen gas. (Electrolysis of water has a conversion efficiency of 70 %.)

It was not possible to determine exactly what effect scaling up of the system would have on overall electric energy conversion efficiency from the test data. However, for this particular process, if the tonnage of RDF were increased to the facility's design level of 4 tons per day, and if the electric energy input remained the same as during the testing, the plasma-enhanced melter would still have produced less electric energy than it consumed (a **negative** 299.2 kWh per ton of RDF).

If the process were scaled up to the equivalent of 150 tons of MSW per day, the results are shown in Figures B and C. The process still has a negative electrical output per ton of RDF, regardless of the scaling assumptions.

As a source of hydrogen, if one were to assume that the hydrogen gas component of the Syngas could be sold as fuel for an amount equal to the projections of the National Hydrogen Association for year 2010 ($6.35 per 1000 cubic foot, which equates to an equivalent gasoline price of $2.50 per gallon), and if the process were scaled up to the equivalent of 150 tons of MSW, the hydrogen value would still be less than the cost of electric energy needed to produce the hydrogen, again regardless of the scaling assumptions.

HECO ENERGY INPUT 776,116 BTU 'A' (303.2 kW)

RDF INPUT 533,756 BTU 'B'

(1.484 TPD)

HMV
PLASMA ARC
SYSTEM

Thermal Glasification Efficiency

$= 100 \text{ X } \frac{C}{A + B} = \boxed{48.64}\ \%$

SYNGAS
OUTPUT

637,073 BTU 'C'

(2187 CUBIC FEET)

COMBINED
CYCLE
GENERATION

ELECTRICAL OUPUT 241,592 BTU 'D' (94.4 kW)

Overall Thermal Efficiency

$= 100 \text{ X } \frac{D}{A + B} = \boxed{18.44}\ \%$

PLASMA-ENHANCED-MELTER

CONDITION: RUN B RDF RATE OF 92.8# IN 45 MINUTES

FIGURE: A

Scaling Factor

= NONE

7/29/02

HECO ENERGY INPUT 2,101,537,685 BTU 'A' (25,565 kW)

RDF INPUT 1,395,609,120 BTU 'B'

(125.64 TPD)

HMV
PLASMA ARC
SYSTEM

Thermal Glasification Efficiency

$= 100 \times \frac{C}{A + B} =$ 49.33 %

SYNGAS
OUTPUT

1,725,078,600 BTU 'C'

(5,922,000 CUBIC FEET)

COMBINED
CYCLE
GENERATION

Electric Energy Cost at $0.10 / kWh
= $61,574/Day

Hydrogen fuel at $6.35/1000 cubic feet (40.36% Hydrogen)
= $15,185/Day

ELECTRICAL OUPUT 654,149,232 BTU 'D' (7,986 kW)

Overall Thermal Efficiency

$= 100 \times \frac{D}{A + B} =$ 18.71 %

PLASMA-ENHANCED-MELTER

CONDITION: LINEAR SCALE UP TO 150 TPD OF MSW (125.4 TPD OF RDF) USING RUN B RDF RATE OF 92.8# IN 45 MINUTES

FIGURE: B

Scaling Factor

= (125.64/92.8)x2000= 2707.76 FOR ALL INPUTS AND OUTPUTS

7/29/02

HECO ENERGY INPUT 780,129,888 BTU 'A' (9,524 kW)

RDF INPUT 1,395,609,120 BTU 'B'

(125.64 TPD)

HMV
PLASMA ARC
SYSTEM

Thermal Glasification Efficiency

$= 100 \text{ X } \frac{C}{A + B} = \boxed{79.29}\ \%$

SYNGAS
OUTPUT

1,725,078,600 BTU 'C'

(5,922,000 CUBIC FEET)

COMBINED
CYCLE
GENERATION

Electric Energy Cost at $0.10 / kWh
= $22,858/Day
Hydrogen fuel at $6.35/1000 cubic feet (40.36% Hydrogen)
= $15,185/Day

ELECTRICAL OUPUT 654,149,232 BTU 'D' (7,986 kW)

Overall Thermal Efficiency

$= 100 \text{ X } \frac{D}{A + B} = \boxed{30.07}\ \%$

PLASMA-ENHANCED-MELTER

CONDITION: LINEAR SCALE UP TO 150 TPD OF MSW (125.4 TPD OF RDF) USING RUN B RDF RATE OF 92.8# IN 45 MINUTES
WITH ELECTRIC ENERGY INPUT SCALED UP FROM 4 TPD UNIT

FIGURE: C

Scaling Factor

= (125.64/92.8)x2000=
2707.76 FOR RDF,
2707.76X(1.484/4)=1004.6
FOR INPUT ELECTRIC
ENERGY

7/29/02

3.0 SOLID WASTE THERMAL GASIFICATION SYSTEMS

Thermal gasification systems have been in commercial use for many years although use of thermal gasification systems to destroy solid wastes is fairly recent. There are three basic methods of solid waste thermal gasification; **air, starved air** and **no air.**

Air systems are conventional combustion systems producing hot gas containing mostly carbon dioxide, oxygen and nitrogen, plus ash. The entire heat of combustion in the solid waste organic material drives the process.

In **starved air** systems, some air is added and carbon monoxide, carbon dioxide and hydrogen are produced via partial combustion of the solid waste organics to form a low heat content synthetic gas along with ash. **Starved air** systems are the most common solid waste gasification systems being researched today.

In **no air** systems, no air is added and thermal degradation takes place via an external source of heat, resulting in destructive distillation of organic materials. A medium heat content gas is formed, plus char and ash. (Pyrolysis oils can also be produced in **no air** systems.) The principal gases produced from **no air** systems include carbon monoxide, carbon dioxide, hydrogen, and methane.

The interest in **starved air** and **no air** systems is threefold:

1. There is less volume of gas produced than in the **air** systems (due to less use of air with its inherent high portion of nitrogen). This lower volume of gas means that the gas handling and cleaning equipment can be much smaller than that of **air** systems, significantly lowering gas handling equipment and energy costs.

2. The synthetic gas has the potential of burning in gas turbine engines in a "combined cycle" mode of generation. Because the synthetic gas eventually is burned in an engine fed by atmospheric air, the hot exhaust gases are then sent to a conventional heat recovery steam boiler and a steam turbine generator. These two together form a "combined cycle" which has an overall thermal efficiency of 38% compared to a steam cycle alone at 30% or the gas turbine alone at 28%, in the size ranges of most municipal waste to energy facilities. The synthetic gas in **starved air** and **no air** systems contains a significant amount of hydrogen. Gas turbine engines are best suited for burning the synthetic gas; however the gas must be extremely clean. Reciprocating engines are not well suited for burning this synthetic gas due to the high hydrogen content which lowers the octane rating and causes detonation or "knocking" to destructive levels. The final exhaust gas quantity from the combined cycle is the same or greater than the exhaust gas quantity from the typical **air** system and some additional treatment of this larger volume is often required (i.e. NOX control).

3. The synthetic gas has the potential for being used to create other valuable chemicals such as hydrogen or the various alcohols (ethanol, methanol, etc.)

The use of the synthetic gas from waste gasification for providing hydrogen for fuel cells via either the **starved air** or the **no air** system has not been proven but provides no thermodynamic benefit over more conventional means for producing hydrogen. The use of the synthetic gas from waste gassification for producing other chemicals such as alcohols for fuel and fuel additives is receiving a lot of attention. Methanol is both a fuel by itself as well as a source of making or replacing MTBE, the present octane enhancing gasoline additive. Methanol is currently being produced mainly by fermentation processes.

Plasma arc gasification systems utilize **starved air, no air** or combinations of both systems. In the case of plasma arc gasification systems, the external source of heat is an electric arc created by two direct current electrodes. To facilitate heat transfer, a gas (typically air, oxygen, helium, argon or nitrogen) is passed between the electrodes of the plasma torch. This gas becomes ionized "plasma" and exists at temperatures of 12,000 °F. to 21,000 °F. Plasma arc torches were demonstrated in 1804 and used commercially by the Siemens Company in the late 1800's. Plasma arc torches have been in use for many years to meet various metal processing needs. Precision cutting of high alloy metals with plasma arc torches is an example.

When combined with a joule heating system to melt the ash in solid waste, the "plasma enhanced melter" has received some interest for destruction of solid and liquid wastes, since the high plasma temperature destroys all organics and the joule heating system turns the ash into a totally inert molten glass-like (vitrified) product which, when solidified, will not leach chemicals into the ground. (Vitrification of municipal solid waste ash is being developed in Japan to further reduce the need for landfills.) Thus, in this system, the components in the waste are completely altered leaving a gas plus non-leachable glass whose volume is a small fraction of the initial substance. Most research into this system has centered on the use of gasification/vitrification systems such as this for volume reduction and destruction of hazardous wastes. The system at Hawaii Medical Vitrification is a plasma-enhanced melting system designed to destroy medical waste. There are currently no commercial plasma-arc systems in operation for destruction of municipal solid waste, although one is reportedly near completion of construction in Japan..

The interest in gasification of municipal solid waste, particularly in Europe and Japan, is not driven by economics since, at this time, no cost-effective gasification process for MSW has been demonstrated anywhere, worldwide. Rather, the interest is due to the bad image which the original "incineration" technologies have created. This is unfortunate since the public as well as most elected public officials do not understand that the recently developed waste-to-energy combustion systems bear little resemblance to the original incinerators which created that bad image. These new systems are far less polluting than the old incinerators and their air emissions proven to be less hazardous than landfills. Further, the claimed higher efficiency of gassification systems has yet to be proven and, in fact, one prominent Japanese University (Nagoya) experimenting with biomass gasification predicts maximum thermal efficiencies of 60%, approximately the same as or slightly less than today's municipal solid waste combustion boilers.

4.0 THE HMV/IET PLASMA ARC SYSTEM

The system used by Hawaii Medical Vitrification (HMB) was supplied by Integrated Environmental Technology, LLC (IET). This plasma arc/vitrification system was originally conceived at MIT and developed for hazardous waste treatment by Battelle Memorial Institute under a government grant. One of the principals of IET, Mr. Jeffrey Surma, left Battelle in 1995 to start IET following a determination by the Department of Energy that the plasma/vitrification system was promising for dealing with hazardous and radioactive wastes. IET's goal was to improve and expand upon the uses of the plasma/vitrification system. For additional information on IET and the development of its system, see Appendix 6.4.

HMV purchased and started up the IET "Plasma Enhanced Melter" system in 2001 for the purpose of destroying medical waste from Honolulu hospitals. Figure 1 depicts the system, which is basically composed of an electric arc plasma torch coupled with an electrode joule (resistance) heating system. Figure 2 is a picture of most of the processing equipment showing the plastic containers of medical waste which are conveyed and dropped batch-wise into the PEM vessel. Figure 3 is a schematic of the Syngas cleaning and processing system and Figure 4 shows the refused derived fuel (RDF) from HPOWER in cardboard containers.

The system was designed for processing up to 4 tons per day of medical waste. Reportedly, IET provides similar systems up to 10 tons per day capacity.

Not shown in any of the figures are the oxygen supply system, the two engine generators, the cooling water cooling and cleaning system, the fairly massive amount of electrical switchgear, transformers and rectifiers or the control room equipment.

Idaho National Engineering and Environmental Laboratory

Schematic of IET Plasma Enhanced Melter

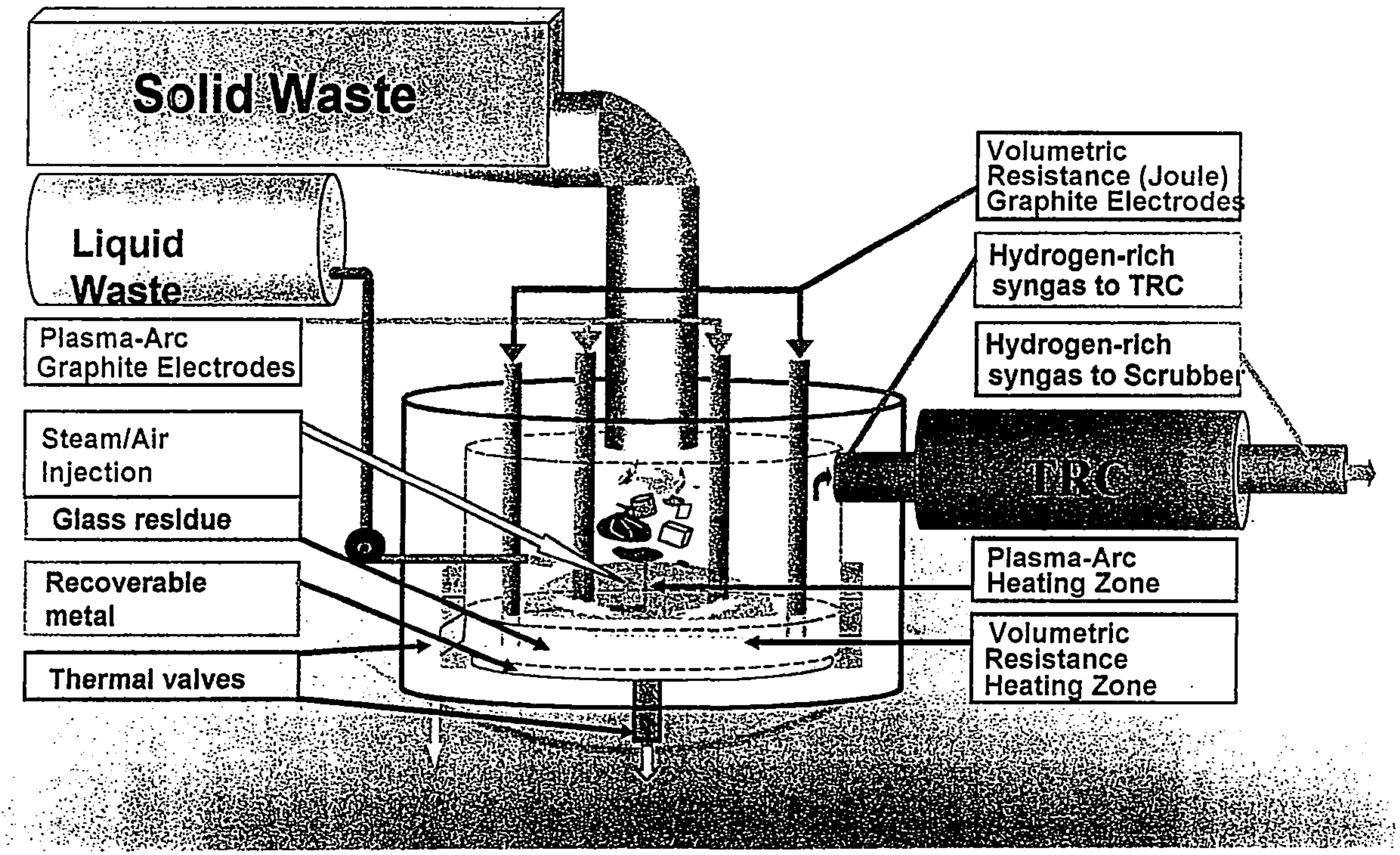


FIGURE 1

Idaho National Engineering and Environmental Laboratory

INEEL

IET PEM operating on Containerized Medical Waste in Hawaii

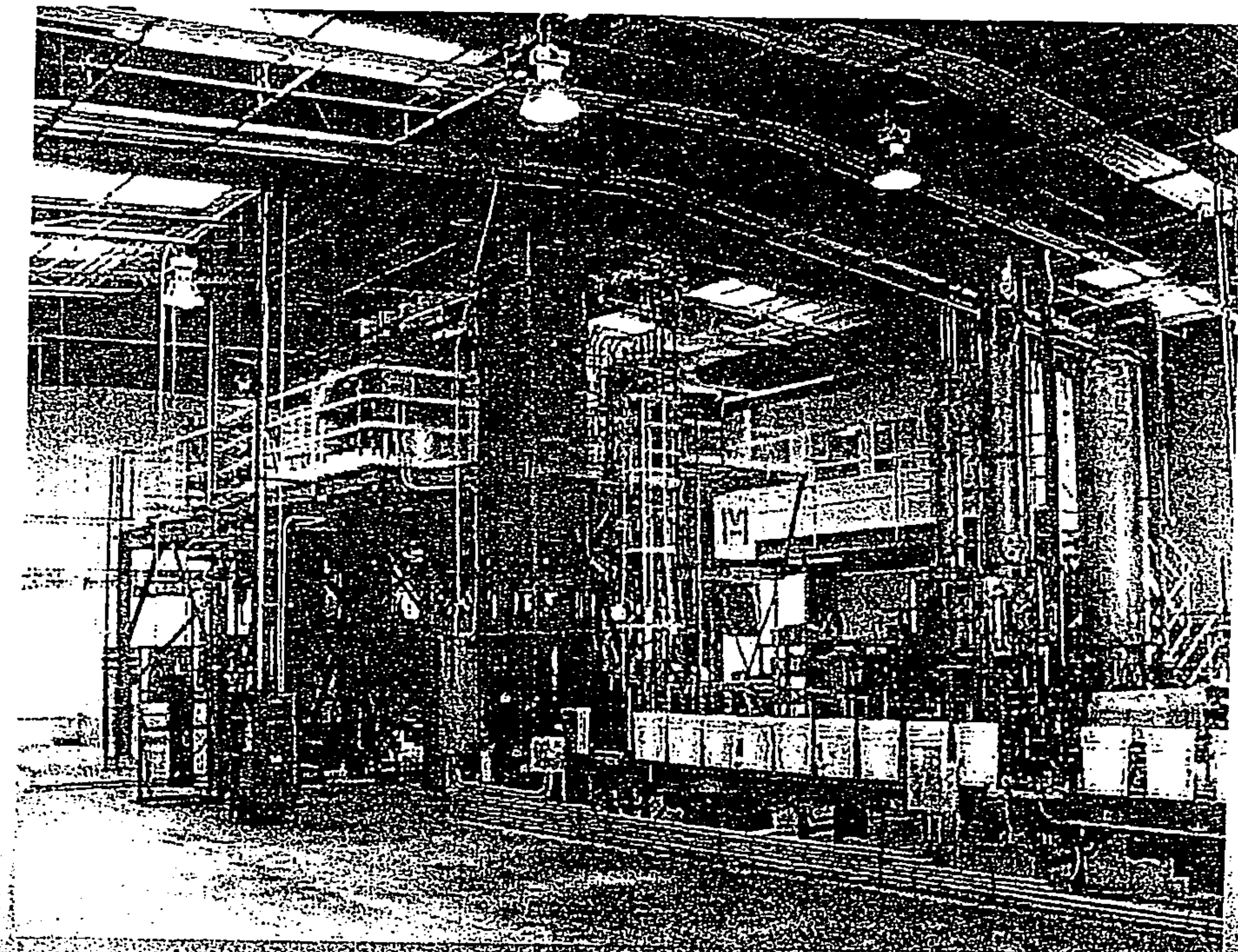
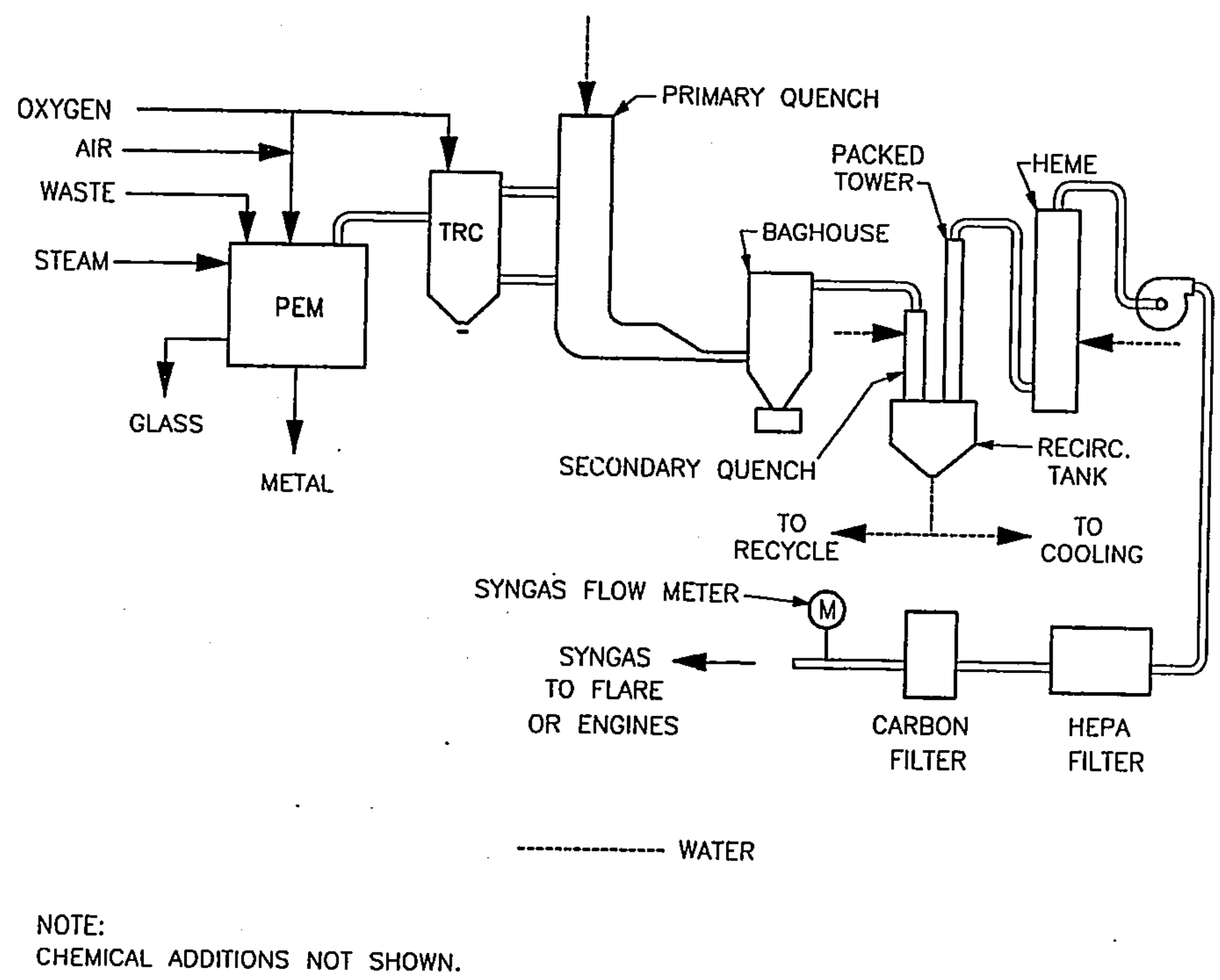


FIGURE 2



PEM GAS CLEANUP

FIGURE 3

RDF FEEDSTOCK
IN CARDBOARD DRUMS

FIGURE 4

5.0 DISCUSSION OF TEST RESULTS

5.1 General

Tests were conducted on January 11-12, 2002 using RDF from HPOWER packed into round cardboard containers. The process rate was reportedly designed to stay within the facility's Department of Health air permit limits of one ton per 24 hours. The Nova gas analyzer had been calibrated using test gases, by an employee of Integrated Environmental Technology. The thermal mass flow meter was installed on the Syngas line and calibrated by an employee of Process Controls. Process data was taken by the plant operators with data on electric energy consumption provided by remote monitoring and metering facilities of Hawaiian Electric.

The runs on 1-11 and 1-12 went reasonably well until the early morning hours of 1-12, when a cardboard drum got hung up in the infeed to the PEM unit. The run was resumed after noon of 1-12 and continued until all the containerized RDF was consumed.

The writer left the premises at noon on 1-12 and obtained data on the previous day and night's run for analysis. No data was provided by HMV for the runs after noon, 1-12.

For this analysis, two reasonably long, uninterrupted runs were chosen as representative of the process inputs and outputs. Run A is the period from 2253-2350 hours on 1-11 and Run B the period from 0404-0449 hours on 1-12.

5.2 The RDF

There were two batches of RDF. One batch (OLD RDF) had been collected in December of the previous month and had been put in sealed cardboard containers. The other batch (NEW RDF) was collected just prior to testing. Two samples of each were analyzed by HARC laboratories in Aiea for moisture and ash. Previous analytical data from HPOWER RDF analyses was used to determine the probable higher heating value of the test RDF.

There was a considerable loss of moisture in the OLD RDF samples. When packed, the OLD RDF containers weighed 8-12 pounds but at the time of the test, they weighed 6-9 pounds. Based on the container weights shown on the data sheets, it was presumed that all of the containers destroyed during Runs A and B were NEW RDF, although that was not confirmed by HMV.

Any additional testing should include complete sampling and analysis of the RDF.

5.3 The Syngas

The thermal dispersion mass flowmeter was reportedly factory calibrated for a gas whose constituents were similar to those from the Syngas, based on data provided by HMV. Process Controls indicated that the error would be a maximum of 3% if the actual gas components fell within the extreme range provided by HMV. Communications with Process Controls following the testing failed to confirm that the actual gas components fell within these ranges. This device provides a measurement of actual (wet) gas flow. The Syngas is presumed to be saturated with water as it is scrubbed with water. Moisture content is only 3.45% at measured condition. For calculation purposes, the Syngas flow was presumed to be as labeled, that is **Standard Dry Cubic Feet.**

The Nova gas analyzer provides a dry gas analysis. Although HMV indicated that the data produced by their process computer was corrected to wet gas flow, no algorithm to do this provided by HMV. The calculations were based on the presumption that the reported gas composition was based on dry gas, although the net effect on heating value is negligible and doesn't change the overall conclusions of this report. The analyzer was calibrated by an employee of IET using test gases prior to and during the tests and found to have little or no drift. An attempt by the writer to check this analyzer using a hand held analyzer was not successful. The unmeasured portion of the gas was presumed to be nitrogen, although that was not verified. (It is likely there are some nitrogen oxides in the Syngas.)

Any additional testing should include grab samples of gas for laboratory analysis and use of a positive displacement gas flow meter.

5.4 Other Parameters

No testing of the vitrified product was conducted and it was presumed it contained no carbon or other combustible element.

Steam used in the process was generated by an electric boiler hence the energy from that steam is accounted for in the overall plant energy consumption.

No correction was made for the energy input from the graphite electrode consumption.

The heating value of the cardboard container was estimated at 8000 BTU/pound. Any further testing should verify this.

APPENDIX 6.1

Calculations

Run	Date	Time	Bucket Wt., #	Wet Syngas Mass Flow Meter, SCFM	Dry Syngas H_2 %	CO %	CO_2 %	CH_4 %	O_2 %	Steam #/hr
A	1-11-02	2253	10.4	49	38	30	13	7	0	114
A		2257	10.2	45	38	29	13	6	0	116
A		2305	11.0	48	39	30	13	5	0	113
A		2311	10.2	49	38	29	13	5	0	116
A		2317	9.8	44	39	30	13	4	0	115
A		2324	10.0	45	38	30	13	5	0	111.5
A		2330	10.4	48	39	30	13	5	0	111.6
A		2336	10.4	45	39	30	13	5	0	118
A		2343	8.2	39	39	30	12	5	0	116
A		2350	—	—	—	—	—	—	—	—
Run A Avg. (TOT)		57 min. (Tot)	90.6 (Tot)	45.8	38.6	29.8	12.9	5.2	0	115.4 (109.6 Tot)
B	1-12-02	0404	9.8	52	41	28	13	6	0	113
B		0408	10.6	63	41	28	13	6	0	110
B		0412	10.8	58	42	29	12	6	0	116
B		0417	8.4	46	42	29	12	7	0	109
B		0421	9	42	41	30	11	8	0	112
B		0467	8.4	32	41	30	11	8	0	112
B		0432	8	49	41	30	11	8	0	112
B		0436	11	45	40	29	11	6	0	110
B		0440	8.4	54	41	30	11	6	0	116
B		0444	8.4	45	41	30	11	7	0	110
B		0449	—	—	—	—	—	—	—	—
Run B Avg. (TOT)		45 min. (Tot)	92.8 (Tot)	48.6	41.1	29.3	11.6	6.8	0	112 (84 Tot)

HUALALAI ENGINEERING, INC.

SUBJECT: Summary of Test Data

DATE 6-21-02
BY TWW
SHEET 1 OF 1
JOB NO

Sample Date	Moisture, %	Ash, %	HHV,* BTU/#	HHV, MAF,** BTU/#	Taken From Boiler #
10/22/99	36.95	13.78	4,404	8,938	2
10/20/99	34.56	13.91	4,844	9,401	2
10/19/99	35.11	9.29	5,357	9,624	2
10/18/99	32.00	11.31	5,042	8,897	2
10/24/99	32.90	12.99	5,350	9,887	1
10/23/99	31.99	8.83	4,967	8,392	1
10/22/99	33.51	16.58	4,753	9,524	1
10/21/99	35.51	13.78	5,043	9,945	1
10/20/99	34.44	8.37	5,434	9,500	1
10/19/99	36.44	14.63	4,612	9,425	1
10/18/99	31.70	17.18	5,164	10,103	1
Ave (mean)	34.10	12.78	4,999	9,421	—

* - HHV = Higher Heating Value
** - MAF = Moisture & Ash Free

HUALALAI ENGINEERING, INC.	SUBJECT Summary of HPOWER RDF Heating Values	DATE 6-21-02 BY TWU SHEET 1 OF 1 JOB NO

Month	RDF % MSW	Gross KWH/Ton MSW	Export KWH/Ton MSW
Jan	85.5	603.5	526.4
Feb	81.2	603.3	526.2
Mar	82.1	598.9	4920
Apr	81.6	593.7	518.0
May	76.7	602.2	526.1
June	82.5	596.0	523.3
July	82.4	588.4	512.0
Aug.	83.1	618.0	541.2
Sept	83.2	606.2	531.1
Oct.	83.8	5821	506.4
Nov	81.2	570.1	485.8
Dec	83.3	592.4	513.5
Ave (Mean)	82.2	596.0	516.9

HUALALAI ENGINEERING, INC.	SUBJECT 1991 HPOWER AVERAGES	DATE 6/21/02 BY [illegible] SHEET 1 OF 1 JOB NO

9421

1. NEW RDF

Date	Moisture* %	Non-Combustibles* %	Combustibles* %	Sample* #
1/11/02	26.8	12.0	61.2	1
1/11/02	28.4	14.9	56.7	2
Ave (mean)	27.6	13.4	58.95	-

Calculate As Fired HHV:

HHV Combustibles = 9,421 BTU/# **

As Fired HHV = 9,421 x 0.5895 = 5,554 BTU/#

2. OLD RDF

DATE	Moisture	Non-Combustibles*	Combustibles*	Sample* #
1/11/02	9.9	13.7	76.4	1
1/11/02	8.2	19.1	72.7	2
Ave (mean)	9.05	16.4	74.55	-

CALCULATE As Fired HHV

HHV Combustibles = 9,421 BTU/# **

As Fired HHV = 9,421 x 0.7455 = 7,023 BTU/#

* DATA FROM HARC Analyses

** " " HPOWER Analyses

HUALALAI ENGINEERING, INC.	SUBJECT HEATING VALUE, AS FIRED FOR TEST RDF.	DATE 6-21-02 BY TW SHEET 1 OF 1 JOB NO

A = 301.2 kW

B = 303.2

1. Run A

Ave Energy = 301.2 kW

Time = 57 min ÷ 60 = 0.95 hr

kWh = 301.2 kW × 0.95 hr = 286.1 kWH

BTU = 286.1 kWh × 3,413 $\frac{BTU}{kWh}$ = 976,459 BTU

2. Run B

Ave Power = 303.2 kW

Time = 45 min ÷ 60 = 0.75 hr

kWh = 303.2 kW × 0.75 hr = 227.4 kWH

BTU = 227.4 kWH × 3,413 $\frac{BTU}{kWh}$ = 776,116 BTU

HUALALAI ENGINEERING, INC.	SUBJECT Electric Energy Input During TEST (Consumption)	DATE 6-21-02 BY TWV SHEET 1 OF 1 JOB NO

1. INPUT ENERGY FORMULA

IE, BTU = Electric Energy Input + SAMPLE HHV

Sample Input HHV = Cardboard Container X 8000 BTU/# (1)
+ RDF x 5554 BTU/# (2)

RDF = Container Total wt – Cardboard Container Wt

Cardboard Container = 0.75# (3) each

2.) Input Elect. Energy

Run A = 976,459 BTU

Run B = 776,116 BTU

3. Sample Input

Run A = (90.6 – 9 x 0.75) 5,554 + 9 x 0.75 x 8,000

= 519,703 BTU

Run B = (92.8 – 10 x 0.75) 5,554 + 10 x 0.75 x 8000

= 533,756 BTU

4. Total Input

RUN A = 976,459 + 519,703 = 1,496,162 BTU

RUN B = 776,116 + 533,756 = 1,309,872 BTU

NOTES:

(1.) – Average Value for dry Paper
(2.) – HHV used is for "NEW" RDF
(3.) – GIVEN BY HMV

HUALALAI ENGINEERING, INC.	SUBJECT: CALCULATE ENERGY Input (Total)	DATE 5-23-07 BY [illegible] SHEET 1 OF 1 JOB NO

1. Assumption

a.) Wet Syngas Mass Flow has been converted to Standard Scfm (60°F) - Per log sheets

b.) Gas Analysis is Dry measurement (Per Nova communication 2/7/02)

2. Gas HHV BTU (per attached)

Run A = 269.1 BTU/scf

Run B = 291.3 BTU/scf

3) Run A.

45.8 scfm x 57 minutes x 269.1 BTU/scf = 702,512 BTU

4. Run B.

48.6 scfm x 45 min x 291.3 BTU/scf = 637,073 BTU

	SUBJECT: CALCULATE Syngas Output Energy	DATE 6-28-02 BY [illegible] SHEET 1 OF 3 JOB NO

Wet Syngas Calculations	Run A					Calc Date:	6/26/02	
	Total Mixture Pressure:					14.696	psia	
	Mixture Temperature:					60	deg. F	
	Gas	Molecular Wt.	Heat of Combustion, BTU/CF	Volumetric Readings, Percent DRY Gas*	DRY Contribution to Heat of Combustion, BTU/CF	Partial Pressure, psia	Volumetric Proportions, Percent WET Gas	WET Contribution to Heat of Combustion, BTU/CF
	H_2	2	325	38.60%	125.5	5.5738	37.93%	123.3
	CO	28	321	29.80%	95.7	4.3031	29.28%	94
	CO_2	44	0	12.90%	0	1.8627	12.67%	0
	CH_4	16	1014	5.20%	52.7	0.7509	5.11%	51.8
	N_2 (balance dry)	28	0	13.50%	0	1.9494	13.26%	0
	H_2O**	18	0	n/a		0.25611	1.74%	0
	TOTALS			100.00%	273.9	14.69601	99.99%	269.10
	*Model as Ideal Gas, Gibbs-Dalton Law applies.							
Notes:	**H_2O is assumed saturated at mixture temperature due to wet scrubbing process.							

Syngas Input

Sh 2 of 3

Wet Syngas Calculations	Run B				Calc Date:	6/26/02	
Total Mixture Pressure:					14.696	psia	
Mixture Temperature:					60	deg. F	
Gas	Molecular Wt.	Heat of Combustion, BTU/CF	Volumetric Readings, Percent DRY Gas*	DRY Contribution to Heat of Combustion, BTU/CF	Partial Pressure, psia	Volumetric Proportions, Percent WET Gas	WET Contribution to Heat of Combustion, BTU/CF
H_2	2	325	41.10%	133.6	5.9348	40.38%	131.2
CO	28	321	29.30%	94.1	4.2309	28.79%	92.4
CO_2	44	0	11.60%	0	1.675	11.40%	0
CH_4	16	1014	6.80%	69	0.9819	6.68%	67.7
N_2 (balance dry)	28	0	11.20%	0	1.6173	11.01%	0
H_2O**	18	0	n/a		0.25611	1.74%	0
TOTALS			100.00%	296.7	14.69601	100.00%	291.30

Notes:
*Model as Ideal Gas, Gibbs-Dalton Law applies.
**H_2O is assumed saturated at mixture temperature due to wet scrubbing process.

Syngas Input
Sh 3 of 3

formed in the combustion process, as described on Page 2–12.

The heating value of manufactured gas is expressed as Btu per cu ft when measured at 60°F and 30 in. Hg, saturated with water vapor. The values for natural gas, however, are commonly reported at a pressure of 14.7 psia (pounds per square inch absolute) or 30 in. Hg, at a temperature of 60°F, and generally on a dry basis.

The heating value of gaseous fuels varies considerably, depending on the constituents present. When not obtainable by test, H_f can be calculated by summing up the heat evolved by the individual combustible fractions of the gas. In Table XVII are shown the principal components, together with their properties at 60°F and 30 in. Hg, moisture-free. When present in different proportions, these make up various fuel gases.

ANSI/ASTM Standards D 3588 gives a method for calculating calorific value and specific gravity of gaseous fuels and includes a method for determining the repeatability and reproducibility of the calculated values.

SPECIFIC GRAVITY

Various methods for determining the specific gravity of a fuel gas are available but three

Table XVII. Combustion Constants of Dry Gases at 60°F and 30 In. Hg

	Chemical Formula	O_2 Reqd./Cu Ft of Dry Gas, Cu Ft	CO_2 Formed/Cu Ft of Dry Gas, Cu Ft	H_2O Formed/Cu Ft of Dry Gas, Cu Ft	Density of Dry Gas, Lb/Cu Ft	HHV of Dry Gas Btu/Cu Ft*	HHV of Dry Gas Btu/Lb
Gas							
Oxygen	O_2	...	...	...	0.08461	...	...
Nitrogen (atmospheric)	N_2	...	...	...	0.07439	...	...
Air	...	...	...	...	0.07655	...	...
Carbon dioxide	CO_2	...	...	...	0.1170	...	...
Water vapor	H_2O	...	...	...	0.04758	...	...
Hydrogen	H_2	0.5	...	1.0	0.005327	325	60,991
Hydrogen sulfide	H_2S	1.5	1.0**	1.0	0.09109	647	7,100
Carbon monoxide	CO	0.5	1.0	...	0.07404	321	4,323
Saturated Hydrocarbons							
Methane	CH_4	2.0	1.0	2.0	0.04246	1014	23,896
Ethane	C_2H_6	3.5	2.0	3.0	0.08029	1789	22,282
Propane	C_3H_8	5.0	3.0	4.0	0.1196	2573	21,523
Butane	C_4H_{10}	6.5	4.0	5.0	0.1582	3392	21,441
Pentane	C_5H_{12}	8.0	5.0	6.0	0.1904	4200	22,058
Unsaturated Hydrocarbons or Illuminants							
Ethylene	C_2H_4	3.0	2.0	2.0	0.07421	1614	21,647
Propylene	C_3H_6	4.5	3.0	3.0	0.1110	2383	21,464
Butylene	C_4H_8	6.0	4.0	4.0	0.1480	3190	21,552
Pentylene	C_5H_{10}	7.5	5.0	5.0	0.1852	4000	21,600
Acetylene	C_2H_2	2.5	2.0	1.0	0.06971	1488	21,344
Benzene	C_6H_6	7.5	6.0	3.0	0.2060	3930	19,068
Toluene	C_7H_8	9.0	7.0	4.0	0.2431	4750	19,537

* If gas is saturated with moisture at 60°F and 30.0 in. Hg, reduce by 1.74%.
** SO_2 rather than CO_2

1. Run A.

1.1 Input Total

Electric Energy Input = 976,459 BTU
WASTE " " = 519,703 "

Total Input = 1,496,162 "

1.2 OUTPUT TOTAL = 702,512 BTU

1.3 Output/Input (Thermal gasification Efficiency)

$$= \frac{702,512}{1496,162} \times 100 = \underline{\underline{46.95\%}}$$

2. Run B

2.1 Input total

Electric Energy Input = 776,116 BTU
WASTE " " = 533,756 "

Total Input = 1,309,872

2.2 Output Total = 637,073 BTU

2.3 Output/Input (Thermal gasification [illegible]

$$= \frac{637,073}{1,309,872} \times 100 = \underline{\underline{48.64\%}}$$

	SUBJECT Summary of Gasification Energy [illegible]	DATE 6-26-02 BY JW SHEET 1 OF 1 JOB NO

1. Assumptions

a.) Combined cycle Heat Rate of 9,000 BTU/kwh

b.) 3,413 BTU/kwh direct conversion

2. Run A

Electric Energy Potential = $\frac{702,512}{9000}$ = 78.1 kWh

3. Run B

Elect. Energy Potential = $\frac{637,073}{9000}$ = 70.8 kWh

	SUBJECT Summary of Potential Electric Energy Generation	DATE 6-26-02 BY TWU SHEET 1 OF 1 JOB NO

APPENDIX 6.2

Test Data

Process D Chart Processing Date 1/11/02 Hawaii Medical Vitrification

Thermo / Mass Flow

Time	Process Temp. Pem Temp.	TRC Temp	Quench Temp.	Process Power AC Delta KW	AC Wye KW	DC 1 KW	DC2 KW	DRY GAS H2	CO	CO2	CH4	O2	TMF ~~Propane SCFH~~ / location	Oxidant O2 / location	TRC O2 %/scfh	Steam % / pph	Bucket weight	Waste type	Container type (P/C)	Comments
126	1221	339	77	59		62		11	6	2	1	2	18 SCFH	24/[illegible]		11/116	6.3	RDF	C	
132	1197	359	81	56		62		18	9	4	1	2	29			10/117	7.6			
138	1191	376	88	54		56		27	15	11	3	1	40			11/118	10			
145	1196	377	96	58		59		31	19	12	5	.6	44			11/112	7.6			
149	1156	386	104	57		63		36	20	12	5	.4	40			11/116	9			
155	1152	403	108	54		73		37	21	12	5	.3	46			11/112	7.2			
157	1155	404	112	54		69		38	22	12	7	.2	51			12/112	6.8			
204	1150	414	116	55		66		37	23	12	7	.2	52			12/112	8.8			
208	1149	420	120	54		61		40	24	12	7	.1	57			12/112	8.2			
—	—															—	8.0			
216	1140	412	122	55		64		40	25	11	6	.1	64			7/67	11.9			
220	1130	413	122	60		69		40	26	11	7	.1	62			6/77	9.2			Gu Dus Ac
224	1110	420	124	46		67		40	27	11	7	.1	67			7/81	16.2			
229	1111	417	124	62		69		40	27	10	7	.1	63			7/81	9.4			
235	1134	419	122	50		67		40	26	10	7	0	49			4/82	10.6			180.8 Drop Drum
1518	1213	408	82	56		55		2.5	2.0	.5	.1	.2	13			11/126	13			
1523	1183	414	88	52		58		12.5	3.8	.9	.1	.4	25			10/119	8.2			
1530	1110	436	104	57		66		32	16	9	2	.1	47			10/123	12.2			
1536	1166	435	111	52		55		35	19	9	3	.1	52			10/122	12.4			
1541	1136	462	119	67		66		38	21	10	4	0	52			9/122	11.8			
1545	1120	466	125	61		71		39	23	10	4	0	50	"		10/119	8.4			
1552	1124	469	130	66		65		39	24	10	6	0	54	"		10/121	13.8			
1556	1105	493	135	63		53		40	25	10	6	0	48	"		9/124	9.4			
1600	1110	486	138	70		67		39	26	10	6	0	50	"		10/118	11.8			
1605	1118	490	140	68		59		39	26	10	7	0	48	"		10/122	10.2			
1610	1131	486	141	73		40		40	27	9	6	0	40	"		9/122	8.6			
1616	1130	497	142	73		64		40	26	10	6	0	40			9/123	9.0			
1620	1119	496	144	70		60		40	26	10	6	0	54			10/120	8.0			
1623	1110	510	147	63		63		40	27	10	6	0	53			10/120	12			149.5
1628	1118	485	146	67		62		41	28	9	6	0	47			9/122	8.6			Drop Drum 157.–
1646	1198	510	132	64		47		40	27	10	4	.1	28	"		10/122	8.2			
1651	1162	485	134	53		56		40	26	11	3	.1	41			10/120	10			265

306.4 lbs. 32 DROPS

HMV shift operator ________ Date ________ IET Process Engineering ________ Date ________

P. cess Data Chart

Processin ate 1/11/02

TMF

Hawaii Medical V fication

	Process Temp.			Process Power				DRY GAS					Oxidant							
Time	Pem Temp.	TRC Temp	Quench Temp.	AC Delta KW	AC Wye KW	DC 1 KW	DC2 KW	H2	C0	C02	Ch4	O2	~~Propane SCFH~~ location	O2 / location	TRC O2 %/scfh	Steam % / pph	Bucket weight	Waste type	Container type (P/C)	Comments
1659	1167	493	135	53	~~66~~	66		42	26	11	4	0	37	20/lance		10/118	10	RDF	C	
1705	1168	495	137	55		55		42	25.7	10	3.6	0	44	40/lance		9/117	7.4	.		
1709	1161	502	140	50		63		43	26	10	3.9	0	46	"		10/117	10.6	.		
1714	1156	510	141	49		56		43	26	9.1	4.3	0	44	"		"	7.4	.		
1722	1110	506	141	55		57		43	26	9.8	4.7	0	37	"		"	10.2	.		
1725	1123	504	144	55		54		43	26	9.8	4.4	0	42	"		"	9.8	.		
1729	1107	507	146	59		46		42.3	25.8	10.4	5	ø	28	"		"	6.6	.		
1736	1060	527	150	57		54		4.5	26.8	10	5.4		~~37~~	"		"	8.2	.		
1744	1079	528	153	61		56		~~0~~	—	—	—		39	"		9/117	16.	.		HOVA
1747	1071	523	154	59		66		40	31.5	15	4.3		39	"		9/119	8.8	.		
1752	1061	527	156	61		62		40.6	29.2	11	6.6		37	"		10/113	8.2	.		101.L
1756	1083	518	155	63		57		39.8	29	11	8		36	"		9/112	7.2	.		
1805	—	—															9.4			
1809	1110	510	150	63		67		40	29	11	6.2		39	"		10/118	8.4			~~Drop Down~~
1814	1100	526	151	62		57		41	29	11	5.6		35	"		9/118	7.0			
1824	1146	494	146	64		61		39	30	11	6	0	39	"		9/115	9.4			
1827	1117	519	148	62		62		40	29	11.3	6	.1	39	"		10/115	5.4			
—																	9.4			
—																	9.2			~~TOTAL 77.4~~
1831	1101	532	152	63		66		40.5	29	11.3	4.4	ø	43	"		10/115	11.2	RDF	C	205.4 Drop Drum
1853	1159	510	139	63		59		41.2	28	11.1	4.2	—	35	.		9/118	7.8			
1855	1123	526	142	54		63		40.1	27.3	11.6	3.5	0	39	"		9/117	8.4			
1859	1096	539	146	57		67		40	26.5	12	2.9	ø	40	"		9/119	8.2			
1910	1088	543	152	61		67		40.8	27.6	11.6	4.8	.1	45	"		9/119	9.8			
1965	1073	551	157	60		59		41	28	11.3	5.6	.1	47	"		9/118	10.8			
—																	7.4			
~~1420~~	1045	563	166	63		68		40.2	28.6	11.1	7	.1	42	"		9/118	8.6			
1919	1039	559	173	63		68		40.2	28.9	10.9	8.7	—	43	"		"	9.4			
1922	1033	559	176	61		71		39.9	29.3	10.8	8.6	—	56	"		9/117	9.6			
~~1925~~	1016	574															11.4			
—																	8.6			
1925	1016	582	181	60		72		39.4	29.8	10.6	8.9	—	45	ø	40	10/114	8.8			108.8

32 DROPS 287.4 LBS.

HMV shift operator ____ Date ____ IET Process Engineering ____ Date ____

Proces. Data Chart ... essi... ite ... 1/11/... ...wa... Medi... Vit...

	Process Temp.			Process Power				DRY GAS					TMF SCFM	Oxidant						
Time	Pem Temp.	TRC Temp	Quench Temp.	AC Delta KW	AC Wye KW	DC 1 KW	DC2 KW	H2	CO	CO2	Ch4	O2	~~Propane SCFM~~ / location	O2 / location	TRC O2 %/scfh	Steam % / pph	Bucket weight	Waste type	Container type (P/C)	Comments
1943	1085	596	170	66		67		39	30	10.5	8.7	0	36	AB/Lance	40/	10/116	10.6	RDF	C	
1946	1085	600	171	65		72		39.7	29.4	10.6	6.4	0	46	a		9/117	6.6			
1950	1077	618	173	66		62		41.1	29.5	10.6	4.9	0	41	"		10/116	9.2			
1954	1050	614	174	68		57		41.2	30	10	4.7	0	39	"		10/114	9.4			
1958	1056	610	176	65		63		40.9	30.2	10	4.9	.	44	"	.	"	8.4			
2002	1054	627	183	66		64		40	30.2	10.4	5.8		49	"		9/116	9.0			
2006	1036	628	185	70		59		40	30	10.6	6.4		57	"		10/110	8.4			
—														13/Lance			10			
—																	8.4			
—																	7.6			
2025	1070	627	180	69		73		39	29.5	10.7	6.4	0	39	"		9/117	8			
2032	1062	631	184	71		67		39	29.6	10.8	6.2		51	"		9/118	7.6			
2036	1053	633	186	69		63		39.6	29.8	11	6.1		40	"		9/117	8.4			
2042	1053	632	186	61		66		40.4	30.3	10.3	6.9		49	"		9/118	8.8			
—																	8.8			
2052	1078	630	186	71		70		40.1	30.3	10	6.6	0	44	"		9/116	9.6			
2057	1081	631	188	72		52		41	30.7	10.1	6	0	42	"		10/114	9.4			
2101	1070	635	189	66		49		41	30	9	5	0	45	"	50/	10/115	8.2			
2106	1074	646	190	62		59		40.2	30	9	6	0	39	"		10/112	7.2			Drop Drum
2129	1160	684	174	61		73		38	28	11	4	0	37	"	.	9/115	7			~~[illegible]~~
2134	1133	727	179	63		69		36.7	26	12	2	.12	34	"		10/114	6.4			
—	—														—	—	7.4			
2150	1124	761	200	56		69		37	28	15	4	0	40	"	60/	9/116	6.6			
2153	1126	792	197	57		58		38	29	14	3	0	39	"	60/	9/118	7.2			
2206	1157	771	195	55		70		38	27	14	3	0	36	"	60/	9/117	7.0			
2212	1159	762	195	53		72		38	27	13	3	0	37	"	60/	10/114	5.9			
2217	1161	762	198	51		73		38	27	14	3	0	37	"	60/	9/114	11.0			
2221	1120	747	199	59		64		39	27	14	3	0	41	"	60/	10/119	9.9			
2227	1096	762	206	66		70		39	28	13	4	0	44	"	60/	10/115	10.6			
2232	1086	765	211	64		71		39	28	13	5	0	41	"	60/	9/116	10.8			
2237	1090	769	215	61		66		38	29	12	6	0	37	"	69/	9/114	10.6			
2242	1055	771	216	68		69		38	29	13	6	0	37	"	60/	10/116	10.9			111

274.6 lbs. 320

HMV shift operator ____________ Date ________

IET Process Engineering ____________ Date ________

Hawaii Medical Vitrification

Time	Process Temp. Pem Temp.	TRC Temp	Quench Temp.	Process Power AC Delta KW	AC Wye KW	DC 1 KW	DC2 KW	DRY GAS H2	CO	CO2	CH4	O2	Oxidant Propane SCFH / location	O2 / location	TRC O2 %/scfh	Steam % / pph	Bucket weight	Waste type	Container type (P/C)	Comments
—	—														—	—	6.6	RDF	C	
0323	1178	765	157	53		66		38	.26	14	4	0.1	34	15 Lance	40	9/113	7.4			
0329	1172	760	160	60		65		34	22	16	3	.1	22	"	"	9/112	7.4			
0335	1169	765	164	56		64		37	23	19	4	0	42	"	"	9/112	8.6			
0341	1165	762	165	61		69		35	24	15	4	0	38	"	"	11/111	8.6			
0346	1152	760	165	60		69		39	25	14	5	0	47	"	"	9/110	7.4			
0350	1140	765	167	65		72		40	26	14	4	0	57	"	"	8/112	6.4			
0355	1120	753	165	65		80		40	27	13	5	0	30	"	"	10/109	8.4			
0359	1149	759	166	67		79		40	25	13	6	0	40	"	"	9/109	7.8			
0404	1123	770	169	68		75		41	28	13	6	0	52	"	"	9/113	9.8			
0408	1125	765	168	45		71		41	28	13	6	0	63	"	"	9/110	10.6			
0412	1098	771	168	39		79		42	29	12	6	0	59	"	"	9/116	10.8			
0417	1082	764	167	41		81		42	29	12	7	0	46	"	"	10/109	8.4			
0421	1080	763	167	42		73		41	30	11	8	0	42	"	"	9/112	9			
0427	1096	756	165	39		84		41	30	11	8	0	32	"	"	9/112	8.4			
0432	1117	762	167	60		75		41	30	11	8	0	49	"	"	9/112	8.	P		1332
0436	1104	761	168	62		73		40	29	11	6	0	45	"	"	9/110	11			
0440	1111	766	169	59		65		41	30	11	6	0	54	"	"	9/112	8.4			
0444	1107	763	166	47		76		41	30	11	7	0	45	"	"	9/110	8.4			
0449	1098	766	166	43		73		42	30	11	6	0	50	"	"	8/113	10.2			
\	\	\	\	\		\		\	\	\	\	\	\	\	\	\	11			
0453	1084	772	167	45		62		42	30	10	6	0	55	"	"	9/116	9			
0459	1067	767	167	45		71		41	30	10	7	0	50	"	"	9/111	8.4			
0503	1065	772	166	44		82		40	31	10	7	0	53	"	"	9/111	7.4			
0512	1113	761	166	43		84		40	31	10	5	0	27	"	"	8/115	9.2			
\	\	\	\	\		\		\	\	\	\	\	\	\	\	\	9.0			
0518	1093	772	166	44		73		40	30	10	6	0	48	"	"	9/113	10.4			
0522	1091	771	168	44		81		40	30	10	5	0	50	"	"	9/110	8.2			
0526	1080	770	167	44		70		41	30	10	5	0	42	"	"	8/113	9.8			110.C Drop Down
0547	1142	767	168	43		70		40	28	11	5	.1	43	"	"	9/109	8.0			
0550	1112	76																		
																	12.4			Bucket stuck/clear.
																	11.2			41.4

Cal 40 15.30 10 6 32 drops 285.6 lbs.

HMV shift operator ____________ Date ________ IET Process Engineering ____________ Date ________

Process Data Chart

Proc... g Da... 211 2 ... Ha... ll M... rific...

Time	Process Temp. Perm Temp.	TRC Temp	Quench Temp.	Process Power AC Delta KW	AC Wye KW	DC 1 KW	DC2 KW	DRY GAS H2	CO	CO2	CH4	O2	TMF Propane SCFH location	Oxidant O2/ location	TRC O2 %/scfh	Steam % / pph	Bucket weight	Waste type	Container type (P/C)	Comment
2253	1097	769	214	65		60		38	30	13	7	0	49	11	60	10/114	10.4	RDF	C	
2257	1073	773	162	69		65		38	29	13	6	0	45	15/18	"	9/116	10.2			
2305	1100	770	160	67		65		39	30	13	5	0	48		"	10/113	11.0			
2311	1095	762	161	67		64		38	29	13	5	0	49			10/116	10.2			A
2317	1092	765	159	61		57		39	30	13	4	0	44			9/115	9.9			
2324	1089	748	161	65		73		38	30	13	5	0	45			10/115	10.0			
2330	1097	750	161	68		66		39	30	13	5	0	48			9/116	10.4			
2336	1084	759	162	59		73		39	30	13	5	0	45			9/118	10.9			
2343	1102	761	162	68		55		39	30	12	5	0	39			10/116	8.2			
2350	–																9.0			
2356	1129	768	162	59		73		39	30	13	4	0	47			9/119	8.8			
2408	1078	749	163	55		63		39	29	14	4	0	45		50	9/115	9.4			
2414	1078	749	161	59		63		40	29	13	4	0	38		"	9/111	8.4			126.2
2421	1068	748	162	59		69		40	29	13	5	0	41		"	8/116	9.6			
2427	1083	751	162	65		52		40	29	12	5	0	51			9/113	9.4			
2433	1090	753	163	63		53		39	29	12	5	0	43			9/113	9.8			
2445	1075	754	164	63		58		39	29	13	5	0	50			8/116	9.6			
2451	1084	754	164	57		72		39	29	13	5	0	48			9/113	9.4			Low Te
0123	1105	772	158	63		53		36	25	13	4	.1			50	9/119	9.0			
–																–	8.6			
–																–	11.4			~~[illegible]~~
–																–	11.3			
–																–	4.4			Drop Dr
156	1226	500	161	62		66		30	19	15	2	.1	29		50	8/116	9.2			
0202	1201	797	163	62		61		26	15	15	1	.2	37		"	8/114	9.2			
0210	1186	800	165	57		61		35	21	15	2	.1	46		"	9/113	7.4			
0219	1162	778	162	57		50		38	25	15	2	.1	38		"	9/113	8.2			
0225	1161	782	163	59		47		38	25	14	2	.1	29		"	9/109	7.2			
0232	1140	793	166	56		47		38	24	14	3	.1	41		"	9/111	12.2			
0238	1120	788	164	56		51		38	24	14	3	.1	45		"	9/113	7.2			
0245	1114	758	166	62		56		37	25	15	4	0	40		"	8/114	8.2			
0253	1109	791	165	63		67		37	24	15	5	.1	43		"	9/113	10.0			178.2 B

297.4 lbs 32

HMV shift operator ____________ Date ________

IET Process Engineering ____________ Date ___

EXPERIMENT STATION
HAWAII AGRICULTURE RESEARCH CENTER
GENETICS & PATHOLOGY DEPARTMENT

Analysis of: Refuse-Derived Fuel Samples (1/11/02)
Date Received: 1/14/02
Sent by: Mr. Ted Vorfeld

SAMPLE DESCRIPTION	MOISTURE %	NON-COMBUSTIBLES %	COMBUSTIBLES %	TOTAL %
1/11/02, #1 NEW RDF	26.8	12.0	61.2	100.0
1/11/02, #1 OLD RDF	9.9	13.7	76.4	100.0
1/11/02, #2 NEW RDF	28.4	14.9	56.7	100.0
1/11/02, #2 OLD RDF	8.2	19.1	72.7	100.0

c: 2 - T. Vorfeld (FAX: 808 - 326-2949)
1 - B. Somera
1 - Files

17-Jan-02

HECo. Meter Data

Hawaii Medical Vitrification
Acct# 0000-6264-001
Jan. 4 thru Jan. 15

Date	Time	KW	KWH
1/11/02	1100	279	69.75
1/11/02	1115	274	68.5
1/11/02	1130	281	70.25
1/11/02	1145	290	72.5
1/11/02	1200	293	73.25
1/11/02	1215	293	73.25
1/11/02	1230	281	70.25
1/11/02	1245	289	72.25
1/11/02	1300	232	58
1/11/02	1315	105	26.25
1/11/02	1330	200	50
1/11/02	1345	194	48.5
1/11/02	1400	197	49.25
1/11/02	1415	204	51
1/11/02	1430	269	67.25
1/11/02	1445	280	70
1/11/02	1500	248	62
1/11/02	1515	259	64.75
1/11/02	1530	297	74.25
1/11/02	1545	301	75.25
1/11/02	1600	305	76.25
1/11/02	1615	296	74
1/11/02	1630	292	73
1/11/02	1645	271	67.75
1/11/02	1700	274	68.5
1/11/02	1715	270	67.5
1/11/02	1730	270	67.5
1/11/02	1745	280	70
1/11/02	1800	296	74
1/11/02	1815	304	76
1/11/02	1830	298	74.5
1/11/02	1845	294	73.5
1/11/02	1900	281	70.25
1/11/02	1915	303	75.75
1/11/02	1930	313	78.25
1/11/02	1945	310	77.5
1/11/02	2000	310	77.5
1/11/02	2015	311	77.75
1/11/02	2030	305	76.25
1/11/02	2045	313	78.25
1/11/02	2100	310	77.5
1/11/02	2115	305	76.25
1/11/02	2130	294	73.5
1/11/02	2145	302	75.5
1/11/02	2200	294	73.5
1/11/02	2215	290	72.5

1/11/02	2230	295	73.75	
1/11/02	2245	305	76.25	
1/11/02	2300	307	76.75	Run A Ave= 301.2kW
1/11/02	2315	300	75	
1/11/02	2330	298	74.5	
1/11/02	2345	296	74	
1/11/02	2400	283	70.75	
1/12/02	15	290	72.5	
1/12/02	30	299	74.75	
1/12/02	45	290	72.5	
1/12/02	100	291	72.75	
1/12/02	115	292	73	
1/12/02	130	298	74.5	
1/12/02	145	306	76.5	
1/12/02	200	292	73	
1/12/02	215	295	73.75	
1/12/02	230	285	71.25	
1/12/02	245	278	69.5	
1/12/02	300	307	76.75	
1/12/02	315	220	55	
1/12/02	330	282	70.5	
1/12/02	345	293	73.25	
1/12/02	400	312	78	
1/12/02	415	301	75.25	
1/12/02	430	298	74.5	Run B Ave= 303.2kW
1/12/02	445	309	77.25	
1/12/02	500	296	74	
1/12/02	515	301	75.25	
1/12/02	530	301	75.25	
1/12/02	545	291	72.75	
1/12/02	600	297	74.25	
1/12/02	615	288	72	
1/12/02	630	298	74.5	
1/12/02	645	253	63.25	
1/12/02	700	223	55.75	
1/12/02	715	208	52	
1/12/02	730	205	51.25	
1/12/02	745	196	49	
1/12/02	800	155	38.75	
1/12/02	815	140	35	
1/12/02	830	77	19.25	
1/12/02	845	78	19.5	
1/12/02	900	112	28	
1/12/02	915	149	37.25	
1/12/02	930	158	39.5	
1/12/02	945	155	38.75	
1/12/02	1000	155	38.75	
1/12/02	1015	155	38.75	
1/12/02	1030	155	38.75	
1/12/02	1045	188	47	
1/12/02	1100	261	65.25	

1/12/02	1115	260	65
1/12/02	1130	264	66
1/12/02	1145	267	66.75
1/12/02	1200	279	69.75
1/12/02	1215	287	71.75
1/12/02	1230	279	69.75
1/12/02	1245	285	71.25
1/12/02	1300	287	71.75
1/12/02	1315	299	74.75
1/12/02	1330	289	72.25
1/12/02	1345	301	75.25
1/12/02	1400	305	76.25
1/12/02	1415	296	74
1/12/02	1430	287	71.75
1/12/02	1445	265	66.25
1/12/02	1500	275	68.75
1/12/02	1515	273	68.25
1/12/02	1530	280	70
1/12/02	1545	282	70.5
1/12/02	1600	278	69.5
1/12/02	1615	286	71.5
1/12/02	1630	283	70.75
1/12/02	1645	277	69.25
1/12/02	1700	279	69.75
1/12/02	1715	272	68
1/12/02	1730	284	71
1/12/02	1745	295	73.75
1/12/02	1800	293	73.25
1/12/02	1815	302	75.5
1/12/02	1830	303	75.75
1/12/02	1845	319	79.75
1/12/02	1900	318	79.5
1/12/02	1915	320	80
1/12/02	1930	323	80.75
1/12/02	1945	317	79.25
1/12/02	2000	309	77.25
1/12/02	2015	318	79.5
1/12/02	2030	318	79.5
1/12/02	2045	318	79.5
1/12/02	2100	329	82.25
1/12/02	2115	313	78.25
1/12/02	2130	318	79.5
1/12/02	2145	329	82.25
1/12/02	2200	283	70.75
1/12/02	2215	313	78.25
1/12/02	2230	335	83.75
1/12/02	2245	331	82.75
1/12/02	2300	331	82.75
1/12/02	2315	337	84.25
1/12/02	2330	341	85.25
1/12/02	2345	334	83.5

1/12/02	2400	322	80.5
1/13/02	15	310	77.5
1/13/02	30	311	77.75
1/13/02	45	312	78
1/13/02	100	318	79.5
1/13/02	115	318	79.5
1/13/02	130	322	80.5
1/13/02	145	315	78.75
1/13/02	200	316	79
1/13/02	215	313	78.25
1/13/02	230	312	78
1/13/02	245	310	77.5
1/13/02	300	307	76.75
1/13/02	315	313	78.25
1/13/02	330	319	79.75
1/13/02	345	319	79.75
1/13/02	400	316	79
1/13/02	415	317	79.25
1/13/02	430	311	77.75
1/13/02	445	307	76.75
1/13/02	500	315	78.75
1/13/02	515	314	78.5
1/13/02	530	316	79
1/13/02	545	313	78.25
1/13/02	600	311	77.75
1/13/02	615	314	78.5
1/13/02	630	301	75.25
1/13/02	645	269	67.25
1/13/02	700	244	61
1/13/02	715	231	57.75
1/13/02	730	179	44.75
1/13/02	745	170	42.5
1/13/02	800	169	42.25

APPENDIX 6.3

JIPOWER Data

MSW, RDF, AND

MONTH	TOTAL NON-RDF - % MSW	RDF - % MSW	BAMR FERROUS - % MSW BURNED	BAMR + WPF FERROUS - % MSW	BAMR NON-FERROUS - % MSW BURNED	BAMR FERROUS / WPF FERROUS %	BAMR NON-FERROUS - % RDF	BAMR FERROUS - % RDF	BAMR NON-FERROUS - % ASH	BAMR FERROUS - % ASH	LB STEAM / TON ADJUSTED MSW PROCESSED	LB STEAM / TON RDF PRODUCED	LB STEAM / KWH GENERATED	LB STEAM / KWH EXPORTED	KWH GENERATED / TON ADJUSTED MSW PROCESSED	KWH EXPORTED / TON ADJUSTED MSW PROCESSED	KEY EVENTS
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	BLANKED PRIMARY TROMMELS 1" SCREENS
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	REMOVED BLANKS ON [illegible] LINE - NOTE FIRST SCREEN
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	REMOVED BLANKS ON [illegible] LINE - NOTE FIRST SCREEN
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	END OF MONTH - REMOVED REMAINING BLANKS ON [illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Annual outage - [illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] OUTAGE LAST WEEK IN AUGUST
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] SUPERHEATER REPLACEMENT OUTAGE

MSW, RDF, AND EXTRACT HISTORY AND PERFORMANCE RATIOS

MONTH	MSW PROCESSED	MSW PROCESSED ADJUSTED FOR RDF BURNED	DAW	FERROUS (BYPASS + DHW + NON SHRED)	RESIDUE	RDF PRODUCED	AVAILABILITY ALL BOILERS %	CAPACITY ALL BOILERS %	LIME CONSUMED TONS	ASH	BAMR NON-FERROUS	BAMR FERROUS	BAMR AVAILABILITY %	GROSS MWH	NET MWH	STATION SERVICE MWH	IMPORT MWH	TOTAL STEAM FLOW KLBS	ON-PEAK CAPACITY %	AVERAGE STEAM ENTHALPY BTU/LB		RATIOS: DAW - % MSW	WFF FERROUS - % MSW	RESIDUE - % MSW
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]

PROCESSING HISTORY DATA

\\POWER\MSW\HISTORY[illegible].xls

TEL:808-675-7330 Jan 09 02 15:36 No.001 P.01

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SOUTH HOLLAND, IL 60473
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FAX: (708) 333-3060

November 10, 1999

HONOLULU RESOURCE REC. VENTURE
91-174 Hanua Street
Kapolei, HI 96707
Attn: Glenn Murata

Sample identification by
Honolulu Resource Recovery

Kind of sample reported to us: RDF

Sample taken at: Honolulu Resource Recovery

Sample taken by: Honolulu Resource Recovery

Date sampled: October 18, 1999

Date received: November 2, 1999

Sample ID: #1
Date: 10/18/99
Boiler 1

NOTE: All visible non-combustible material was removed prior to chemical analysis & calculated into this report.
Non-Combustible Material = 1.6%

P.O. No. HRR-2572

Analysis Report No. 71-106007 Page 1 of 1

SHORT PROXIMATE ANALYSIS

	As Received	Dry Basis	
% Moisture	31.70	xxxxx	
%Ash	17.18	25.16	
Btu/lb	5164	7561	MAF 10103
% Sulfur	0.14	0.21	

METHODS
Moisture: ASTM E 949; Ash: ASTM E 830; Btu/lb: ASTM E 711; Sulfur: ASTM E 775

ave 11 samples
= 34.10% moist

6590

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

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November 8, 1999

HONOLULU RESOURCE REC. VENTURE
91-174 Hanua Street
Kapolei, HI 96707
Attn: Glen Murata

Sample identification by
Honolulu Resource Recovery

Kind of sample reported to us: RDF

Sample taken at: Honolulu Resource Recovery

Sample taken by: Honolulu Resource Recovery

Date sampled: October 19, 1999

Date received: November 2, 1999

Sample ID: #2
Date: 10/19/99
Boiler 1
NOTE: All visible non-combustible material was removed prior to chemical analysis & calculated into this report.
Non-Combustible Material = 3.8%
P.O. No. HRR-2572

Analysis Report No. 71-106008 Page 1 of 1

SHORT PROXIMATE ANALYSIS

	As Received	Dry Basis		
% Moisture	36.44	xxxxx		
%Ash	14.63	23.01		
Btu/lb	4612	7256	MAF	9425
% Sulfur	0.08	0.13		

METHODS
Moisture: ASTM E 949; Ash: ASTM E 830; Btu/lb: ASTM E 711; Sulfur: ASTM E 775

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Joseph B. Neises V.P.
South Holland Laboratory

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TERMS AND CONDITIONS ON REVERSE

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HONOLULU RESOURCE REC. VENTURE
91-174 Hanua Street
Kapolei, HI 96707
Attn: Glen Murata

Sample identification by
Honolulu Resource Recovery

Kind of sample reported to us: RDF

Sample taken at: Honolulu Resource Recovery

Sample taken by: Honolulu Resource Recovery

Date sampled: October 20, 1999

Date received: November 2, 1999

Sample ID: #3
Date: 10/20/99
Boiler 1
NOTE: All visible non-combustible material was removed prior to chemical analysis & calculated into this report.
Non-Combustible Material = 1.9%
P.O. No. HRR-2572

Analysis Report No. 71-106009 Page 1 of 1

SHORT PROXIMATE ANALYSIS

	As Received	Dry Basis		
% Moisture	34.44	xxxxx		
%Ash	8.37	12.76		
Btu/lb	5434	8288	MAF	9500
% Sulfur	0.11	0.17		

METHODS
Moisture: ASTM E 949; Ash: ASTM E 830; Btu/lb: ASTM E 711; Sulfur: ASTM E 775

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.
Joseph B. Novak
South Holland Laboratory

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November 9, 1999

HONOLULU RESOURCE REC. VENTURE
91-174 Hanua Street
Kapolei, HI 96707
Attn: Glenn Murata

Sample identification by
Honolulu Resource Recovery

Kind of sample reported to us: RDF

Sample taken at: Honolulu Resource Recovery

Sample taken by: Honolulu Resource Recovery

Date sampled: October 21, 1999

Date received: November 2, 1999

Sample ID: #4
Date: 10/21/99
Boiler 1
NOTE: All visible non-combustible material was removed prior to chemical analysis & calculated into this report.
Non-Combustible Material = 4.4%
P.O. No. HRR-2572

Analysis Report No. 71-106010

Page 1 of 1

SHORT PROXIMATE ANALYSIS

	As Received	Dry Basis		
% Moisture	35.51	xxxxx		
%Ash	13.78	21.37		
Btu/lb	5043	7820	MAF	9945
% Sulfur	0.13	0.20		

METHODS
Moisture: ASTM E 949; Ash: ASTM E 830; Btu/lb: ASTM E 711; Sulfur: ASTM E 775

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Joseph B. Housey V.C.
South Holland Laboratory

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HONOLULU RESOURCE REC. VENTURE
91-174 Hanua Street
Kapolei, HI 96707
Attn: Glen Murata

Sample identification by
Honolulu Resource Recovery

Kind of sample reported to us: RDF

Sample taken at: Honolulu Resource Recovery

Sample taken by: Honolulu Resource Recovery

Date sampled: October 22, 1999

Date received: November 2, 1999

Sample ID: #5
Date: 10/22/99
Boiler 1
NOTE: All visible non-combustible material was removed prior to chemical analysis & calculated into this report.
Non-Combustible Material = 5.7%
P.O. No. HRR-2572

Analysis Report No. 71-106011

SHORT PROXIMATE ANALYSIS

	As Received	Dry Basis		
% Moisture	33.51	xxxxx		
%Ash	16.58	24.94		
Btu/lb	4753	7149	MAF	9524
% Sulfur	0.11	0.16		

METHODS
Moisture: ASTM E 949; Ash: ASTM E 830; Btu/lb: ASTM E 711; Sulfur: ASTM E 775

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Joseph L. B. Nauser V.C
South Holland Laboratory

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November 8, 1999

HONOLULU RESOURCE REC. VENTURE
91-174 Hanua Street
Kapolei, HI 96707
Attn: Glen Murata

Sample identification by
Honolulu Resource Recovery

Kind of sample reported to us: RDF

Sample taken at: Honolulu Resource Recovery

Sample taken by: Honolulu Resource Recovery

Date sampled: October 23, 1999

Date received: November 2, 1999

Sample ID: #6
Date: 10/23/99
Boiler 1
NOTE: All visible non-combustible material was removed prior to chemical analysis & calculated into this report.
Non-Combustible Material = 2.0%
P.O. No. HRR-2572

Analysis Report No. 71-106012

SHORT PROXIMATE ANALYSIS

	As Received	Dry Basis		
% Moisture	31.99	xxxxx		
%Ash	8.83	12.98		
Btu/lb	4967	7303	MAF	8392
% Sulfur	0.14	0.20		

METHODS
Moisture: ASTM E 949; Ash: ASTM E 830; Btu/lb: ASTM E 711; Sulfur: ASTM E 775

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Joseph B. Nauses V.C.
South Holland Laboratory

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HONOLULU RESOURCE REC. VENTURE
91-174 Hanua Street
Kapolei, HI 96707
Attn: Glen Murata

Sample identification by
Honolulu Resource Recovery

Kind of sample reported to us: RDF

Sample taken at: Honolulu Resource Recovery

Sample taken by: Honolulu Resource Recovery

Date sampled: October 24, 1999

Date received: November 2, 1999

Sample ID: #7
Date: 10/24/99
Boiler 1
NOTE: All visible non-combustible material was removed prior to chemical analysis & calculated into this report.
Non-Combustible Material = 0.1%
P.O. No. HRR-2572

Analysis Report No. 71-106013

SHORT PROXIMATE ANALYSIS

	As Received	Dry Basis		
% Moisture	32.90	xxxxx		
%Ash	12.99	19.36		
Btu/lb	5350	7973	MAF	9887
% Sulfur	0.06	0.09		

METHODS
Moisture: ASTM E 949; Ash: ASTM E 830; Btu/lb: ASTM E 711; Sulfur: ASTM E 775

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Joseph B. Nousey V.C.
South Holland Laboratory

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91-174 Hanua Street
Kapolei, HI 96707
Attn: Glen Murata

Sample identification by
Honolulu Resource Recovery

Kind of sample reported to us: RDF

Sample taken at: Honolulu Resource Recovery

Sample taken by: Honolulu Resource Recovery

Date sampled: October 18, 1999

Date received: November 2, 1999

Sample ID: #8
Date: 10/18/99
Boiler 2

NOTE: All visible non-combustible material was removed prior to chemical analysis & calculated into this report.
Non-Combustible Material = 1.0%
P.O. No. HRR-2572

Analysis Report No. 71-106014

Page 1 of 1

SHORT PROXIMATE ANALYSIS

	As Received	Dry Basis		
% Moisture	32.00	xxxxx		
%Ash	11.31	16.63		
Btu/lb	5042	7415	MAF	8894
% Sulfur	0.14	0.20		

METHODS
Moisture: ASTM E 949; Ash: ASTM E 830; Btu/lb: ASTM E 711; Sulfur: ASTM E 775

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Joseph B. Nuzum, V.C
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91-174 Hanua Street
Kapolei, HI 96707
Attn: Glen Murata

Sample identification by
Honolulu Resource Recovery

Kind of sample reported to us: RDF

Sample taken at: Honolulu Resource Recovery

Sample taken by: Honolulu Resource Recovery

Date sampled: October 19, 1999

Date received: November 2, 1999

Sample ID: #9
Date: 10/19/99
Boiler 2
NOTE: All visible non-combustible material was removed prior to chemical analysis & calculated into this report.
Non-Combustible Material = 1.5%
P.O. No. HRR-2572

Analysis Report No. 71-106015

SHORT PROXIMATE ANALYSIS

	As Received	Dry Basis		
% Moisture	35.11	xxxxx		
%Ash	9.29	14.32		
Btu/lb	5351	8246	MAF	9624
% Sulfur	0.14	0.22		

METHODS
Moisture: ASTM E 949; Ash: ASTM E 830; Btu/lb: ASTM E 711; Sulfur: ASTM E 775

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.
Joseph B. Nouse V.C.
South Holland Laboratory

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HONOLULU RESOURCE REC. VENTURE
91-174 Hanua Street
Kapolei, HI 96707
Attn: Glen Murata

Sample identification by
Honolulu Resource Recovery

Kind of sample reported to us: RDF

Sample taken at: Honolulu Resource Recovery

Sample taken by: Honolulu Resource Recovery

Date sampled: October 20, 1999

Date received: November 2, 1999

Sample ID: #10 .
Date: 10/20/99
Boiler 2
NOTE: All visible non-combustible material was removed prior to chemical analysis & calculated into this report.
Non-Combustible Material = 1.0%
P.O. No. HRR-2572

Analysis Report No. 71-106016

Page 1 of 1

SHORT PROXIMATE ANALYSIS

	As Received	Dry Basis		
% Moisture	34.56	xxxxx		
%Ash	13.91	21.26		
Btu/lb	4844	7402	MAF	9401
% Sulfur	0.14	0.22		

METHODS
Moisture: ASTM E 949; Ash: ASTM E 830; Btu/lb: ASTM E 711; Sulfur: ASTM E 775

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Joseph B. Nousey V.C
South Holland Laboratory

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HONOLULU RESOURCE REC. VENTURE
91-174 Hanua Street
Kapolei, HI 96707
Attn: Glen Murata

Sample identification by
Honolulu Resource Recovery

Kind of sample reported to us	RDF
Sample taken at	Honolulu Resource Recovery
Sample taken by	Honolulu Resource Recovery
Date sampled	October 22, 1999
Date received	November 2, 1999

Sample ID: #11
Date: 10/22/99
Boiler 2
NOTE: All visible non-combustible material was removed prior to chemical analysis & calculated into this report.
Non-Combustible Material = 6.4%
P.O. No. HRR-2572

Analysis Report No. 71-106017

SHORT PROXIMATE ANALYSIS

	As Received	Dry Basis		
% Moisture	36.95	xxxxx		
%Ash	13.78	21.85		
Btu/lb	4404	6985	MAF	8938
% Sulfur	0.10	0.16		

METHODS
Moisture: ASTM E 949; Ash: ASTM E 830; Btu/lb: ASTM E 711; Sulfur: ASTM E 775

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.
Joseph B. Houser, V.C.
South Holland Laboratory

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APPENDIX 6.4

IET Website Information

Integrated Environmental Technologies, LLC

Plasma Enhanced Melter (PEM) Systems Overview

News
PEM Systems
System Overview
Advantages and Features
Proprietary Rights
PEM™ Process Details
Treatability Studies
Who is IET
Commercial Systems
IET Facilities
FAQ
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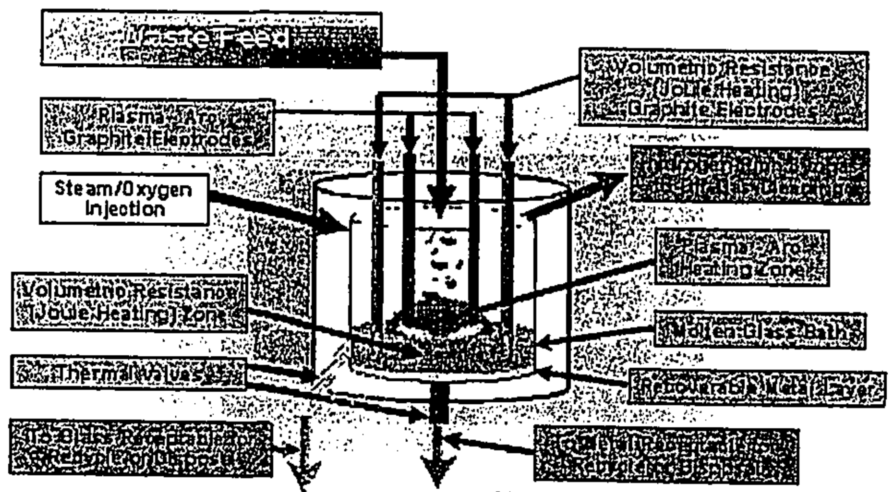

Plasma Enhanced Melter™ Process Hearth

PEM™ systems provide a revolutionary way of dealing with two very pressing problems faced by today's society: waste treatment and disposal, and clean sources of energy. The Company believes the PEM™ system is superior to competing methods of waste treatment and disposal because of its economic and environmental advantages and its potential to be used across a wide variety of applications, including distributed power production. These advantages provide lower waste processing costs for the customer, optional on-site power generation, greater utilization of waste materials for commercial products, valuable secondary revenue streams from these products, environmentally friendly operations and minimized future liability for the waste. The historically dominant industry treatment methods, incineration and landfilling, cannot make these claims. As a result, customers located globally seeking waste treatment services are turning more readily to new methods of waste management. IET's PEM™ systems are the best available alternative.

The PEM™ system uses heating from electrically conducting gas (a plasma) in a special glassification system to convert wastes to valuable products. PEM™ systems are highly effective in processing a wide variety of waste streams, including hazardous, medical, radioactive, industrial, municipal and tire wastes. The systems are also highly capable of creating commercially valuable products from waste in the form of energy (ultra-clean power generation using the hydrogen-rich gas) and useful solid byproducts (roofing tiles, insulating panels, sand-blasting media and other construction-related products). The environmental attractiveness of the PEM™ system results from very clean, pollution-free operations and provides the potential to ease permitting requirements, thereby shortening the sales cycle, as well as associated installation costs.

In addition to providing cost effective, environmentally responsible treatment and extraction of value from waste, the PEM™ system can be used as part of a distributed power production system. For many waste streams, the hydrogen-rich gas created by processing waste can be used in a clean-burn, low-NOx electric generating system. Since the PEM™ system can be scaled down to fairly small units (about 4 tons per day), they can be coupled with small-scale independent power generating systems in the 1 to 5 MW range. Such combined systems can be installed in a variety of locations to provide local power and eliminate service interruptions and price swings. Because a portion of the fuel is waste, costs can be contained and kept competitive. These combined PEM-GEN™ systems can solve two problems - waste treatment and disposal and electricity supply - in a simple, effective manner.

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Integrated Environmental Technologies, LLC

History of IET and the Development of the PEM™ System

IET technology has its origins in many decades of work in the development of two technologies - plasma technology and glass melter technology. By integrating these two technologies in a very special way, IET technology provides the ultimate capability in converting waste into useful products and maximizes the potential for recycling. The technology achieves this goal by an optimized form of high temperature electrical heating. The IET technology builds upon extensive U.S. Department of Energy sponsored research at Massachusetts Institute of Technology (MIT) and Battelle Pacific Northwest National Laboratory (PNNL).

Plasmas are electrically conducting gases. Because of their special properties they are sometimes referred to as the fourth state of matter. Plasmas exist over a wide range of temperatures and are generally hotter then 5,000 °C. Familiar plasmas on earth are lightning bolts and electric arc furnaces used for steel making. The sun and the stars are also plasmas, producing their power at very high temperatures by thermonuclear fusion. In fact, most of the universe consists of plasmas.

At MIT, plasma applications have been investigated extensively at the Plasma Science and Fusion Center, MIT's largest on-campus laboratory. In 1991, the Plasma Science and Fusion Center decided to investigate the use of plasmas for treatment of radioactive waste at United States Department of Energy sites. The high temperature of plasmas and their ability to treat waste without the adverse environmental effects encountered in incineration made plasma technology a very attractive area for investigation. MIT, together with an industrial subcontractor, formed a collaborative effort with PNNL. PNNL is considered one of the world leaders in waste treatment technology because of its work as the research and development laboratory at the U.S. Department of Energy Hanford site in Richland, Washington. The Hanford site is one of the major Department of Energy sites in America.

The MIT - PNNL effort constructed a research device at MIT for studies of plasma arc waste treatment. The system employed a single graphite electrode and was used for a variety of tests. These tests confirmed the basic attractiveness of plasmas for treating mixtures of radioactive and hazardous waste.

In 1995, this research program was evaluated by a Department of Energy review. The review concluded that the graphite electrode DC arc plasma system was the most promising approach for meeting its needs to treat mixtures of hazardous and radioactive waste.

Encouraged by the progress of the government sponsored program, the principals of the program - Dr. Daniel R. Cohn of MIT, Jeffrey E. Surma of PNNL and Charles H. Titus, who had been with General Electric Company and was a consultant to MIT- began to think of ways to improve the plasma waste treatment process and to make it applicable to all types of waste including medical waste, tires, a variety of hazardous waste and municipal waste.

Dr. Cohn, Mr. Surma and Mr. Titus developed a concept for integrating plasma technology with glass melter technology, which had been very successfully developed for treatment of the most dangerous radioactive waste - high level waste. Instead of a single graphite electrode, they developed a concept for combining a specially optimized configuration of multiple plasma electrodes, which would provide radiant heating, with submerged electrodes in a molten glass bath, which would provide resistive heating of the bath. The system provided optimized electrical heating with exceptional process control. This powerful basic concept was then developed in depth and in a variety of embodiments. Mr. Surma, Mr. Titus and Dr. Cohn have since obtained extensive patent protection for their work.

Since this new approach represented a major advance and could provide the ultimate in waste treatment, the inventors began to look for ways to commercialize the technology. They teamed with Larry Dinkin, a very successful entrepreneur and investor whom Dr. Cohn had known for some time. The technology that was developed, which is called Plasma Enhanced Melter™ (PEM™) technology converts waste into clean gas which may have useful energy value, glass and, in some cases, recyclable metals. The gas is produced from the organic material in the waste. The glass, which is produced from the inorganic material, is highly stable and non-leachable. Extensive studies by Mr. Surma and his coworkers at PNNL have shown that this type of glass will completely immobilize waste. The funds expended in the development of this technology include over $300 million of U.S. government R & D support for waste treatment at PNNL in addition to $12 million spent specifically on the arc plasma system program at MIT.

Dr. Cohn, Messrs. Titus, Surma and Dinkin founded Integrated Environmental Technologies (IET) in July 1995. IET has exclusive rights to the PEM™ technology. In 1996, IET opened its Technology Center in Richland, Washington.

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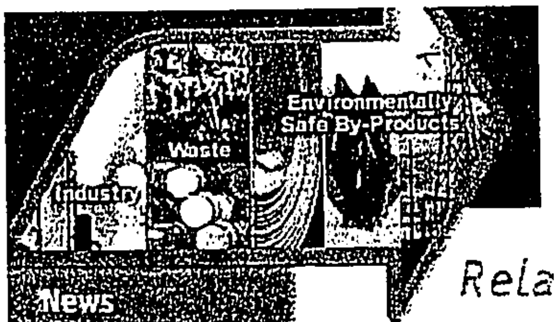

Integrated Environmental Technologies, LLC

Relationship with Battelle

IET has an agreement with Battelle Memorial Institute ("BMI"), a shareholder of the Company, pursuant to which BMI will act as a supplier of technical support and potential customer contacts.

BMI is a nonprofit international technology company with headquarters in Columbus, Ohio. It is a multidisciplinary research organization and is recognized as a world leader in technology research and development associated with the environment, energy, national security, health and technology management consulting. BMI has a worldwide staff of approximately 8,000 scientists, engineers, and supporting specialists, and a business volume of more than $750 million a year. BMI's major technology centers are located in Columbus, Ohio; Richland, Washington; Amarillo, Texas; Frankfurt, Germany; Brookhaven, New York, and Geneva, Switzerland. Battelle PNNL, located near IET's Technology Center in Richland, Washington, is operated by BMI.

Battelle PNNL is one of the United States' national laboratories performing research and development in the areas of national defense, energy and the environment, among others. Battelle PNNL pioneered the development of the joule heated glass melter technology for nuclear waste immobilization and has over thirty years of experience in the field of waste vitrification, glass chemistry, and melter design and deployment. It is the premier research center for waste glassification. The BMI staff also has extensive experience and expertise in the area of combustion and biomass gasification.

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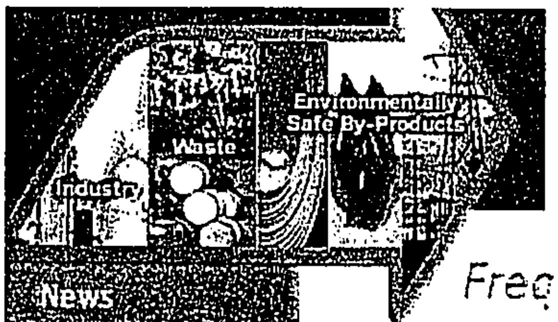

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Frequently Asked Questions

Here are some of the most frequently asked questions about the IET's Plasma Enhanced Melter(TM) systems.

FAQ: Design

Question: How much automation is provided to minimize labor cost?

Answer: A typical system is fully automated, except for assuring that all supplies and waste are present in their appropriate storage/feeder systems for feeding to the PEM™, replenishing the graphite electrodes, intermittent draining of the molten glass into receptacles, removal of scrubber system filters and removal of the filled containers of glassy residue.

Question: Can you build a system smaller than the Model 4 PEM™? For example, could you build a system to process 0.5 metric ton per day.

Answer: The primary limiting factor in manufacturing small PEM™ systems is the need to maintain a physical size large enough to receive the waste with minimal pretreatment.

Question: Does a PEM™ process waste in batches or is the waste fed constantly via an auger or conveyor, or in the case of liquids, a pipe?

Answer: The type of mechanism used for introducing the waste into the system is dependent upon the waste being processed. Continuous feeding of the waste, such as through a screw conveyor for solids and a pipe or tube for liquids and gases, provides the highest operating rates and the highest level of efficiency. However, some wastes are placed in containers at the point of generation, such as medical waste. It is frequently more efficient to process these wastes in their containers on a batch basis than to attempt to convert the waste to a bulk form.

Bulk and batch systems are both equipped with a nitrogen injection system to minimize the volume of air introduced into the PEM™ chamber and to prevent the escape of process gasses from the chamber while waste is being introduced.

Question: Are the PEM™ system inner furnace bricks resistant to chlorine?

Answer: The characteristics of the refractory brick and materials in a PEM™ are carefully matched to the specific application to assure maximum refractory life, even when processing chlorinated wastes. Also, the system is operated in a manner that minimizes the corrosive effects of chlorine on the refractory materials. The materials of construction of the off-gas treatment system are also compatible with the contaminants in the gas, including chlorine.

Question: What is the rate of consumption of the graphite electrode material?

Answer: The PEM™ has two sets of electrodes, which are consumed at different rates. The size of the electrodes increases as the size of the system increases. For a Model 4 PEM™, the electrodes are made up of sections that are about 0.6 meters (2 feet) in length and 15 cm (6 inches) in diameter.; For most wastes, each of the three AC electrodes, which maintain the temperature of the molten glass residue, require addition of one section of graphite electrode material every 3 to 4 weeks. Each of the three DC electrodes, which provide the plasma energy, requires the addition of one length of electrode every 2 to 3 days when processing organic wastes and one length every week when processing inorganic waste, such as ash from municipal waste incinerators.

The electrodes are replenished by attaching a new section to the top of the electrode. The top of the electrode is outside the PEM™. The electrode is inserted into the PEM™ through a sealed control mechanism that automatically feeds the electrode into the PEM™ at the required rate. It is not necessary to open the PEM™ chamber to replenish the electrodes. It is, of course, necessary to turn off the electrical power to the PEM™ while replenishing the electrodes, which takes about 15 minutes.

Question: How much space is required for the equipment required for removal of the vitrified glass from the PEM™?

Answer: For small systems, the vitrified glass is typically collected in and disposed in 100 liter or 200 liter containers. The weight of these containers, when filled with glass residue, is approximately 500 kg and 1000 kg, respectively . The receiving container is placed inside a containment cylinder that is attached to the PEM™ by a collar. This unit has metal wheels that rest on short sections of track to allow the filled container to be easily rolled aside when it is full. The empty container is positioned below the outer diameter of the PEM™ processing unit. At least 6 feet of space is required for extension of the track for removal of full containers.

Question: What is the largest diameter of the waste entry port available for the Model 4 and Model 10 PEM™?

Answer: For the Model 4 it's 45cm(18in.), Model 10 it's 60cm(24in.)

Question: Which PEM™ model is large enough to process automobile tires whole?

Answer: The Model 10 PEM™ has a waste entry opening that is 60cm. in diameter and is the smallest PEM™ system that is able to process whole tires from automobiles.

Question: We would like to process municipal waste and used tires in the same system using the same feeder mechanism. Is this possible?

Answer: Yes, this is both possible and advantageous because of the high level of excess energy produced from tires.

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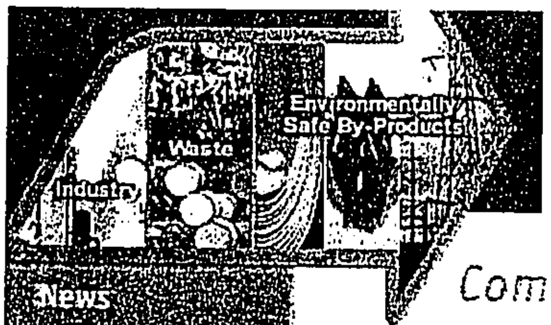

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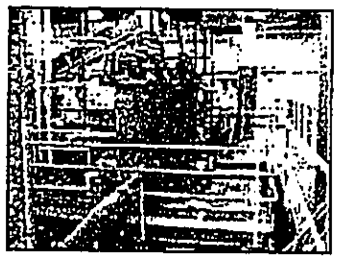
Commercial Systems

IET has sold several commercial PEM™ units throughout the world to process a wide range of waste materials. A few of these systems that are already successfully operating at customer sites, processing waste are shown below.

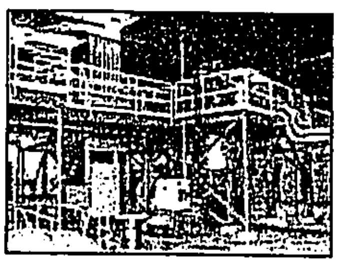
Allied Technology Group, Inc. (ATG)

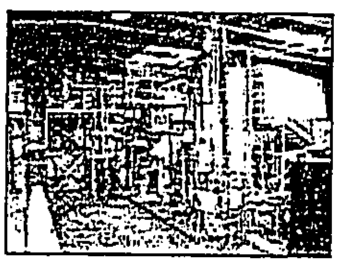
Allied Technology Group, Inc.'s (ATG) Mixed Waste Treatment Facility in Richland, WA is treating a combination of hazardous and radioactive waste, some of the most difficult material in the world to process.

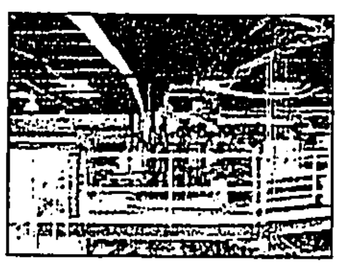


Asia Pacific Environmental Technologies (APET)

Asia Pacific Environmental Technology's (APET) Hawaii Medical Vitrification (HMV) facility in Honolulu, HI is treating hospital and medical waste from the Honolulu area, destroying all pathogens and biohazards and generating electricity as a byproduct.







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PEM™ Technology to Replace Incinerators in Japan

Integrated Environmental Technologies, LLC (IET) and Sanwa Donetsu Kogyo, a division of Hitachi, have signed a non-exclusive collaboration agreement in which Sanwa will market and install IET's proprietary Plasma Enhanced Melter™ (PEM™) waste treatment and energy recovery systems in Japan. Sanwa plans to replace over two hundred municipal waste incinerators that it has built or sold with the clean, environmentally responsible PEM™ systems. In addition, Sanwa plans to market the PEM™ system for biohazardous / medical waste and for industrial / hazardous waste applications. Along with the collaboration agreement, Sanwa has made an equity investment in IET.

Since its inception in 1995, IET has developed and commercialized the PEM™ technology, building on over 30 years and $300 million of research and development at the U.S. Department of Energy's Pacific Northwest National Laboratory, which is operated by Battelle Memorial Institute (an equity partner in IET) and on additional research performed at Massachusetts Institute of Technology. IET has PEM™ systems in commercial operation at sites processing medical / biohazardous waste, cleanly converting the material into electricity and a useful glass byproduct and mixed radioactive and hazardous wastes, reducing their volume and converting them into a safe, stable material for final disposal.

The PEM™ system, a non-combustion technology that uses electrical heating, offers many advantages over conventional waste treatment methods such as incineration including a virtual elimination of harmful emissions, lower operating costs, smaller system size which allow for plants to be distributed closer to the point of generation and the potential for creating valuable products from the waste. These products include a hydrogen-rich fuel gas that can be used to improve efficiency and reduce emissions of electric generation systems and value-added industrial materials such as abrasive grit and highly insulating construction bricks. By operating in an environmentally responsible manner, virtually no dioxins or furans are generated by the PEM™ system and other harmful emissions such as nitrogen oxides are reduced to insignificant levels, thus making it a much more acceptable and beneficial process to the general public.

In addition to the collaboration with Sanwa, IET has partnered with Onyx Environmental Services, one of the largest hazardous waste treatment companies in North America and a division of Vivendi (of France), the world's largest provider of environmental services to jointly market IET's PEM™ systems. The partnership provides for IET to team with Onyx's large, experienced sales force to approach their customer base, which includes nearly all major chemical manufacturers and hazardous waste generators, to install on-site PEM™ systems, which would be owned and operated by Onyx. Along with this joint sales and marketing agreement, Onyx has ordered a PEM™ system to be installed at one of their hazardous waste treatment facilities, which will provide a showcase installation to demonstrate the PEM™ system to the hazardous waste market. IET is a Limited Liability Company located in Richland, WA and is the exclusive worldwide provider of the PEM™ system.

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APPENDIX 6.5

MISCELLANEOUS COMMUNICATIONS

AOL Anywhere

ScreenName Sign-out

Main | My AOL | Mail | People | Search | Shop | Channels | Devices

AOL Mail

Download Now | Close | Keep As New | Delete | Prev 3 of 12 Next

Subj: HECO data
Date: Thu, 24 Jan 2002 7:51:00 PM Eastern Standard Time
From: CHGorsuch
To: Hualeng

Ted Vorfeld- HECO-HMV11502.xls (56832 bytes)

Ted,

I did receive your envelope containing 1999 RDF sample analysis of moisture, ash and Btu/lb. Thanks for this input. I am working on the spread sheet analysis of all the data and will send you a copy when it is completed. I am using NOVA wet values in the analysis. Attached is a spread sheet (Data starts on line 714). More later.
Craig

Include original text in Reply.

Reply | Reply All | Forward | Address Book

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Subj: RDF Testing
Date: Fri, 18 Jan 2002 3:48:24 PM Eastern Standard Time
From: Hualeng
To: CHGorsuch
CC: colin@ieee.com

RDFAnalysis.PDF (22647 bytes)

Include original text In Reply | Reply | Reply All | Forward | Address Book

Craig,

I am attaching a copy of the RDF analyses performed by HARC. As you can see, the "Old" RDF is considerably drier than the "New" RDF. The "New" RDF is also somewhat dryer than the HPOWER "Regular" analyses I mailed to you the other day.

In any event, the RDF burned during the testing needs to be multiplied by the ratio of the 'dry' components. For example, the "Old" RDF needs to be multiplied by 1.3737 and the "New" RDF needs to be multiplied by 1.0986 to get the equivalent "Regular" RDF. I hope this is clear.

In order to relate the corrected RDF to MSW, divide the corrected RDF by 0.8221 (the 2001 average) to get MSW.

Your "Net" kWh can then be related to HPOWER's 500+ kWh net per ton MSW.

Here are my recommendations for the completed tests:

1. Correct either the mass flowmeter to dry gas or the NOVA to wet gas, so the numbers are compatible.
2. Please identify the OLD vs NEW RDF on the data sheets.
3. PLease send me the HECO meter readings.
4. Please ask the engine supplier to provide a guaranteed heat rate for the gas analyses from the tests.
5. Please ask Process Controls to verify tha their Mass flowmeter is accurate for the Syhngan alysis found during the tests.
6. Please account for the graphite rod consumption, if possible, or use average historic numbers.
7. Please ask the experts if the gas alanyes 'balance' contains any NOX as opposed to pure nitrogen as I was told by John.

Thanks and I look forward to your report.

Ted Vorfeld

HUALALAI ENGINEERING, INC.
75-5259 C Mamalahoa Highway • Holualoa, Hawaii 96725
Phone: (808)326-9058 • FAX: (808)326-2949 • email: hualeng@aol.com

MEMORANDUM

January 8, 2002

TO: Colin Jones

FROM: Ted Vorfeld

SUBJECT: Phase I a Protocol for RDF Testing

REF: Your Email of January 7, 2002 and Draft Protocol of January 2002

I spoke with Craig Gorsuch this afternoon and we discussed a number of issues related to the testing. I also spoke with Rennie Renfroe of Process Controls this morning. Some of the following will address various issues in your Email. Most of what follows pertain only to the Phase I a testing. I will try and deal with subsequent testing once this phase is completed.

1. Schedule

   Testing is to commence on Wednesday or Thursday or this week and continue through Friday of this week. I will plan on being on site for Friday's testing and will **confirm this with Craig tomorrow afternoon.**

2. Instrumentation

   The mass flowmeter has been installed by Process Controls. This is the only instrument with Process Controls' involvement. The accuracy of this meter is +/-1% if the gas is in the 'average' range of values provided by HMV and +/- 3% if at the extreme range of values provided by HMV.

   The gas analyzer will be calibrated by HMV prior to the run using some standard calibration gas containing hydrogen, CO etc. **This instrument will provide a continuous analysis.**

   The electric revenue meter is a ratcheting meter that reads only incoming power and has a digital output. HMV intends to read this output at regular intervals. HECO will also provide a continuous graphical representation via their remote monitoring system. (For Phase I b, HMV is in negotiations with HECO to provide in/out capability and metering. According to Craig, HMV has filled out the necessary application for this type of service and has agreed to the restrictions HECO ordinarily requires for such service.)

   Weighing of RDF and its containers will be performed manually.

Injected steam is currently metered but is uncorrected for pressure and temperature. Steam consumption will not be part of the Phase I a algorithm.

3. Cardboard Containers

At present, the approximate ¾ pound cardboard containers are packed with approximately 8 pounds of RDF. Plans are underway to compress the RDF to twice this density to improve overall accuracy. HMV will use a nominal 8,000 BTU/# value (HHV) for the containers (equivalent to normal values for paper), **but will confirm this calculation.**

Energy from cardboard containers will be deducted from the calculated HHV of the output gas.

4. Graphite Electrodes

Although expected to be a small value, HMV will also account for energy provided by electrode consumption. **HMV will either weigh the electrodes before and after the test or use historic electrode consumption per hour of operation.**

5. The Algorithm

The algorithm to determine 'net' output energy per ton of RDF is being created by Integrated Environmental Technologies, LLC (IET), the provider of the plasma-arc technology. **This algorithm will be made available to the City as soon as it is available.**

6. Use of HHV vs. LHV

Craig and I discussed this issue and the importance of using consistent heating values for inputs of cardboard and graphite as well as the output gas. **I continue to recommend using Higher Heating Values (HHV) throughout the testing.**

7. Other Recommendations for Phase I a Protocol

   A. Take at least three grab samples of gas and have this gas analyzed for constituents by U of H to confirm that the gas falls within the range of constituents specified for the mass flow meter.
   B. Provide a statement by the gas flow meter manufacturer on the gas analysis the meter was calibrated for and the effects on data for variations in this analysis.
   C. Read the input power kWh meter at a minimum of 10 minute intervals.
   D. Take at minimum three samples of RDF during the run and have them analyzed for moisture and ash.

Document2

cc: Craig Gorsuch/Frank Doyle via Email

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DEMONSTRATION PROTOCOL: PLASMA ARC MASS BALANCE

PHASE IA: INITIAL ANALYSIS OF TOTAL INPUT OF ENERGY AND DERIVED ENERGY OUTPUT FOR REFUSE DERIVED FUEL (RDF) USING SYNGAS MASS FLOWMETER AND NOVA GAS ANALYZER.

PHASE IB: INITIAL ANALYSIS OF TOTAL INPUT OF ENERGY AND DERIVED ENERGY OUTPUT FOR REFUSE DERIVED FUEL (RDF) USING GENERATOR

PARTICIPANTS:

Asia Pacific Environmental Technology (APET), Inc.
City & County of Honolulu
Hawaii State Department of Health

Post-it® Fax Note 7671	Date 1-7-02 # of pages 14
To TED VORFELD	From E DAGGE
Co./Dept.	Co.
Phone #	Phone # 527-6664
Fax # 808-326-2949	Fax # 527-5864

January 2002

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1. Introduction

Asia Pacific Environmental Technology, Inc. (APET) proposes that the Hawaii Medical Vitrification, Inc.'s (HMV) plasma arc facility utilize a segment of its commercial operations to conduct a series of incremental performance tests designed to determine mass balance data for energy and constituents for Refuse Derived Fuel (RDF) and possible additional waste streams in the future such as sludge, bagasse, grit, ash, rubber, and cooking oil.

The proposed demonstration protocol for plasma arc mass balance will be implemented through three phases:

Phase IA: Initial analysis of total input of energy and derived energy output for refuse derived fuel (RDF) using syngas mass flowmeter and nova gas analyzer.

Phase IB: Initial analysis of total input of energy and derived energy output for refuse derived fuel (RDF) using our genset.

Phase II: Basic mass balance diagram for energy and constituents for refuse derived fuel (RDF)

Phase III: Complete mass balance diagram for energy and constituents for refuse derived fuel (RDF)

The participants in the demonstration may include:

- The City and County of Honolulu;
- APET (Asia Pacific Environmental Technology, Inc.), who is the majority stockholder and operates the HMV plasma system;
- The US Navy PHNYY&IMF (Pearl Harbor Naval Shipyard and Intermediate Maintenance Facility);
- The Hawaii State Department of Health, CAB (Clean Air Branch);
- The Hawaii State Department of Health, SHWB (Solid and Hazardous Waste Branch); and
- The University of Hawaii.

These organizations are referred to as the Evaluation Team in this document.

This protocol summarizes Phase IA and Phase IB of the demonstration test and suggests responsibilities of each member of the Evaluation Team, describes the procedures to be followed, summarizes the data to be gathered, and suggests possible outcomes of the demonstration.

1.1 Reason for the Demonstration

The Evaluation Team recognizes that the City is dedicated to seriously considering potential methods to reduce the amount of waste material sent to its Waimanalo Gulch Landfill. The methods to do so include recycling, composting, other waste reduction programs such as source reduction, and technologies such as the plasma arc system being tested in this demonstration.

Any alternative to land filling must meet several criteria, including having a net cost of disposal approximately equal to the anticipated cost of landfill disposal. Technology vendors must also

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show that the process has been used on the waste stream and the capacity for which it is being proposed. The technology must also offer very clean emissions.

The Hawaii Medical Vitrification (HMV) facility is the first Plasma – arc infectious waste destruction facility in the world. The technology works and the proposed demonstration takes this technology to the next level with RDF. The technology has the potential to not only reduce the volume of MSW streams but also to generate recyclable materials such as glass grit and hydrogen gas that can be used to generate electricity. The demonstration project will generate new mass balance and waste-to-fuel data that has never existed before.

The Department of Energy (DOE) is interested in this Waste-to-Energy-to-Hydrogen Fuel technology and the data will help to support public-private ventures to develop this technology.

2 Phase I Waste Stream to Be Tested

This demonstration will determine the energy mass balance of RDF processed through the plasma-arc facility.

2.1 Municipal Solid Waste (MSW) and Refuse Derived Fuel (RDF)

The MSW accepted at the Waimanalo Gulch Landfill is similar to the MSW accepted at H-POWER. The material is shredded and has much of the ferrous metal removed to produce an RDF (refuse derived fuel). The processing at H-POWER is similar to that required before MSW is converted in a plasma system. While the RDF is not identical to the MSW being disposed at the Waimanalo Gulch Landfill, it is within a range of material composition expected and the Evaluation Team considers it to be adequate for this demonstration.

The RDF passes through an eight inch screen so the particles of waste will generally be eight inches in size or smaller. Some long slender materials (such as a wood 2x4 or a piece of pipe) will pass through the screen. They will be removed for this test. Since the feed port on the plasma vessel will accept material that is smaller than four inches, particles of RDF that are larger than that will also be removed.

3 Evaluation Team Responsibilities

Each of the members of the Evaluation Team has agreed to accept responsibilities for participation in the management of the demonstration, logistical support, participating in the data gathering or analysis, or supporting the demonstration with direct financial contributions. This section summarizes those arrangements.

3.1 City & County of Honolulu

The City is one of the two primary parties to this demonstration. It has the responsibilities identified in this section.

3.1.1 Management Support

The City has no responsibility for the management of the demonstration. It will participate in the meetings preparing for the demonstration, the test itself, analysis of the data, and review of the report.

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3.1.2 Logistical Support

The City is responsible for the following:

- Providing RDF as needed.
- Supporting APET in its efforts to obtain clearance from the Department of Health to operate the plasma system at four TPD.

3.1.3 Analytical Support

The City will assist in identifying the data that will be taken during the test. It will assist in analyzing the data and will review the results.

3.1.4 Financial Support

The City will participate financially in the demonstration test for each phase.

3.2 APET

APET is the other party that has a major role in the demonstration test. This section describes its responsibilities.

[illegible]

APET will provide overall management for the project. It will provide operations management of the plasma system and will schedule the processing of the test waste streams with the usual medical waste it processes to enable separate testing of the waste streams.

3.2.2 Logistical Support

The logistics support to be provide by APET includes:

- Providing the plasma-arc system and the operating staff to process the test waste streams.
- Providing equipment to feed the waste to the process vessel.
- Notifying the Department of Health (CAB and SHWB) for the demonstration testing.

3.2.3 Analytical Support

APET will provide the data and the analysis of the waste materials and inputs/outputs of the plasma system.

The data to be analyzed will be taken from the continuous monitoring equipment that controls the plasma system operations and from other sources.

3.2.4 Financial Support

APET will make the plasma system available for testing the three different phases. APET will provide the staff and employees needed to support the demonstration tests.

3.3 US Navy

The primary interest of the US Navy's PHNSY&IMF is in the use of the glass as a replacement for the sandblasting material now used in its maintenance operations. They also have a strong

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interest in minimizing disposal cost and diverting materials from landfill disposal. Their responsibilities are summarized in this section.

3.3.1 Management Support

The PHNSY&IMF will provide advice and assistance with management of the project.

3.3.2 Logistical Support

The PHNSY&IMF has no logistics responsibilities.

3.3.3 Analytical Support

The PHNSY&IMF will provide advice and assistance determining which chemical tests are needed and with analysis of the data. PHNSY&IMF will provide the source testing services for the chemical tests of the glass.

3.3.4 Financial Support

The PHNSY&IMF has no financial responsibilities.

3.4 Department of Health, Clean Air Branch

The CAB is responsible for permitting the plasma system and for ensuring that its operation complies with state and federal law. Their role is summarized in this section.

3.4.1 Management Support

The CAB will provide advice and assistance with management of the project.

3.4.2 Logistical Support

The CAB will provide advice and assistance to minimize the time required to obtain permission to operate the plasma system with the demonstration waste streams.

3.4.3 Analytical Support

The CAB will provide a list of materials for which emission source testing will be needed during Phase II and III of the demonstration test.

3.4.4 Financial Support

The CAB has no financial responsibilities.

3.5 Department of Health, Solid and Hazardous Waste Branch

The SHWB is responsible for permitting the plasma system and for ensuring that its operation complies with state and federal law. Their role is summarized in this section.

3.5.1 Management Support

The SHWB will provide advice and assistance with management of the project.

3.5.2 Logistical Support

The SHWB will provide advice and assistance to minimize the time required to obtain the permission to accept the additional waste materials for the demonstration.

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3.5.3 Analytical Support

The SHWB will provide advice and assistance to identify the data that should be gathered and reviewing the analysis of the data.

3.5.4 Financial Support

The SHWB has no financial responsibilities.

3.6 University of Hawaii (UH)

The University of Hawaii (UH) is interested in using the hydrogen gas produced by the plasma system in its fuel cells. Their role in the demonstration test to better understand the amount and quality of hydrogen that can be produced.

3.6.1 Management Support

The UH will provide advice and assistance with management of the project.

3.6.2 Logistical Support

The UH will provide a low temperature fuel cell if possible in Phase II and III to use the hydrogen production during the demonstration. If a fuel cell is not available, UH will evaluate the test to identify the factors that will need to be achieved in tests to use the fuel cell. A grab sample test of the syngas for each of the waste streams will be collected and analyzed by UH for gas composition.

3.6.3 Analytical Support

The UH will provide the tests of the syngas on each phase of the demonstration being tested.

3.6.4 Financial Support

The UH has no financial responsibilities beyond supporting the cost of the testing except to provide a fuel cell for use in the demonstration.

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4 Test Protocols

APET will process MSW, in the form of RDF, and other possible waste streams through its plasma-arc system during the three phases of the demonstration.

4.1 Phase IA: Initial Analysis of Total Input of Energy and Derived Energy Output for Refuse Derived Fuel (RDF) Using Syngas Mass Flowmeter And Nova Gas Analyzer.

4.1.1 Purpose of Phase IA

The purpose of Phase I of the demonstration run is to establish preliminary data indicating the energy mass balance of the plasma arc system on MSW. The demonstration should demonstrate that for every ton of RDF processed, a net quantity of energy (kwh) is available for sale to the Hawaiian Electric Company (HECO). For example, the City's H-Power processes MSW to electrical power at a guaranteed efficiency of 540 kwh/ton.

During Phase IA the energy input will be determined by HECO metering. The energy output will be determined by syngas analysis using a flowmeter and Nova gas analyzer to determine the BTU value for the syngas.

4.1.2 Preparation and Setup

The preparation and setup of the Plasma-arc unit for the demonstration run began 01 DEC 2001 and will continue up until the actual processing of RDF for the demonstration. The packaging of RDF into cardboard containers used to feed the RDF into the Plasma-arc system began 03 DEC 2001. (The 6,000 BTUs from each cardboard container will be subtracted from the total BTUs to accurately reflect the RDF BTUs).

The testing schedule is planned as follows:

ACTIVITY	DATE
Preparation/Setup Plasma-arc Unit	02-10 JAN 2002
Preparation RDF	13-16 DEC 2001 and 02-10 JAN 2002
Processing 3 tons of RDF at rate of 1 tpd	10-15 JAN 2002
Test Result/Report submitted to City for review	16 JAN 2002
Test Result/Report finalized	18 JAN 2002

Preliminary data for energy mass balance will be provided to the City prior to 30 DEC.

Three tons of RDF will be processed over a five day period. The plasma-arc system will be operated at one TPD capacity during the test. The general sequence of activities will be as follows:

1. Cool down from medical waste processing.
2. Remove the glass from prior processing.

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3. Process MSW for the agreed to period. The first segment will be the startup phase and no data will be collected for the demonstration. The second, longest segment will be the testing phase during which data will be collected for the demonstration. The last phase is the cool down phase during which no data will be collected for the demonstration.

4. Remove the glass.

4.1.3 Test Procedure

The Test Procedure will be as follows:

(Primary)

1. Indicate and determine all energy input into the system through HECO monitors.
2. Total energy output from GENSET through HECO monitors. — ?

(Backup)

3. Meters setup to monitor syngas output
4. Mass flow units to measure both mass flow (via 4-20 madc) and mass flow total (via a discrete output pulse)
5. Gas analyzer monitors the % H_2, CO, CO_2, O_2 and hydrocarbon gases.
6. Correlate BTU content per standard cubic foot via algorithm to determine BTUs available for energy output production.

The gathered information will then be used to design a more complete and accurate mass balance for both energy and constituents during Phases II and III of the mass balance demonstration.

4.2 Phase IB: Initial Analysis of Total Input of Energy and Derived Energy Output for Refuse Derived Fuel (RDF) Using Generator.

4.2.1 Purpose of Phase IB

During Phase IB the energy input will be determined by HECO metering. The energy out will be determined by syngas analysis using a generator to determine the kW values.

4.2.2 Preparation and Setup

The same preparation and setup as Phase IA will be followed in Phase IB with different time frames.

4.2.3 Test Procedure

The same Phase IA test procedure will be followed in Phase IB with the generator as the primary source of energy output.

4.3 Phase II: BASIC MASS BALANCE DIAGRAM FOR ENERGY AND CONSTITUENTS FOR REFUSE DERIVED FUEL (RDF)

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(Phase II will be described in future documents)

4.4 Phase III: COMPLETE MASS BALANCE DIAGRAM FOR ENERGY AND CONSTITUENTS FOR REFUSE DERIVED FUEL (RDF)

(Phase III will be described in future documents)

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5 Data Analysis

The data gathered during the demonstration will be used to:

1. Estimate the net cost of processing RDF and ash through the Plasma-arc system.

2. Identify advantages or limitations of the plasma system in processing the waste streams.

3. Demonstrate the technology's ability to meet all environmental requirements to the satisfaction of the department of health.

5.1 Operations Data

The operating data to be taken and the frequency are summarized in Table 1.

Table 1
Data to be Gathered

Data	Frequency
Amount processed	Continuous
kWh purchased	Continuous
kWh produced	Continuous
Glass added	Start of batch
Glass removed	End of batch
Metal removed	End of batch
Average vessel temperature	Continuous
Average syngas flow	Continuous

5.2 Chemical Analyses

The analyses to be provided are:

- Phase II and III testing of the syngas before energy production. One sample will be taken from the syngas produced by each of the test waste streams.

- Phase II and III source testing of the engine generator exhaust for cadmium, carbon monoxide, dioxins/furans, hydrogen chloride, lead, mercury, oxides of nitrogen, particulate matter, and sulfur dioxide (the pollutants specified by the CAB).

- Total metal and TCLP analysis of the glass produced by each of the three test waste streams. The glass from each waste stream will be segregated and a sample taken from each stream for testing.

5.3 Process Flow Diagram

The process flow diagram for the plasma system is included as figure 1. It is intended to aid the understanding of the monitoring data analysis.

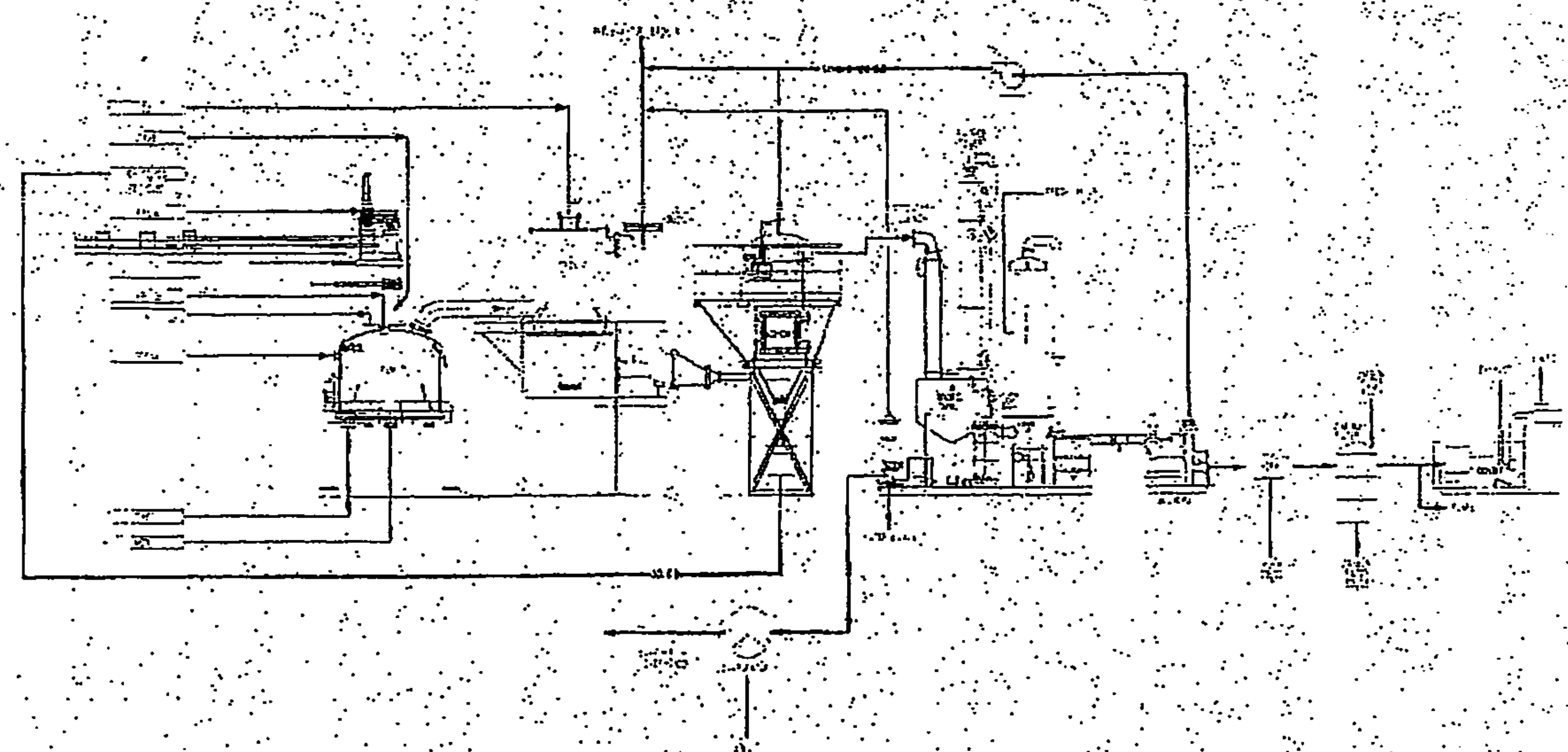

FIGURE. 1: PROCESS FLOW DIAGRAM

Subj: Testing Elements-Phase A
Date: Thu, 20 Dec 2001 2:54:02 PM Eastern Standard Time
From: Hualeng
To: CHGorsuch
CC: rennie@hawaii.rr.com, colin@ieee.org

Craig,
After looking at the site yesterday there are some things I would like included in the protocol.

1. The RDF needs to be sampled and analyzed for moisture, ash and, preferably, HHV so it can be corrected to the normal moisture, ash and HHV. HHV can be tested by bomb calorimeter at HARC in Aiea. It looks like this stuff on hand has been sitting around for a while and is probably much drier than normal RDF.
2. Correct for the mass and HHV of cardboard containers, at minimum. If these for a significant portion of the treated mass, the gas composition might be severely affected. Sugest you wiegh one or two full containers and also the containers by themselves so we can see if the cardboard mass is significant before we run the tests.
3. Correct for the carbon electrode usage unless it can be shown that the carbon consumption is insignificant.
4. Any propane usage needs to be included. I notice that there are lines connected to the flare but I don't know where the gas composition and flow will be measuresd.
5. We need to know the steam consumption mass.
6. I presume we are going to get the gas analysis and calculate heating value based on the mixture. If there is a way to get some gas samples tested for HHV, that would be best. I don't know who in Hawaii does this. With the high hydrogen content, there will be more than the usual diffeence between HHV and LHV so we must be consistent throughout by using HHV.

Ted Vorfeld

ASIA PACIFIC
ENVIRONMENTAL TECHNOLOGY

December 14, 2001

Frank Doyle, P.E.
Deputy Director
Departmental of Environmental Services
City and County of Honolulu
650 South King Street
Honolulu, HI 96813

Dear Frank,

Reference: Demonstration Protocol

Financing

We have ordered equipment and started to conduct *Phase I: Initial Analysis of Total Input of Energy and Derived Energy Output for RDF* of the three phase demonstration run. Enclosed you will find copies of invoices for equipment needs as follows:

SynGas Flow Meter	$3624.00
Delta-V Hardware & Software	$24985.00
TOTAL	**$28609.00**

Programming Flow Meter	$680.00
Delta-V Programming	$6800.00
TOTAL	**$7480.00**

The City's participation in financing of $25,000 will be applied to the cost of measurement and control equipment. APET will cover the labor costs and apply additional equipment costs to future additional funding for Phase II and III of the mass balance demonstration.

1088 Bishop Street • Suite 1130 • Honolulu, Hawaii 96813 • Tel. (808) 532-0512 • Fax (808) 532-0515

Preparation and Setup

The preparation and setup of the Plasma-arc unit for the demonstration run began 01 DEC and will continue up until the processing of RDF. The packaging of RDF into cardboard containers used to feed the RDF into the Plasma-arc system began 03 DEC. (The 6,000 BTUs from each cardboard container will be subtracted from the total BTUs to accurately reflect the RDF BTUs). The testing schedule is planned as follows:

ACTIVITY	DATE
Preparation/Setup Plasma-arc Unit	01-17 DEC
Preparation RDF	13-16 DEC
Processing 3 tons of RDF at rate of 1 tpd	17 -22 DEC
Preliminary Data Compilation	21-30 DEC

Preliminary data for energy mass balance will be provided to the City prior to 30 DEC.

Test Procedure

The Test Procedure will be as follows:

(Primary)

1. Indicate and determine all energy input into the system through HECO monitors.
2. Total energy output from GENSET through HECO monitors.

(Backup)

3. Meters setup to monitor syngas output
4. Mass flow units to measure both mass flow (via 4-20 madc) and mass flow total (via a discrete output pulse)
5. Gas analyzer monitors the % H_2, CO, CO_2, O_2 and hydrocarbon gases.
6. Correlate BTU content per standard cubic foot via algorithm to determine BTUs available for energy output production.

Please contact me for additional information as needed.

Sincerely,

Samuel Y. K. Liu
President and CEO

Enclosure

APPENDIX 6.5

Glossary and Abbreviations

ABBREVIATIONS

BTU	British Thermal Unit
HEME	High efficiency mist eliminator
HEPA	High efficiency particulate air (a type of filter)
HHV	Higher Heating Value
HMV	Hawaii Medical Vitrification
MSW	Municipal solid waste
MTBE	Methyl-tertbutyl ether (a gasoline additive)
RDF	Refuse derived fuel (shredded and partially cleaned MSW)
TRC	Thermal residence chamber
IET	Integrated Environmental Technologies, LLC

GLOSSARY

Vitrification	A process in which non combustible material is melted and fused into a glass-like material.
Plasma	An ionized gas, often considered to be the fourth state of matter (i.e. solid, liquid, gas, plasma).
Gasification	The process of turning a solid into a gas.
Combined Cycle	Usually the process of burning fuel in a gas turbine generator and using the hot exhaust gas to generate steam and electricity.
Syngas	Synthetic gas formed by manufacturing process.

APPENDIX H

Review of Plasma Arc Technology for Waste Disposal

December 10, 2002

December 10, 2002

R·W·BECK

Ms. Wilma Namumnart
Refuse Division
1000 Uluohia Street
Kapolei, HI 96707

Dear Wilma:

Subject: MSW Disposal via Plasma Arc Technology
Final Report

R. W. Beck is pleased to submit our Final Report on the Review of Plasma Arc Technology for Waste Disposal in Honolulu. We are sending you an electronic copy of the Report in pdf format. Unfortunately, we do not have the articles in Appendix A in an electronic format. However, we are also sending, by Federal Express, three hard copies of the Report which will include the articles in Appendix A.

Very truly yours,

R. W. BECK, INC.

Herb

Herbert M. Kosstrin, Ph.D.
Principal and Senior Director
Special Projects

HMK/njc

Enclosure

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CITY OF HONOLULU
REVIEW OF PLASMA ARC TECHNOLOGY FOR WASTE DISPOSAL

Prepared by

R. W. BECK, INC.

December 10, 2002

R·W·BECK

Letter of Transmittal
Table of Contents

This report has been prepared for the use of the client for the specific purposes identified in the report. The conclusions, observations and recommendations contained herein attributed to R. W. Beck, Inc. (R. W. Beck) constitute the opinions of R. W. Beck. To the extent that statements, information and opinions provided by the client or others have been used in the preparation of this report, R. W. Beck has relied upon the same to be accurate, and for which no assurances are intended and no representations or warranties are made. R. W. Beck makes no certification and gives no assurances except as explicitly set forth in this report.

Executive Summary

This report examines the application of plasma arc gasification technology ("Plasma Technology") for the disposal of municipal solid waste ("MSW") in four parts.

Types of Waste

First, it presents an overview of four types of waste that are currently being addressed with Plasma Technology worldwide:

- MSW includes most household trash, such as paper, plastic, metals, and organic waste. Approximately 128 million tons of MSW are generated in the United States each year. Most MSW in the U.S. is disposed in landfills or waste-to-energy ("WTE") plants. No MSW in the U.S. is disposed in a plasma facility.
- Hazardous waste includes various toxic industrial wastes. Approximately 40 million tons of hazardous waste is generated in the U.S. each year and most of it is incinerated or injected underground.
- Medical waste is a specific type of hazardous waste. Approximately 100,000 tons of medical waste is generated in the U.S. each year. It may be disposed through incineration or subjected to autoclaving, microwaves, radio waves, with the disinfected waste being landfilled.
- Incinerator ash is the residue from a WTE plant. Approximately 30 million tons of ash is generated in the U.S. each year and most of it is landfilled.

Plasma Technology

Second, the Report discusses plasma technology and the differences between plasma technology and state-of-the-art WTE. A plasma arc facility is a system consisting of three parts: (1) the plasma reactor, (2) environmental controls, and (3) a power generation unit (optional).

The plasma reactor is an enclosed chamber into which the waste is fed. Plasma torches provide the heat, 3000°C or higher, in the chamber which converts organic material to a gas and inorganic material into a glassy slag. The plasma facility may generate electric power, using the fuel gases produced in the reactor. These fuel gases may be combusted in a waste-heat boiler, or cleaned and fed into a combustion turbine or other combustion device. However, the plasma facility must be large enough, in terms of wáste throughput, to justify the cost of a power generation unit. The environmental controls on a plasma facility will be located downstream of the reactor and may include scrubbers, a carbon injection system, or a baghouse, whether or not the facility is generating electricity.

Plasma technology is currently in the "demonstration" phase of its development. Only one small commercial plasma facility, located in Yoshii, Japan, is currently disposing of MSW (25 tpd) and has been doing so since 1999. A second facility, the EcoValley Plant in Utashinai, Japan, is in start-up mode and is due to begin receiving MSW in December, 2002 (166 tpd). A demonstration plasma facility for the disposal of hazardous waste is located in Lorton, Virginia (10 tpd) and a medical waste disposal facility has been operating since 1998 in Honolulu (1 tpd). Several facilities in Japan are vitrifying incinerator ash.

Environmental Performance

Third, the Report examines the environmental performance of plasma technology and compares it to WTE. Because of the brief operating history and our inability to obtain environmental data from the Japanese operators, environmental data from an MSW-plasma facility was not available. However, environmental data from the PEPS plasma facility in Virginia which disposes of hazardous waste and medical waste was available. This information was compared with the environmental data from H-Power. The air emissions from both the PEPS plasma facility and H-Power were within their respective permit limits. In certain configurations, a plasma facility will have an advantage over a WTE plant in removing sulfur. In terms of the other regulated pollutants, including dioxins and furans, a plasma facility and a WTE plant will both meet current permit limits. The higher temperature in a plasma facility vitrifies the slag, allowing for the potential beneficial use of this material and making it less likely to leach than the ash from a WTE plant. However, the data shows that the results from the EPA's TCLP tests for both types of facilities are with the regulatory limits.

Financing Issues

Fourth, the Report discusses some of the key challenges related to the financing of an MSW-plasma facility. One of the obvious challenges is the lack of operating history for MSW-plasma facilities. The newness of this application of Plasma Technology – only one small-scale facility operating for about two years – will make investors cautious. Furthermore, the scale of the one operating facility – 24 tons per day – is well below the throughput necessary to solve Honolulu's long-term MSW disposal needs.

The developer of an MSW-plasma facility will face two kinds of risks. The first risk is the construction risk which includes the cost of designing, permitting, constructing, and testing the facility. Some of the construction risk can be mitigated through performance guarantees, equipment warranties, and insurance instruments. The second risk is the waste-disposal risk. Who will pay for the disposal of MSW at alternative sites, if the facility doesn't work? And if the facility cannot be fixed, who will pay for the City's lost opportunity to establish a workable disposal facility? The allocation of these risks will be a critical factor in the financing of a MSW-plasma facility.

Determining the cost of an MSW-Plasma facility is difficult because the facility could be configured in any one of several ways, each with its own advantages, disadvantages, costs, and risks. For example, the facility could use a waste heat boiler for the fuel gases, to keep costs down, or a combustion turbine to generate more net power. The additional net power might be economically advantageous, depending on the efficiency of the unit and the price received for electricity.

If the City wishes to obtain more concrete cost information and pursue the development of an MSW-plasma-arc facility, the next step would be to determine the City's MSW disposal needs, decide how much risk the City wishes to bear, and issue a Request for Proposals. This Report includes a section of specific questions and answers in Section 5.

Section 1
Waste and Waste Disposal

Understanding the use of plasma arc technology for waste disposal first requires some understanding of the types of waste that require disposal and the methods typically used to dispose of the waste. 'Waste' is a very general term that can be sub-divided in many different ways. For the purposes of this report, we will focus on the four types of waste that are currently being disposed in one or more plasma arc facilities worldwide. The four types of waste are:

1. Municipal Solid Waste ("MSW"),
2. Hazardous Waste,
3. Medical Waste, and
4. Incinerator Ash.

These wastes differ from each other and disposing of each presents a somewhat different set of problems.

1.1. Municipal Solid Waste ("MSW")

MSW consists of everyday items such as product packaging, grass clippings, furniture, clothing, bottles, food scraps, appliances, and batteries. Taken as a whole, MSW is highly variable. That is, MSW includes many different types of materials – paper, metal, plastic, vegetable matter, glass, and animal wastes. Heterogeneity is a key characteristic of MSW.

In the "Characterization of Municipal Solid Waste for 2000" the United States Environmental Protection Agency ("USEPA") estimates that approximately 128,000,000 tons of MSW were disposed in the United States in 1999, or about 889 lbs. per person per year. According to the USEPA, approximately 70 percent of the MSW in the United States was disposed in landfills or waste-to-energy facilities in 1999.

1.2. Hazardous Waste

Hazardous waste is a broad category of wastes that includes, but is not limited to, industrial wastes, radioactive wastes, and toxic substances. Because of the dangers of handling, transporting, and disposing of hazardous waste, their management is carefully regulated by the USEPA. Because of the danger to human health and the environment, hazardous wastes must be destroyed or rendered harmless. Although hazardous wastes include a wide variety of materials, the facilities that transport, store, and dispose of these wastes typically manage a relatively narrow range of materials, such as hazardous chemical wastes or medical wastes (see below). Facilities are designed to handle specific types of hazardous wastes. The individual hazardous wastes are more homogeneous than MSW.

In its "1999 Biennial RCRA Hazardous Waste Report", the USEPA estimated that approximately 40 million tons of hazardous wastes were generated in the United States, or about 278 lbs per person per year. According to the same report, Hawaii generated only 1,456 tons, approximately 2.38 lbs per person – the lowest total in the United States. According to the USEPA, approximately 81 percent of hazardous waste was disposed by land disposal or thermal treatment. The primary means of land disposal of liquid wastes is deepwell injection. Thermal treatment includes both energy recovery and incineration.

1.3. Medical Waste

Medical waste is one specific type of hazardous waste. The US EPA defines medical waste as "any solid waste generated in the diagnosis, treatment, or immunization of human beings or animals, in research pertaining thereto, or in the production or testing of biologicals." It includes, but is not limited to, body organs, tissue, blood-soaked bandages, needles used to give shots or draw blood, and discarded surgical instruments. Like other hazardous wastes, the disposal of medical wastes is carefully regulated. These wastes are also relatively homogeneous.

The USEPA estimates that approximately 100,000 tons of medical wastes were generated in 2000, or about 0.69 lbs per person per year. According to the USEPA, more than 90 percent of medical waste was disposed by incineration in 1999. Other methods of disposal include subjecting it to high-frequency radio waves, microwaves, or steam autoclaving. For facilities that disinfect the material, the residue is typically landfilled.

1.4. Incinerator Ash

The USEPA, reports, that in 2000, the 102 waste-to-energy ("WTE") plants in the United States disposed of approximately 35 million tons of MSW. The combustion of the MSW in these waste-to-energy WTE plants results in an ash which must then be disposed. The amount of ash produced represents approximately 25 percent of the amount of MSW disposed in the WTE plant. The ash from a WTE plant is less heterogeneous than the MSW.

Assuming that 25 percent of the 35 million tons of MSW disposed in WTE plants became ash, approximately 8.75 million tons of ash, or about 61 lbs per person per year, were generated. According to the USEPA, most ash from WTE plants is disposed in landfills. WTE plants periodically test their ash to confirm that it passes the standard USEPA TCLP test for leaching heavy metals.

Table 1 summarizes the characteristics of the four types of waste discussed above.

Table 1
Four Types of Waste

Type of Waste	Annual Generation (1)	Typical Constituents	Conventional Disposal Facilities
MSW (2)	888.89	Household trash, paper, plastic, metals, organics	Landfills, WTE plants
Hazardous (3)	277.78	Chemcia waste, radio- active material, heavy metals	Incineration, deepwell injection
Medical (4)	0.69	Body parts, tissue, blood	Incineration, micro waves, auto-claving
Ash (5)	52.08	Incinerator ash	Landfilling

1. Pounds per person per year based on USEPA data
2. Municipal Solid Waste – Sources: USEPA; Characterization of Municipal Solid Waste, 2000
3. Hazardous Wastes – Source: USEPA; The National Biennial RCRA Hazardous Waste Report (1999 data)
4. Medical Waste – Source: USEPA; Medical Waste: Frequently Asked Questions
5. Incinerator Ash – Source: Integrated Waste Services Association

To understand the advantages and issues of disposing of these types of waste in a plasma arc facility, it is necessary to understand some basic principals of plasma technology.

Section 2
Plasma Technology for Waste Disposal

2.1. Plasma Technology

2.1.1. Background

Plasma as a method to generate heat is a proven, well-demonstrated commercial technology at work around the world. In the 19^{th} century, plasma technology it was developed and used in Europe for the metals industry. At the beginning of the 20^{th} century, the chemical industry used plasma heaters to extract acetylene gas from natural gas. In the early 1960s, the United States National Aeronautics and Space Administration used plasma technology to simulate the high temperatures that orbiting space vehicles would encounter when reentering earth's dense atmosphere. In the 1980s, large-scale plasma heater processes were built and commissioned for a variety of industrial applications, particularly for metals and chemicals.

Although plasma technology has a long track record, its application to waste disposal is more limited. During the past twenty years, the use of plasma technology for waste disposal has undergone extensive research and small-scale development. It has been tested and evaluated on many types of wastes, including automobile shredder residue, sludges, asbestos fibers, medical waste, and MSW. This R&D effort is continuing and some small-scale commercial plasma facilities for disposing of waste have been operating for more than a decade.

2.1.2. Basics of Plasma Technology

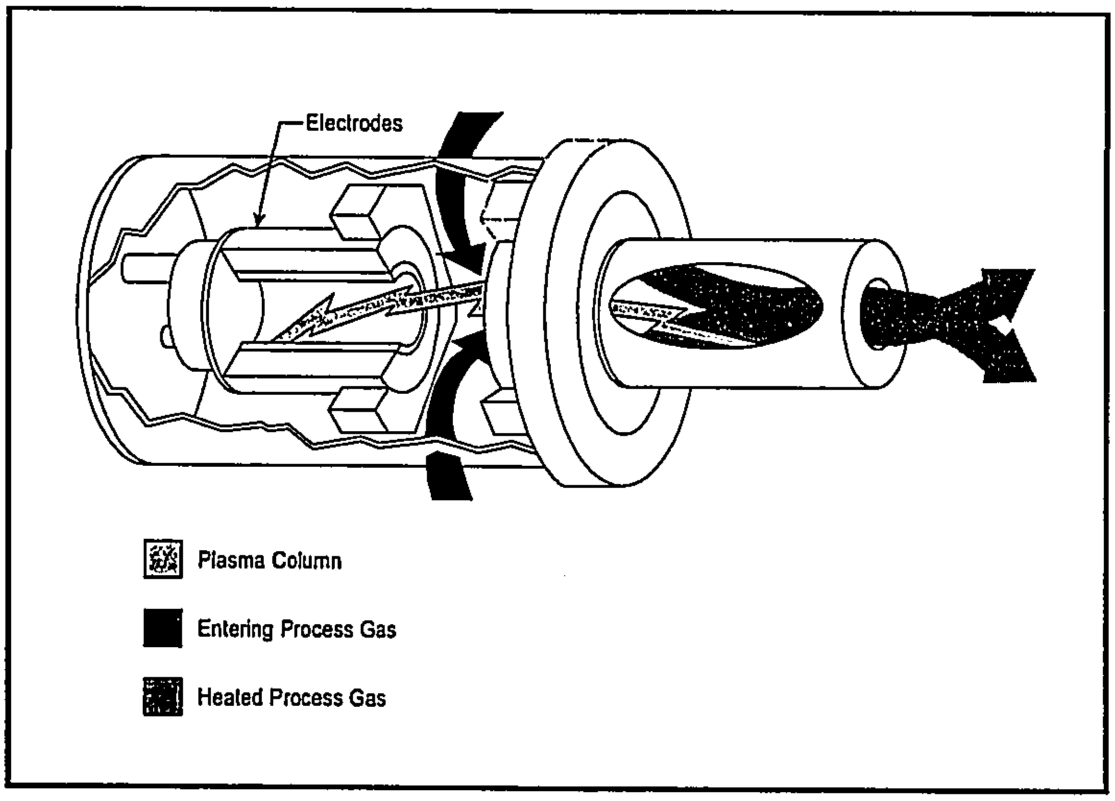
Plasma is a hot ionized gas resulting from an electrical discharge. Plasma technology uses an electrical discharge (the "arc") to heat a gas, typically oxygen or nitrogen, to very high temperatures, potentially in excess of 3000 degrees Celsius ("C"). The heated gas can then be used as a controlled heat source of a particular application. These applications can include welding, cutting, or the disposal of waste materials. In the applications of plasma arc gasification on waste materials, the amount of oxygen in a plasma reactor, as in any gasification system, is carefully controlled to eliminate combustion and promote gasification. The extreme heat generated in a plasma reactor actually pulls apart the organic molecular structure of the material to produce a simpler gaseous structure, primarily CO, H_2, and CO_2.

As applied to the disposal of waste, such as MSW, the gases heated by the plasma arc come into contact with the waste, melting the inorganic fraction of the waste and gasifying the organic and hydrocarbon (plastic, rubber, etc.) fraction.

2.1.3. The Plasma Reactor

The Plasma Technology resides in an enclosed reactor into which the MSW is fed and processed. The gases in the reactor are heated by one or more plasma torches or electrodes. There are two types of plasma torches, the transferred torch and the non-transferred torch. The transferred torch creates an external electric arc between the tip of the torch and a metal bath or the conductive lining of the reactor wall. A variation on the transfer torch is the graphite electrode, as used in the Hawaii Medical Vitrification plant. In this case the electrical energy goes through the graphite electrode and "ARC's" to the metal both similar to the ARC used in an aluminum smelter. In the non-transferred torch, the arc is internal, within the torch itself and the gases are fed into the torch, heated, and escape through the tip of the torch (see Figure 1). Both types of torches have been in commercial operation for a decade.

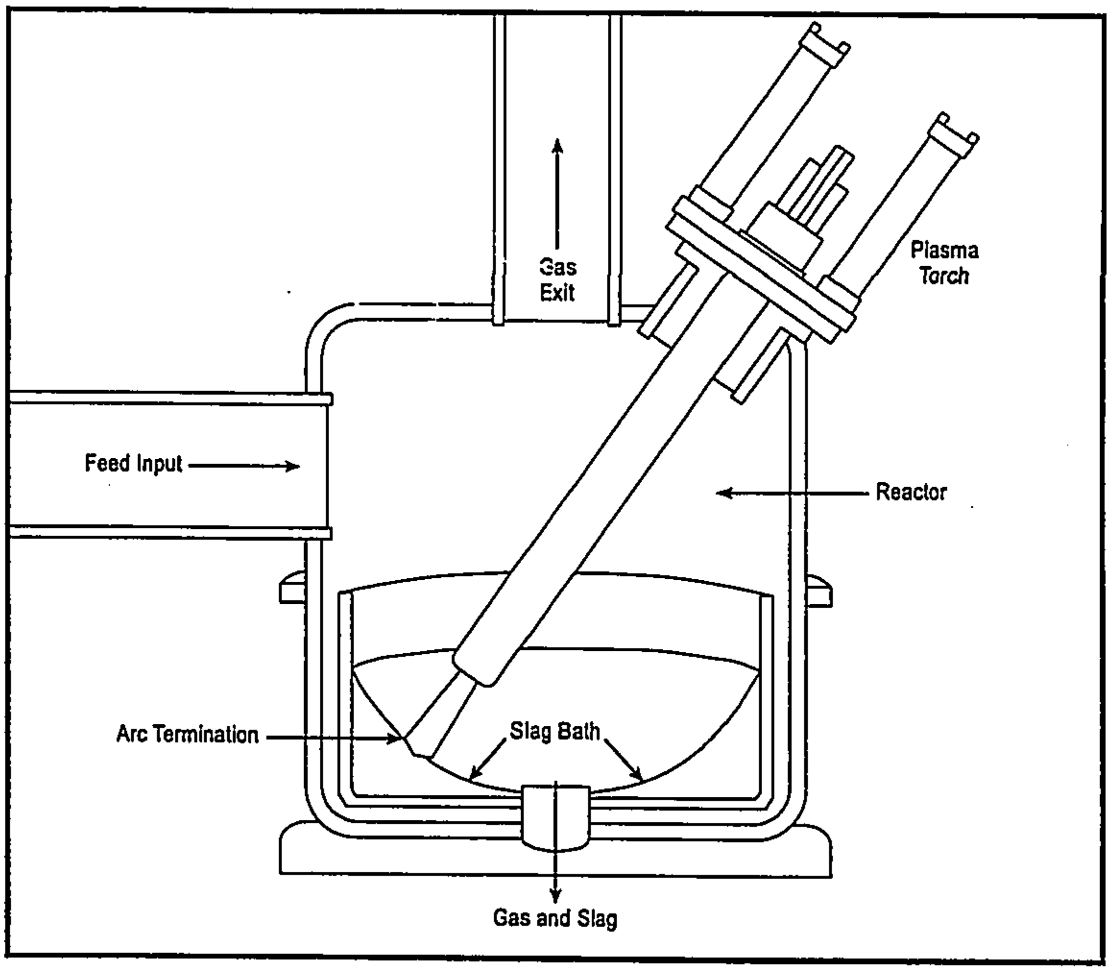
Figure 1
Westinghouse Non-Transferred Plasma Torch



There are two approaches to the current design of the plasma reactors. In the first approach, promoted by Westinghouse and Hitachi, a low pressure gas passes over a water cooled non-transferred torch, outside of the reactor. The hot gas then flows from the torch into the waste reactor to melt and gasify the MSW.

The second approach is an in-situ torch, promoted by several suppliers. Here, the plasma torch is placed inside the reactor itself (see Figure 2). This torch can either be a non-transferred torch or a transfer torch. When using a transferred torch, the electrode extends into the waste reactor and the electric arc is generated between the tip of the torch and the conducting receiver, i.e., the metal slag in the reactor bottom or a conducting wall. The low pressure gas is heated in the external arc. Alternatively, a non-transferred torch can be used in which the ionized gas is created within the torch and is projected onto the waste. In each case the electrical source for the torch is direct current.

Figure 2
In-Situ Plasma Torch Reactor



Typically, the MSW enters the reactor through a point at the top or the side of the reactor and, after contact with the ionized gas, the metals and ash form a liquid pool at the bottom of the reactor. The organic portion of the MSW is gasified, rises, and exits at the top of the reactor.

Proponents of the in-situ torch claim its advantages include better heat transfer to the waste and a hotter reactor temperature, resulting in more complete waste conversion. The main disadvantage is the potential corrosive effect of the waste and the gases on the torch in the reactor. Proponents of the external torch point out that this approach protects the torch from the corrosive effects of the waste and prolongs the mechanical integrity of the torches. For a graphite electrode, the graphite is consumed over time and needs to be replaced.

Both approaches have been applied to small-scale commercial MSW or medical waste processing units. The throughput of the largest external system is approximately four tons per hour and the throughput of the largest internal system is approximately 10 tons per day. Pilot units using the in-situ approach have reportedly operated at one ton per hour. The external Westinghouse/Hitachi design has been scaled up to 83 tons per day per reactor at Utashinai, Japan, currently in start-up. In addition a 14 tons-per-hour (336 tons per day) Westinghouse/Solena design is reportedly under construction in Rome, Italy.

As noted above, the Plasma Technology results in two outputs: (1) a burnable gas and (2) a glass-like slag, resulting from a process called "vitrification." The combustible gas can either be burned immediately in a closed-coupled combustion chamber or cleaned of containments and used to fuel a combustion turbine power plant.

It is important to understand that certain metals, such as mercury, lead, zinc, and cadmium, may be volatilized, depending on the temperature in the reactor. That is, if the temperature is low, the metal will be melted and become part of the slag at the bottom of the reactor. If the temperature is high, the metal will be vaporized and rise with the gases out the top of the reactor. For example, lead volatilizes at 1737 degrees Celsius ("°C"). Below this temperature, the lead becomes part of the slag; above this temperature, it escapes with the gases and must be captured elsewhere in the system. Mercury has a very low temperature of volatilization (about 360°C) and vaporizes in almost any combustion system.

2.1.4. The Power Generation Unit

Plasma arc facilities consume power to create the plasma arc destroy the waste. At the same time, these facilities are capable of generating power. The cost of adding power generation equipment will depend on the throughput of the facility and the type of equipment used. When the amount of power consumed by the facility is less than the amount produced by the facility, there is a net power output which can be sold and becomes a source of revenue. Currently, there are two approaches to the generation of electric power in plasma facilities.

In the first approach, the combustible gas, or synthesis gas ("syngas"), produced in the reactor is burned in a close-coupled combustion chamber and passes the hot gases through a waste heat boiler to generate steam and, subsequently, power. The resulting flue gases must be cleaned by an air pollution control ("APC") system that is similar to the system in a state-of-the art WTE plant. The APC in this configuration is downstream of the boiler.

The second approach to generating power is to use the syngas to fuel a combustion turbine. The burning of the syngas in a combustion turbine combined cycle ("CTCC") power plant is more efficient and will typically produce more net power that would be produced using a waste-heat boiler. However, the syngas must be cleaned before it enters the turbine. Chlorine, sulfur, mercury, and other elements that would harm the turbine must be removed from the syngas before it can enter the turbine's combustion chamber. The system used to clear these gases would be similar to systems currently used at coal gasification plants or in the petrochemical industry, although at a much reduced scale. Typical coal gasification systems consume 2000 tons per day of coal and produce 250 MWe of power. The CTCC is typically more difficult to operate than a boiler because the turbine requires gas with a relatively consistant heating value. Using a gas with a highly variable heating value may have a detrimental effect on the operation, thereby increasing operating costs. The problem is that the heterogeneity of MSW (primarily in the moisture content) results in a highly variable gas heating value (i.e., BTU content). The addition of supplemental natural gas to the syngas can overcome this problem but it introduces additional complexities and costs to the operation of the facility.

2.1.5. Environmental Controls

In addition to the plasma reactor and the power generation unit, an MSW-plasma arc facility will require certain environmental controls to avoid polluting water, air, and/or soils.

2.1.5.1. Water

All power plants consume water for cooling and steam generation. However, this water usually does not require treatment because it simply recycled and does not pick up pollutants from the process. Plasma reactors themselves do not use a significant amount of water with one exception. That exception is facilities that burn the syngas in a CTCC. As noted above, this gas must be cleaned prior to use and the removal of chlorine, sulfur and other problem substances result in both the condensation of the water produced in the process and the water used for scrubbing that must be treated. The specific design for treatment depends on the size of the system and the type of technology. The types of equipment would include scrubbers, filters, and sorbant systems. The circulating water in these systems needs to have the problem substances removed. The costs would depend on the size of the facility and the specific type of clean-up technology used.

2.1.5.2. Solids

As noted above, the primary solid output from plasma facilities is a glassy slag, the result of melting the inorganic fraction of the waste. Any waste disposal facility generating an ash or slag is required by the USEPA to subject it to a Toxicity Characteristic Leaching Procedure ("TCLP") test. The TCLP test is designed to measure the amount of eight elements that leach from the material being tested. As Table 8 in Section 3 indicates, TCLP tests on plasma facilities, even those processing highly hazardous materials or medical waste, show results that are well below regulatory limits. In other words, the plasma arc technology melts the inorganic material so that almost none of it can leach back into the environment.

2.1.5.3. Air

The discharging of pollutants into the air is also regulated by the USEPA, as well as state environmental agencies. Air emission regulations apply to all facilities disposing of waste, including landfills, incinerators, WTEs, and plasma facilities. The emissions of concern to the USEPA include sulfur dioxide (SO_2), hydrogen chloride (HCL), carbon monoxide (CO), nitric oxides (NO_X), particulates (PM), volatile compounds (VOCs) and hazardous air pollutants (HAPs). HAPs include chlorinated hydrocarbons (dioxins.). Plasma arc facilities control different pollutants in different areas of the plant. Table 2 below shows the type of emission, the location of the control device, the type of residue, and the ultimate disposal point for the residue for both types of facility configurations.

Table 2

Plasma Arc Air Emission and Control Devices

Emission	Waste Heat Boiler Control Device (1)	Combustion Turbine Control Device (1)	Residue	Disposal of Residue
SO_2	Scrubber	Absorbant (2)	Scrubber residue	Landfill
HCL	Scrubber	Scrubber/concentrator	Scrubber/concentrator residue	Landfill
CO/VOCs	Boiler	Turbine	NA – consumed	NA
NO_X	Boiler	Turbine	NA – consumed	NA
PM	Baghouse filter	Scrubber Filter	Fly ash	Landfill
Volatile Metals	Carbon filter (1)	Scrubber Filter	Fly ash	Landfill
Dioxins/HAPs	Plasma Reactor	Plasma Reactor	NA – consumed	NA

1. With a waste-heat boiler, the scrubber will be at the back-end of the boiler. With a combustion turbine, the scrubber absorbants are upstream of the combustion turbine.
2. For the combustion turbine case, the sulfur could become a product

There are two points to note in Table 2. First, plasma arc facilities, no matter what the configuration, must include some type of air pollution control systems. The cost of these facilities depends on the type of controls being used and the size of the facility. Second, the air pollution control systems for plasma facilities generate residue which must be disposed in a landfill. For example, as noted above, certain metals may be volatilized in the plasma reactor and must be captured in carbon filters which, in turn, must be disposed. Therefore, any plasma facility will require some amount of landfill capacity although less than a WTE plant. The amount of capacity required (i.e., residue generated) is discussed in more detail Section 3 of this Report.

2.2. Applications of Plasma Technology

As noted in Section 1, plasma technology is currently being used to dispose of four types of waste: MSW, hazardous wastes, medical wastes, and incinerator ash.

2.2.1. MSW

Based on our research, there are two MSW disposal facilities using plasma arc technology currently operating in Japan. We have been unable to identify any other MSW-plasma facilities operating in the rest of the world. There is one other MSW plasma facility currently reported to be under construction in Rome, Italy. There are no operating facilities in the United States and we know of no municipalities that have issued or are in the process of issuing an RFP for an MSW plasma facility.

Yoshii Facility: This plant, commissioned in 1999 and located in Yoshii, Japan, is designed to process 24 tpd of MSW in a single train. Developed by Hitachi Metals and Westinghouse Plasma Corporation, its reactor uses external non-transfer torches and sends the syngas to a waste-heat boiler. The facility does not generate electricity. Information on the air emissions and the disposition of the slag have been requested but not yet received.

EcoValley Facility: Commissioned in late 2002 and still in start-up, this plant is located in Utashinai, Japan and has two 83 tpd trains, a total capacity of 166 tpd. Although the plant has been designed for both automobile shredder residue ("ASR") and MSW, it has been using exclusively ASR during start-up. The reactor uses four Westinghouse torches and black coke is added to the base of the reactor to maintain stable operations. This facility was developed by Hitachi Metals and Westinghouse Plasma Corporation and has the same configuration as the Yoshii plant. The slag is now being tested for suitability as a roadbed material. The Japanese government helped to fund this facility.

Rome, Italy: This facility is reportedly under construction and is anticipated to be fully commissioned sometime in 2004 and designed to have a capacity of 336 tpd. It is being developed by the Solena Group with a plasma torches supplied by Westinghouse, the gas cleanup system by LGL, and a Frame 6 combustion turbine from General Electric. One of the project drivers is the electric rate of 14 cents per Kwh above prevailing rate, guaranteed by the Italian Government.

Table 3 is a summary of the three MSW plasma facilities.

Table 3

MSW Plasma Facilities

	Yoshii	Utashinai	Rome
Commissioning	1999	2002	2004 expected
Throughput (tpd)	24	166	336
Feedstock	MSW	ASR and MSW	MSW
Reactor Type	External torches (3)	External torches (3)	External torches (3)
Syngas Usage	Waste heat boiler	Waste heat boiler	Combustion turbine
Net Power Generated	None	4100 KW (1)	Yes, amount TBD
Air Pollution Control	Baghouse (2)	Baghouse (2)	Pre-combustion
Slag Usage	NA	Now in testing	TBD

1. Based on a feedstock of auto shredder residue; the results from MSW is yet to be determined..
2. The baghouse with filters are located downstream of combustion chamber.
3. These facilities use the Westinghouse torch.

2.2.2. Other Wastes

There appear to be at least half a dozen plasma facilities disposing of other types of waste. In addition, vendors who were interviewed for this report, referred to many other facilities in the planning and conceptual design stages. Table 4 lists some of the current plasma facilities processing wastes worldwide.

Table 4
Plasma Arc Technology Waste Disposal Facilities

Feedstock	Facility Location
EAF dust	Lundskrona, Sweden
Incinerator ash	Bordeax, France
Incinerator ash	Kinuura, Japan
Incinerator ash	Chiba City, Japan
Medical waste	Hawaii Medical Waste Vitrification
Medical waste/hazardous waste	Lorton, Virginia
Radioactive waste	Radon, Russia

2.3. Comparison of Plasma Technology and Waste-to-Energy

2.3.1. Status of Technologies

The disposal of MSW using conventional waste-to-energy technology is well established. According to the USEPA, in 2000, the 102 waste-to-energy facilities, most with multiple boilers, in the U.S. accounted for the disposal of approximately 35 million tons of MSW, approximately 14 percent of the total amount of MSW generated in the United States. The 102 facilities in the United States have an average throughput of more than 900 tons per day and have, on average, been operating for more than 10 years. The oldest WTE plant has been operating continuously since the 1970's.

By contrast, disposal of MSW using plasma technology is just beginning. There are no continuiously operating MSW plasma facilities in the United States and only two operating in the rest of the world. These two facilities have an average throughput of less than 100 tons per day and the oldest facility has been operating since 1999. As noted above, there are plasma facilities disposing of other kinds of waste throughout the world.

2.3.2. Energy Recovery

Modern waste-to-energy facilities are designed, built, and operated to recover energy from the waste they produce. The 102 WTE plants in the U.S. produce more than 2,800 MW of electricity. Most incinerators that are too small or too inefficient to recover energy have all but disappeared in the United States because they cannot compete economically with other forms of waste disposal.

Although any plasma facility can be designed to recovery energy, not all these facilities actually do so. The economics of power generation are site-specific. Of the two MSW plasma facilities currently operating in Japan, one recovers energy and one does not. When using ASR as a feedstock, the EcoValley facility produces approximately 7900 Kw gross and consumes 3800 Kw to operate, resulting in a net positive output of 4100 Kw. Because plasma facilities, such as the Yoshii MSW-plasma facility, are relatively small, the cost of installing and operating an energy recovery unit cannot be justified.

2.3.3. Overall Efficiencies

A typical WTE facility can be expected to produce between 400 Kwh and 600 Kwh per ton of waste processed. For example, H-Power produces 534 Kwh per ton of waste processed. MSW with a high moisture content or a high percentage of non-combustibles will reduce the efficiency of any WTE plant.

With a 4100 KW net output for 183 tpd per day of waste, the EcoValley facility generates approximately 537 Kwh per ton of waste processed. However, the auto shredder residue that the EcoValley facility is processing typically has a higher heating value than MSW and would be expected to generate more net energy. Once the EcoValley facility begins to process MSW, it will be possible to calculate its efficiency for this feedstock and make a more accurate comparison.

Based on the performance of other types of gasifiers as compared to their combustor counterparts (e.g., coal gasification combined cycle plants), a plasma facility with a combustion turbine might be more efficient at producing electricity than a state-of-the-art WTE plant, but there are no commercial plasma facilities with combustion turbines with which to confirm this supposition. An MSW-plasma facility with a combustion turbine is anticipated to begin operation in 2004. Table 5 summarizes the differences between H-Power and the EcoValley plasma facility.

Table 5

Comparison of H-Power and EcoValley

	H-Power	EcoValley
Location	Honolulu, HI	Utashinai, Japan
Start of Operations	1987	2002
Feedstock	MSW	MSW and ASR
Technology	WTE/RDF	Plasma Arc
Design Throughput	1800 tpd	183 tpd
Net Power (1)	534 Kwh/ton	537 Kwh/ton(2)
Air Emission Control	Scrubber/ESP	Quench/Dry Injection
Slag/Ash Usage	Ash is landfilled	Now in testing

1. The baghouse with filters are located downstream of combustion chamber.
2. Based on ASR as feedstock

2.3.4. Revenues

There are three potential sources of revenue from either a WTE plant or an MSW-plasma facility: (1) energy sales, (2) sale cf other outputs, and (3) tipping fees. Revenue from the sale of energy depends on the price for electricity and the net amount of electricity generated. Presumably the electric rate will be the same, whether the electric is generated by a WTE plant or a plasma facility. As noted above, the amount of energy recovered by a WTE or plasma facility will depend on the technology that each plant utilizes.

The sale of other outputs, such as steel, ash or slag, will depend on the price for comparable competing materials, such as landfill cover or construction materials, and are typically in the range of $0 to $25.00 per ton. In some cases additional process, such as screening or crushing, are required to make this material market-ready.

In an open market, without subsidies, tipping fees typically make up the largest source of revenue for a waste disposal facility. The tipping fee revenues, along with the other sources discussed above, must support operating costs, debt service, and a return on capital. The current tipping fee at H-Power is $81.27, including the 12 percent recycling surcharge and the $0.35 per ton state disposal charge.

Estimating the tipping fee for a plasma facility would require information on the operating costs, debt service, and the return on capital. At the present time, it is not possible to estimate these costs without more specific information on the nature of the facility and the structure of the financial arrangement for a plasma facility in Honolulu. The project economics are discussed in more detail in Section 4 of this Report.

The difference between WTE plants and plasma facilities in terms of environmental impacts is discussed in Section 3 below.

Section 3
Environmental Performance

In evaluating the performance of plasma technology for waste disposal, a critical characteristic is its impact on the environment. This impact is related to the quality of the gases (air emissions), solids (ash or slag), and liquids (water) that are emitted from the facility. All commercial waste disposal facilities must meet regulations which set limits on the amount of certain substances that can be emitted. In the United States, the U.S. EPA and the individual states set those limits. In Japan, the Ministry of International Trade and Industry ("MITI") is the regulatory body.

The only plasma facility currently processing MSW is the Yoshii facility and we have been unable to obtain testing data from this facility. The EcoValley facility at Utashinai is in start-up and will not begin to process MSW until December of 2002. To provide information on the environmental performance plasma facilities, in the absence of data from MSW-plasma facilities, we have included data from a plasma facility processing hazardous waste and medical waste.

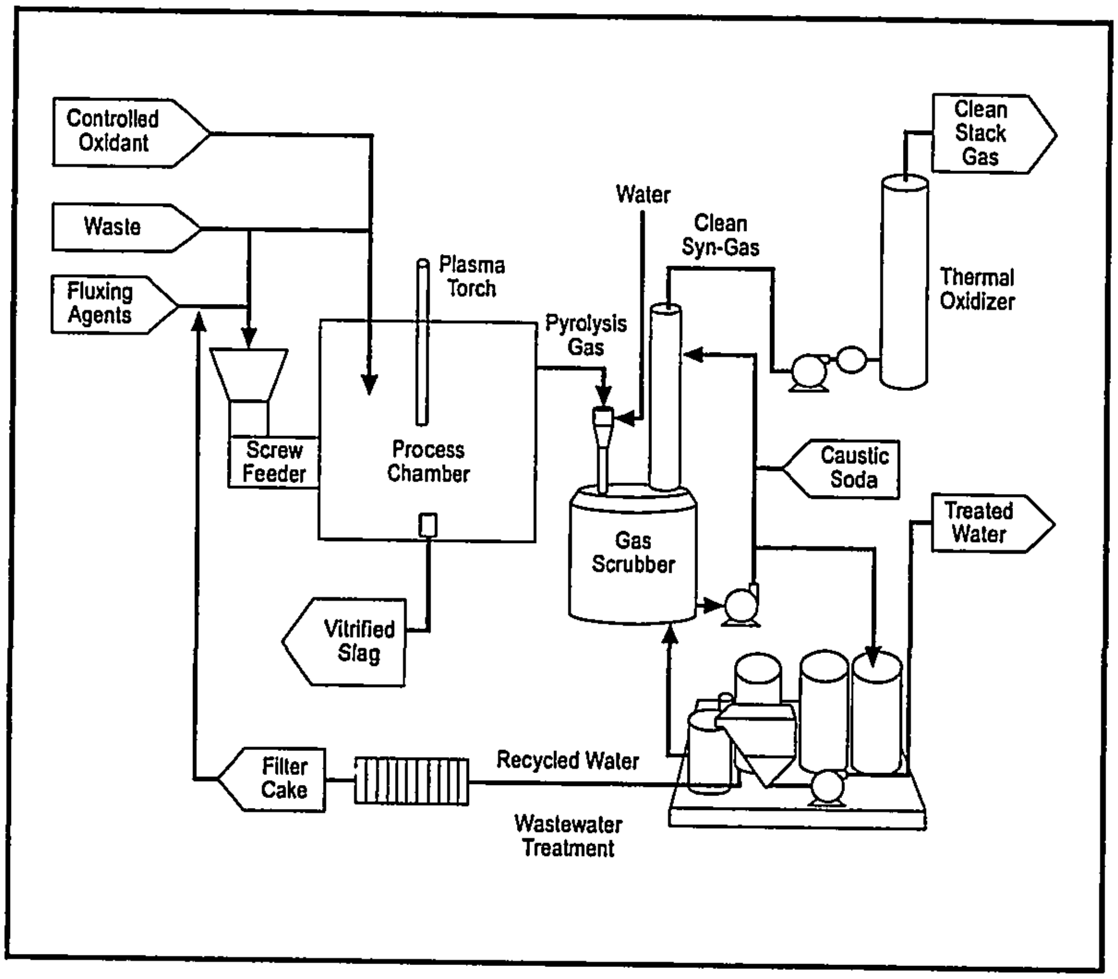
3.1. Air Emissions

To provide some information on the ability of plasma arc facilities to meet air emission permit limits, we compared the test data from the Plasma Energy Pyrolysis System ("PEPS") Facility in Lorton, Virginia and its permit limits.

No test data was available from the Hawaii Medical Vitrification ("HMV") facility because it has received an exemption from air testing. The exemption was granted because HMV's current permitted throughput of one tpd is below the State of Hawaii's testing threshold. However, the installed capacity of the HMV facility is four tpd and a new application has been submitted to increase the permitted capacity to four tpd. If the permit is approved, the HMV facility will have to begin air emissions tests.

The PEPS facility is a demonstration facility for disposal of hazardous and medical wastes in Lorton, Virginia. It has an installed capacity of 10 tdp and is powered by a 1 MW diesel generator. It has no power output because the facility's throughput is too small and its operation is too intermittent to justify the cost of a power generation unit. The syngas produced in the reactor is combusted in a thermal oxidizer. A diagram of the PEPS facility is presented in Figure 3

Figure 3
PEPS Plasma Facility



There are two regulatory standards for air emissions that apply to the PEPS facility. The first is the Hospital/Medical/Infectious Waste Incinerator New Source Performance Standards ("HMIWI NSPS") that are issued by the USEPA. These are the minimum requirements for air emissions that a facility must meet. In addition, the Virginia Department of Environmental Quality issues an air permit with additional, stricter standards for some substances. These two requirements, as well as the actual test data from the PEPS facility are shown in Table 6.

Table 6

Air Emissions from the PEPS Medical Waste Facility

(ppm)

Substance	Pollution Control (1)	HMIWI NSPS	Permit Limit	PEPS Test Results
Particulate Matter	Wet Scrubber	34.0	32.1	17.0
Carbon Monoxide	Boiler/Turbine	0.466	0.349	0.151
Dioxin/Furan	Plasma Reactor	0.000006	No Reg.	0.00000376
Hydrogen Chloride	Scrubber	22.80	12.60	2.50
Lead	Wet Scrubber	0.0700	No Reg.	0.0277
Cadminum	Wet Scrubber	0.0400	No Reg.	0.0584
Mercury	Wet Scrubber	0.5500	No Reg.	0.4080
NO_X	Boiler/Turbine	250	No Reg.	60
SO_X	Wet Scrubber			

1. Location of the device to control that pollutant
Source: Vanguard Research, Inc

As Table 6 shows, the air emissions from the PEPS facility are below the permit limits, with the exception of cadmium. The PEPS reported that subsequent tests indicated that cadmium was within regulatory limits.

As noted in Section 1, the heating value and composition of MSW tends to be more variable than the heating value and composition of medical waste. This variability poses particular issues for an MSW facility that are typically solved through operating experience. A facility operator will learn how to optimize the facility over time, through experience.

The incineration of MSW in a waste-to-energy facility, such as H-Power, generates the pollutants as disposal in a plasma arc facility. Table 7 shows the pollutants, location of the pollution control devices, permit limits and test results from H-Power.

Table 7

Air Emissions from H-Power Waste to Energy Facility

Substance	Pollution Control (4)	Permit Limit	H-Power Test Test Results (5)
Particulate Matter (1)	Baghouse	27	13
Carbon Monoxide (2)	Furnace	200	34.5
Dioxin/Furan (3)	Furnace	60	10
Hydrogen Chloride (2)	Dry Scrubber	29	12
Lead (1)	Baghouse	0.44	0.37
Cadminum (1)	Baghouse	0.040	0.0072
Mercury (1)	Carbon Injection/Baghouse	0.080	0.021 (6)
NO_X(2)	Boiler	250	199
SO_X(2)	Dry Scrubber	29	13

1. Emissions in units of mg/dscm@7%O_2
2. Emissions in units of ppmdv@7%O_2
3. Emissions in units of ng/dscm@7%O_2
4. Location of the device to control that pollutant
5. *Average of three runs on* Unit 1, Test dates June 17-20, 2002
6. Analyte was below detection limits

Source: H-Power

As Tables 6 and 7 show the air emissions from both the PEPS facility and H-Power are below their respective permit limits. It is reasonable to assume that a plasma arc facility could be constructed to dispose of MSW and operated to meet the permit limits for air emissions, since most of the pollution control equipment would be added downstream of the plasma reactor.

3.2. Solid Residue

Both WTEs and plasma facilities produce solid residue. Approximately 25 percent of the MSW throughtput in a typical WTE results in bottom and fly ash. Depending on the air pollution control system employed, approximately the same percentage of throughput would be produced, in the form of slag and other residue, from a plasma facility disposing of MSW. A WTE or plasma facility with a throughput of 200 tpd of MSW would produce approximately 50 tpd of solid residue. The environmental impact of the solid residue from these facilities would be determined in the same way. However, the slag from a plasma reactor should have some beneficial use, while currently, almost all WTE ash is landfilled.

The USEPA has established the Toxicity Characteristics Leaching Procedure ("TCLP") test for determining the amount of heavy metals that leach from incinerator ash or slag from a waste disposal facility. The TCLP test measures the presence of eight elements after acid is poured over a sample of the ash or slag. All incineration and plasma facilities in the United States must perform TCLP tests on their residue. In Japan, ash is also tested for the presence of pollutants. However, because we have not received the results of environmental testing from the Yoshii facility and no test data has been generated at the EcoValley facility, we cannot provide test results on slag from an MSW-plasma facility.

However, TCLP data is available for slag from the PEPS facility. Table 8 shows the current permit limits for the TCLP test and compares these with the test results from PEPS processing both regulated medical waste ("RMW") and a hazardous waste called agricultural blast media ("ABM"). For the purposes of comparison, recognizing that the characteristics of MSW differ from those of RMW and ABM, the results of the TCLP test results for H-Power are also presented in Table 8.

Table 8
TCLP Toxicity Limits and Test Results for Slag and Ash
(all units in ppm)

	USEPA Toxicity Limits	PEPS Facility	PEPS Facility	H-Power Plant
Feedstock		RMW	ABM	MSW
Arsenic (As)	5.0	0.200	0.200	0.025
Barium	100	NA	NA	0.66
Cadmium (Cd)	1.0	0.140	0.100	0.005
Chromium (Cr)	5.0	0.720	0.200	0.005
Lead (Pb)	5.0	0.730	0.200	0.025
Mercury (Hg)	0.2	0.020	0.020	0.00029
Selenium (Se)	1.0	0.500	0.500	0.025
Silver (Ag)	5.0	0.100	0.100	0.005

Table 8 shows that the data for slag for both RMW and ABM and the ash from H-Power are below the USEPA toxicity limits. A plasma facility may also produce residue from its scrubber, baghouse, or other pollution control equipment. This is where any metals which have been volatilized, such as mercury, lead, and cadmium, will be recovered. This non-slag residue is also subject to TCLP tests. According to the operators of the PEPS facility, the non-slag residue from the PEPS facility also passed the TCLP tests, although the test data is not available at this time. The PEPS facility is also experimenting with the recirculation of these residues through the plasma reactor to create a more closed-loop system. These experiments are still underway and the capability to fully recycle all the residue is not assured.

3.3 Water

Although some plasma systems may use water to quench and clean the gases coming from the plasma reactor, it is also possible to use a dry system. However, the choice of the combustion system (boiler or combustion turbine) will determine the extent of required water treatment. The two MSW-plasma plants now operating – EcoValley and Utashinai – do not generate wastewater. The PEPS facility has used both a dry system and a wet system that includes a wastewater treatment plant. The residue from the PEPS wastewater treatment plant is a filter cake and becomes part of the solid residue of the facility. The proposed Rome facility would need to treat some wastewater.

Section 4
Financing Issues

4.1 Facility Economics

There are two reasons why the capital and operating costs for an MSW-plasma facility are difficult to estimate. First, as discussed above, plasma arc technology is not monolithic. Existing facilities use different methods to produce plasma, to utilize the syngas they produce, and implement the necessary environmental controls. Each of the configurations for these facilities has a different cost structure. Second, there is very limited operating history for MSW–plasma arc facilities and this history is on small-scale plants.

The lack of operating history is an inherent problem with new technologies. As Table 3 shows, only two of the three MSW plasma arc facilities – the Yoshii and EcoValley plants in Japan – have been completed and one (EcoValley) is currently in start-up and has not yet begun processing MSW. Previous experience with WTEs shows that the nature of MSW, particularly its heterogeneity, presents a special set of problems that are solved only through operating experience.

There is also the matter of scale. The throughput of the existing MSW plasma facilities is well-below what the City of Honolulu will need to meet its waste disposal needs over the next 15 years, or even what it will want to provide in the short-term. The only plant now disposing of MSW, the Yoshii plant, has a throughput of only 24 tons per day. The EcoValley plant will process 166 tons per day, but it is not scheduled to begin processing MSW until December, 2002. Scaling-up a facility, regardless of the process, can present a number of technical problems that affect both capital and operating costs.

The actual capital and operating costs will ultimately depend on the way in which the plant is constructed and how the various project risks and project costs are allocated. For example, certain operating costs may be negotiated as pass-through costs, but the number and amount of these costs will not be known until bids are received and negotiations are underway.

The net operating costs will also be affected by the amount of electric power the plasma facility generates, if any, and the price it receives for this power. Electricity rates are site-specific and further complicate the determination of costs.

To begin to resolve the uncertainties surrounding the capital and operating costs, the City can issue a Request for Proposals ("RFP"), specifying the amount of waste to be delivered and the terms vendors must meet. The RFP will give the vendors a clear understanding of those risks that the City is willing to accept and those it wishes to pass on to the vendor. Responses to the RFP will provide the City with its first look at costs for a facility tailored to meet its needs.

4.2 Financing New Technologies

The financing of a new-technology project, such as a plasma-arc facility to dispose of MSW, will require both debt and equity. Typically, a project like this, in the current market environment and without a similar operating unit with several years of experience, would require a 30-40 percent or higher equity contribution or government support to secure non-recourse project debt. The equity participant(s) would accept complete risk, in return for an appropriate return on their investment.

The debt portion of the financing can be either recourse or non-recourse to the borrower. Recourse debt means that the project is backed by the developer who has sufficient resources to pay off the debt if the project fails. Non-resource debt means that the project is backed solely by the income from the project itself. A borrower with substantial resources that is willing to back the project with its own balance sheet could probably raise sufficient funds to construct a reasonably-sized plant.

More typically, Project Financing uses non-recourse debt. Since a lender of non-recourse debt will depend on the success of the project, that lender wants certain kinds of protection. For example, the engineering, procurement, and construction ("EPC") contract must be a fixed price, date certain turnkey agreement. In addition, Project Financing typically requires guarantees, warranties, and liquidated damages (at least through the successful completion of the Acceptance Tests) to be provided by the EPC contractor. These protections may be supplemented by Special Project insurance that may cover a portion of these requirements. The totality of the fixed price, the date certain, the guarantees, warranties, liquidated damages, and insurance, act to insulate the lender from technical problems with the project.

Typically, the scale-up limitations for a facility will depend on the specific applications, previous history, the level of the guarantees provided by the vendor, and other issues associated with the technology.

The difficulty with new technologies, that have not been previously financed, is that lenders typically require more stringent guarantees from the EPC Contractor. In addition, the time and effort required by the Project Developer to raise the required debt and equity can be prolonged. It is not unusual for the financing process of a new technology to take several years. Overall, using Project Financing to finance an MSW-plasma facility will depend on the terms of the EPC contract, the insurance available, and the financial strength of the owner.

4.3 Risk Allocation

Probably the most effective means of identifying the costs of MSW disposal using Plasma Arc Gasification is to issue an RFP, and one of the key issues in the RFP will be the allocation of risk. The allocation of risk between the City and any potential facility owners ("PFO") will affect the final costs to the City and may limit the ability of the PFO's to obtain financing.

The Project faces two key types of risk. The primary risk is the construction risk and is tied to the investment in the facility itself. As noted above, this type of risk can be mitigated by various guarantees, warranties, and liquidated damages from vendors. The City has made it clear that it expects the PFO to bear this type of risk.

The second risk is associated with the disposal MSW in case the project is delayed, operates below design capacity, or doesn't work at all. To illustrate this risk for the PFO, assume that the PFO has won a 15-year contract to design and build a plant to dispose of 150 TPD of MSW for a tipping fee of $75 per ton. In the worst case scenario, the plant doesn't work, so that the PFO must repay its loan, and is responsible for disposing of 150 TPD of waste at a price that may exceed the tipping fee for the next 15 years. For the vendor of a new technology, this additional risk may limit or eliminate the interest of PFOs in responding to the RFP.

If the City accepts a portion of this "disposal" risk by paying for the cost of disposing of the non processed MSW, the risk to the PFO for poor operations or poor project management is limited to its investment. By accepting all, or a portion of the disposal risk, the City must still address the long-term disposal of MSW. This could include the short-term landfill disposal costs and the costs of developing a new long-term alternative (e.g., the expansion of H-Power).

If the city does not accept a portion of this "disposal" risk, by charging the PFO a fee for disposal services in excess of the PFO's proposed tipping fee, the PFO's risk could increase beyond the original investment. Whether the risk is limited to a specific dollar amount or is unlimited will have a bearing on the ability of the PFO to obtain financing for the project. Although this "disposal" risk is common in the MSW facilities with which we are familiar, it is a key consideration with a new technology. In Hawaii with its limited access to alternative means of disposal, it will have a clear bearing on the PFOs' interest in the Project.

Section 5
Questions and Answers

To provide the reader with a summary of some of the key issues around plasma technology, we have included the answers to some questions that have been raised repeatedly during the preparation of this Report.

Q: Is Plasma Arc a new technology?

A: No. Plasma technology has been used for more than a century, particularly in the metals and chemical industries. Plasma arc technology for waste disposal has been used for a number of years to manage hazardous waste and vitrify ash.

Q: What is the operating history of facilities using plasma arc technology to dispose of municipal solid waste ("MSW")?

A: There are only two facilities now operating that use plasma arc technology to dispose of MSW. The facility in Yoshii, Japan, is a 10 ton per day plant that has been operating since 1999. The EcoValley facility, in Uatashinai, Japan, is a 166 ton per day plant that is in start-up. Although it is designed to dispose of MSW, it was not scheduled to begin taking MSW until December 2002. A third MSW-plasma facility is under construction in Rome, Italy, but is not scheduled to be in commercial operation until sometime in 2004.

Q: Why aren't there more plasma arc facilities disposing of solid waste?

A: Until recently, the unit cost of building and operating a plasma facility was significantly higher than the unit cost of a state-of-the-art landfill or waste-to-energy plant. Plasma facilities consume significant amounts of energy to achieve their high (3000°C) reactor temperatures. This makes them costly to operate. According to proponents, plasma technology makes the most sense in places where landfill costs are very high and environmental regulations are strict, such as Japan, or where the government provides some type of financial support.

Q: Are plasma facilities more environmentally friendly than waste-to-energy plants?

A: First, it is important to remember that both WTE plants and plasma facilities, if they are properly designed, constructed and operated, can meet all current environmental regulations.

There are three important differences between a plasma facility and a WTE plant that affect environmental performance: (1) the plasma reactor operates at a higher temperature than the furnace in a WTE plant, (2) a plasma reactor operates in "reducing conditions" (i.e., with less oxygen than a WTE furnace). Plasma technology gasifies, rather than incinerates, and (3) a plasma facility has <u>two</u> points at which heat is applied, the reactor and the boiler or combustion turbine where the syngas is burned. The temperature in this "secondary" chamber is lower than the furnace of a WTE. These three differences result in four potential differences in environmental performance between a plasma facility and a WTE plant.

- The plasma facility's higher reactor temperature vitrifies the solid residue (turns it into a glassy slag) which is less likely to leach contaminants than the ash from a WTE plant.
- The plasma facility's higher reactor temperature can more completely destroy hazardous wastes, including dioxins that may be present in MSW, than a WTE furnace.
- The reducing conditions in a plasma reactor allow the use of technologies that are more efficient at removing sulfur. A WTE furnace uses more oxygen and doesn't allow the use of these technologies.
- Because the temperature in a plasma facility's secondary chamber (boiler or turbine) is lower than a WTE furnace, less NO_X will form.

Of course these environmental advantages all come with a cost.

Q: **Does a plasma facility eliminate the need for a landfill?**

A: No. Even if the vitrified slag is used for construction or some other beneficial purpose, a plasma facility will produce residue from its scrubber or baghouse. The Volatile metals, such as mercury, lead, zinc, and cadmium, will vaporize in a plasma reactor, will not be melted into the slag, and have to be captured elsewhere in the system. While the amounts of residue may be relatively small, it will still be necessary to landfill some residue.

Q: **Can plasma facilities produce electricity, like a waste-to-energy plant?**

A: Yes. Although a plasma facility consumes a significant amount of energy in creating the plasma arc, it can produce energy if the material it is acting on has a sufficient heating value. In other words, the plasma facility can capture the BTUs in a feedstock like MSW and use it to create energy. However, because the equipment to produce the electricity is expensive, energy production doesn't make sense unless (1) the feedstock has a high heating value (lots of BTUs per pound) and the throughput is substantial. If the amount of electricity the plasma facility produces is greater than the amount of electricity it consumes, it becomes a net generator of electricity.

Q: **Are plasma facilities more efficient at producing electricty that waste-to-energy plants.**

A: Plasma facilities consume more energy per unit of throughput, than WTEs. A plasma facility using a conventional boiler to burn the syngas will produce less net energy than a WTE plant with the same throughput. However, if a plasma facility is combined with a combustion turbine combined cycle power plant, it has the potential to generate more net power than a state-of-the art WTE plant with the same throughput.

Q: **How much would an MSW-plasma arc facility cost to build?**
A: We don't have enough information to answer this question. It would depend on the size of the facility, the type and configuration of the equipment, and the allocation of the project risks. The first step in finding out how much a plant would cost would be to develop and issue a Request for Proposals.

Q: **How much would an MSW-plasma arc facility cost to operate?**
A: Again, we don't have enough information. We would have to know the size of the plant and the type and configuration of the equipment. If the plasma facility was a net generator of electricity, we would want to know the price at which they could sell it.

Q: **How does plasma arc technology differ from waste-to-energy?**
A: There are at least three important differences between plasma arc technology and waste to energy. First, plasma arc is a gasification technology and waste-to-energy is a combustion technology. That is, a plasma arc facility applies heat, but restricts the amount of oxygen in the reactor to produce a burnable gas, while a WTE plant combines both heat and oxygen in its furnace to combust the MSW in one step. Second, the temperatures achieved by plasma arc (3000 °C.) are significantly higher that the temperatures in a WTE furnace (1200 °C). This higher heat results in more complete destruction of the waste and is more costly to produce. Third, higher temperature in the plasma reactor vitrifies the residue, producing a glassy slag, while the WTE produces a powdery ash.

Q: **What is the role of plasma arc technology in solid waste management?**
A: Plasma arc gasification technology's role in solid waste management is becoming established in the areas of hazardous waste disposal, medical waste disposal, and ash vitrification. There are facilities in Japan, Europe, and the United States currently using plasma arc technology to dispose of these three wastes. With only one 24 tpd MSW-Plasma facility in commercial operation and a second 166 tpd MSW-Plasma facility in start-up, plasma arc technology's role in the disposal of MSW, is in the nascent stage of development.

APPENDICES

Appendix A: Published Articles

The following published articles describe various aspects of plasma arc technology

1. Plasma Arc Technologies
   Construction Engineering & Management
   Purdue University
   June, 2000

2. Multi-Recovery fromWaste in a Novel Compound Shaft-Reactor-Plasma-Mixing-Destruction-Chamber Approach
   Hetland and Jynum
   July, 2001

3. Plasma Heat: Worldwide Developments Using A Demonstrated, Unique Heat Source for Waste Treatment & Industrial Applications
   Camacho, Nunn, and Benda
   March, 2000

4. Plasma Arc Systems
   CMPS&F – Environment Australia
   Appropriate Technologies for Treatment of Scheduled Wastes
   Review Report #7
   November, 1997

5. Mixed Waste Facility Risk Assessment for a Commercial Plasma-Based Gasification and Vitrification System
   Jaraysi, Massimino, Domingo, et al
   WM99 Oral Session 53
   March, 1999

6. Plasma Power
   Kimberly Link-Wills
   Georgia Tech Alumni Online
   Summer, 2002

7. Plasma Gasification Waste Treatment Technology
   White Paper
   Resorption Canada Limited
   April, 2001

8. General Description of the Plasma Enhanced Melter
William J. Quapp, PE
White Paper
Integrated Environmental Technologies, Inc
September, 2002

9. Plasma Vitrification of Waste Incinerator Ashes
Cedzynska, Kolacinski, et al
Technical University of Lodz, Poland
No date

10. The Utilization of Solena Group Integrated Plasma Gasification Combined with Combined Cycle System (IPGCC)
White Paper
Solena Group
No date

11. Plasma Pyrolysis
Thomas A. Damberger
HI Disposal Systems
February, 1999

12. Using the Centrifugal Method for the Plasma-Arc Vitrification of Waste
R.K. Womack
JOM Journal
The Minerals, Metals, and Materials Society
1999

Appendix B: Contacts in the Plasma Arc Industry

The following organizations are involved in plasma arc technology for waste disposal

1. **The Construction Research Center at the Georgia Institute of Technology**
   Dr. Louis J. Circeo
   Georgia Tech Research Institute
   Atlanta, GA 30332-0837
   (404) 894-2070
   A research and development center headed by Louis Circeo, a pioneer in the development of waste disposal applications for plasma arc technology.

2. **Westinghouse Plasma Corporation**
   Dan Lazzard
   Plasma Center – Waltz Mill Site
   Madison, PA 15663
   (724) 722-7052
   http://www.westinghouse-plasma.com/
   The co-developer of the only commercial plasma arc facility disposing of MSW, the 166-tpd plant in Utshantai, Japan

3. **Hitachi Metals**
   Environmental Systems Company
   +81-3-5765-4701
   http://www.hitachi-metals.co.jp/e/prod/prod07/p07_2_02.html
   The co-developer of the only commercial plasma arc facility disposing of MSW, the 166-tpd plant in Utshantai, Japan

4. **Integratead Environmental Technologies, LLC.**
   David Lamar
   1935 Butler Loop
   Richland, WA 99352
   (509) 946-5700
   http://www.inentec.com/
   The designer/engineer for the medical waste plasma unit in Honolulu, HI.

5. **The Solena Group**
   Dennis Miller, Chief Scientist
   Ronald Regan Building and Intl Trade Center
   1300 Pennsylvania Ave.
   Washington D.C. 20004
   (202) 682-2405
   http://www.solenagroup.com/html/contact/contact.asp

6. **The Phoenix Solutions Company**
   Douglas Frame, President
   3324 Winpark Drive
   Crystal, MN 55427
   (763) 544-2721
   http://www.phoenixsolutionsco.com/main/index.php
   One of the largest manufacturer of plasma torches and process components. Their equipment is in approximately twenty ash vitrificaiton plants in Japan.

7. **SRL Plasma Ltd.**
   Rex Williams
   PO Box 119
   Narangba, Queensland
   AUSTRALIA 4504
   617-3203-3400
   http://www.srlplasma.com/srlpages/srlframe.html

8. **Plasma Environmental Technologies, Inc.**
   130 Adelaide Stree West, Suite 2320
   Toronto, Ontario, CANADA M5H 3P5
   (416) 599-9979
   http://www.plasmaenvironmental.com/index.asp?counter=counter_id

9. **Resporption Canada Ltd.**
   Randy Bennett – Director of Business Development
   2610 Del Zotto Avenue
   Gloucester, Ontario
   CANADA K1T 3V7
   (613) 831-0590
   http://www.rcl-plasma.com/
   RCL designs plasma units for disposal of ash and hazardous material using off-the-shelf components.

10. **MSE Technology Applications, Inc**
    200 Technology Way
    PO Box 4087
    Butte, MT 59702
    (406) 494-7100
    contact@msw.com

11. **HI Disposal Systems**
    PO Box 1724
    Indianapolis, IN 46206
    (866) 500-1724
    http://www.hawkinsindustries.com/hawkins_0.html

12. **Tetronics Limited**
    David Deegan
    Wicklesham Farm
    Faringdon, Oxon
    UNITED KINGDOM SN7 7PN
    +44 (0) 1367 240224
    http://www.tetronics.com/homepageframe.html

13. **Encore Environmental Solutions, Inc.**
    Gary Von Sesen, CEO
    932 Heykoop Drive
    Morristown, TN 37814
    (423) 587-7383
    http://www.encoreenvironmental.com/

14. **Europlasma**
    contactprocess@europlasma.com
    http://www.europlasma.com/gb/contact/principale.htm
    Develops, builds and markets plasma torches

15. **PEAT, Inc.**
    Marlin Springer, President
    Huntsville, AL
    (256) 859-3006
    http://www.peat.com/frameset.html

16. **Vanguard Research, Inc**
    10400 Easton Place Suite 450
    Fairfax, VA 22030
    (703) 934-6300
    http://www.jdmag.wpafb.af.mil/peps.pdf
    Developer of Lorton, Virginia hazardous waste facility

Appendix C: Summary of Telephone Interviews

Telephone Call Summary

Date/Time of Call: September 24, 2002; 3:30pm

Person Called: Dr. Louis Circeo
Contact Information: Center for Construction Research
Georgia Institute of Technology
Atlanta, GA 30332
(404) 894-2070

Dr. Circeo is the Director of Construction Research and a Professor of Architecture at the Georgia Institute of Technology and a leading academician in the field of plasma technology. He runs a plasma research facility at Georgia Tech and has delivered a number of papers and presentation on the use of plasma for waste disposal.

I asked him to comment specifically on the use of plasma technology for the disposal of MSW and he immediately cited the new Westinghouse/Hitachi plant in Japan. In fact, Circeo said he was the person that brought Westinghouse and Hitachi together. He said the W/H plant was the only commercial plasma facility designed to handle MSW that he was aware of. Furthermore, he felt Westinghouse was the only credible player in the business that was addressing MSW disposal. There are a number of facilities in Japan and Europe that use plasma for ash vitrification, but only the W/H plant is being designed to handle MSW.

He did not have any information capital or operating costs and referred us to Westinghouse to get that kind of information. Circeo warned me several times about the number of "fly-by-night" companies out in the marketplace who claim to have a plasma technology, but have not proven their technology in an operating facility. Again, he cited Westinghouse as the most credible company in the business.

Circeo also mentioned a resolution by the Georgia State Legislature in the spring of 2002 that encouraged/supported the use of plasma technology for waste disposal. This resolution has prompted the formation of several small companies that are pursuing plasma technology in Georgia. One of these companies, PR Power, is apparently try to develop a tire disposal facility using plasma.

Dr. Circeo promised to send us a packet of information on his research and invited us to visit his research lab at Georgia Tech if we were in Atlanta. In closing, I mentioned that R.W. Beck is about to begin a state-wide waste characterization study for the State of Georgia.

Tom Jones

Telephone Call Summary

Date/Time of Call:	October 3, 2002; 2:30 pm
Person Called:	David Lamar
Contact Information:	Integrated Environmental Technology, LLC 1935 Butler Loop Richland, WA 99352 (509) 946-5700

Integrated Environmental Technologies (IET") is the supplier of the core technology for the plasma arc medical waste gasification facility in Hawaii. The unit is 3-4 TPD plant accepts the Regulated Medical Waste ("RMW") in 8 gallon buckets. The bucket with the waste is fed into the plasma reactor. The reactor has graphite torches (or electrodes) in the glass melt to keep the melt in the liquid state and other torches above the melt to provide the heat to process the organic/ hydrocarbon material. Steam and oxygen are injected to complete the gasification process. The synthesis gas (240-270 BTU/SCF) is sent to an internal combustion engine after cleaning (engine mixes about 10 percent propane for stability).

The Plasma arc uses DC current generated. There is no net electrical output from the medical waste unit. IET reports that a net power output is generated at plant sizes above 25 TPD. Oxygen Demand is at 0.1 equivalence (1.0 would be sufficient oxygen to combust) and the amount of steam required depends on the feedstock. The steam is used to complete the water gas shift reaction and Bouvard reaction. For plastics, three times the required water is used; for cellulose 1.5 times is used.

Hawaii is the first IET unit to come on line (February 2001), a second facility is in Japan (10 TPD) currently finishing construction. Scale-up is anticipated to go to a 250-300 TPD per unit. However, the next step for IET is expected to be a 50 TPD unit. It is worth noting that Honolulu's RMW unit tested some RDF from H-Power and reported that it worked well.

The system uses a gravity feed, reactor is at slightly negative pressure (- 5" H2O). Top temperature is 100-1200 C minimizing potential tar formation. Tar will form during upset conditions. IET stated that an MSW unit would probably need 6-inch minus material. Main concerns would be potential damage to an electrode. The flow sheet is gasifier, quench, baghouse, acid gas removal, carbon bed and engine.

O & M electrodes are a consumable. The rate of consumption is in the range of 8-15 percent of graphite per ton of waste. The large refractory units are relined every 3 to 8 years. Smaller units are relined in the range of 1 to 3 years. Tap hole are expected to be redrilled every 2 years, but more experience is need to be sure of this estimate. The AC electrode in the bath maintains the melt and DC electrodes process the waste. IET estimates that the capital cost for 100 TPD process train is in the range of 20-23 million dollars. This does not include feed preparation. Cost data is an order of magnitude estimate.

Telephone Call Summary

Date/Time of Call: November 5, 2002; 10:00am

Person Called: Len Frame
Contact Information Phoenix Solutions, Inc.
3324 Winpark Drive
Crystal, MN 55427 .
(763) 544-2721

Phoenix Solutions, Inc. ("Phoenix") claims to be one of the largest manufactures of both transferred and non-transferred plasma torches in the world. They supply torches to firms that design and build full plasma-arc systems. Phoenix does not advocate one type of torch (i.e., transfer vs. non-transfer) over another. Their torches are copper-plated, water-cooled, and can use either air or nitrogen. Their torches are placed inside the reactor which maximizes the heat available to process the waste, but also corrodes the torches more quickly. They advocate a shorter, squatter reactor than Westinghouse, introducing the MSW in the side, rather that the top.

Phoenix estimates that a 125 TPD facility would require 3 MW of power to operate. Mr. Frame stated that unless a system using their torches and combined with a combustion turbine produced a minimum of one MW per tons of waste, it would probably not be able to compete with other methods of MSW disposal. However, this estimate is hypothetical because none of their units have actually been used with a combustion turbine.

Up to this point, Phoenix has focused on medical and hazardous waste disposal applications in countries with high landfill costs and strict environmental regulations. Phoenix has 20 operating units in place in Japan and supplied the torches for the Honolulu medical waste facility. If they received an RFP from Honolulu, they would try to find a partner who could lead the project and respond.

Telephone Call Summary

Date/Time of Call: October 15, 2002; 11:00am

Person Called:
Contact Information:
Randy Bennett
Resporption Canada, Ltd.
2610 Del Zotto Ave.
Gloucester, Ontario K1T 3V7
CANADA
(613) 831-0590

Resorption Canada Limited ("RCL") is a developer of Plasma Arc systems for waste disposal. They have been operating a pilot plant near Ottawa Canada for over 15 years. The pilot plant has approximately 1200 hours of operation. They use plasma torches manufactured by Phoenix Solutions, Inc of Crystal, Minnesota or Europlasma of France. RCL's pilot plant has a 150 kW torch which gives it a capacity of approximately 4 tons per day of MSW. RCI does R & D work and is in the process of developing their first commercial unit in the Far East for biomedical waste and hazardous waste.

RCL's system uses a DC torch that is a *water-cooled*. *The electrical* discharge heats a flowing gas (primarily air). The torch extends into the reactor vessel, with the hot plasma exiting the end of the torch to the desired point in the reactor. The system operates as a gasification system at high temperatures. The typical gasification reaction occurs producing a synthesis gas rich in hydrogen and carbon monoxide. The addition of steam allows a level of control on the ratio of hydrogen to carbon monoxide. They clean up the gases (still in the syngas phase) with standard hydrocarbon processing techniques. The gas can be used as a fuel gas in the proper combustion equipment. The reactor is operated at slightly negative pressure to ensure containment of the gases.

RCL indicated that a commercial system might contain modules of approximately 250 TPD each using three torches with a total of 4 MW's of power. The maximum single torch is approximately 2 MW. RCL has performed some commercial design that calls for a 500 TPD plant using two units each with 4 MWs of torches. This system would generate 30 MW gross and 17.5 MW net. (using approximately 5000 Btu/pound waste). Note that at 17.5 MW net, the net output is 350 kW/ton. This is substantially less than the 550 to 600 kW net per ton that a standard mass burn WTE unit will produce. However, it correlates with the use of approximately 400 kW per ton of the torch. RCL reported that the waste does no need to be sized, if the reactor input feed port is large enough. Waste is introduced in the side of the reactor. We note that without operational experience there are mechanical issues that would need to be addressed for scale-up to a commercial size unit. The size of a 250 TPD unit would be 16 feet in diameter. Slag is tapped off the side of the reactor.

RCL claims that their breakeven tip fee (with no return on capital- debt or equity) is approximately $45/ton. They also claim that they can purchase process insurance from FM Global.

The typical advantages of Plasma gasification were stated: a) no residue to be landfilled because the ash is vitrified, b) extremely high temperatures that convert the organics to a harmless gas, and c) the compact size of the reactor. RCL's approach is to concentrate on higher value wastes in areas where MSW landfill costs are high and environmental regulations are strict.

Telephone Call Summary

Date/Time of Call: November 13, 2002; 3:00 pm

Person Called: Dennis Miller
Contact Information: Ronald Regan Building and Intl. Trade Center
1300 Pennsylvania Ave.
Washington D.C. 20004
(202) 682-2405

The Solena Group is a developer of projects using waste fuels, including MSW. They do not own any technology but utilize technology supplied by others to put together the technology portion of a project. One of their main thrusts is the use of plasma arc gasification of MSW to produce a synthesis gas to be used in a combined cycle operation. Their main concentration is in the European Union ("EU") primarily Italy and Spain. The EU has two attributes that encourage alternative methods of disposal of MSW. First landfill space is scarce and expensive and certain countries have placed restrictions on what can be deposited in landfills. Second the EU has set a goal for increasing percentages of power to be generated from renewable resources. According to Mr. Miller, the Italian government is offering an incentive to renewable energy projects of the equivalent of 14 cents per KWh generated above the prevailing rate for electric power. Solena also reports that they are also developing projects in Asia (e.g., Malaysia and the Philippines).

Mr. Miller stated that Solena Group's first commercial plasma system combining MSW disposal and a combustion turbine is currently under construction in Rome, Italy and is anticipated to go into operation by the end of May 2003. It utilizes the Westinghouse Plasma Torch system, a gas cleanup system to be supplied by LGL (a French company) and a Frame 6 combustion turbine supplied by General Electric in a combined cycle operation. The plant incorporates a 14 ton per hour single train reactor, and the MSW is first processed to produce an RDF which is then baled for drying and storage. The bales are broken up prior to being fed into the reactor. Depending on the final heating value of the resulting synthesis gas, the combustion turbine may need supplemental fuel. Solena reports to have developed working relationships with Stone & Webster and CM2H Hill, as well as local constructors. They intend to build modular units based on a 20 ton per hour reactor, and the associated combustion turbine. Solena Group stated that they have obtained project technology insurance from Marsh & McLennan.

Mr. Miller stated that Solena can finance projects based on turnkey contracts and that their minimum size would be a single train 20 ton per hour unit (480 tons per day). They believe that a plant of this size would produce three times as much net power as it consumed. This would be equivalent to approximately 150,000 tons per year of waste at an 85 percent capacity factor.

Telephone Call Summary

Date/Time of Call: September 22, 2002; 9:00 am

Person Called: David Deegan
Contact Information: Tetronics Limited
Wicklesham Farm
Faringdon, Oxon
United Kingdom SN7 7PN
+44 (0) 1367 240224

Tetronics is a UK company that is primarily in the business of supplying plasma systems for steel manufacturing and waste treatment. Ash vitrification is their primary waste area with over 30 units in operation. They have one liquid hazardous waste gasification unit in Italy as a demonstration project. They also have several pilot facilities in the UK (3 MW capacity) and 5-10 TPD capacity. Current systems run from 3 TPD to over 100 TPD.

Tetronics used either a graphite transferred torches or a non-transferred gas heating torches that are water-cooled and could be subject to corrosion. All are DC systems. For an MSW application they would use the graphite electrode type to a metal pool, with a conductive refractory. The waste would gasify in the heat generated by the pool and a supply of air. The graphite electrode is sacrificial being used up at a rate of 1-2 percent of the waste throughput. We had no discussion of tar formation, however, the average reactor temperature was stated to be 1800 C. MSW systems would operate at slightly negative pressures. For an ash unit power consumption is on the order of 550-600 KWe/tonne this needs to be increased by heat losses (overall efficiency is ~80-90 percent). We will be getting additional information.

There appears to be depth in experience in ash vitrification, but little experience in other types of wastes. The Company was established in 1936and has license agreements with MHI in Japan. It sells both reactors or whole systems. The gases generated in the reactor would go to combustion chamber, waste heat boiler and an air pollution control system.

Telephone Call Summary

Date/Time of Call: September 19, 2002; 9:30am

Person Called: Dan Lazzara
Contact Information: Westinghouse Plasma Corporation
Plasma Center – Waltz Mill
Madison, PA 15663
(724) 722-7052

Westinghouse is a supplier of Plasma arc technology only. It does not supply complete plants. (the equipment they supply includes reactors and torches and ends at the point where the gas and solids exit the reactor. They have been supplying their equipment for plasma arc technology for 14 years in commercial operations. Previous applications in the metal industry include the fired coupla for General Motors in Defiance, Ohio. The GM plant runs on air, using a single train with a 500-600 TPD capacity. The design is somewhat different than the design of an MSW reactor.

Current waste disposal installations in Japan: Yoshii, a 1 ton per hour (24 TPD), single unit demonstration plant owned by Hatachi and a 180 TPD unit now in start-up with two units (4 tph each). There is also a pilot plant at the Westinghouse Plasma Research Center in Madison, Pennsylvania.

The Westinghouse units are operated under slightly negative pressure and are gravity fed. The only feed restriction is the size of the opening. All of the inerts are melted and all the organics are gasified. The reactor is an updraft design, with the hot air created by the plasma injected near the bottom of the reactor. The air can reach temperatures of 8000 F. and reacts in a coke/carbon bed

MSW is not required to be pre-treated unless it cannot pass through the input port. The plasma injection point is about ½ way up the reactor. Gas velocities are low. The Plasma torches are DC-fired. However, they heat air and the air does the heating and gasification. Particluate carryover is low and NOx generation is low. The generated synthesis gas is about 150 Btu/scf, depends on heating value of the MSW. Top gas temperature is 1000-1200 C (minimizes tar formation). Energy use is 100 kwh/ton (if all ash it would be 600-900 kwh/ton). Hatachi takes the gas to a boiler and generates steam. No gas cleaning between the reactor and the boiler. Main synthesis gases are CO, H_2, CO_2 and N_2. Enriched air can be used to enhance the heating value. GE can burn the synthesis gas in a turbine, if the gas is cleaned and cold.

All liquid slag is taken off through one tap. The capital cost of the reactor system is on the order of $200/kW of thermal capacity.

Appendix D: Plasma Waste Disposal Facilities

Ash Vitrification

Facility: Fly Ash Vitrification Plant
Location: Cenon, France
Types of Waste: Fly ash from incineration of MSW (120,000 tpd) and sludge (18,000 tpy)
Capacity: 7 tpd/2,400 tonnes per year
http://www.europlasma.com

Facility: Kakogawa Plant
Location: Kakogawa, Japan
Type of Waste: Fly ash from fluidized bed incinerator
Capacity: 30 tpd/5,000 tpy

Facility: Shimonoseki Plant
Location: Shimonoseki, Japan
Type of Waste: Fly ash and bottom ash from grate incineration furnace
Capacity: 41 tpd/10,000 tpy

Facility: Imizu Plant
Location: Imizu, Japan
Type of Waste: Fly ash from fluidized bed incinerator
Capacity: 12 tpd/ 3,000 tpy

Facility: IHI Plant
Location: Kinuura, Japan
Type of Waste: Fly ash and bottom ash from 240 tpd MSW incinerator
Capacity: NA

Hazardous Waste Facilities

Facility: INERTAM-Cofal SA
Location: Morcenx, France
Type of Waste: asbestos melting unit
Capacity: 22tpd/8,000 tonnes per year
http://www.europlasma.com

Facility: Hawaii Medical Vitrification Facility
Location: Honolulu, Hawaii
Type of Waste: Medical Waste
Capacity:

Facility:
Location: Lorton, Virgina
Type of Waste: Agricultural Blast Media
Capacity:
http://www.jdmag.wpafb.af.mil/peps.pdf

Facility: Nufarm Ltd (herbicide manufacturer)
Location: Laverton, Victoria AUSTRALIA
Type of Waste: Liquid and gaseous hazardous wastes
Capacity: 4 tonnes per day
http://www.eidn.com.au/plasma.html

MSW Facilities

Facility: Pilot Plant
Location: Yoshii, Japan
Type of Waste: MSW
Capacity: 25 tpd

Facility: ASR/MSW Facility
Location: Utashinai, Japan
Type of Waste: Auto-shredder residue and MSW
Capacity: 166 tpd

Facility: Solena/Westinghouse Project (now under construction)
Location: Rome, Italy
Type of Waste: Municipal and industrial wastes
Capacity: 366 tpd