Waimanalo Gulch Landfill Alternatives Analysis Technical Memorandum

Prepared for

Cades Schutte, LLP
1000 Bishop St., Suite 1200
Honolulu, HI 96813

Prepared by

Parametrix
411 108th Avenue NE, Suite 1800
Bellevue, WA 98004-5571
T. 425.458.6200 F. 425.458.6363
www.parametrix.com

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CERTIFICATION

The technical material and data contained in this document were prepared under the supervision and direction of the undersigned, whose seal, as a professional engineer licensed to practice as such, is affixed below.

Prepared by Ann Radil

Checked by Dwight Miller, PE

Approved by Dwight Miller, PE

DWIGHT E. MILLER
LICENSED PROFESSIONAL ENGINEER
No. 7217-C
HAWAII, U.S.A.

This work was prepared by me or under my supervision

12/13/11

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INTRODUCTION

This technical memorandum was prepared to enable comparison of waste management, recycling, and waste to energy (WTE) practices and goals at the Waimanalo Gulch Sanitary Landfill (WGSL) with comparable landfills in order to inform an expert witness testimony.

Specifically, the 2008 *Integrated Solid Waste Management Plan Update* (SWMPU) prepared for the City by R.W. Beck for the City and County of Honolulu (City) states that the primary objective used to design an integrated solid waste management system for the City is to maximize recovery of solid waste through reuse, recycling, composting, and energy conversion in order to minimize the amount of waste requiring landfill disposal. The following discussion evaluates the City's efforts to date to realize this objective. A three-phased approach was used to complete this analysis: 1) current municipal solid waste (MSW) practices at WGSL were characterized; 2) research of MSW management and goals at comparable cities and counties in California and Washington was compiled; and 3) a gap analysis comparing the current practices at WGSL with methods proven to be economically and technically feasible at comparable locations was performed.

The results of this investigation identify where and how the City's existing MSW management practices and use of alternative treatment technologies meet, exceed, or are deficient at realizing the efficiencies realized by comparable locations. Specifically, when compared to the current state of practice for refuse disposal and alternative treatment technologies, there are several aspects of the City's MSW practices that may be improved upon, including:

- Management of biosolids;
- Management of biomedical waste;
- Management of ash and residue from WTE facilities; and
- Methodology used to evaluate alternative technologies.

The following discussion provides greater detail on how the City's current refuse disposal and treatment technologies compare to the state of the practice.

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OVERVIEW OF WASTE GENERATION ON OAHU

Table 1 summarizes MSW waste streams to the WGSL, and to and from the H-POWER facility.

Table 1. Total Waste Stream on Oahu (Tons)

Waste Stream Characterization	2006	2007	2008	2009	2010
C&D Recycling	121,000	148,000	216,745	116,670	101,556
C&D Landfill	250,000	250,000	279,787	231,225	194,133
General Material Recycling (MSW)	421,072	453,372	456,876	426,947	448,639
Trash Shipping (MSW)	-	-	-	13,142	4,487
H-POWER Waste to Energy	454,068	396,218	431,599	418,618	418,095
H-POWER Ash and Residue	191,800	189,351	191,713	188,683	179,946
MSW Landfill	286,842	306,691	233,065	178,512	163,736
Total Landfill Diversification %	58%	57%	61%	62%	64%
Total Tonnage	1,724,782	1,743,632	1,809,785	1,573,797	1,510,592

Source: Department of Environmental Services, City and County of Honolulu. November 2011. Recycling and Landfill Diversion.

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COMPARISON OF RECYCLING EFFORTS WITH STANDARD PRACTICES

The SWMPU describes various private- and public-sector reuse and recycling efforts, including those managed by the City and County of Honolulu. The following discussion does not comprehensively describe the City's waste reduction and recycling program. Rather, it provides a high-level overview of current recycling efforts in order to provide sufficient rationale of where and how the City's existing practices are inconsistent with current standard practices.

Overview of the City and County of Honolulu's Residential Recycling Efforts

In 2007 the City began a pilot program involving a twice-a-month residential curbside collection of mixed recyclables. In November 2011, the City released an evaluation of the effectiveness of the island-wide curbside collection system during FY 2011. The findings of the report are summarized in Table 2.

Table 2. Results of Evaluating the Effectiveness of the Curbside Recycling Program

Capture of Mixed Recyclables (tons)	Capture of Greenwaste (tons)	Capture of Mixed Recyclables (% of total waste stream)	Capture of Greenwaste (% of total greenwaste stream)
18,000	53,000	52%	77%

Based on the evaluation of the effectiveness of the curbside recycling program completed in 2011, the City has identified discrete measures to increase participation in the program and decrease contamination rates. In the next phase of the project, the City will evaluate the feasibility of a two-pronged approach that will allow fruit and vegetable peelings to be included in the curbside collection, and address other food leftovers through a waste prevention education campaign.

Further participation will be measured through scientific market research (polling Oahu residents) in the next phase of this evaluation process. The results will provide insight for affecting behavioral changes to improve participation and recycling habits.

Comparison with Standard Practices

A 52 percent capture rate for mixed recyclables and a 77 percent capture rate of greenwaste indicate that the City's residential recycling program is already achieving a high participation and recovery level. In the case of greenwaste, this recovery rate suggests 90 percent participation at an 85 percent recovery level or vice versa. This is consistent with participation and recovery rates realized at comparable locations in California and Washington. Further, the items collected in the curbside recycling programs are consistent with those collected in comparable curbside recycling programs.

However, the City's recycling efforts are inconsistent with the current standard practices in three ways:

1. The City was slow to establish a residential curbside recycling program.

   In 1970 there were a handful of cities with curbside recycling programs. Today there are 9,000. Economic indicators suggest that many cities were operating curbside recycling programs in 2000. For example, in 1968 the United States recycling industry consisted of 8,000 companies that employed 79,000 people, with annual sales of $4.6 billion. By 2000, 56,000 private and public facilities employed 1.1

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million jobs and had $236 billion in annual sales (Seldman, 2011). As previously stated, the City began piloting their current residential curbside recycling program in 2007.

2. The City has not formally adopted goals to guide future recycling and bioconversion efforts.

The 2011 Curbside Recycling Program Evaluation and Strategic Planning Phase I report contains recommendations for increasing recovery rates for mixed recyclables, maintaining current recovery rates for green waste, and developing strategies to increase capture rates while reducing contamination. However, unlike comparable locations, the City does not appear to have established formal goals to guide waste reuse and recycling programs.

King County, Washington, for example, has established the following waste prevention, waste disposal, and recycling goals (King County Solid Waste Division, 2011):

- King County defines a decline in waste as an overall reduction in the amount of materials disposed of or recycled. By 2020, King County wants to reduce waste generation to 20.4 pounds per week per capita, and 58 pounds per week per employee.
- King County defines reductions in disposal over time as an increase in waste prevention and/or recycling. By 2020, King County wants waste disposal rates to be reduced to 14.2 pounds per week per capita, and 22.9 pounds per week per employee.
- King County's recycling goal combines single-family, multi-family, non-residential, and self-haul recycling activity. The goal reflects the estimated recycling rate achievable if the recommended strategies in the Comprehensive Plan for Waste Prevention are implemented. The recycling goals are to increase the overall recycling rate by 2015 to 55 percent; and the overall recycling rate by 2020 to 70 percent.

To realize its waste reduction, waste prevention, and recycling goals, King County is developing and operationalizing waste reduction, waste prevention, and recycling programs that are more ambitious and expansive than those provided by the City as described in the SWMPU.

3. The City does not currently operate a food waste collection program.

In Portland, Salem, Corvallis, and Keizer, Oregon, food scraps and food-soiled paper may be recycled. In King County, Washington, food scraps and food-soiled paper may be recycled in the yard waste cart provided by haulers, and food scrap recycling service is available to 98 percent of single-family residents who have curbside garbage service. In comparison, while the City's *2011 Curbside Recycling Program Evaluation and Strategic Planning Phase I* report (DES 2011b) contains a recommendation to develop an operational plan for collecting food waste, the City has fallen behind the current state of practice by failing to develop and operationalize a food waste collection program earlier.

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COMPARISON OF WTE PRACTICES WITH STANDARD PRACTICES

The following discussion provides a high-level overview of the City's current WTE efforts, and describes alternative management practices consistent with the current state of practice.

Overview of the City's WTE Efforts

H-POWER is located in Kapolei on a 28-acre site in the James Campbell Industrial Park near interstate highway H-1. At the H-POWER facility, combustible MSW is processed into refuse derived fuel (RDF) that is used to generate electricity. Approximately 90 percent of the volume and 70 to 75 percent of the weight of the MSW processed at H-POWER is diverted from the landfill to generate electricity. H-POWER has a nominal rating of 2,200 tons per day of MSW throughput and is capable of generating approximately 46 megawatts of electric energy and a separate, derivative amount of Renewable Energy Credits (RECs). According to the SWMPU, between 1990 and 2008 the H-POWER facility has converted over 10 million tons of refuse to 550 million kilowatt hours (kWh) of electricity.

In fiscal year (FY) 2006, 454,068 tons of waste was recycled for energy at H-POWER, and in 2010, 418,095 tons of waste was recycled for energy (see Table 1). The H-POWER facility is capable of recycling 600,000 tons of waste for energy, indicating that in 2010 the energy recovery boilers operated at approximately 70 percent capacity.

The City considers maximizing the conversion of WTE essential to meeting waste reduction goals. Between 2005 and 2008, H-POWER indicated a need to increase WTE capacity because approximately 100,000 to 150,000 tons of combustible waste was disposed at the landfill due to WTE capacity limitations. Initially, the City planned to procure the development of a facility that would provide an alternative WTE technology to H-POWER's RDF technology on a site adjacent to the H-POWER site. However, the City has opted to increase the capacity at H-POWER by procuring a mass burn combustion system that is capable of annually burning at least an additional 300,000 tons/year of waste. Specifically, the City is currently building a 900-ton-per-day expansion of the existing facility. The expansion includes the addition of a third combustor unit, turbine/generator, and associated air pollution control equipment.

The City began negotiating with the Bank of America to officially acquire full ownership of the H-POWER generating facility in 2008, and today the H-POWER facility is fully owned by the City.

In the SWMPU, the City concluded that increasing recycling and expanding WTE capacity will not permanently or totally eliminate the need for landfill disposal capacity for combustible MSW, and that some residual landfill capacity will always be required for residue and ash. The SWMPU presents the City's plan to extend the landfill's current use permit, and develop a new MSW landfill (these topics are subjects of other reports).

Ash and Residue Production at the H-POWER Facility

The ash and residue from H-POWER is delivered to the landfill for disposal. In FY 2006, WGSL received approximately 88,500 tons of ash and 79,500 tons of residue from the H-POWER facility. The July 21, 2010 *Status Report on Reducing and/or Continuing the Use of WGSL* reports the following tons of ash and residue delivered to WGSL from the H-POWER facility:

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- April 2010—19,672 tons
- May 2010—19,103 tons
- June 2010—19,410 tons

Recycling of Residual Waste and Ash from the H-POWER Facility

The City is continuing to work with the Hawaii State Department of Health (DOH) to identify acceptable methods to recycle residual waste and ash from the H-POWER facility. The SWMPU identifies expanding the beneficial use of non-organic by-products as a key strategy for diverting waste from WGSL. Specifically, the SWMPU identified the following potential uses of non-toxic bottom ash and fly ash to be investigated:

- Use as a road base aggregate;
- Use for clay soil stabilization; and
- Use as a landfill cover.

The City ordinance currently cites the following directive regarding the reuse of ash:

> *Ash residue generated by energy recovery facilities or solid waste incinerators shall be handled as special waste unless determined to be otherwise and shall be disposed in an ash monofill or as determined by the director.*

Thus, the City will approve WTE ash material for beneficial use on a case-by-case basis.

Ash reuse is also subject to state laws. The DOH's Hazardous Waste Section established the Pollution Prevention & Waste Minimization Program to promote effective environmental protection while helping businesses reduce costs. This division is responsible for managing the state's Beneficial Use program. The division has not yet defined a Beneficial Use Policy for any materials, including bottom and fly ash.

Comparison with Standard Practices

WTE ash has been reused in construction since the early 1970s. Common applications are sub-base material, structural fill, and aggregate in asphalt or concrete. However, in the past, contaminant concentrations of fly ash exceeded the allowable threshold values. Ash reuse is therefore restricted to proven processes. Because there are no nationwide standards in the United States, less than 5 percent of the WTE ash is beneficially used (compared to bottom ash reuse of ~70 percent in Germany and ~90 percent in the Netherlands).

The Association of State and Territorial Solid Waste Management Officials (ASTSWMO) established a Beneficial Use Task Force (Task Force) to study how states are managing requests to use non-hazardous, industrial solid wastes rather than dispose of them in landfills. The Task Force's primary goal is to collect and share information that will assist states and territories in developing or improving programs and processes to handle these requests.

The Task Force found that 33 of the 40 reporting states, or 82.5 percent, indicated they had either formal or informal decision-making processes or programs relating to the beneficial use of solid wastes. The length of time that states have had experience with beneficial use programs or processes varies considerably, from less than 2 to more than 10 years. Eight states have had programs or processes in existence for 2 years or less and seven have had them between 2 and 5 years. Fourteen states reported programs or processes in existence between 5 and 10 years and four states reported them in place for over 10 years.

Not surprisingly, the underlying authority for beneficial use programs and processes varies greatly between states. Of the responding states, 14 indicated their activities were based on statutory authority, 20 had regulations for beneficial use, and 7 used policy memoranda or

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guidance documents in their programs (some states had 2 or all 3 of these). Seven states also indicated that they used "agency discretion" in making beneficial use decisions.

About one-half of the states have an actual written definition of beneficial use or a similar term. Five states have statutes containing a definition of beneficial use, 13 have a definition in regulations, and 5 have a definition in policies or guidelines that specifically define beneficial use. While definitions differ and in some cases apply only to a limited number of waste types, beneficial use typically constitutes use either in a manufacturing process to make a product or as a substitute for a raw material or product. Other components that are less prevalent in definitions but that are often used as evaluation review criteria include: 1) existence of valid markets; 2) prevention of speculative accumulation; and 3) protection of public health and the environment.

Approximately one-half of the states indicated that wastes approved for beneficial use, regardless whether through a specific beneficial use determination or another programmatic process, were also considered exempt from solid waste regulations. Chemically binding waste in a material such as cement, concrete, or asphalt is a practice considered acceptable by 70 percent of the responding states. However, only 21 percent allow blending to meet target contaminant levels.

For example, the State of Pennsylvania enacted regulations regarding the beneficial use of fly ash, bottom ash, and boiler slag resulting from the combustion of coal (25 PA Code Chs. 287, 290 and 299, 2010). Specifically, Pennsylvania Code Title 25, Chapter 290 defines the beneficial uses of ash to include use in concrete, extraction or recovery of materials and chemicals from coal ash, use of fly ash as a stabilized product, use of bottom ash or boiler slag as anti-skid or surface preparation material, use of coal ash as a raw material for a product with commercial value, use as pipe bedding, and use for mine subsidence control, mine fire control, and mine sealing. The regulations further state that if the ash has been modified to a stabilized product, and meets chemical and physical certification standards, the ash may be used as structural fill or as a soil amendment or soil substitute.

By not developing a programmatic approach to approving the reuse of WTE ash in materials such as cement, concrete, or asphalt, the City has failed to maximize recovery of waste. Further, planning to facilitate beneficial use of ash began in 2008, and the City has still not made progress on this issue. Therefore, based on this evaluation of standard practices, the City has failed to make timely progress towards beneficially using ash from the H-POWER facility.

COMPARISON OF BIOSOLIDS MANAGEMENT WITH STANDARD PRACTICES

Biosolids are the nutrient-rich organic materials resulting from the treatment of sewage sludge (the solid, semisolid, or liquid untreated residue generated during the treatment of domestic sewage in a treatment facility). When treated and processed, sewage sludge becomes biosolids, which can be safely recycled and applied as fertilizer to sustainably improve and maintain productive soils and stimulate plant growth. The following discussion provides a high-level overview of the City's current practices for handling of wastewater/sewage sludge and biosolids management, and describes biosolids management practices consistent with the current state of practice.

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Overview of the City's Management of Biosolids

Historically, municipal wastewater sludge has been landfilled at WGSL after being treated. However, in 2006 the City began working with private vendors to divert this material from landfill disposal. Currently, the City is contracting with Synagro to produce fertilizer pellets from approximately 20,000 tons of sewage sludge from the Sand Island Wastewater Treatment Plant, and is working with the DOH to use the fertilizer pellets on Oahu. On July 15, 2010, the City awarded a contract to Hawaiian Earth Recycling to process approximately 100,000 tons of the City's sewage sludge. This action intends to reduce the waste stream to the WGSL while creating a marketable soil amendment product.

Comparison with Standard Practices

The City and County's current sewage sludge and biosolids management efforts are inconsistent with the current state of practice in three ways:

1. The City was slow to establish and grow its biosolids management program.

   King County's Biosolids Management Program has been recycling biosolids since 1973. Currently, King County's treatment plants produce about 112,000 tons of dewatered biosolids each year.

   Between 1987 and 1989, the City of Los Angeles disposed of sewage sludge in landfills, and in 1989 the City started an extensive beneficial reuse program. Today the City's Bureau of Sanitation operates four wastewater treatment facilities within a 600-square-mile area, and manages the 225,000 tons of biosolids as a treated valuable commodity.

   The City failed to develop a biosolids management program until 2006, at which time the City had capacity to process up to 10,000 dry tons of biosolids annually.

2. The City has not developed a biosolids management program consistent with best practices for continuous improvement in the areas of environmental performance and regulatory compliance.

   The National Biosolids Partnership (NBP) Biosolids Management Program is based on internationally recognized standards for an Environmental Management System/International Organization of Standardization (ISO 14001). With guidance from biosolids professionals, experts, and leading biosolids management organizations, the NBP program serves as a model for continuous improvement in the areas of environmental performance and regulatory compliance.
   Organizations that have become certified by the NBP Biosolids Management Program collectively manage more than 12 percent of the biosolids in the United States. These organizations have documented significant benefits in using the program's tools to reduce operating costs and achieve greater efficiencies. King County has earned the NBP certification for its biosolids Environmental Management System. The City's biosolids management program is not NBP certified.
   Becoming certified through the NBP Biosolids Management Program would force the City to consider diverse technologies, end products, and beneficial uses of biosolids-derived products, and develop the reserve capacity to manage the projected volume of biosolids. Essentially, NBP provides a planning process that, once completed, would result in a robust biosolids management program.

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3. The City has inadequately evaluated and developed market demand for biosolids.

   There are two classifications of biosolids based on pathogen content: 1) Class A biosolids have been treated to reduce pathogens to a level where there are no site access or crop restrictions—Class A designation is required for use on lawns and gardens; 2) Class B biosolids have been treated to reduce pathogens to a level that is safe for application on land with an initial period of limited public access and crop restrictions. Treatments to produce Class A biosolids do not affect the metals or organic chemicals in the biosolids; odor may or may not be affected. Federal regulations set maximum limits on trace metal content in biosolids. All biosolids to be land applied must be under the maximum limits; biosolids meeting a second (lower) set of metal standards (i.e., are of consistently higher quality) have fewer restrictions for use, and produce higher value amendments.

   Thus, there are several variables that affect decisions regarding the treatment and application of biosolids-derived products, including treatment practices and anticipated end use. Biosolids are an important soil amendment product; as a result, there are suitable applications other than silviculture or agriculture. For example, biosolids have been used to improve soil conditions in disturbed areas. When developing a biosolids management program, comparable cities and counties have found that it is useful to complete an assessment of potential end uses for biosolids, in order to inform decision about the treatment and development of specific biosolids-derived products.

   Further, after evaluating market demand, cities and counties have often passed regulations to facilitate the use of biosolids and bolster market demand. King County, for example, developed a "checklist" of site characteristics that must be met to facilitate the permitting process. Further, the County's Biosolids Policies state that King County "shall seek to maximize program reliability and minimize risk by one or more of the following: 1) maintaining reserve capacity to manage approximately 150 percent of projected volume of biosolids; 2) considering diverse technologies, end products, and beneficial uses; or 3) pursuing contractual protections including agreements with other public agencies in the interest of cooperatively sharing resources where appropriate. King County also passed regulations requiring that biosolids-derived products be used as a soil amendment in landscaping projects funded by King County.

Additional information on the King County's biosolids program is available at: http://www.kingcounty.gov/environment/wastewater/Biosolids/AboutBiosolids.aspx.

Additional information on the City of Los Angeles' biosolids program is available at: http://www.lacitysan.org/biosolidsems/our_program/overview.htm.

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COMPARISON OF MEDICAL WASTE MANAGEMENT WITH STANDARD PRACTICES

Approximately 100,000 tons of medical waste is generated in the United States each year. It may be disposed through incineration or subjected to autoclaving, microwaves, and radio waves, with the disinfected waste being landfilled (Beck, 2003).

There are numerous laws, regulations, standards, and guidelines governing biohazardous materials and many aspects of their disposal and recovery are relegated to the state and local level. Many regulations are based on the EPA's *Model Guidelines for State Medical Waste Management*. Others are governed by federal regulations issued by the U.S. Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), the Department of Transportation (DOT) and United States Postal Service (USPS). The EPA's Medical Waste Tracking Act has established guidelines for the segregation, handling, containment, labeling, and transport of medical waste. Most states have developed their medical waste regulatory framework around these guidelines.

Overview of the City's Handling of Biomedical Waste

Medical waste can be disposed of in landfills after certain procedures related to their handling have been followed. The SWMPU states that, in general, regulations require that infectious medical waste be sterilized (rendered non-infectious) or incinerated.

Comparison with Standard Practices

The City's current efforts to manage biomedical waste are inconsistent with the current state of practice in two ways:

1. The City does not require medical waste to be incinerated prior to being landfilled, and as a result, does not follow standard practices to reduce the volume of medical waste being landfilled at WGSL.
   Incineration is recognized as a practical method of disposing of certain hazardous waste materials, including biomedical waste. Incineration has particularly strong benefits for the treatment of certain types of medical wastes, such as clinical wastes and certain hazardous wastes where pathogens and toxins can be destroyed by high temperatures.

2. The City has failed to adequately evaluate alternative technologies to convert biomedical waste into fuels.

   Medical waste is a potentially rich source of chemicals that can be converted into fuels and a wide range of other chemicals. It is possible to destroy medical waste and recover and convert the energy content into a synthetic gas that can be reformulated into any number of chemical derivatives such as ethanol. Many companies are following this path with various technologies, but the volume being processed today is minimal.

   In March 2010, S4 Energy Solutions LLC, a joint venture by Waste Management, Inc. and InEnTec LLC, announced plans to develop a plasma gasification facility at Waste Management's Columbia Ridge Landfill in Arlington, Oregon (SustainableBusiness.com News, 2010). The planned facility will convert municipal solid waste into fuels and energy.

While the City has evaluated plasma-gasification systems as an alternative disposal technology, they have failed to adequately evaluate the impact that developing a plasma gasification system would have on the handling of biomedical wastes. Specifically, none of the technical studies used to evaluate the economic and technical feasibility of the plasma gasification system mentioned medical wastes, and as a result, these studies failed to capture some of the benefits realized by the technology, including the reduced costs of less frequent and intensive handling of biomedical wastes when used as an input to a plasma gasification system relative to landfilling sterilized biomedical waste at WGSL. By failing to include the current costs of autoclaving and handling required to sterilize biomedical wastes to be landfilled, the City artificially inflated the net cost per ton of waste disposal in the economic feasibility assessment of plasma gasification technology.

The purpose of this discussion is to point out that by failing to compare the environmental and economic benefits of using medical waste as a feedstock to power a plasma gasification system with the City's current practice of sterilizing and landfilling medical waste at WGSL, the City failed to adequately capture the benefits of this alternative technology. The following section provides additional, related discussion of how the City's methodology to evaluate the economic feasibility of alternative technology practices compares to standard practices.

COMPARISON OF EVALUATIONS OF ALTERNATIVE DISPOSAL TECHNOLOGIES WITH STANDARD PRACTICES

Since 2006, the City has completed two significant evaluations of alternative disposal technologies: first in the SWMPU and again in the Waimanalo Landfill Expansion Final Environmental Impact Statement (FEIS). The SWMPU contains an evaluation of a variety of conversion technologies, including anaerobic digestion, WTE, pyrolysis, and composting. The FEIS alternatives analysis considered use of alternative refuse disposal and treatment technologies suitable for use on Oahu, transshipment of refuse off-island, and efforts to identify alternative locations for the siting of a municipal sanitary landfill in compliance with EPA standards and other applicable criteria.

The alternative management options and the standards used to evaluate the economic and technical feasibility of the alternative disposal technologies presented in planning documents are described in greater detail in the following section. In addition, the following section compares the City's framework for evaluating alternative disposal technologies with current standard practices.

Evaluation of Alternative Disposal Technologies in the 2008 Solid Waste Management Plan Update

As part of the SWMPU, the City evaluated a variety of conversion technologies, other than landfilling, to ultimately manage the portion of Oahu's solid waste stream that is not targeted upstream to be reduced, reused, recycled, or composted. The first step in this analysis was to review different alternatives to landfill disposal including the following four options:

- Anaerobic digestion;
- WTE;
- Pyrolysis/Gasification; and
- MSW composting.

The following paragraphs summarize the rationale presented in the SWMPU for pursuing, or excluding, these alternative disposal technologies:

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Based on the commercial status of the four technologies, anaerobic digestion and pyrolysis/gasification were excluded from further consideration. These two technologies have been applied commercially to various components of the solid waste stream outside of the U.S. However, there are no full-scale commercially operating facilities in the U.S. using these technologies with MSW as their feedstock.

The two remaining technologies, MSW composting and WTE, are being used by commercially operating facilities in the U.S. MSW composting requires extensive pre-processing to ensure decomposition and volume reduction up to 70 percent. The industry's historical operating history has reflected volume reduction of less than 70 percent and inadequate markets for the compost by-product. In many instances throughout the U.S., MSW compost facility operators receive no revenues from compost sales.

WTE has an extensive operating history with a proven track record of volume reduction approaching 80 percent to 90 percent. WTE facilities, such as H-POWER, generate electricity that has a continuous and well-defined market. H-POWER currently is a RDF facility that involves some pre-processing of the MSW (removal of metals and other non-combustibles) to enhance the heating value of the MSW. The demand for the energy from non-conventional sources, such as WTE, continues to grow and is critical to Hawaii which has the highest cost of energy in the U.S. Moreover, in Hawaii, the generation of electricity from a WTE plant directly offsets fossil fuel, importation, combustion, and greenhouse gas emissions, as virtually all of Hawaii's electricity, apart from H-POWER, is generated from imported fuel oil.

Therefore, based on the criteria of commercial operating viability, landfill diversion potential and by-product demand, the City selected WTE as its preferred alternative to landfill disposal. However, the City plans to continue to monitor new technologies throughout the planning period to determine if revisiting these technologies may be appropriate at some point in the future.

Evaluation of Alternative Disposal Technologies in the Waimanalo Landfill Expansion Final Environmental Impact Statement

In November 2006, the R.M. Towill Corporation prepared an Environmental Impact Statement Preparation Notice for the WGSL expansion pursuant to Chapter 343, Hawaii Revised Statutes, and Title 11, Chapter 200 of the Hawaii Administrative Rules (HRS). The FEIS was completed in 2008 and may be accessed via the Department of Environmental Service's Technical Studies website.

The alternatives included the no action alternative; the use of alternative technologies to refuse disposal; the transshipment of waste off-island; and the use of landfilling at alternative sites to meet Oahu's refuse disposal requirements.

Evaluation of Alternative Technologies for Refuse Disposal

The FEIS presents the City's criteria for vetting potential technologies. These criteria are:

1. The technology must process waste materials being disposed in the WGSL.
2. The technology must be operating at full scale and processing the amount of material expected at the WGSL.
3. 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.

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A summary of the process used to evaluate technologies is provided in the Executive Summary of the FEIS. In general, the preparers of the FEIS first conducted an extensive survey of the available systems or alternative technologies; used a two-tiered screening process to narrow the survey results to seven technologies; and then used a set of short-listed technologies. To enable 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.

While the alternative technologies evaluated did not achieve all of the City's objectives (they failed the cost objective), they were recognized to be highly effective alternatives for diverting the refuse stream from the WGSL. The technologies evaluated include:

- Plasma gasification;
- Gypsum recycling plant; and
- Metal recycling plant.

Preliminary results indicated that several alternatives could be implemented without requiring major changes to the existing City refuse management system. The most promising alternative, plasma gasification, could potentially divert as much as 90 percent of the estimated 278,000 tons of refuse being sent to the landfill. If this alternative were to be implemented, the only major waste stream requiring disposal would be the H-POWER ash, which is estimated to be 108,000 tons per year. The other two alternatives, the metal and gypsum recycling plants, have a potential of diverting 11 and 7 percent, respectively.

The FEIS identifies treated wood as a problematic material because it contains potentially toxic materials that limit options to reduce volume or recycle. Hence, any thermal technology used to process the wood must contend with the toxic metals emissions. The plasma gasification/vitrification technology offers the most advantageous solution in dealing with toxic contamination in the wood stream due to its high operating temperatures.

The plasma gasification and gypsum recycling plant will convert refuse to products that could be sold in the Hawaii region. It is estimated that the plasma gasification would produce 900 kWh per ton of refuse processed, with 300 kWh available to be sold. The gypsum produced can be sold as an agricultural soil additive, animal bedding, and oil absorbing product. Metal recycling products (the products from the third alternative) must be shipped offshore for recycling.

Currently, there are no large capacity municipal gasification/vitrification installations based on direct current (DC) arc plasma systems. When the FEIS was being prepared, the capacity of the largest operational DC arc plasma system was approximately 10 tons/day. These systems are primarily used for hazardous and medical waste applications in the United States.

Metal recycling is a common technology used by industrial facilities generating scrap metal and most municipal refuse systems. When the FEIS was being prepared, there were at least two gypsum recycling plants in the United States.

The plasma gasification system would require both air emissions and water discharge permits. The metal recycling and gypsum recycling plants are expected to require only air emissions permits. EISs would be required for all three alternatives.

The FEIS estimated that it would have taken 70 months (after the FEIS was completed in 2008) to acquire the plasma gasification system, and 32 months for the metal and gypsum recycling plants. Assuming private ownership, the estimated net revenue (including sale of all products and payment of the full disposal tip fee) per ton of waste processed using the three technologies are:

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- 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 price paid in 2008 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. Based on these criteria, the study prepared in accordance with the development of the FEIS found that none of the three technologies met the City's criterion.

The plasma gasification 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 did not satisfy 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.

Summary of Public Comments

A number of issues and concerns were raised by the community during the series of scoping meetings. The following list is a consolidation of comments received when the comment period ended on August 30, 2006 regarding the exploration of alternatives:

- Need to look at all alternatives that are appearing (i.e., plasma arc gasification, etc.) and determine how these alternatives fit in with everything else that the City is doing, including how they can reduce the waste stream to allow for the earliest closing possible of the landfill.
- Need to explore all viable alternatives.
- Need to look at other places, especially Europe, and how they dispose of their waste, the kinds of incentives/taxes/sanctions they use to reshape people's attitudes at the curbside.
- Need to address things that can be done to reduce the amount of waste that goes to the landfill—curbside recycling, alternative technologies, partnerships with the business community to promote recycling and reuse, etc.
- Need to get innovative and creative.
- Need to increase H-POWER and explore reuse of ash—H-POWER type facilities could be decentralized and built anywhere.
- Need to address transshipping of waste.
- Need to address providing a funding stream to address alternatives.
- Need to speed up action on alternatives.
- Need to address the implementation of the comprehensive and mandatory island-wide recycling program (proposed to be done by December 2006).
- Alternatives looked at must be explained including why they are rejected—the exploration must be rigorous.

Evaluation of the Transshipment of Refuse Off-Island

According to the January 22, 2010 Status Report on Reducing and/or Continuing the Use of WGSL, a Notice to Proceed was issued to contractor Hawaiian Waste Systems (HWS) on September 25, 2009. Both parties agreed that delivery of MSW would start on September 28, 2009. At the contractor's request, the City agreed to start out the contract by delivering to HWS 150 tons per day of refuse that is normally taken to WGSL for disposal. The City's

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planned normal delivery tonnage to HWS during the duration of the contract was 300 tons per day.

Following the reduced tonnage startup period, the City ramped up to 300 tons per day at the request of HWS. During the scheduled maintenance period (on October 10, October 15 to 17, and October 19 to 20) for H-POWER, approximately 400 tons per day were delivered to HWS. HWS had been baling and wrapping the waste directed to their facility by the City.

HWS originally notified the City that the first shipment of baled MSW would leave the island for mainland disposal on November 2, 2009. This date was not achieved and several other subsequent shipping dates were also not achieved. An environmental assessment for HWS' revised plan to ship the baled waste to different ports (Longview, Washington; Rainier, Oregon; and Portland, Oregon) than originally proposed (Roosevelt, Washington) was posted on the Federal Register on January 19, 2010. The closing date for comments was February 18, 2010. HWS' ability to ship the baled refuse was hindered by its lack of all the necessary permits that are required by authorities such as the U.S. Department of Agriculture and the U.S. Army Corps of Engineers. Recognizing that shipping MSW to mainland locations was not likely to happen, the City began negotiations to cancel its contract with HWS in August 2010 (Reyes, 2010).

Comparison with Standard Practices

The City's evaluation of alternative disposal technologies is inconsistent with the current state of practice, since it failed to develop and apply realistic and effective cost criteria.

Specifically, the City has stated that the "net cost of the technology must be no greater than the fee paid for disposal." The inadequacies of this criterion and the methods used to calculate the costs of the existing MSW management system are as follows.

1. The City failed to adequately represent the costs of existing procedures to sterilize biomedical wastes in their evaluation of the economic feasibility of alternative disposal technologies.

   According to the FEIS, the most promising alternative disposal technology is plasma gasification. Further, plasma gasification has demonstrated utility at converting biomedical waste streams into usable energy. However, the economic feasibility assessment did not include in its cost comparison the expense of special handling (staff, training, facilities, etc.) required to sterilize medical wastes. Sterilization of biomedical waste typically is performed using an autoclave, an instrument that subjects biomedical wastes to high pressure saturated steam at 121 °C for around 15–20 minutes. Failing to include the costs of autoclaving in an evaluation of economically feasible alternatives unfairly skews the analysis towards maintaining the status quo. For these reasons, the $28/ton of additional cost associated with the plasma gasification technology is not reliable, since it fails to accurately reflect the costs of biomedical wastes in the current system.

2. The City and County failed to adequately represent the likelihood and cost of future storm events in their evaluation of alternative disposal technologies.

   The January 13, 2011 storm event and subsequent release of contaminated stormwater and MSW from the WGSL illustrate the importance of ensuring that wastes accepted at the landfill be properly stored. Further, it is widely accepted that accidental releases of MSW negatively impact tourism and recreation, which are significant sources of revenue in the City and County's economy.

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Natural Resource Damage Assessment (NRDA), or the measurement of the performance of "ecosystem services," is an accepted framework for evaluating the costs of hazardous substance release, and quantifying the risks to the environment and human health.

Ecosystem services are the vital functions and products that natural systems provide including supporting functions such as nutrient cycling or soil formation; products such as fresh water and fuel; regulating services such as flood or climate regulation; and cultural resources such as recreational, educational, or aesthetic opportunities. Some ecosystem services can be easily incorporated into economic systems, such as timber being the property of the landowner. However, many are not considered private property and therefore fall under the category of public good in which everyone benefits but no one owns.

Various NRDA and ecosystem services frameworks are used by public and private-sector agencies to track how changing conditions (e.g., storm events and release of contaminants) affect the provisioning of ecosystem services including recreation and tourism. By applying an ecosystem services-based framework to the January 2011 storm event and release, and factoring in the likelihood of future storm events and releases, the City could incorporate the value of ecosystem services into their evaluations of alternative disposal technologies, because doing so would provide a comprehensive accounting of the costs of the current system. Failing to take into consideration the likelihood and impacts of future storm events and releases produces an artificially low estimate of the real cost of continued landfilling at WGSL.

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SUMMARY

Based on the analysis described in this technical memorandum, the following items summarize where the City's current consideration and use of alternative disposal technologies is inconsistent with the current state of practice.

1. The City's residential curbside recycling program has been in operation for a relatively short period of time.
2. The City has not formally adopted goals to guide future recycling and bioconversion efforts.
3. The City has failed to make timely progress towards beneficially using ash from the H-POWER facility.
4. The City does not currently operate a food waste collection program.
5. The City has been slow to establish and grow its biosolids management program.
6. The City has not developed a biosolids management program consistent with available and accepted best practice guidelines.
7. The City has inadequately evaluated and developed market demand for biosolids.
8. The City does not require medical waste to be incinerated prior to being landfilled, and as a result, does not follow standard practices to reduce the volume of medical waste being landfilled at WGSL.
9. The City has failed to adequately evaluate alternative technologies to convert biomedical waste into fuels.
10. The City has failed to adequately represent the costs of existing procedures to sterilize biomedical wastes in their evaluation of the economic feasibility of alternative disposal technologies.
11. The City failed to adequately represent the likelihood and cost of future storm events in their evaluation of alternative disposal technologies.

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