No. 12-325

RESOLUTION

RELATING TO THE BUDGET PROVISO FOR THE SAND ISLAND WASTEWATER TREATMENT PLANT SOLIDS HANDLING PROJECT.

WHEREAS, in Ordinance 12-20, the Fiscal Year 2013 Executive Capital Budget ordinance, the Council of the City and County of Honolulu appropriated $22,500,000 for the Sand Island Wastewater Treatment Plant Solids Handling Project ("Project"); and

WHEREAS, the Project description included a proviso requiring, among other things, the submission of a report from the City administration comparing the viability and cost-effectiveness of a publicly-funded second digester with a privately-financed thermophilic operation/project; and

WHEREAS, on November 19, 2012, the Director of Budget and Fiscal Services (BFS) submitted the Feasibility Analysis for the Project (Departmental Communication 780) to the Council which has been attached hereto as Exhibit A; and

WHEREAS, the Council has convened a public hearing on December 5, 2012 in accordance with the proviso included in the description of the Project; now, therefore,

BE IT RESOLVED by the Council of the City and County of Honolulu that the Council finds that the budget proviso relating to the Sand Island Wastewater Treatment Plant Solids Handling Project has been satisfied; and

CITY COUNCIL
CITY AND COUNTY OF HONOLULU
HONOLULU, HAWAII

No. 12-325

RESOLUTION

BE IT FINALLY RESOLVED that copies of this resolution be transmitted to the Director of Budget and Fiscal Services and the Director of Environmental Services.

INTRODUCED BY:

(br)

DATE OF INTRODUCTION:

NOV 29 2012
Honolulu, Hawaii

Councilmembers

DEPARTMENT OF BUDGET AND FISCAL SERVICES
CITY AND COUNTY OF HONOLULU
530 SOUTH KING STREET, ROOM 208 • HONOLULU, HAWAII 96813
PHONE: (808) 768-3900 • FAX: (808) 768-3179 • INTERNET: www.honolulu.gov

PETER B. CARLISLE
MAYOR

MICHAEL R. HANSEN
DIRECTOR

NELSON H. KOYANAGI, JR.
DEPUTY DIRECTOR

November 19, 2012

The Honorable Ernest Y. Martin, Chair
and Members
Honolulu City Council
530 South King Street, Room 202
Honolulu, Hawaii 96813

Dear Chair Martin and Councilmembers:

Subject: Ordinance 12 – 20
Bill 15 (2012), CD2, FD2
Project Number 2012054
Sand Island Wastewater Treatment Plant Solids Handling

Attached is the feasibility analysis for the Sand Island Wastewater Treatment Plant Solids Handling Project Number 2012054. The analysis was prepared to comply with the budget proviso for the respective CIP project.

Should you have any questions, please contact me at 768-3901.

Sincerely,

Michael R Hansen

Michael R. Hansen, Director
Budget and Fiscal Services

Attachments

APPROVED:

Mayor Peter B. Carlisle FOR

Douglas S. Chin
Managing Director

DEPT. COM. 780

EXHIBIT A

FEASIBILITY ANALYSIS

Sand Island Wastewater Treatment Plant
Project Number: 2012054

Executive Summary

The feasibility analysis concludes that the publicly-funded second digester is more viable and cost-effective compared to a privately-financed thermophilic operation/project. The conclusion is mainly due to the following advantages of a mesophilic anaerobic digester:

- System is more widely used and stable;
- Provides the added capacity and redundancy required;
- System could be brought online faster while limiting identified risks and related costs as the procurement of services falls under an existing contract;
- More cost effective with lower municipal interest rates and operating, maintenance and energy costs; and
- The land footprint for the expansion is already available at the existing facility.

The mesophilic anaerobic second digester would also avoid many negative issues inherent with the thermophilic system that include: a) historically unacceptable odor levels; b) land availability for the facility; c) potential agricultural land requirement for disposition of biosolids; d) lack of required redundancy; e) higher energy requirement resulting in less biogas for energy production at the plant; and f) penalties for breach of the existing operating contract.

Background

In 2002, the City & County of Honolulu, Department of Environmental Services (ENV) initiated a project to beneficially reuse biosolids from the Sand Island Wastewater Treatment Plant (SIWWTP). The purpose of the project was to replace an aging solids handling process at SIWWTP, divert waste from the landfill, and comply with the 309 Consent Decree, Civ. No. 94-00765 DAE, May 15, 1995, which required beneficial reuse of sewage sludge.

The project came on line in 2007, and met the intended purposes. It consisted of installing a new single stage anaerobic mesophilic digestion process, utilizing an egg-shaped anaerobic digester (ESD) and a biosolids storage tank, dewatering facility (centrifuges) and a high temperature drying unit to create a Class A biosolid as defined by Environmental Protection Agency (EPA) 40 CFR 503 in the final form of pellets. The project was awarded via the competitive State procurement 'request for proposals' (RFP) process to a contractor that demonstrated expertise at a national level to construct and operate the new solids treatment facility. The contractor, Synagro-WWT, Inc. (Synagro), operates and maintains the solids handling system and is responsible for the distribution of the pellets for beneficial reuse for the duration of the contract (November 30, 2022).

In 2008, the city initiated a change in the wastewater treatment process known as Chemical Enhanced Primary Treatment (CEPT), which resulted in a dramatic increase in the volume of suspended solids being removed from the wastewater. The surplus solids tank capacity that was designed into the original ESD was therefore rapidly consumed with the processing of the additional solids. Consequently, it was brought to the city's attention in March 2010 that there was a need to expand the solids treatment facility to address future capacity issues at SIWWTP.

The existing service contract, see, § 3.6(a), allows the second ESD (plan, design, and construction) to be done by Synagro, as validated by the State Procurement Office (SPO), see, Attachment 1-A, State of Hawai'i Procurement Office review of Synagro contract, dated Sept. 14, 2012. In Fiscal Year (FY) 2012-2013, the City Council approved $21,500,000 of construction funding in Ordinance 12–20, Bill 15 (2012), CD2, FD2, with the following proviso:

> *"Plan, design, construct and inspect wastewater treatment plant solids handling improvements. No funds may be expended for construction until* ***1) the department has provided the Council with a detailed and impartial feasibility analysis that compares the viability and cost-effectiveness of constructing a publicly-funded second digester over a privately-financed thermophilic operation/project;*** *and 2) the Council's convening of a public hearing to be informed of the issued Request for Proposal and to accept or reject the feasibility analysis. Should this analysis be rejected by the Council, no funds may be expended for this activity."*

The purpose of this analysis is to comply with the first provision of the proviso. Henceforth, the publicly-funded second digester will be referred to as "Option 1" and the privately-financed thermophilic operation/project will be referred to as "Option 2."

There are several *caveats* that should be noted: (1) Co-generation is not included in this analysis because the City is in the process of including co-generation at all current and future wastewater treatment plants. Thus, the City would directly realize the savings in energy costs, regardless of the process used. (2) Currently, there are no viable proposals under evaluation for a two-stage thermophilic system so cost will have to be estimated based on national data. And, (3) Based on a request for information from all members of the National Association of Clean Water Agencies (NACWA) no privately owned and operated facilities of a similar capacity exist that resemble the description in the proviso.

COST EFFECTIVENESS

In performing the feasibility analysis of 'cost effectiveness,' the factors considered included financing cost, profit margin, cost of construction, energy costs, cost of sludge disposal, odor control cost, and operating costs.

Financing Cost:

Option 1:
The City recently issued wastewater revenue bonds and obtained a 3.7% interest rate.

Option 2:
Communications through the NACWA have indicated that privately financed projects of this nature have averaged about a 6% to 7% interest rate.

Cost of project:

Option 1:
Ordinance 12-20, the FY 2012-2013 Executive Capital Budget and Program, includes an appropriation of $21.5 million for the second digester at SIWWTP. The project includes a new ESD, biosolids holding tank, and required piping and appurtenances.

Option 2:
A two-stage thermophilic system will require four new tanks to account for system redundancy, centrifuge for dewatering, odor control, supernatant treatment unit, and a building to house the dewatering operations. The existing ESD could be a standby unit or incorporated into the new system. However, the existing ESD, dewatering and drying unit are city owned property. For privatization, the complete system should be private to avoid operations and personnel conflicts.

Western Lake Superior Sanitary District in Duluth, Minnesota constructed (using public funds) a new two-stage temperature phased anaerobic digestion system at a cost of $32.6 million. The facility is a secondary treatment facility that produces 8,000 dry tons per year of Class B biosolid that is distributed to local farmers at no cost. (It is considered a Class B biosolid since EPA has not approved it as Class A.) The facility treats 43 million gallons per day. SIWWTP treats 70 million gallons per day. A rough estimate to construct a similar facility at SIWWTP to handle the current total loading of 12,000 dry tons per year, based on the Duluth cost per dry ton would translate to $48.9 million dollars. This cost estimate would only provide capacity to meet the current loading, not the future loading.

Another city that recently moved from composting to heat treatment/pelletization is Philadelphia, Pa. (January, 2012). The design-build-own-operate (DBOO), $70 million single stage heat treatment project in Philadelphia was privately financed at 7%. The operation cost is $26.35 million dollars per year for solids treatment and distribution for reuse. The facility treats 20 dry tons per day (SIWWTP facility currently treats 10 tons per day). A rough estimate of the cost, based on Philadelphia's experience, for a single-stage facility for Honolulu would be $35 million. Note that this only includes a thermal drying facility, which evaporates water and forms fertilizer pellets. There would be additional costs to build a digester, which the City needs for additional capacity and redundant waste stabilization capacity.

Cost of Sludge Disposal:

Option 1:
Cost of biosolid distribution is included in the contract.

Option 2:
As noted in the Beneficial Reuse section below, Class A biosolids may be subject to EPA requirements that the biosolids be applied to land and monitored. If the biosolids produced by Option 2 require land application, there will be additional costs for land and for the cost of application.

Based on information from Los Angeles County Sanitation District (LACSD) (information by phone), 1,200 to 1,500 acres of agricultural zoned land may be needed for land application for Honolulu's requirements, and additional land is needed for a buffer zone for access and odors. In LACSD, the biosolids are transported 100 miles to an agricultural area away from residents because of the strong odors upon application. It is unlikely that there is a sufficient-sized parcel of agricultural land on Oahu that also is remote from residents.

Besides the additional land cost if such a parcel was available, additional considerations include the cost of trucking the biosolid and its application as well as the EPA 832-F-00-064 requirement factors for site suitability, such as soil characteristics, slope, depth to groundwater, and proximity to surface water. Furthermore, the project would also have to comply with State of Hawaii Department of Health regulations.

In addition to the cost of the land, the cost of land application can vary from $60 to $290 per dry ton, depending on preparation and land application methods. See Attachment 1-B, Environmental Protection Agency, Biosolids Technology Fact Sheet, "Land Application of Biosolids". At 12,000 dry tons per year current capacity, the land application cost could range from $720,000 to $3,480,000 per year.

In a telephone conversation with Duluth Minnesota Public Relations Officer, Western Lake Superior Sanitary District, it was learned that Duluth upgraded its WWTP Solids Handing Unit in 2001 to a temperature phased anaerobic digestion multi-staged system utilizing thermophilic in the first stage followed by mesophilic in the second stage. Odors have been an issue during dewatering and land application.

The final product does demonstrate a pathogen reduction consistent with Class A requirements, but the product has not been approved by EPA as a Class A biosolid.

Duluth employs a method of disposal in hay fields following the requirements for Class B land application. This results in a greater land requirement than Los Angeles.

For the 10 wet tons per day of production, the Duluth land requirement is 2,000 acres whereas Los Angeles produces 500 wet tons per day with a land requirement of 5,000 acres. Similar to Los Angeles, Duluth rotates the disposal to different parcels. The area of land application is remote so it won't affect any population centers with odors.

As Duluth does not own and operate a landfill, municipal solid waste is trucked to Wisconsin for disposal.

Operating Costs:

Option 1:
EPA literature suggests that Operating and Maintenance (O&M) cost for a publicly run facility can be approximately $52 per dry ton.

Option 2:
O&M costs are difficult to estimate since the private owner would be including the loan debt service, overhead costs, profit (15% to 20%), payments to investors, bond guarantee costs, insurance costs, hauling costs, disposal costs for residue or rejected batches and labor costs. Given the additional oversight required to maintain a thermophilic system, operations will in addition require more labor and resulting labor costs.

VIABILITY

In performing the feasibility analysis of 'viability,' the factors considered included mesophilic vs. thermophilic systems, beneficial reuse, availability of funds, procurement of services, timing, and performance.

Mesophilic versus Thermophilic Digester Systems:

The viability[1] of the two alternatives is significantly impacted by the characteristics of the anaerobic digester system used. See Attachment 1-C, Wales Centre of Excellence for Anaerobic Digestion, "Mesophilic & Thermophilic Systems". Both mesophilic and thermophilic systems are viable methods of wastewater solids treatment. However, the thermophilic process requires more energy, produces a more odorous product, and requires additional treatment of the wastewater produced in processing.

Option 1:

[1] Viable is defined in the Oxford U.S. English Online Dictionary as "capable of working successfully; feasible."

Mesophilic bacteria has an optimal temperature for growth at 95°F. Mesophilic systems are stable due to the fact that a wider diversity of bacteria grows at mesophilic temperatures and are generally more robust and adaptable to changing environmental conditions. This is the most common process for solids treatment used across the United States for large wastewater treatment plants (Metcalf and Eddy, "Wastewater Engineering", Fourth Edition). According to EPA Region 9, about 85% of California's biosolids (on a tonnage basis) is mesophilically digested and another 9% is thermophilically digested.

Single stage mesophilic digesters offer a greater simplicity for operators and a single tank reduces the capital cost for digester systems. Given that the flows for SIWWTP average about 80° F, energy consumption to maintain the optimum temperature is low.

Option 2:
Thermophilic bacteria thrive at 131°F and may provide better pathogen kill due to the higher temperature. It also offers faster reaction rates and shorter retention times. The thermophilic bacteria population is limited and careful monitoring of the temperature distribution within the digester is required. Thermophilic systems require more energy in order to maintain the higher temperature and mixing operation.

Odor issues have been noted to be significant during the single stage thermophilic process and therefore the facility site's proximity to residents must be considered (see, Attachment 1-D). Higher ammonia recycle loads from the dewatering process are associated with the process, which sometimes cause problems in meeting ammonia discharge requirements for the treatment plant ("Advanced Anaerobic Digestion Performance Comparisons"). The supernatant[2] is higher in dissolved solids (Metcalf and Eddy, "Wastewater Engineering", Fourth Edition) and the return flows may require special treatment prior to discharge in order to maintain National Pollutant Discharge Elimination System (NPDES) compliance. Because SIWWTP is a primary facility, it is not capable of treating the side stream flows from this process.

Beneficial Reuse:

The limited land availability for Honolulu directs the city to pursue a sustainable environment. A key component of sustainability is to maximize recycling or reuse of waste. The general practice in other jurisdictions for sludge disposal is land application and/or landfill (EPA Region 9 information). The City's philosophy is to minimize the use of a landfill and pursue beneficial reuse of its waste, in order to extend the life of the current landfill. According to EPA rules (40 CFR 503), only "exceptional quality[3]" biosolids can be distributed for reuse as fertilizer without land restriction (p. 20-21, "EPA Regulations and Technology: Control of Pathogens and Vector Attraction in Sewage

[2] Supernatant is defined in the Oxford U.S. English Online Dictionary as "the liquid lying above a solid residue after crystallization, precipitation, centrifugation, or other process."
[3] "Exceptional quality" biosolids meet the following requirements: 1) Part 503 pollution control limits; 2) Class A pathogen reduction and 3) one of the first eight vector attraction reduction options listed in part 503.33(b)(1) through (b)(8).

Sludge"). Any future process is expected to comply with the City's goal of beneficial reuse of biosolids, which requires production of exceptional quality biosolids, or at a minimum, Class A biosolids. The city has a contract to process the Honouliuli and Kailua biosolids to meet Class A criteria. Eventually, all biosolids will be processed versus using the landfill as a primary disposal location.

Option 1:
SIWWTP is processing wastewater and distributing the exceptional quality pelletized biosolids for agricultural use. To meet the requirements of EPA 40 CFR 503 for a Class A biosolid, six alternatives are presented from which an agency can choose. SIWWTP facility is currently permitted under Alternative 1, thermally treated sewage sludge.

Option 2:
A single-stage thermophilic anaerobic digestion process can produce Class A biosolids, however, there are significant odor issues that would present a problem for SIWWTP because it is located near densely populated areas. The County Sanitation Districts of Los Angeles County conducted research on single stage thermophilic digestion to achieve Class A biosolids at its Carson Joint Water Pollution Control Plant (JWPCP). Its conclusion was "The energy requirement and odor generation make this process an unlikely choice for the Districts to pursue as a means of obtaining Class A material. Odor work performed during the dewatering tests show the thermophilic samples were on average 30% higher in odor strength than mesophilic samples." (See Attachment 1-D). The County Sanitation Districts also concluded, "an odorous product will have difficulty finding public acceptance and hence a market even if it is Class A material."

For a single stage thermophilic process, supporting infrastructure such as odor control, dewatering, and heat treatment will be required processes. EPA has concerns regarding complete mixing (Ref Section 4.4, Alternative 1: Thermally treated Sewage Sludge, "EPA Environmental Regulations and Technology, "Control of Pathogens and Vector Attraction in Sewage Sludge"), in that "...it is mandatory for all sewage sludge particles to meet the time-temperature regime," and that "for processes such as thermophilic digestion, it is important that the digester...not allow for short circuiting of untreated sewage." An option offered is to "carry out the process in two or more vessels" which leads to a multiple stage process. For these reasons, only a multiple stage process will be considered to satisfy the reuse goals of the City and County of Honolulu.

A two-stage thermophilic anaerobic digestion process may produce Class A biosolids, however, this is determined by the EPA on a case by case basis. In one case, the Los Angeles Hyperion WWTP moved to a two stage thermophilic anaerobic process in an effort to comply with a recent ordinance prohibiting the land application of Class B biosolids, which was its former method of biosolids disposal. Table 3, "Comparison of Anaerobic Digestion Processes" (see, Attachment 1-B) shows that staged thermophilic used at Hyperion produces a Class A pathogen level product, but the footnotes indicate a) it is believed to meet Class A requirements, but formal pathogen equivalency has not been approved by EPA; and b) one process has been approved as a site-specific process by EPA, but the technology has not been approved for national equivalency for Class A. Therefore, while a two-stage thermophilic anaerobic process *may* produce Class A biosolids, it will require a site-specific approval by the EPA.

Another consideration is the disposal of the treated biosolids. As stated earlier, LACSD produces a Class A biosolid but is still required to spread the biosolids on a dedicated parcel of land and carefully monitor the biosolids under the Land Application criteria to meet EPA requirements (see, Attachment 1-B). If Honolulu is restricted to land application of a thermophilic product, the cost of land and land application must also be included. According to LACSD, there is significant odor during and slightly after land application, therefore land application near population areas is strongly discouraged. (Phone conversation with L.A. Sanitation District staff).

Availability of Funds:

Option 1:
Ordinance 12-20, the FY 2012-13 Executive Capital Budget and Program, includes a $21.5 million appropriation for the SIWWTP Solids Handling Construction Project.

Funding will be through the issuance of revenue bonds by the City and County of Honolulu. The project needs to be on line by the end of 2015. The last issuance of bonds was at a 3.7% interest rate. Part of this project will most likely be paid from that issuance.

Option 2:
A privately financed, owned and operated facility would need to raise funds without the use of City revenue bonds, bond guarantee or cosignatory. Communications through the National Association of Clean Water Agencies (NACWA) have indicated that the privately financed projects of this nature have averaged about a 6% to 7% interest rate.

Procurement of Services:

Option 1:
The City has an existing contract with Synagro. to operate and maintain the existing solids handling system. The contract, as verified by the State of Hawaii Procurement Office (see, Attachment 1-A), also allows Synagro to plan, design, construct, and subsequently operate, a second ESD. Synagro is already under contract to plan and design a second digester; ENV is currently drafting a contract amendment to include, in part, the construction aspect of the second ESD. The amendment is currently being negotiated with Synagro.

Option 2:
Option 2 would require initiation of the procurement process (competitive RFP), solicitation, selection, and contracting. The estimated amount of time required to complete the competitive RFP process for this type of project is six to twelve months. Once the proposed contract has been finalized, the consultant will have to initiate

planning (specifically environmental and land easement documents), design, construction and possible land acquisition to cover the need and resulting cost of biosolid disposal via land application, if required. The time it would take to complete this process is unknown, however, an example is Hawaii Earth Recycling (HER). It has taken HER over two years to acquire its permits for the composting facility planned for the Wahiawa area and they still have yet to break ground.

Timing:

The need for the second ESD is based on EPA's findings of the insufficient capacity of the existing ESD to address present and future quantities of sludge entering SIWWTP and the lack of redundant waste stabilization capacity. See, Attachment 1-E, page 6 (EPA 'April 18, 2012 Clean Water Act Inspection,' dated June 11, 2012,). In addition, Attachment 1-E, page 8 notes that any digester failure or scheduled maintenance of the digester lasting longer than the 12-day retention time in the sludge holding tanks would impair the ability to operate the SIWWTP.

It is recommended that digesters be taken off line every 7 to 10 years for routine maintenance (Metcalf and Eddy, "Wastewater Engineering", Fourth Edition, and confirmed by Synagro). The current unit went into operation in 2007 and is now in its sixth year of operation, therefore routine maintenance should be completed by 2015. Such maintenance and inspection requires the ESD to be taken completely out of service, which cannot be done without an operating back-up system. Failure in operating the solids handling facility will result in enforcement action by the regulators (Department of Health and/or EPA) and increased costs. Unanticipated digester failure is a possibility, and any delay in construction of a new system increases that risk. Therefore, a future project needs to meet the 2015 completion date to be considered viable. Furthermore, the anticipated development of several large construction projects, including Hilton Hawaiian Village, Kyo-Ya and Kaka'ako will require increased capacity by 2016.

Option 1:
An existing digester with the capacity to treat 12,000 dry tons annually is currently in operation. Option 1 does not replace this unit but will be constructed alongside the ESD to expand the capacity to accommodate the loading for the next 25 years. The second digester would provide the needed additional capacity as well as redundancy required by the EPA. The scheduled completion date of late 2015 will allow the existing unit to be maintained within its recommended time frame.

Option 2:
It is unknown whether Option 2 could meet the need for increased capacity and redundant waste stabilization capacity by 2015. As noted in the "Procurement of Services" section, the estimated amount of time required to complete the competitive RFP process for this type of project is six to twelve months. Once the proposed contract has been finalized, the consultant will have to initiate planning (specifically environmental and land easement documents), design, construction and possible land

acquisition to cover the need and resulting cost of biosolid disposal via land application, if required.

Performance:

Option 1:
The ESD at the SIWWTP has been operating for over five years. During this time, the ESD has complied with the City's policy of beneficial reuse of biosolids by producing exceptional quality biosolids that are distributed for reuse. Option 1 would use the same technology and the same contractor, therefore the same level of performance is expected.

Option 2:
There are risks in using a privately financed and operated system. Although regulatory liabilities would be the responsibility of the owner, the City would still be at regulatory risk since the permit is issued to the City. Any regulatory action would be levied against the City, not the private owner. The City would have to recover any financial impacts from the operator, but consequential damages may have a greater impact. For these reasons, the City should either own the system, or make sure the City's interests are thoroughly covered when selecting and contracting with a private entity.

There is little information available for a privately funded DBOO facility within a publicly owned treatment plant. There are significant funding and operational requirements for a private entity (examples from Philadelphia project), including the following:

- Financial guarantee on performance as well as proof of tangible net worth during the life of the contract;
- Ability to obtain funds without the benefit of a publicly supported bond, bond guarantee or cosignatory;
- Performance bond to cover the design and construction, environmental and liability insurance, a letter of credit, and a tangible net worth equal to the cost of the completed asset;
- Responsibility for operational and maintenance costs;
- Demonstrated history of thermophilic treatment experience; and
- Insurance to demonstrate responsibility for regulatory liabilities associated with the operation of the privately owned and operated facility.

The risk to the City comes not only from finding a private entity to assume these responsibilities within the time frame, but also the risk of failure should the private entity falter in any of its responsibilities.

In addition, conversion to a new system and operators presents risks. The wastewater treatment process requires several prescribed steps that need to be precisely performed in coordination between the city operators and a private contracted operator. Option 2 would involve both a new process and new operators, and weaknesses in either the process or the operators could cause performance problems.

CONCLUSION

Based on the above analysis, Option 1, the publicly funded second mesophilic anaerobic digester, is more viable and cost-effective compared to Option 2, a privately-financed and privately owned thermophilic operation/project, for the following primary reasons:

- The existing process (mesophilic anaerobic digestion) utilized at the SIWWTP is a more widely used and stable system when compared to single stage thermophilic anaerobic digestion. The city utilizes mesophilic anaerobic digestion across the island. Given that the influent wastewater is already at 80°F, very little energy is required to maintain the process temperature. City operators are familiar with the process and it coincides with the existing biosolids reuse program. The heat treatment process at the SIWWTP provides a Class A biosolid that can be widely distributed for reuse, whereas a single stage thermophilic process has yet to be approved as a Class A biosolid by the EPA.

- Single stage thermophilic process has a history of unacceptable odor. Biosolids would still require heat treatment to be classified as Class A for reuse purposes.

- Option 1 can be brought online faster than Option 2. Funds have been appropriated for Option 1 and the procurement of services fall under an existing contract. No procurement process has been initiated for Option 2.

- Capacity and redundancy issues are the basis for the appropriation supporting Option 1. Option 2 would be considered a new project as it would be a complete replacement of the existing facility requiring a twenty-five-year capacity and redundancy.

- Option 1 has the advantage of being successfully completed sooner than Option 2 while limiting the identified risks and related costs.

- Option 1 is the more cost-effective option due to:

  - The lower municipal interest rates available to the City as compared to the private sector.

  - Option 1, the addition of a second ESD, has been planned for and the necessary connections and footprint of land at SIWWTP already exist. The availability of land at SIWWTP has been identified as an issue for Option 2.

  - Odor and return flow treatment has not been required at SIWWTP. Odor control units are in place for the current operation and are adequate for Option 1, a second ESD with mesophilic process.

- o Both projects will utilize an ESD, therefore Option 2 has no advantage over Option 1.
- o Energy requirements for Option 2 will be greater, resulting in less biogas for energy production at the plant.
- o Operations and maintenance costs will increase for Option 2 to cover debt service, profit, investor returns, and other financial obligations that the city will require of the owner.
- o Option 1 will not require the purchase of agricultural land for disposal of odorous biosolids.
- o Option 1 is in concurrence with the existing Synagro contract, whereas Option 2 would breach the contract and incur significant penalties imposed by §6 of the contract.

Attachment 1-A

NEIL ABERCROMBIE
GOVERNOR

AARON S. FUJIOKA
ADMINISTRATOR

STATE OF HAWAII
STATE PROCUREMENT OFFICE
P.O. Box 119
Honolulu, Hawaii 96810-0119
Tel: (808) 587-4700 Fax: (808) 587-4703
http://hawaii.gov/spo

SPO 13-026

September 14, 2012

The Honorable Romy M. Cachola
Councilmember
Honolulu City Council
Honolulu Hawaii 96813-3065

Subject: Financing, Design, Engineering, Construction, Testing and Operation/Maintenance of an In-vessel Bioconversion Facility, City and County of Honolulu and Synagro-WWT, Inc.

Dear Councilmember Cachola:

In response to your letter dated May 14, 2012 regarding subject contract, the State Procurement Office (SPO) has completed its review.

The SPO requested from the City & County of Honolulu's Department of Budget & Fiscal Services (City), copies of the solicitation, including addenda's, SYNAGRO-WWT Inc's proposal; and other documents which substantiates the City's decision to not compete the building of a second digester.

Based on the documents provided by the City (approximately 2,000 pages) for IFB No. F-96960, the following findings and determinations are made.

FINDINGS:

IFB: F-96960 FOR IN-VESSEL BIOCONVERSION FACILITY PROJECT issued on October 29, 1999, contained the following APPENDICES:

- Appendix A: Pricing Proposal
- Appendix B: Construction Contract
- Appendix C: Operation and Maintenance

APPENDIX B:

Article I of the Construction Contract, Definitions, page I-2, *"Facility" means the Sludge, Green Waste and Food Waste In-Vessel Bioconversion Facility, together with related and appurtenant structures and equipment, which is used to process these materials into Recovered Materials.* Therefore, by definition, any equipment including an additional digester is considered as part of the Facility.

Article V of the Construction Contract, Section 5.1 DESIGN OF FACILITY, page V-1. *"...The design shall take into consideration the requirement that the Facility may be operated beyond the initial term of the fifteen (15) year operating period, subject to appropriate maintenance and/or replacement of parts... (b.) perform all other architectural and engineering design work required for the Facility in its entirety..."* This language indicates the design of the Facility must anticipate the likelihood of future expansion that must be factored into the initial design, for the life of the facility or beyond the initial 15 year operating period.

Section 5.5 DESIGN AND CAPACITY, page V-4. *"In designing the Facility, the Contractor shall ensure that the Facility shall meet the Guaranteed Capacity requirement. In addition, the Contractor shall design the Facility so that adequate space is available to insure that the Facility will be capable of being expanded in the future to a capacity up to 30,000 dry TPY sludge."*

Article VI, Section 6.1 CONSTRUCTION OF FACILITY, Page VI-1, *"...The Contractor shall furnish and/or procure all services, labor, equipment, materials and appurtenances necessary to construct the Facility in its entirety, all in accordance with this contract... Organization, planning, management, direction, supervision, and responsibility for all construction operations necessary to complete the Facility in its entirety, and the furnishing, as necessary for the performance of construction work, of all construction facilities..."*
The work "entirety" used in this section and used in Section 5.1 above, indicate the construction of the Facility extends beyond the initial term of the fifteen (15) year operating period. Such that, any new construction within the Facility would be considered applicable to this section, in which the Contractor shall be responsible for.

APPENDIX C:

Section 3.6 CHANGES TO FACILITY, Page no. III-5. " *In the event that there is a change to the facility, the parties shall assume the following responsibilities: a. The Contractor shall have sole responsibilities for the design and construction of any changes to the Facility which involve or affect process equipment or the guarantees or obligations of the Contractor and which the City and Contractor mutually deem necessary or desirable for any reason during the term of the Contract…*" This section addressed the design and construction of any future expansion of the In-Vessel Bioconversion Facility would be conducted by the selected Contractor.

Other sections in the solicitation that support expansion of the facility are Section I of the Invitation For Bids (IFB), page I-5, states, "... specified as "Excess Tonnage" may be made available during the 15-year operating contract. Based on the above, the IFB disclosed future expansions would be included as part of the scope of work.

It is also indicated in the Written Questions and Responses to IFB Issued: December 21, 1999. Question 24: *Can the plant be modified to produce a more valuable product after initial completion?*

Agency Response: *Yes, Provided that modifications are completed in conformance with the Contracts and any additional land requirements are the responsibility of the Contractor.*

DETERMINATION:

Based on the SPO review of documents provided, IFB No. F-96960 FOR IN-VESSEL BIOCONVERSION FACILITY PROJECT was conducted as a multi-step competitive sealed bidding pursuant to HRS section 103D-302 and HAR Section 3-122-22 in effect in 1999. Sections 5.1, 5.5, 6.1 and 3.6 of the IFB includes language that describes the scope of work as encompassing the entire design, construction, and operation/maintenance of the In-Vessel Bioconversion Facility including any future design and construction changes in which the awarded contractor is responsible. The scope of work ensures that the selected offeror who designed, constructed, operated and maintained the facility would be in the best position to insure compatibility within the single system and able to offer an expedient and cost effective solution for any construction and operation/maintenance issues that may arise.

The documents provided to the SPO shows modifications to the Facility after the initial completion of the facility is allowed provided it is done within the terms of the contract and is the responsibility of the selected Contractor. (APPENDIX B, Article V, Section 5.5) Therefore, from the start of the solicitation, it was made known to all offerors that the Contractor selected would be responsible for future modifications of the Facility.

SPO 13-026

The following will address questions contained in your May 14, 2012 letter:

1. *Was the City Administration permitted under the Procurement Code to amend the Operating Contract to provide for Synagro to do the Planning, Engineering and Permitting work for the second digester and related facilities at the Sand Island WWTP, without following the Procurement Code provisions on the procurement of professional services?*

As stated in the findings (APPENDIX B) the project's scope of work encompasses the entire design, construction, and operation/maintenance of the In-Vessel Bioconversion Facility including any future design and construction changes in which the awarded contractor is responsible. For this procurement, the procuring agency was not restricted to only utilize the professional service source selection method. For example, HRS section 103D-303 and HAR section 3-122 Subchapter 6, Competitive Sealed Proposals, effective 1997, allows for design build construction contracts conducted as a Request for Proposal (RFP). Another appropriate and allowable source selection method for construction is HRS section 103D-302 and HAR section3-122 subchapter 5, Competitive Sealed Bidding, effective 1997 in which the City and County of Honolulu conducted a Multi-step sealed bidding to award this project. *Pursuant to HAR section 3-122-22 (a), effective 1997, Multi-step process is designed to obtain the benefits of competitive sealed bidding by award of a contract to the lowest responsive, responsible bidder, and at the same time obtaining the benefits of the competitive sealed proposals procedure through the solicitation of un-priced technical offers and the conduct of discussions to evaluate and determine the acceptability of technical offers.*

2. *Would it violate the Procurement Code if the City Administration were to allow Synagro to construct a second digester and related facilities at the Sand Island WWTP without going through the normal procurement process, consistent with the 10th WHEREAS Clause of Amendment No. 2 and Mayor's Message No. 10 (2012)?*

The second question asked is similar to the first question; therefore, the same response is given.

In response to the Mayor's January 26, 2012 written response #10. "A second Synagro digester would not have to go through the procurement process and, as the known and existing system, approval and permitting would be faster, making it arguably the most expediently emergency solution if the single digester fails", the SPO offers no comment on the information contained in the Mayor's Message No. 10 (2012), as we are not privy to the context or circumstances for his comments.

The SPO does not view amending the contract allowing Synagro to design and construct the second digester as a means to expedite the procurement process. The solicitation encompassed the thought process of having the same vendor design and construct both digesters such that the same company would be in the best position to insure a seamless integration and compatibility within the same single system, most effective in managing risks, and having cost effective solutions for construction and operation issues, as well as expediting the completion of the second digester.

3. *Is it proper for a party preparing a scope of work for a City construction project to be eligible to bid on or submit a proposal for the same construction project?*

Pursuant to HRS chapter 103D-405 and HAR section 3-122-13(e) state, *A contractor paid for services to develop or prepare specifications or work statements shall be precluded from submitting an offer or receiving a contract for that particular solicitation.* No documents were provided to the SPO to indicate that a third party had prepared the scope of services in the solicitation.

If your staff has any questions they may contact Ruth Yamaguchi at 586-0554 or you may call me at 587-4700.

Sincerely,

Aaron S. Fujioka

United States Environmental Protection Agency
Office of Water Washington, D.C.
EPA 832-F-00-064 September 2000

EPA

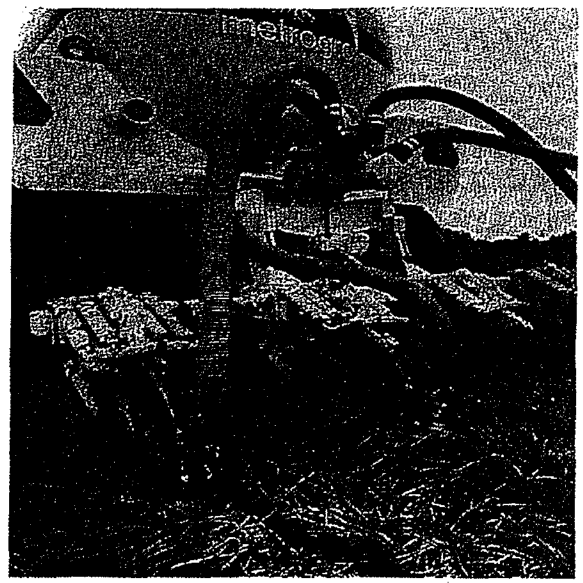
Biosolids Technology Fact Sheet
Land Application of Biosolids

DESCRIPTION

Biosolids are primarily organic materials produced during wastewater treatment which may be put to beneficial use. An example of such use is the addition of biosolids to soil to supply nutrients and replenish soil organic matter. This is known as land application. Biosolids can be used on agricultural land, forests, rangelands, or on disturbed land in need of reclamation.

Recycling biosolids through land application serves several purposes. It improves soil properties, such as texture and water holding capacity, which make conditions more favorable for root growth and increases the drought tolerance of vegetation. Biosolids application also supplies nutrients essential for plant growth, including nitrogen and phosphorous, as well as some essential micro nutrients such as nickel, zinc, and copper. Biosolids can also serve as an alternative or substitute for expensive chemical fertilizers. The nutrients in the biosolids offer several advantages over those in inorganic fertilizers because they are organic and are released slowly to growing plants. These organic forms of nutrients are less water soluble and, therefore, less likely to leach into groundwater or run off into surface waters.

There are several methods to apply biosolids. The selection of the method depends on the type of land and the consistency of the biosolids. Liquid biosolids are essentially 94 to 97 percent water with relatively low amounts of solids (3 to 6 percent). These can be injected into the soil or applied to the land surface. Specialized vehicles are used to inject biosolids into the soil, as shown in Figure 1. These tankers have hoses leading from the storage tank to injection nozzles which release the biosolids.

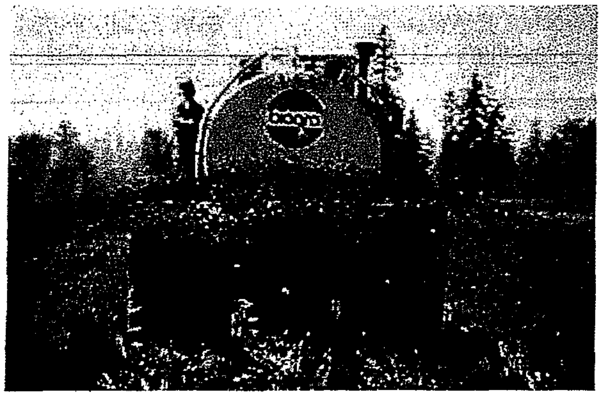


Source: U.S. EPA, 1984.

FIGURE 1 BIOSOLIDS INJECTION EQUIPMENT

Modified tanker trucks are used for surface application (Figure 2). Biosolids applied to the land surface are usually incorporated into the soil with conventional farm equipment.

It is often economical to reduce the volume of biosolids prior to transportation or storage. The amount of water in biosolids can be reduced through mechanical processes such as draining, pressing, or centrifuging, resulting in a material composed of up to 30 percent dry solids. This material will be the consistency of damp soil. Dewatered biosolids do not require any specialized equipment and can be applied with conventional agricultural equipment, such as manure spreaders pulled by tractors.



Source: U.S. EPA, 1986.

FIGURE 2 LIQUID APPLICATION OF BIOSOLIDS

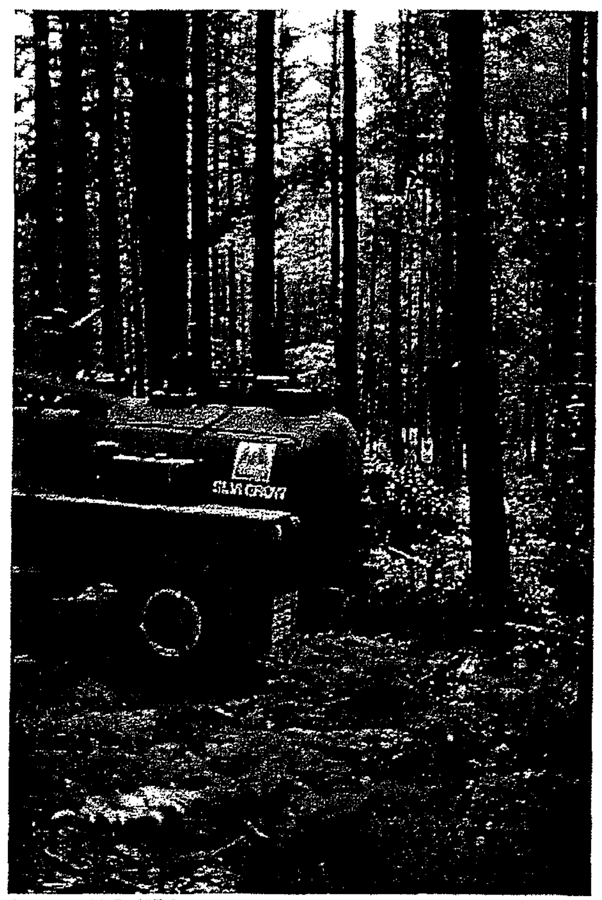
Figure 3 shows the spraying of biosolids, an application method primarily used in forested or reclamation sites. Liquid biosolids are sprayed from a tank towed by a truck or other vehicle.

The Environmental Protection Agency's 40 CFR Part 503, *Standards for the Use and Disposal of Sewage Sludge* (the Part 503 Rule), requires that wastewater solids be processed before they are land applied. This processing is referred to as "stabilization" and helps minimize odor generation, destroys pathogens (disease causing organisms), and reduces vector attraction potential. There are several methods to stabilize wastewater solids, including:

- Adjustment of pH, or alkaline stabilization.
- Digestion.
- Composting.
- Heat drying.

The Part 503 Rule defines two types of biosolids with respect to pathogen reduction, Class A and Class B, depending on the degree of treatment the solids have received. Both types are safe for land application, but additional requirements are imposed on Class B materials. These are detailed in the Part 503 Rule and include such things as restricting public access to the application site, limiting livestock grazing, and controlling crop harvesting schedules. Class A biosolids (biosolids treated so that there are no detectable pathogens) are not subject to these restrictions.

In addition to stabilization, the Part 503 Rule sets maximum concentrations of metals which cannot be exceeded in biosolids that will be land applied. These are termed Ceiling Concentrations. Part 503 also establishes Cumulative Pollutant Loading Rates for eight metals which may not be exceeded at land application sites. A third set of metals criteria is also included in Part 503, known as Pollutant Concentrations. If these concentrations are not exceeded in the biosolids to be land applied, the Cumulative Pollutant Loading Rates do not need to be tracked. Table 1 shows the three sets of federal limits applicable to biosolids to be land applied.



Source: U.S. EPA, 1986.

FIGURE 3 APPLICATION OF LIQUID BIOSOLIDS TO FOREST LAND

TABLE 1 MAXIMUM METAL CONCENTRATIONS

Metal	Ceiling Concentration (mg/kg)	Cumulative Pollutant Loading Rates (kg/hectare)	Pollutant Concentrations (mg/kg)
Arsenic	75	41	41
Cadmium	85	39	39
Copper	4,300	1,500	1,500
Lead	840	300	300
Mercury	57	17	17
Molybdenum	75	NL	NL
Nickel	420	420	420
Selenium	100	100	100
Zinc	7,500	2,800	2,800

NL = No limit

Source: U.S. EPA, 1993 and 1994.

The term *Exceptional Quality* is often used to describe a biosolids product which meets Class A pathogen reduction requirements, the most stringent metals limits (Pollutant Concentrations), and vector attraction reduction standards specified in the Part 503 Rule. Vectors (flies, mosquitoes, rodents, birds, etc.) Can transmit diseases directly to humans or play a specific role in the life cycle of a pathogen as a host. Vector attraction reduction refers to processing which makes the biosolids less attractive to vectors thereby reducing the potential for transmitting diseases. Exceptional Quality biosolids products are as safe as other agricultural and horticultural products and may be used without site restrictions.

APPLICABILITY

Land application is well-suited for managing solids from any size wastewater treatment facility. As the method of choice for small facilities, it offers cost advantages, benefits to the environment, and value to the agricultural community. However, biosolids produced by many major metropolitan areas across the country are also land applied. For example, biosolids from the Blue Plains Wastewater Treatment Facility serving the District of Columbia and surrounding communities in Virginia and Maryland have been land applied since the plant began operation in 1930. The cities of Philadelphia, Chicago, Denver, New York, Seattle, and Los Angeles all land apply at least part of their biosolids production.

Land application is most easily implemented where agricultural land is available near the site of biosolids production, but advances in transportation have made land application viable even where hauling distances are greater than 1,000 miles. For example, Philadelphia hauls dewatered biosolids 250 miles to reclaim strip-mines in western Pennsylvania and New York City ships some of its biosolids over 2,000 miles to Texas and Colorado.

ADVANTAGES AND DISADVANTAGES

Land application offers several advantages as well as some disadvantages that must be considered before selecting this option for managing biosolids.

Advantages

Land application is an excellent way to recycle wastewater solids as long as the material is quality-controlled. It returns valuable nutrients to the soil and enhances conditions for vegetative growth. Land application is a relatively inexpensive option and capital investments are generally lower than other biosolids management technologies. Contractors can provide the necessary hauling and land application equipment. In addition, on-site spatial needs can be relatively minor depending on the method of stabilization selected.

Disadvantages

Although land application requires relatively less capital, the process can be labor intensive. Even if contractors are used for application, management oversight is essential for program success. Land application is also limited to certain times of the year, especially in colder climates. Biosolids should not be applied to frozen or snow covered grounds, while farm fields are sometimes not accessible during the growing season. Therefore, it is often necessary to provide a storage capacity in conjunction with land application programs. Even when the timing is right (for example, prior to crop planting in agricultural applications), weather can interfere with the application. Spring rains can make it impossible to get application equipment into farm fields, making it necessary to store biosolids until weather conditions improve.

Another disadvantage of land application is potential public opposition, which is encountered most often when the beneficial use site is close to residential areas. One of the primary reasons for public concern is odor. In worst case situations, municipalities or counties may pass ordinances which ban or restrict the use of biosolids. However, many successful programs have gained public support through effective communications, an absolutely essential component in the beneficial use of biosolids.

Environmental Impacts

Despite many positive impacts to the environment, land application can have negative impacts on water, soil, and air if not practiced correctly.

Negative impacts to water result from the application of biosolids at rates that exceed the nutrient requirements of the vegetation. Excess nutrients in the biosolids (primarily nitrogen compounds) can leach from the soil and reach groundwater. Runoff from rainfall may also carry excess nutrients to surface water. However, because biosolids are a slow release fertilizer, the potential for nitrogen compounds to leach from biosolids amended soil is less than that posed by the use of chemical fertilizers. In areas fertilized by either biosolids or chemicals, these potential impacts are mitigated by proper management practices, including the application of biosolids at agronomic rates (the rate nutrients are used by the vegetation.) Maintenance of buffer zones between application areas and surface water bodies and soil conservation practices will minimize impacts to surface water.

Negative impacts to soil can result from mismanagement of a biosolids land application. Federal regulations contain standards related to all metals of concern and application of biosolids which meets these standards should not result in the accumulation of metals to harmful levels. Stringent record keeping and reporting requirements on both the federal and state level are imposed to prevent mismanagement.

Odors from biosolids applications are the primary negative impact to the air. Most odors associated with land application are a greater nuisance than threat to human health or the environment. Odor controls focus on reducing the odor potential of the biosolids or incorporating them into the soil. Stabilization processes such as digestion can decrease the potential for odor generation. Biosolids that have been disinfected through the addition of lime may emit ammonia odors but they are generally localized and dissipate rapidly. Biosolids stabilization reduces odors and usually results in an operation that is less offensive than manure application.

Overall, a properly managed biosolids land application program is preferable to the use of conventional fertilizers for the following reasons:

- Biosolids are a recycled product, use of which does not deplete non-renewable resources such as phosphorous.
- The nutrients in biosolids are not as soluble as those in chemical fertilizers and are therefore released more slowly.
- Biosolids appliers are required to maintain setbacks from water resources and are often subject to more stringent soil conservation and erosion control practices, nutrient

management, and record keeping and reporting requirements than farmers who use only chemical fertilizers or manures.

- Biosolids are closely monitored.

- The organic matter in biosolids improves soil properties for optimum plant growth, including tilth, friability, fertility and water holding capacity. They also decrease the need for pesticide use.

A joint policy statement of the U.S. Department of Agriculture, the U.S. Food & Drug Administration, and the U.S. Environmental Protection Agency states, "...the use of high quality biosolids coupled with proper management procedures, should safeguard the consumer from contaminated crops and minimize any potential adverse effect on the environment" (U.S. EPA, 1981).

DESIGN CRITERIA

Design criteria for land application programs address issues related to application rates and suitable sites. Design criteria for physical facilities (such as stabilization) that are part of land application programs are discussed in separate fact sheets. Biosolids, site, and vegetative characteristics are the most important design factors to consider.

Biosolids must meet regulatory requirements for stabilization and metals content. In addition, nutrient content and physical characteristics, such as percent solids, are used to determine the appropriate application rate for the crop that will be grown and the soil in which the crops will be grown.

Site suitability is determined based on such factors as soil characteristics, slope, depth to groundwater, and proximity to surface water. In addition, many states have established site requirements to further protect water quality. Some examples include:

- Sufficient land to provide areas of non-application (buffers) around surface water bodies, wells, and wetlands.

- Depth from the soil surface to groundwater equal to at least one meter.

- Soil pH in the range of 5.5 to 7.5 to minimize metal leaching and maximize crop growing conditions.

Site suitability is also influenced by the character of the surrounding area. While odors and truck traffic many not be objectionable in an agricultural area, both will adversely impact residential developments and community centers close to fields where biosolids are applied.

The type of vegetation to be grown is also a design consideration. Vegetation, like soil characteristics, will generally not exclude biosolids application since most vegetation will benefit from the practice. However, the type of vegetation will impact the choice of application equipment, the amount of biosolids to be applied, and the timing of applications. The effect of vegetation on the choice of application equipment is discussed above in the description of this technology. The amount of biosolids that may be applied to a site is a function of the amount of nutrients required by the vegetation and the amount of metals found in the biosolids. Table 2 summarizes the application frequency, timing, and rates for various types of sites.

Another factor to be considered in designing a land application program is the timing of applications. Long periods of saturated or frozen ground limit opportunities for application. This is an important consideration in programs using agricultural lands; applications must be performed at times convenient

Typical Biosolids Application Rate Scenario

The recommended minimum amount of nitrogen needed by a typical corn crop to be grown in New Jersey is 120 pounds per acre per year. Biosolids containing 3 percent nitrogen could be applied at up to 5.4 dry tons per acre if used to supply all the nitrogen needed by the crop (i.e., no other nitrogen fertilizers used.) A city producing 10 dry tons of biosolids per day would require access to almost 700 acres of corn. If the biosolids contained only 1.5 percent nitrogen, twice as many tons could be applied per acre, requiring only half as many acres to land apply the same amount of biosolids generated.

TABLE 2 TYPICAL BIOSOLIDS APPLICATION SCENARIOS

Type of Site/Vegetation	Schedule	Application Frequency	Application Rate
Agricultural land			
Corn	April, May, after harvest	Annually	5 to 10 dry tons per acre
Small grains	March-June, August, fall	Up to 3 times per year	2 to 5 dry tons per acre
Soybeans	April-June, fall	Annually	5 to 20 dry tons per acre
Hay	After each cutting	Up to 3 times per year	2 to 5 dry tons per acre
Forest land	Year round	Once every 2 - 5 years	5 to 100 dry tons per acre
Range land	Year round	Once every 1 - 2 years	2 to 60 dry tons per acre
Reclamation sites	Year round	Once	60 to 100 dry tons per acre

Source: U.S. EPA, 1994.

to the farmer and must not interfere with the planting of crops. Most application of biosolids to agricultural land occurs in the early spring or late fall. As a result, storage or an alternate biosolids management option must be available to handle biosolids when application is not possible. Forest lands and reclamation sites allow more leeway in the timing of applications. In some areas of the United States, application can proceed year round.

Application is most beneficial on agricultural land in late fall or early spring before the crop is planted. Timing is less critical in forest applications when nutrients can be incorporated into the soil throughout the growing period. Winter application is less desirable in many locales. Rangelands and pasturelands also are more adaptable to applications during various seasons. Applications can be made as long as ground is not saturated or snow covered and whenever livestock can be grazed on alternate lands for at least 30 days after the application. The timing of single applications in land reclamation programs is less critical and may be dictated by factors such as regulatory compliance schedules.

PERFORMANCE

In 1995, approximately 54 percent of wastewater treatment plants managed biosolids through land application, an increase of almost 20 percent from information reported in 1993 (WEF, 1997 and U.S. EPA, 1993.) The vast majority of these land application programs use agricultural land, with minor amounts applied to forest lands, rangelands, or land in need of reclamation.

The use of land application increased steadily in the 1980s for several reasons, including decreasing availability and increasing costs associated with landfill disposal. Research also helped refine procedures for proper land application. Meanwhile, implementation of the Nationwide Pretreatment Program resulted in significant improvements in biosolids quality. The 1993 adoption of the Part 503 Rule created a structure for consistent application procedures across the nation. The regulations were developed with input from the U.S. Department of Agriculture, the U.S. Food and Drug Administration, biosolids generators, environmental groups, the public, state regulators, and academic researchers. Conservative assumptions were used to create regulations to "protect public health and the environment from all reasonably anticipated adverse effects" (U.S. EPA, 1993).

Land application is a reliable biosolids management option as long as the system is designed to address such issues as storage or alternate management for biosolids during periods when application cannot take place due to unfavorable weather or field conditions. Public opposition rather than technical constraints is the most common reason for discontinuing land application programs.

> *"In fact, in all the years that properly treated biosolids have been applied to the land, we have been unable to find one documented case of illness or disease that resulted."*
>
> Martha Prothro, Former Deputy Assistant Administrator for Water, U.S. Environmental Protection Agency.

Source: Water Environment Web, 1998.

OPERATION AND MAINTENANCE

Land application systems generally use uncomplicated, reliable equipment. Operations include pathogen reduction processing, dewatering, loading of transport vehicles, transfer to application equipment, and the actual application. Operations and maintenance considerations associated with pathogen reduction processing are discussed in other fact sheets. The other operations require labor skills of heavy equipment operators, equipment maintenance personnel, and field technicians for sampling, all normally associated with wastewater treatment facilities.

In addition, the biosolids generator is responsible for complying with state and local requirements as well as federal regulations. The biosolids manager must be able to calculate agronomic rates and comply with record keeping and recording requirements. In fact, the generator and land applier must sign certification statements verifying accuracy and compliance. The generator should also allocate time to communicate with farmers, landowners, and neighbors about the benefits of biosolids recycling. Control of odors, along with a viable monitoring program, is most important for public acceptance.

COSTS

It is difficult to estimate the cost of land application of biosolids without specific program details. For example, there is some economy of scale due to large equipment purchases. The same size machine might be needed for a program that manages 10 dry tons of biosolids per day as one managing 50 dry tons per day; the cost of that machine can be spread over the 10 or 50 dry tons, greatly affecting average costs per dry ton. One source identified costs for land application varying from $60 to $290 per dry ton (O'Dette, 1996.) This range reflects the wide variety in land application methods as well as varying methods to prepare biosolids for land application. For example, costs for programs using dewatered biosolids include an additional step whereas costs for programs using liquid biosolids do not reflect the cost of dewatering. They do, however, include generally higher transportation costs.

Despite the wide range of costs for land application programs, several elements must be considered in estimating the cost of any biosolids land application program:

- Purchase of application equipment or contracting for application services.
- Transportation.
- Equipment maintenance and fuel.
- Loading facilities.
- Labor.
- Capital, operation and maintenance of stabilization facilities.
- Ability to manage and control odors.
- Dewatering (optional).
- Storage or alternate management option for periods when application is not possible due to weather or climate.
- Regulatory compliance, such as permit applications, site monitoring, and biosolids analyses.
- Public education and outreach efforts.

Land must also be secured. Some municipalities have purchased farms for land application; others apply biosolids to privately held land.

Some operating costs can be offset through the sale of the biosolids material. Since the biosolids reduce the need for fertilizers and pH adjustment, farmers sometimes pay to have biosolids applied to their lands.

REFERENCES

Other Related Fact Sheets

Odor Management in Biosolids Management
EPA 832-F-00-067
September 2000

Centrifugal Dewatering/Thickening
EPA 832-F-053
September 2000

Belt Filter Press
EPA 832-F-00-057
September 2000

Filter Press, Recessed Plate
EPA 832-F-00-058
September 2000

Alkaline Stabilization of Biosolids
EPA 832-F-00-052
September 2000

Other EPA Fact Sheets can be found at the following web address:
http://www.epa.gov/owmitnet/mtbfact.htm.

1. O'Dette, R.G., 1996. Determining the Most Cost Effective Option for Biosolids and Residuals Management. In *Proceedings of the 10th Annual Residuals and Biosolids Management Conference: 10 Years of Progress and a Look Toward the Future*. Alexandria. Water Environment Federation.

2. Sopper, W.E., Seaker, E.M., and Bastian, R.K., Editors, 1982. *Land Reclamation and Biomass Production and Municipal Wastewater and Sludge*. University Park. The Pennsylvania State University Press.

3. U.S. Environmental Protection Agency, 1995. *Amendments to the Standards for the Use or Disposal of Sewage Sludge (40 Code of Federal Regulations Part 503)*. Washington, D.C. U.S. Environmental Protection Agency.

4. U.S. Environmental Protection Agency, 1994. *Biosolids Recycling: Beneficial Technologies for a Better Environment.* EPA 832-R-94-009. Washington, D.C. U.S. Environmental Protection Agency, Office of Water.

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12. Water Environment Web, http://www.wef.org/doc/bioquotes.html, September 3, 1998.

13. Water Quality Management Library, 1992. *Municipal Sewage Sludge Management: Processing, Utilization and Disposal*, ed. Cecil Lue-Hing, David R. Zenz, Richard Kuchenrither. Lancaster. Technomic Publishing Company, Inc.

ADDITIONAL INFORMATION

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Chris Peot
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Arnold, MD 21012

For more information contact:

Municipal Technology Branch
U.S. EPA
Mail Code 4204
1200 Pennsylvania Avenue, NW
Washington, D.C. 20460

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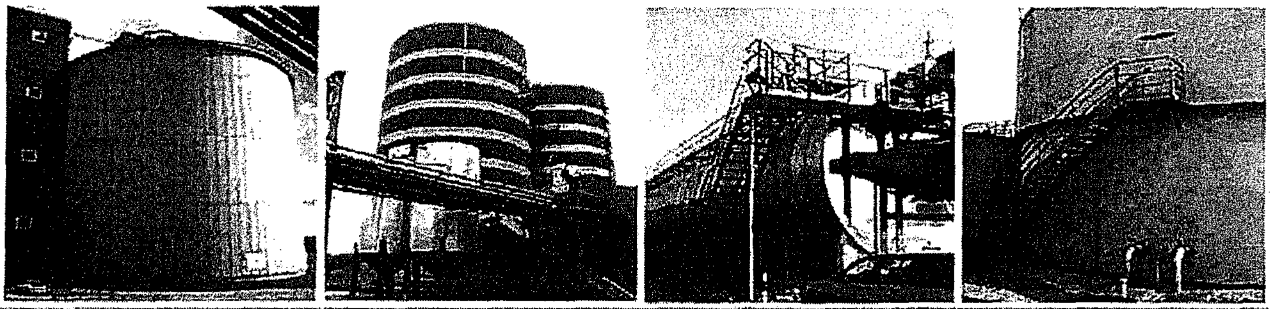
MUNICIPAL TECHNOLOGY BRANCH

Attachment 1-C

THE AD CENTRE

THE WALES CENTRE OF EXCELLENCE FOR ANAEROBIC DIGESTION

Search



MESOPHILIC AND THERMOPHILIC SYSTEMS

Anaerobic digesters are normally operated at either mesophilic temperatures (30-40°C) or moderately thermophilic temperatures (50-60°C), allowing optimal growth of the bacteria involved in the breakdown of the organic matter. The main advantages and disadvantages of operating at each temperature range are described below.

Mesophilic Digestion Systems

Mesophilic bacteria have an optimal temperature for growth between 30-40°C and consequently mesophilic digesters are usually operated at temperatures around 35°C. It is essential for efficient operation to control temperature since reaction rates drop off considerably as temperature falls below 35 C and there is also a sharp drop off in activity at temperatures above 45°C, as mesophilic bacteria become inhibited by the heat.

Mesophilic digestion systems are generally more stable than thermophilic systems due to the fact that a wider diversity of bacteria grow at mesophilic temperatures and these bacteria are generally more robust and adaptable to changing environmental conditions.

Case studies of operational mesophilic digestion systems can be seen below:

Vasteras Case Study

Kahlenberg Case Study

Greimel Case Study

Holsworthy Case Study

Thermophilic Digestion Systems

Thermophilic bacteria have an optimal temperature range of 50-60°C. Thermophilic digesters are usually operated as close as possible to 55°C. Thermophilic digestion offers the advantages of faster reaction rates compared to mesophilic digestion, leading to shorter retention times. Thermophilic digestion also provides better pathogen kill due to the higher temparatures, although this is less important if the waste stream is pasteurised as part of the treatment process.

Thermophilic systems are usually more expensive to operate as they require additional energy to maintain the higher operating temperatures. Another drawback of thermophilic systems is the greater sensitivity to operational and environmental conditions e.g. greater temperature control. For feedstocks rich in nitrogen where ammonium/ammonia can result in inhibition of the digestion process, thermophilic operation is less recommended.

Thermophilic systems can be of benefit where high solid content feedstock with optimal C: N ratios are available.

Case studies of operational thermophilic digestion systems can be seen below:

Zurich Otelfingen Case Study

Pohlsche Heide Case Study

Lintrup Case Study

Whichever thermal regime is used it is of great importance to keep the temperature as constant as possible as even small fluctuations in temperature can affect operating performance and the rate of biogas production. A sudden temperature drop can result in the inhibition of the methane producing bacteria (methanogens). Consequently, temperature control for the anaerobic digestion process is considered as one of the main design parameters.

Heat requirements to either the inflowing feed or to the digestion vessel are usually fulfilled on-site from the conversion of biogas to heat directly or via the recovered heat in a CHP unit. Digestion vessels should also be insulated since ambient temperature changes can also affect digestion performance.

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The LACSD Experience with Thermophilic Digestion: Start-up and Operation of a Full-Scale Reactor from Mesophilic Conditions

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ABSTRACT: Research on achieving Class A material through thermophilic digestion at 55 °C (131 °F) in a continuously fed, single reactor configuration was performed at the Districts' Joint Water Pollution Control Plant (JWPCP) in Carson. Bench-scale (8.0 l) work showed that sufficient thermophilies for seeding purposes exist in mesophilic cultures at 35 °C (96 °F). After stable bench-scale thermophilic operation was demonstrated, a 14,000 m^3 (3.7 million gal.) digester was converted from mesophilic operation to thermophilic operation. Conversion was complete in 3 months, and has led to stable operation and sustainable pathogen kill sufficient to meet the Class A pathogen standards. This level of pathogen destruction is possible because the Districts' digester design differs significantly from an idealized, continuous flow stirred tank reactor (CFSTR). Parameters investigated include pathogen destruction, gas production, VS destruction, volatile acids production, dewatering, steam usage, gas composition and odors. The energy requirement and odor generation potential make this process an unlikely choice for the Districts to pursue as a means of obtaining Class A material.

KEYWORDS: thermophilic, pathogen, digester, fecal coliforms, Class A

INTRODUCTION

Early in 1999, the County Sanitation Districts of Los Angeles County (Districts) recognized the possibility that future options for the disposal of Class B biosolids would be increasingly limited. Proposed legislation in counties important to the Districts' biosolids disposal strategy call for the prohibition of Class B biosolids disposal originating from sources outside those counties. With these possible restrictions on the horizon, the Districts began investigating options for generating Class A biosolids.

One focus in this effort was with thermophilic digestion. This investigation began with some early bench-scale work which demonstrated that a safe, controlled start-up with mesophilic seed was possible, and that stable thermophilic operation could be maintained. These efforts gave Districts' management the confidence to start testing in January 2000 with a plant-scale digester.

LOS ANGELES COUNTY FACILITIES AND BIOSOLIDS GENERATION

This test digester is located at one of the Districts•largest facilities, the Joint Water Pollution Control Plant (JWPCP) in Carson. This plant plays a pivotal role in the Districts• solids treatment and disposal strategy. The Sanitation Districts operate 11 wastewater treatment plants treating a basin-wide flow of approximately 25.2 m^3/s (576 MGD) for roughly 5.0 million people located in the greater metropolitan Los Angeles County area. Six of the Districts largest facilities are connected through a regional network of sewers and treatment facilities known as the Joint Outfall System (JOS) servicing the wastewater treatment needs of roughly 4.6 million people. The public served by this system generate roughly 21.9 m^3/s (500 MDG) of wastewater that is conveyed though over 1600 km (1000 miles) of main trunk sewers to those six facilities.

JWPCP FACILITIES, DIGESTION AND SOLIDS HANDLING

The solids generated by the tertiary treatment of 7.23 m^3/s (165 MGD) of wastewater by 5 upstream water reclamation plants in the JOS are conveyed to the Districts•largest wastewater treatment facility, the JWPCP for final processing. Additionally, the JWPCP itself is responsible for the treatment of 14.7 m^3/s (335 MGD) of sewage. The majority of this flow receives treatment at that facility•s pure oxygen secondary reactors, while the balance receives advanced primary treatment. These two effluents are re-combined before final discharge to the ocean. Beginning in December 2002, the JWPCP will begin operation as a full secondary treatment facility. Thus, the JWPCP is the lead facility in the treatment and disposal of the solids generated by the treatment of roughly 21.9 m^3/s (500 MGD) by the JOS.

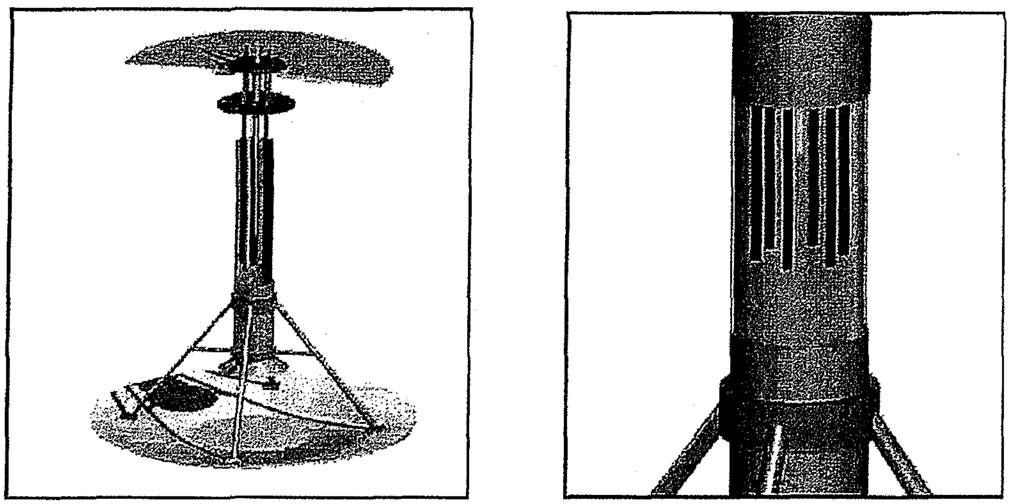
The JWPCP digestion system treats roughly 0.18 m^3/s (4 MGD) of combined sludge flows, resulting in a hydraulic retention time (HRT) for this system of about 18 to 20 days. The feed consists of 0.15 m^3/s (3.5 MGD) of roughly 3.5 % TS, 72% VS primary sludge, and 0.020 m^3/s (0.45 MGD) of 5.5% TS, 77% VS Thickened Waste Activated Sludge (TWAS). All except the digester set aside for thermophilic operation operate at 35 °C (96 °F). All these anaerobic digesters use steam injection for heating and gas re-circulation with draft tubes for mixing. There are 20 feeding events per day, making the feeding partially continuous.

The plant digesters are roughly 14,000 m^3 (3.7 million gallons) in volume. They are 38.1 m (125 ft) in diameter and 15.2 m (50 ft) deep at its lowest point. Each digester has in service a 93.2 kW (125 hp) blower that is used for gas recirculation and injection at each draft tube mixer. There are 5 draft tubes per digester; internal views of these draft tube mixers are shown in Figure 1. The right hand view reveals the six gas lances where compressed digester gas is released to provide the lifting force, and one centrally located steam lance. The steam lance exposes the rising sludge column to saturated steam at 118 °C (244 °F). Each draft tube mixer creates a region of high mixing intensity wherein a CSTR-like zone is developed. Digested sludge must pass through several of these high intensity mixing zones before exiting the digester.

The location of the feed inlet and the digested sludge run-off are at opposite ends of the digester and at opposite elevations as shown in Figure 2. The feed is admitted on top of the liquid, while the digester effluent is drawn from an opening in the run-off pipe about 9.1 m (30 ft) below the liquid level, and about 33.5 m (110 ft) horizontally from the feed entrance point. In this arrangement, sludge has to pass through several zones of mixing before it can exit the digester. This pathway minimizes short circuiting of the feed into the digested sludge effluent, and creates a reactor flow pattern that is a hybrid of a true CFSTR and plug flow. This distinction is important because theoretically, an idealized, single stage, CFSTR even if operated at thermophilic temperatures cannot achieve the necessary pathogen kill at a 20 day HRT (Schafer, 2000; Krugel, 1998).

Figure 1: Digester Draft Tube Mixer Internal Views

(not to scale)



These digesters produce roughly 227,000 m^3 (8 million ft^3) of digester gas each day. Hydrogen sulfide in this gas is controlled by the aggressive dosing of iron salts to the collection system and to the primary sludge. Currently, about 2400 gallons of 32 % by wt. ferrous chloride solution are added per million gallons of sludge fed. This iron salt addition program is needed to satisfy the requirements of the local air quality management district which enforces a 40 ppm total sulfur limit for gaseous fuels. However, no ferric salts are added to assist in primary settling under normal operating circumstances, instead, anionic polymer is added. Roughly 85% of this gas volume is combusted in gas turbines that generate 13 MW of electrical power that is used on site or exported to the local power grid. The remaining gas is used by the boilers for steam generation, or to power internal combustion engine driven pumps.

At the solids handling facilities, digested biosolids are dewatered to about 27% TS by low-speed scroll centrifuges. Mannic, cationic polymer is added at a dose of roughly 10-12 lb of polymer per ton of dry cake to assist dewatering. The roughly 1400 wet tons per day of cake solids are temporarily stored in sludge silos before loading onto trucks for final disposal. This mass corresponds to about 60 truckloads a day of Class B material. About 55% of this cake is land-applied, 36% composted off-site, and remainder is either incinerated in a cement kiln or buried in a Districts operated landfill.

Proposed legislation in three counties important to the Districts•biosolids disposal plan targets the land application of Class B biosolids. There are even attempts by some counties to restrict the application of Class A biosolids generated from sources outside of those counties. Since the options for Class B disposal seem to be disappearing much faster than those for Class A, the added expense necessary for unit-processes that can achieve Class A status is more justifiable. Of those options that could be applied at the JWPCP, thermophilic digestion is the one on-site option that would require the least amount of new construction and the lowest capital cost to implement.

LABORATORY PROCEDURES

The digested sludges were analyzed for Total Solids (EPA 160.3), Volatile Solids (EPA 160.4), pH (Standard Methods 4500-H+), alkalinity (Standard Methods 2320B), volatile acids (Standard Methods 160.4), and ammonia-nitrogen (Standard Methods 4500-NH3 B and E). Volatile solids destruction was calculated using the van Kleeck formula. For this project, a gas chromatography method for fractioning and determining the individual volatile acids in a digested sludge matrix was refined. In this method, the speciated volatile acid samples were prepared for gas chromatography by acidification, centrifugation, and filtration of the samples. These prepared samples were then analyzed for the individual acids by GC (gas chromatography) / FID (flame ionization detection) by Standard Methods draft method 5560D. Bi-weekly volatile acids analysis of digested sludges from thermophilic and mesophilic digesters, and of spiked samples by the GC method and method 160.4 show very close agreement (within 10% relative error).

Volatile organic compounds in digester gas were determined by GC/MS (mass spectroscopy) using a method based on USEPA Method TO-15. Total hydrocarbons in digester gas samples were determined by GC/FID using a method based on USEPA Method TO-12.

Permanent gases (fixed gases) in digester gas samples were determined using GC/TCD (thermal conductivity detection). Sulfur gases in digester gas were determined using GC/SCD (sulfur chemiluminescence detection) by SCAQMD Method 307.91. Hydrogen sulfide analysis was included in the GC sulfur gas work performed weekly, and was determined daily by colorimetric tube. Siloxanes were analyzed by a GC-MS method developed in the JWPCP laboratory, utilizing sample collection as in Method TO-15, and heated loop injection into a non-polar DB1 capillary column followed by mass spectroscopy.

Fecal coliform levels were determined by 18th edition Standard Methods 9221.E. The density of *Salmonella* sp. was determined by the MSRV (modified semi-solid Rappaport-Vasilliadis) method (EPA draft Method 1682). The helmith ova detection and viability were determined through the method outlined in Appendix I of EPA/625/R-92/013 (White House document). Enteric Viruses were determined using modifications of EPA methods found in The Manual of Methods for Virology, chapters 7 and 10.

BENCH-SCALE EFFORTS

The Research department at the JWPCP has operated bench-scale digesters in various configurations since the early 1980's. At the time this investigation began, these 8.0 l, bench-scale, batch-fed digesters were operating at the same mesophilic temperatures and the same HRT as the plant digesters. The importance of their operation for this study was in the verification of a scheme to convert these mesophilic digesters to stable thermophilic operation.

The first attempt to convert these bench-scale mesophilic digesters to thermophilic temperatures utilized a slow ramping of the temperature (Garber, 1975). The feed rate was kept constant while the temperature was elevated 0.5 °C (1 °F) per week. When the temperature reached 39.4 °C (103 °F), the gas production plummeted and the volatile acids quickly started to rise. Further temperature increases did not result in a resumption of gas production to levels consistent with normal digestion, and the volatile acids alkalinity ratio approached 0.5. After 4 months of operation under these conditions this effort was abandoned.

On June 15th, 1999, a shock temperature increase method was used to develop a thermophilic culture from mesophilic seed (Aitken and Mullennix, 1992). In this method, one of the bench-scale digesters was filled nearly to the top with mesophilicly digested sludge. Once filled, this digester was then immediately placed in a water bath preset to a thermophilic operating temperature of 55 °C (131 °F). Initially, no sludge was fed to this digester. Small aliquots of digested sludge were removed once per day for volatile acids, pH and alkalinity analysis. These parameters were tracked to determine if any trend developed. Within nine days, the volatile acids reached a peak of 1460 mg/l as acetic even though the digester had not been fed. When the volatile acids level dropped to below 200 mg/l, feeding was initiated at a rate near a 600 day HRT. This initial feed rate was chosen because it was the result of feeding the smallest amount of sludge that could be reliably measured. The feed volume was doubled every 10 days to reflect the anticipated growth of the thermophilies (Ghosh, 1999) and to include a safety factor against the process turning sour. The goal in this effort was to develop a guaranteed method of start-up applicable to the plant digesters, not to define the quickest means of starting a thermophilic culture. The Districts philosophy was that it was better to develop a culture slowly with great certainty in its stability than to attempt a fast but potentially unstable startup. Such an unstable start-up would produce 3.8 million gallons of highly odorous sludge creating a nuisance in the community . Within two months, the bench-scale digester was steadily operating at thermophilic temperatures with the same relative feed rate as the plant digesters.

PLANT-SCALE THERMOPHILIC CONVERSION

After stable and successful bench-scale thermophilic operation was demonstrated, plans were made for the conversion of one, 14,000 m^3 (3.7 million gallon) mesophilic digester to thermophilic conditions. The procedure used for this conversion was the same as that used for the bench-scale digesters. Eight hours after terminating feed to one of the mesophilic digesters, all the steam valves to that digester were opened completely, raising the temperature as quickly as possible. The temperature was allowed to increase until the target temperature of 55 ^{o}C (131 ^{o}F) was reached roughly 4 days later. The volatile acids and gas production were monitored to determine the timing and amount of feed to add as in the case of the bench-scale digesters. Within two weeks of achieving thermophilic temperatures, the volatile acids peaked at 1200 mg/l as shown in Figure 3 even though no feed was being sent to the digester. When the volatile acids dropped to just above 300 mg/l 12 days later, 18.9 m^3 (5000 gal.) of raw primary sludge was fed to the digester. This amount was chosen because it is the smallest volume that can be reliably measured by the plant instrumentation. The feed increase rate was again chosen to match the anticipated growth rate of the thermophilic methanogens with a conservative safety factor built in. After about two months of feed increases, the feed rate to the thermophilic digester matched that of the other plant digesters and successful thermophilic operation was achieved.

THERMOPHILIC LONG TERM OPERATION

During the operation of this process, there were events that could have put the digester operation at risk. On one occasion, the steam valve was accidentally closed for several days dropping the temperature from 55 °C (131 °F) to 52.2 °C (126 °F) in three days. Shortly thereafter, one of the feed valves stuck open sending uncontrolled amounts of sludge into the digester. In spite of these events, pathogen kill was maintained, and the process quickly recovered, demonstrating the unanticipated resilient nature of this process.

The only indication of potential instability was a brief rise in the volatile acids content shown in Figure 4, and a distribution shift of volatile acids towards propionic and higher shown in Figure 5. The higher mol. wt. volatile acids generated in these events have more potential to cause odor problems than the volatile acids normally produced (Ghosh, 1999). Operation under more typical conditions show a different distribution of volatile acids with acetic being most common, and a higher volatile acids content overall.

Figure 6 displays the gas production for the 90 day period from March through May 2001. For the most part, the gas production from both the mesophilic and thermophilic units are in step with each other. The fluctuations shown represent weekly variations in the volatile solids loading to the digesters. These results are on a dry basis and corrected to standard conditions. The slightly lower gas production from the thermophilic digester is consistent with the volatile solids destruction results which are roughly 50% for the mesophilic and 48% for the thermophilic. The gas produced per pound VS destroyed is similar to that obtained in mesophilic digestion. These gas production, VS destruction and stability results are contrary to what was expected before this investigation began (Buhr and Andrews, 1977).

Figure 7 shows the fecal coliform densities for the different sludges being tested for the most recent 90 day period. The high value in that time frame is 770 MPN / g. In spite of the fact that this process occurs in one CFSTR, the Class A fecal coliform standard is met. This is possible because the sludge must pass through several mixing zones and come into direct contact with steam inside the draft tube mixers before exiting the digester.

Table 1 shows the results for some other pathogens of interest. This process is effective in achieving pathogen destruction for *Salmonella* sp., viable Ascaris Ova and enteric viruses. All the EPA 503 pathogen standards for Class A material are met even though the thermophilic digestion process is not operated in batch mode. Note also that the result for the viable Ascaris Ova for the raw sludge is already close to the EPA 503 limit.

These data leave open the possibility that thermophilic digestion as performed at the JWPCP could meet the Class A criteria either under Alternative 4 (Sewage Sludge Treated in Unknown Process), or Alternative 6 (Use of a Process Equivalent to PFRP). One difficulty is that the inlet levels of Ascaris Ova are too low to demonstrate consistent ova inactivation. It is unrealistic to spike a 14,000 m^3 plant scale digester with enough ova to determine Class A equivalency. Sophisticated tracer tests are needed to demonstrate the true flow pattern inside the JWPCP digesters, to determine the fraction of sludge that passes through the draft tube mixers and the actual time sludge spends in the draft tube while it is in direct contact with saturated steam at 118 °C (244 °F).

Table 1: Results for Other Pathogens of Interest

Pathogen	Units	Thermophilic Digester Effluent	Mesophilic Digester Effluent	Undigested Primary and TWAS	EPA 503 Class A Standard
Salmonella	MPN/g	< 0.08	102	1100	< 0.75
Total Ascaris	ova/g	< 0.2	No Data	0.34	
Viable Ascaris	ova/g	< 0.04		0.27	< 0.25
Enteric Viruses	pfu/g	< 0.21	< 0.6	33	< 0.25

Table 2 summarizes operational results obtained in the comparison of thermophilic and mesophilic digestion at the JWPCP. The pH increase caused by the enhanced protein decomposition seen in thermophilic digestion is not trivial, it will have real effects on the dewatering of the sludge because the polymer used at the JWPCP has an optimum pH range that corresponds better with mesophilic sludge than thermophilic sludge. At the pH range typical of thermophilic sludge, both jar tests and dewatering tests show that roughly 25% more polymer was needed to get the same level of cake dryness as from the dewatering of mesophilic digested sludge. There was little difference between the percent solids capture of these options.

Table 3 summarizes the gas analysis obtained during this testing. The gas from the thermophilic digester has more contaminants in general than mesophilic digester gas. Since 85% of the digester gas is combusted in gas turbines that require extensive gas pre-treatment, the presence of additional gas contaminants will necessitate a re-design of that system if this plant is to convert to thermophilic operation. One interesting phenomena displayed in the thermophilic digester is the apparent inhibition of reductive dehalogenation. In an anaerobic, mesophilic environment, tetrachloroethylene is broken down in a series of reactions that ultimately produce vinyl chloride (Vogel, T. M., and P.L. McCarty.,1985). This process appears to be inhibited at the step that converts trichloroethylene to cis-,1,2-dicholroethylene in the thermophilic environment as evidenced by the build-up of trichloroethylene.

Odor work performed during the dewatering tests show that thermophilic samples were on average 30% higher in odor strength than mesophilic samples. Additionally, the personal experience of the Operations staff and Districts Management that witnessed the test indicates that the hedonic tone is much less acceptable. One possible explanation for this fact is reflected in Figure 4 which shows the volatile acid distribution for the sludges tested. The higher molecular wt. acids found in thermophilic effluents have greater potential to generate objectionable odors than acetic acid on its own (Ghosh, 1999). Additionally, the thermophilic effluents contain slightly higher amounts of ammonia which can also contribute significantly to odor.

Table 2: Operational Comparison between Thermophilic and Mesophilic Anaerobic Digestion

Lab or Operational Parameter	Units	Thermophilic 30 Day Average	Mesophilic 30 Day Average
Vol. Acids as Acetic by Distillation Method	mg/l	140	13
Alkalinity as CaCO3	mg/l	3488	3471
Ammonia Nitrogen	mg/l	1002	879
pH		7.63	7.26
Digested Sludge Total Solids	%	2.55	2.68
Digested Sludge Volatile Solids	%	60.9	60.5
Methane Content, Dry Basis	%	62.5	63.1
Carbon Dioxide Content, Dry Basis	%	37.5	36.9
Moisture Content	%	10.0	4.25
Hydrogen Sulfide	ppm v/v	25.0	16.8
Gas Produced, Wet, Non-Standard	m^3 / day	13.7	13.8
Methane Produced, Dry Basis Using % CH4 30d Average	m^3 / day	7.73	8.34
Raw Sludge Total Solids 30 d Average	%	3.74	3.74
Raw Sludge Volatile Solids 30 d Average	%	74.6	74.6
TWAS Total Solids 30 d Average	%	4.94	4.94
TWAS Volatile Solids 30 d Average	%	77.7	77.7
Flow Weighted Average Feed % TS	%	3.97	3.97
Flow Weighted Average Feed % VS	%	75.2	75.2
Volatile Solids Destruction	%	46.3	47.2
Dry-Basis CH4 Produced per # VS Destroyed	m^3 / kg-VS	0.73	0.76
Steam Usage	kg/d x 10^3	52.6	19.2
Temperature	°C	55.3	35.7
Raw Sludge Feed	m^3 / day	611.2	625.8
TWAS Feed	m^3 / day	160.3	162.5
Hydraulic Retention Time	Days	18.2	20.2

Table 3: Analysis of Thermophilic and Mesophilic Digester Gases

Compound	Units	Thermophilic Average	Mesophilic Average
Hydrogen Sulfide	ppm v/v	25.0	16.8
Methyl Mercaptan	ppm v/v	0.77	0.26
Ethyl Mercaptan	ppm v/v	0.83	0.27
Carbonyl Sulfide	ppm v/v	0.25	0.25
Carbon Disulfide	ppm v/v	0.30	0.26
Dimethyl Sulfide	ppm v/v	0.28	0.25
Dimethyldisulfide	ppm v/v	0.25	0.25
Nonmethane Organics TO-12	ppm as C	3770	1728
Methylene Chloride	ppb v/v	52	46
Chloroform	ppb v/v	9.4	9.5
1,1,1-Trichloroethane	ppb v/v	5.5	5.7
Carbon Tetrachloride	ppb v/v	5.0	4.8
1,1-Dichloroethene	ppb v/v	6.8	6.8
Trichloroethylene	ppb v/v	191	32
Tetrachloroethylene	ppb v/v	287	33
Chlorobenzene	ppb v/v	23	693
Vinyl Chloride	ppb v/v	6.7	119
O-Dichlorobenzene	ppb v/v	456	257
M-Dichlorobenzene	ppb v/v	97	100
P-Dichlorobenzene	ppb v/v	455	253
1,1-Dichloroethane	ppb v/v	6.3	5.9
1,2-Dichloroethane	ppb v/v	87	84
Benzene	ppb v/v	622	520
Toluene	ppb v/v	3053	2274
Ethyl Benzene	ppb v/v	817	626
O-Xylene	ppb v/v	1603	1127
M & P- Xylene	ppb v/v	4121	2968
Methyl-Tert-Butyl-Ether	ppb v/v	1241	836
Acetonitrile	ppb v/v	146	130
Freon 11 (CCl3F)	ppb v/v	4.8	4.6
1,2-Dibromoethane	ppb v/v	6.2	5.8
1,3-Butadiene	ppb v/v	13	12
Cis-1,2-Dichloroethylene	ppb v/v	20	231
Benzyl Chloride	ppb v/v	234	230
Octach3cyclotetrasiloxane	ppm v/v	4.8	3.0
Decach3cyclopentasiloxane	ppm v/v	6.0	1.5

CONCLUSIONS

Although the Districts have done a lot of work on thermophilic digestion, it is not a given that this is the route will lead the Districts to Class A biosolids. Another possibility is to expand the Districts' off-site composting activities. Off-site composting has the advantages of requiring less capital investment, lower energy requirements, and diminished chance of creating an odor nuisance.

Odor issues are paramount to the Districts because this facility is located in a densely populated area in the Los Angeles air basin; over 14,000 people live within a 1/4 mile radius of the JWPCP's boundaries. The community surrounding this facility includes some school zones and other sensitive receptors. The Districts' have made tremendous strides in their efforts to mitigate odors from the JWPCP such as moving off-site the extensive windrow composting operation, replacing old covers for primary treatment process and enhanced odor control stations employing caustic scrubbers and activated carbon. Nevertheless, people in this community believe that the JWPCP can be a source of significant odors. Because of this heightened sensitivity, community activists have developed capable methods of organizing opposition to those plant operations that they feel have the capability to generate strong odors. Just as importantly, there are odor nuisance laws that are enforced by the SCAQMD which the Districts have to obey to maintain operating permits. If thermophilic digestion was operated full scale at the JWPCP, it is likely that only the most aggressive odor control system could contain and treat the odors, leaving open the possibility that a serious nuisance problem could develop. Finally, an odorous product will have difficulty finding public acceptance and hence a market even if it is Class A material. Ultimately, the Districts' concern for the odor potential of this process is one reason why it is unlikely that thermophilic digestion will be pursued as a means of obtaining Class A status.

One advantage that thermophilic digestion has over other alternatives for generating Class A biosolids is that this option would require the least amount of new construction for the JWPCP compared to pasteurization. Nevertheless, a rough estimate of the cost for the conversion of the plant digestion system to thermophilic operation is about $30 million, not including upgraded odor control for the JWPCP solids handling facilities. The additional natural gas needed for digester heating is over $2.8 million per year. These capital and energy costs are far in excess of that needed for off-site composting even if the sludge cake has to be trucked over 100 miles to reach the composting site.

ACKNOWLEDGMENTS

The Districts would like to thank Dr. Sam Ghosh for the expertise he provided during the early stages of this project.

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105

June 11, 2012

In Reply Refer To: WTR-7

Ross Tanimoto, Deputy Director
Department of Environmental Services
City and County of Honolulu
1000 Uluohia Street, Suite 308
Kapolei, Hawaii 96707

Re: April 18, 2012 Clean Water Act Inspection

Dear Mr. Tanimoto:

Enclosed is the June 5th report for our April 18, 2012 inspection of the sludge handling processes of the Sand Island Wastewater Treatment Plant. Please submit a short response to the findings in Sections 1 and 2, to EPA, and the Hawaii Department of Health, by **August 30, 2012**. The main findings are summarized below:

1 A single digester operates at capacity or at times slightly over capacity, as measured by a comparison of solids retention times (SRT) against standard design criteria. Because the 2010 Consent Decree interim limits are statistically equivalent to the effluent discharge quality in 2009-2010, any increases in treatment plant loadings since then would necessitate increased solids removals, which if directed into the digester for waste stabilization would reduce the SRT and interfere with the reuse and disposal of sludge.

2 There is no redundant waste stabilization capacity. Any digester failure or scheduled maintenance of the digester lasting longer than the retention time in the sludge holding tanks (~ two weeks) would impair the ability to operate the Sand Island WWTP.

We appreciate your helpfulness extended to us during this inspection. We are available to the State of Hawaii Department of Health, and to you to assist in any way. Please do not hesitate to call Greg V. Arthur of my staff at (415) 972-3504 or e-mail at arthur.greg@epa.gov.

Sincerely,

Original signed by:

Ken Greenberg, Chief
CWA Compliance Office

Enclosure

cc: Mike Tsuji, HDOH

U.S. ENVIRONMENTAL PROTECTION AGENCY

REGION 9

CLEAN WATER ACT COMPLIANCE OFFICE

NPDES COMPLIANCE EVALUATION INSPECTION REPORT

NPDES Permittee:	City and County of Honolulu (NPDES Permit No. HI0020117)
Facility:	Sand Island Wastewater Treatment Plant Solids Handling Facilities 91-480 Malakole Street, Honolulu, Hawaii 96707
Receiving Water:	Pacific Ocean
Date of Inspection:	April 18, 2012

Inspection Participants:

US EPA:	Greg V. Arthur, Region 9, CWA Compliance Office, (415) 972-3504
Hawaii DOH:	Mike Tsuji, Supervisor, Enforcement Section, (808) 586-4309
City & County of Honolulu:	Earl Ng, Assistant Chief, Treatment Disposal Div, (808) 368-3468 Ross Tanimoto, Dep Director, Dept Envr Services, (808) 682-2282 Herman Tombee, Sand Island Shift Supervisor, (808) 768-4434
Synagro:	Clyde Harris, Plant Manager, (727) 546-2875 Jon Waltjen, Operations Manager, (808) 847-0800 Additional Info – On 6/1/12 from Layne Baroldi by e-mail

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Report Prepared By:	Greg V. Arthur, Environmental Engineer June 5, 2012

1.0 Scope and Purpose

On April 18, 2012, EPA and the State of Hawaii, Department of Health (HDOH) conducted a compliance evaluation inspection of the solids handing facilities of the City and County of Honolulu's (CCH) Sand Island Wastewater Treatment Plant, located in Honolulu, Oahu, Hawaii (Sand Island WWTP). The purpose was to ensure compliance with the NPDES permit and applicable Federal regulations covering the operation of the wastewater treatment plant solids handling facilities. In particular, it was to ensure:

- Compliance with the Standard NPDES permit Conditions, regarding the proper operation and maintenance of the solids handling facilities.

The Sand Island WWTP is a major NPDES permitted discharger of treated domestic wastewaters to waters of the United States. HDOH last issued NPDES Permit No. HI00200117 to CCH on September 30, 1998 with less-than-secondary limits based on a 301(h) waiver from the Federal secondary standards for organics and solids. In addition, CCH, EPA and HDOH agreed to a consent decree lodged on August 10, 2010. The 2010 Consent Decree established performance-based interim limits for organics and solids that supersede the NPDES permit limits until completion of the final compliance milestones set in Item 31 of the Consent Decree. The participants of this compliance evaluation inspection are listed on the title page. Arthur conducted the inspection.

See Figure 1 in Section 1.1 on page 3 for a schematic of the layout and configuration of the Sand Island WWTP solids handling facilities. Photo documentation of this inspection follows in Section 1.5 on page 5.

1.1 Facility Description

Ownership - CCH owns all portions of the Sand Island WWTP including the solids handling facilities inspected by EPA on this day.

Solids Generation - The Sand Island WWTP generates sludge solely from advanced chemically-aided primary clarification. The treatment plant does not provide secondary biological treatment. The primary sludge includes the dosed ferric chloride coagulant and polymer flocculent necessary to keep the solids removal rates high enough to maintain compliance with the 2010 Consent Decree interim limits for solids and organics in the WWTP effluent discharge. For April 2011 through March 2012, CCH determined that the Sand Island WWTP primary sludge generation rate averaged 28 dry tons per day and ranged from 24 to 33 dry tons per day. CCH also determined the solids content of thickened primary sludge to average 6.4% and range from 5.0% to 7.0%. This results in the production of 100,000 to 120,000 gallons of thickened primary sludge for solids handing.

Solids Handling Facilities - The solids handling facilities comprises thickened sludge equalization in four holding tanks each with a capacity of 108,000 gallons, anaerobic stabilization in a single 2.35 million gallon egg-shaped digester, stabilized sludge equalization in an 800,000 gallon surge holding tank, centrifuge dewatering, solids pelletizing through drum oven drying and cooling, and pelletizing fume destruction through an air condenser, bag house, fume scrubber, and thermal-oxidizer. See Photos #1, #2, and #3 in Section 1.5 on page 5 of this report.

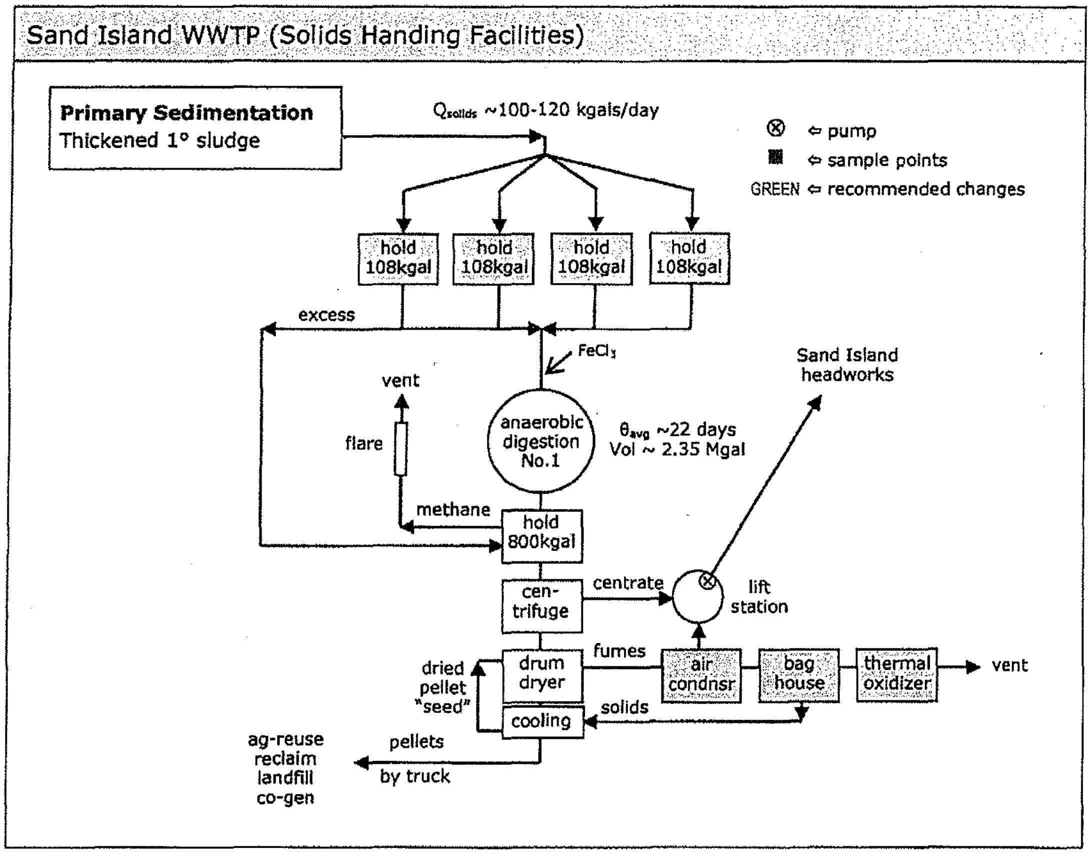

Figure 1 – Current Configuration and Layout

1.2 Facility Operations

CCH contracts with Synagro to provide the operation and maintenance of the Sand Island WWTP solids handling facilities.

Delivery - The operating procedures start with CCH informing Synagro of how much thickened primary sludge must be drawn from the Sand Island WWTP for disposal. The Synagro representatives stated that currently they are required to draw between 100,000 and 120,000 gallons of sludge per day. Synagro directs the thickened primary sludge to a single egg-shaped digester but can temporarily bypass excess volumes around the digester to the centrifuge and drum drying oven for stabilization through sludge drying. The CCH representatives indicated that in the past year, because of intermittent digester operations over capacity, CCH prepared emergency procedures to off-haul excess sludge by truck to other CCH wastewater treatment plants.

Digester Operation - Synagro operates the single digester in the mesophilic temperature range with the digester temperature kept at a constant 97.9°F to 98.2°. Digester capacity and the sludge loading rates resulted in solids retention times (SRTs) in April 2011 through March 2012 that averaged 22 days, with the minimum and maximum SRTs ranging from 19 to 26 days. According to CCH, the digester produces between 250,000 and 300,000 standard cubic feet of methane per day.

Dewatering - Synagro outlets digested sludge from the digester to a surge tank for metered feed through two dewatering centrifuges followed by a pelletizing drum dryer. The dryer operates at a sludge inlet temperature of 1,000°F, with a cooling cycle reducing the pellet outlet temperature to 200°F. The oven heating involves burning methane generated by the digester with excess methane burned by flare. The surge tank provides 6.5 to 8.0 days of stabilized sludge holding. Fumes from the pelletizing drum dryer also are directed through fume scrubbing with the bag house solids returned to the drum dryer, and air condenser condensate returned along with centrifuge centrate to the Sand Island WWTP headworks.

Solids Disposal - CCH collects the pelletized digested sludge for off-hauling by truck to agriculture reuse when the SRT is over 18 days. According to CCH, when the SRT is less than 18 days, CCH hauls the pelletized digested sludge to a municipal landfill. Also according to CCH, Hawaiian Electric by agreement can take digested sludge for co-generation but only when the SRT is over 18 days. See Photo #4 in Section 1.5 on page 5 of this report.

1.3 Facility SIC Code

The CCH Sand Island Wastewater Treatment Plant is assigned the SIC code for sewerage systems (SIC 4952).

1.4 References

[1] WEF Manual of Practice 8, Design of Municipal Wastewater Treatment Plants, Volume 3, Chapter 22 Stabilization, pp. 22-20, 4th Ed. 1998, Water and Environment Federation, Alexandria, VA, and the American Society of Civil Engineers, Reston, VA. http://www.wef.org/mop8

[2] Ibid., WEF Manual of Practice 8, Vol 3, Chapter 22, pp. 22-17 and 22-27.

[3] Ibid., WEF Manual of Practice 8, Vol 3, Chapter 22, pp. 22-32.

[4] Ibid., WEF Manual of Practice 8, Vol 3, Chapter 22, pp. 22-12 and Figure 22.2.

1.5 Photo Documentation

Four of the six photographs taken during this inspection are depicted below and saved as *sandisland-01-041812.jpg through sandisland-06-041812.jpg.*

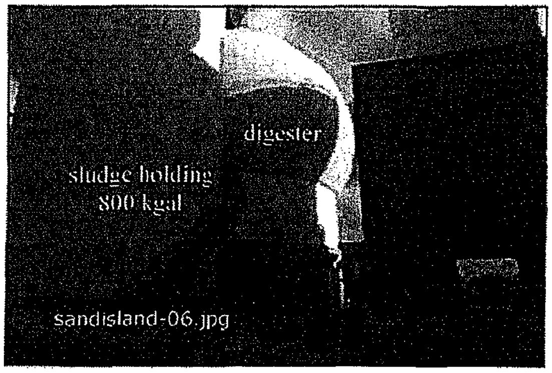

Photo #1: Sand Island WWTP Single Digester
Taken By: Greg V. Arthur
Date: 04/18/12

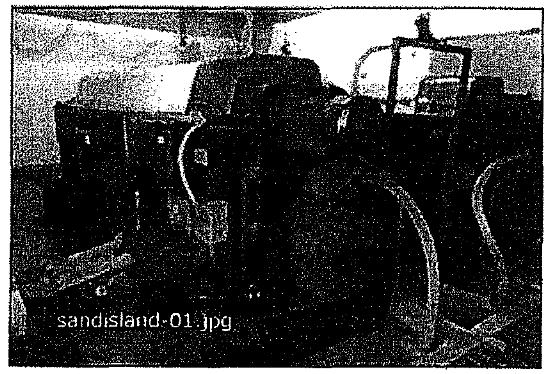

Photo #2: Sand Island WWTP Sludge Centrifuges
Taken By: Greg V. Arthur
Date: 04/18/12

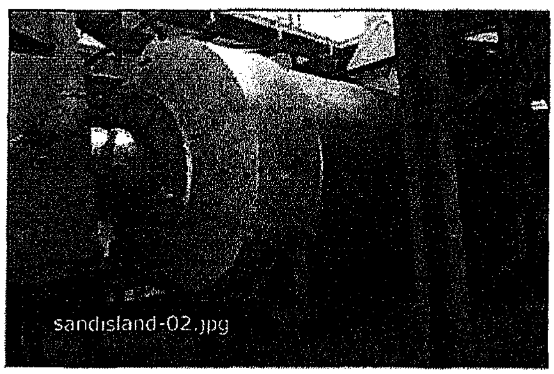

Photo #3: Sand Island WWTP Pelletizer Drum Dryer
Taken By: Greg V. Arthur
Date: 04/18/12

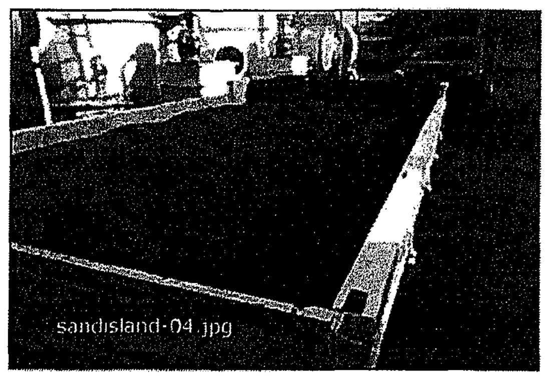

Photo #4: Sand Island WWTP Sludge Pellets
Taken By: Greg V. Arthur
Date: 04/18/12

2.0 NPDES Permit Limits and Conditions

> *The Permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the Permittee to achieve compliance with the conditions of this permit. Proper operation and maintenance also includes adequate laboratory controls and appropriate quality assurance procedures. This provision requires the operation of back-up or auxiliary facilities or similar systems which are installed by the Permittee only when the operation is necessary to achieve compliance with the conditions of this permit.*
>
> *NPDES Permit No.HI0020117*
> *Provision 9, HDOH Standard NPDES Permit Conditions*

This compliance review was limited to NPDES permit provisions regarding the proper operation and maintenance of the solids handling facilities at the Sand Island WWTP.

Summary

Synagro currently operates the single Sand Island WWTP digester at capacity or at times slightly over capacity, as measured by a comparison of solids retention times (SRT) against standard design criteria. Because the 2010 Consent Decree interim limits are statistically equivalent to the discharge quality in 2009-2010, any increases in treatment plant loadings would necessitate increased solids removals, which if directed to the digester for waste stabilization would reduce the SRT and interfere with sludge reuse and disposal. Since the removal of primary solids is necessary to achieve compliance with the consent decree interim limits, and since removed solids require stabilization for disposal, operating the digester at SRTs below standard design criteria would not be considered proper operation and maintenance of the treatment and control used to achieve compliance.

Requirements

- None.

Recommendations

- CCH should increase digester capacity in order to increase the solids retention time above the standard design criteria.

- CCH should provide enough redundant digester capacity to ensure the continuous operation of the solids stabilization facilities at the Sand Island WWTP.

2.1 Performance Requirements

The 2010 Consent Decree established interim limits for biochemical oxygen demand (BOD), and total suspended solids (TSS) based on the recent past performance of the Sand Island WWTP. These interim limits are listed below. They were derived from an analysis of daily self-monitoring results from 2009-2010 and set at the statistically calculated 95^{th}% events.

2010 Consent Decree Interim Limits			
Sand Island WWTP	Month-Avg	Week-Avg	Daily-Max
BOD concentration	119 mg/l	122 mg/l	-
mass loading	89414 lbs/day	91594 lbs/day	-
removal rate	30%	-	-
TSS concentration	48 mg/l	50 mg/l	-
mass loading	36349 lbs/day	37403 lbs/day	-
removal rate	60%	-	-

As a result, these interim limits constrain the future effluent discharge quality of the Sand Island WWTP to be statistically equivalent to the reference years of 2009-2010. These interim limits will remain in effect until completion in 2035 of the final compliance milestones for the installation of secondary treatment. In effect, through 2035, consistent compliance with these interim limits will require CCH to remove solids at rates equal to or greater than the rates in the reference years of 2009-2010.

2.2 Digester Capacity

The capacity, as measured by the SRT, of a high-rate, constant-temperature, mesophilic digester for primary solids largely depends on the volume over time and solids content of the primary sludge delivered for waste stabilization [1]. See Section 1.4 on page 4.

From April 2011 through March 2012, the CCH Sand Island WWTP operations to comply with the 2010 Consent Decree interim limits resulted in generated sludge volumes over time of 100-120 kgal/day with solids contents around 6.4%. In order to handle these loadings, Synagro operated the digester at SRTs of 19 to 26 days with an average SRT of 22 days. The SRT design standard design criteria for high-rate, constant-temperature, mesophilic digesters is usually listed as 15 to 20 days for mixed primary and secondary sludges [2]. But for primary sludges only, the SRTs are higher, with the SRTs for 45% of high-rate, constant-temperature, mesophilic digesters surveyed nationwide falling between 21 and 25 days, 11% at 16 to 20 days, and the remaining 44% above 26 days [3].

As a result, Synagro currently operates the single Sand Island WWTP digester at capacity or at times slightly over capacity since the average SRTs are reported as essentially equivalent to the standard design criteria [3], and the low end of the Sand Island SRT range is below the low end of the standard design criteria.

This means any increase over 2009-2010 treatment plant influent loadings would necessitate increased solids removals over current levels in order to comply with the 2010 Consent Decree interim limits. Any increased solids loadings directed into the digester for waste stabilization would reduce the SRT. According to CCH, at SRTs below 18 days, digested and pelletized sludge would be disqualified from agricultural reuse and as co-generation feedstock. At SRTs below 10-12 days, methane fermentation would not come to completion which results in the washout of un-stabilized solids [4].

2.3 Redundancy

There is only one digester. The equalization tanks before and after the digester can provide at a maximum around 12 days of emergency retention. The pelletizing drum dryer also could heat stabilize undigested solids for an unspecified time as a temporary measure. However, in essence, any digester failure or scheduled maintenance of the single digester lasting longer than 12 days would result in an impairment or inability to operate the Sand Island WWTP.