Inland Empire Utilities Agency
A MUNICIPAL WATER DISTRICT

RP-5 SHF & REEP Independent Evaluation

100% Draft Report

August 6, 2009

Prepared by:

BLACK & VEATCH
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INLAND EMPIRE UTILITIES AGENCY	RP-5 – SHF/REEP Independent Evaluation
Title: **Evaluation of Regional Plant 5 Solids Handling Facility and Renewable Energy Efficiency Project – Final Report**	Rev. 1
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	Review by IEUA:
	Final Submitted to Client (Yes/No):

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LIST OF ACRONYMS

Acronym	Definition
Agency	Inland Empire Utilities Agency
barg	Pressure – bar gauge
BOD	Biological Oxygen Demand
BTU	British Thermal Unit
CCWRF	Carbon Canyon Water Reclamation Facility
CDWR	California Department of Water Resources
CEC	California Energy Commission
cf	Cubic feet
cfd	Cubic feet per day
CNG	Compressed natural gas
CO	Carbon Monoxide
COD	Chemical Oxygen Demand
CPUC	California Public Utilities Commission
DAF	Dissolved air floatation thickener
EEC	Environmental Engineering & Contracting, Inc.
ERC	Emission Reduction Credit
FOGs	Fats, oils, and greases
FTE	Fulltime equivalent
gpd	Gallons per day
H_2S	Hydrogen sulfide
IBR	Induced blanket reactor
IC	Internal combustion
IERCF	Inland Empire Regional Composting Facility
kW	Kilowatt
kW.hr	Kilowatt.hour
MG	Million gallons
MMBtu	Million BTU
MGD	Million gallons per day
NOx	Nitrogen Oxides (NO_3, NO_2, N_2O)
ORC	Organic Rankine Cycle
ppm	Part per million
ppmvd	Part per million by volume on dry basis
psi	Pounds per square inch

Acronym	Definition
REEP	Renewable Energy Efficiency Project
RP-2	Regional Water Reclamation Facility No. 2
RP-5	Regional Water Reclamation Facility No. 5
SARI	Santa Ana Regional Interceptor
SCAQMD	South Coast Air Quality Management District
SCE	Southern California Edison
scfm	Standard cubic feet per minute
SCGC	Southern California Gas Company (SCGC)
SGIP	Self Generation Incentive Program
SHF	Solids Handling Facility
SRF	State Revolving Fund
TES	Thermal Energy Storage
THP	Thermal Hydrolysis Process
TKN	Total Kjeldahl Nitrogen
TWAS	Thickened waste activated sludge
VOC	Volatile Organic Compound
WAS	Waste activated sludge
WURD	Western United Resources Development, Inc.
WWTP	Waste Water Treatment Plant

EXECUTIVE SUMMARY

Scope of Report

Black and Veatch were appointed after a competitive Proposal and Interview Process to conduct an Independent Review and Evaluation of the RP-5 Solids Handling Facility (SHF), REEP Co-Generation Facility, RP-2 and RP-5 Gas System, and Desalter Engines. In addition B&V reviewed and identified the regulatory South Coast Air Quality Management District issues associated with operating the REEP engines and other biogas and natural gas fired engine generators. B&V reviewed the State and Federal funding agreements to determine any outstanding IEUA commitments associated with these funds. B&V also identified other potential options for use of the facility, including submittals from third parties and has reviewed the cost of decommissioning the facility.

Background

IEUA commissioned an Organics Management Study in August 2000. The Study produced an Organics Management Policy Objective as follows:

> "The IEUA will develop and implement an Organics Management Program in its service area consistent with its mission to protect public health, the groundwater basin and the environment. To the extent it is economically feasible, the Program will seek to protect the Chino Groundwater Basin from infiltration of salts and nitrogen compounds generated on dairies so as to reduce the future cost of removing such contaminants from the groundwater. In pursuing this policy the IEUA calls upon its member communities to be active partners in achieving diversion of organic solids from landfill disposal and to be consumers of recycled organic products generated within the community".

This resulted in the release of an Organics Management Strategy Business Plan (Business Plan) dated May 31, 2001. The Business Plan proposed the acquisition of several sites for digestion and composting facilities. The facilities would be constructed in phases and expanded as necessary to accommodate the biosolids treatment and utilization needs of the IEUA. To achieve the energy recovery objectives of IEUA, the Business Plan identified an integrated approach. The plan called for the construction of several anaerobic digesters and co-generation facilities at IEUA's wastewater treatment plants to provide treatment for collected dairy washwater - which contains high concentrations of manure. The biosolids from treatment of wastewater and washwater would then be anaerobically digested. The resulting biogas would be used to generate electricity through co-generation to power the treatment facility and eliminate or reduce the need to purchase electricity from the grid.

As part of the program to generate power from dairy manure in the region, several demonstration pilot plants were proposed to determine the economics of different technologies and resolve technical issues associated with these technologies.

The first phase of the program was construction of the Phase IA manure digester with grants from the U. S. Department of Agriculture/Natural Resources Conservation Service and California Energy Commission. The anticipated power generation was 500 kW. The RP-5 Phase IA Manure Digester was a plug-flow digester constructed adjacent to RP-5. The first stage of the plug-flow digester was placed in operation in December 2001. The design was modular and was intended to be easily expanded in phases to about four times its initial capacity if proven to be effective in providing economical power generation from manure. In the future, as dairies relocate out of the area, this facility could possibly be used for biosolids treatment. Expansion of this facility would most likely be funded by Federal and/or State grants.

The next phase of the program was Phase IB. The plug flow digester was modified to a partially mixed digester with a grant from Western United Resources Development, Inc. The anticipated power generation was an additional 443 kW.

The third phase of the program was construction of Phase II digesters using European Technology with a grant from the California Energy Commission. The anticipated power generation was about 1,500 kW.

The RP-5 Renewable Energy Efficiency Project (REEP) was established in April 2003 after securing a grant Cooperative Agreement with the Department of Energy (DOE) on July 12, 2002. REEP was conceived as a series of full-scale demonstration systems, designed to test and research innovative combinations of primary and secondary energy generation processes, using methane gas derived from local processing of food waste, dairy manure, and other organic material. The original goals of the project were as follows:

- To create renewable energy-based generation systems with energy efficiencies of 65% or more in the REEP project (not manure digesters).
- To develop a research and development project that has not been done before to determine feasibility
- To design an energy efficient system based on the generation demands at RP-5 (match loads) and provide power and recovered heat to the new Inland Empire Utilities Agency (Agency) headquarters complex
- To design a system that is cost effective and transferable to other public agencies and/or the private industry
- To have no environmental impacts and to produce significant clean air/water quality benefits

Project Funding and Incentives Received

The REEP and RP-5 SHF projects were funded or incentives were received from the following grant and incentive programs:

1. Gas Company-Self Generation Incentive Program - $1,000,000
2. Department of Energy - $2,326,000
3. U.S. Department of Agriculture/Natural Resources Conservation Service (Phase I) - $4,900,000
4. California Energy Commission (Phase I) - $5,000,000

5. Western United Resources Development, Inc (Phase IB) - $773,175
6. California Energy Commission (Phase II) - $3,000,000

Project Construction

There were four phases of construction as mentioned in the project background. Phase IA involved the construction of one rectangular, below grade plug flow digester with 1.2 million gallon (MG) capacity, which was built in 2001-2002. During Phase IB, the plug flow digester was converted to a completely-mixed digester in 2005. In Phase II, two steel, aboveground completely-mixed digesters with 1.2 MG capacity each were constructed. These two new digesters were based on European technology, and they were built in 2005-2006 and commissioned in May 2007. Lastly, construction of the REEP cogeneration facility was completed in June 2007.

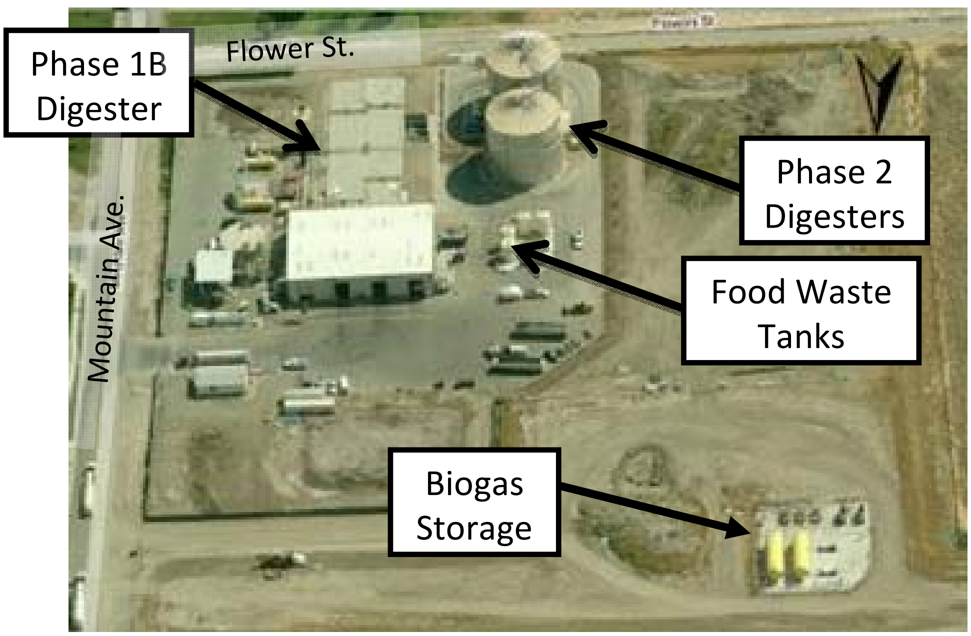


Figure 0-1 – RP-5 Solids Handling Facility

Project Permitting

The RP-5 Facility is a Title V facility. Title V is a federal requirement, whenever a facility emits greater than 10 ton/yr of criteria pollutants (NOx, CO, PM10, VOC, etc). SCAQMD is required to enforce the federal requirement. However, more stringent air quality regulations are enforced in the South Coast Air Quality District because of non-attainment status in the South Coast basin. Air emissions from the operation of internal combustion engines are controlled in the SCAQMD by Rule 1110.2.

Startup and Operation

The RP-5 SHF/REEP facility was started in 4 phases:

Table 0-1 - Phased Startup Schedule

Phase	Operator	Design Schedule	Actual Startup
Phase 1A	Synagro – 2001/2003 IEUA Operations – 2003		March 2002
Phase 1B	IEUA Operations	June 2005	December 2005
Phase 2	IEUA CM & Engineering	December 2005	May 2007
REEP	IEUA Operations		May 2008 – Jan 2009
REEP	IEUA CM & Engineering	May 2006	Jan 2009[a]

[a] The REEP facility commissioning started in late 2007.

REEP Engine Commissioning Difficulties

Project commissioning and startup was suspended due to exhaust system damage caused by detonation in the early stage of engine commissioning using digester gas. Damage to the exhaust system was repaired and additional safety measures installed. In addition, ambiguity in the "gas cleaning system" definition described in the Permit to Construct issued by SCAQMD, delayed progress. The Agency attempted to work with SCAQMD to modify the permit to correct the "gas cleaning system" description.

During the time period of these discussions, SCAQMD issued an amendment to Rule 1110.2 in February 2008. The initial SCAQMD permit for the REEP engines allowed the use of supplementary natural gas up to 40% by volume. The engines were designed to meet air emissions permitted at the time by SCAQMD. However, the February 2008 amendment to Rule 1110.2 made two changes: 1) It made air emissions more stringent for all engines; 2) It temporarily (until July 2012) relieved any landfill or biogas engine from meeting these limits provided that the engines operate on a minimum 90% biogas feed as fuel source. After July 2012 the more stringent emission levels will apply.

The REEP engines were not designed to comply with these more stringent levels and digester gas supply from the RP-5 SHF was insufficient to continuously supply 90% of one engine's fuel requirements. Therefore the REEP commissioning activities have not been completed.

Suspension of RP-5 SHF and REEP Project

On February 4, 2009 the IEUA board decided to re-establish the original manure recycling service rate of $80 per load. As result manure delivery to RP5 SHF decreased to a few loads per day.

Board Decision M2009-2-4 was as follow:

1. Approve to re-establish the original manure recycling service rate of $80 per load, effective immediately; and

2. Create a 2-member panel, consisting of the President and Vice President of the Board of Directors, to meet and work with the dairies on a mutually agreeable rate.

The IEUA Board decided to suspend operation at RP-5 SH5/REEP on February 18, 2009, after an internal review of project economics indicated that operational costs exceeded revenue, and in response to no manure supply.
(Minutes for the Meeting of the Board of Directors of the Inland Empire Utilities Agency, Wednesday, February 18, 2009.

Board Decision M2009-2-8 was as follows:

1. Defer construction/start-up service for the RP-5 REEP engines;
2. Suspend acceptance of manure deliveries due to inadequate deliveries for minimum operation of the RP-5 Solids Handling Facility; and
3. Approve the development of a plan to address surplus dairy manure project equipment (tankers and Honey-vacs).

Developments Post Project Suspension

There have been other developments material to the RP-5 SHF and REEP review since the Board Suspension.

- The 1 MW and (0.82 MW Standby) engine generators at the Desalter facility utilized biogas from the RP-5 SHF while REEP engines were unavailable, for the generation of power for this facility.
- The Desalter facility is owned by the Chino Desalter Authority (CDA) but was operated by IEUA. The Desalter engines also fall under the new SCAQMD Rule 1110.2, requiring the natural gas usage to be limited to 10%, requiring a minimum 90% biogas to 10% natural gas blend.
- CDA determined that the cost of complying with SCQAQMD Rule 1110.2 and complying with future permit provisions for more stringent air emissions is uneconomic. These engine generators were stopped when the RP-5 SHF facility was suspended and are not intended to be operated.

Technical Review of Manure Digestion

B&V have drawn the following conclusions from the technical analysis of the RP-5 SHF and REEP digestion project:

1. The estimated biogas yields from the digestion of manure agreed with the SCS Engineers design basis within expected limits for a biological process.
2. The accepted food waste quantities in 2008 were insufficient to assess biogas yield.
3. Based on the inadequate gas production values and the SCAQMD amendment to the REEP engine permit, the digesters cannot produce sufficient biogas to operate a single 1.5 MW engine generator using manure as a digester feed source.

4. The 1 MW and (0.82 MW Standby) engine generators at the Desalter facility utilized biogas from the RP-5 SHF while REEP engines were unavailable, for the generation of power for this facility. However these engine generators were stopped when the RP-5 SHF facility was suspended and are not intended to be operated.
5. Therefore there is currently no beneficial use for biogas generated at the RP-5 SHF given the constraints of the AQMD Rule 1110.2 amendment.
6. It was anticipated that the RP-5 REEP would initially be operated in a mode whereby the generators' output matches the RP-5 facilities electrical load. When the RP-5 facilities load exceeds the running generator's output, the balance is imported from the SCE grid to make up the shortfall. Future operation included a "net metering" mode in which two engines could be operated at the same time and the excess power generation would be metered and credited against electrical usage at the Agency's other qualifying facilities (K Kapphahn, 2008). The new solar facility that was installed and has been in operation since 2009 has reduced average electrical demand significantly. This is not a limiting factor of itself as the "net metering" option would have allowed use of the power at any other "child" plants if gas is generated from manure digestion.
7. Therefore there is a significantly reduced potential use of biogas for future production of electricity at the RP-5/ Headquarters building if SCAQMD Rule 1110.2 compliant equipment is installed, but use could be made of the power at other IEUA facilities.

Economic Review of Manure Digestion

B&V have drawn the following conclusions from the economic analysis of the RP-5 SHF and REEP digestion project:

1. The adopted rate for manure hauling was $80 per load. In 2007/2008 the rate was temporary lowered to promote the program. The temporary subsidy applied to manure hauling represents in excess of 55% of the value of the potential electricity that can be generated from this manure.
2. Fiber hauling costs for dewatered manure and disposal costs for liquid wastes, chemical costs for H_2S control were underestimated.
3. Labor costs for operations and maintenance were underestimated.
4. Environmental credits presently available to IEUA were over-estimated.

B&V has calculated the following summary project revenues and project costs for 2008.

Table 0-2 - B&V Estimated Project Revenues 2008

Item	% of Total	Revenue
Energy	88%	$1,077,167
Food Waste Tipping Fee	1%	$10,296
Manure Haul/Tipping Fee	9%	$105,969
Environmental Credits	2%	$29,857
Grant		
Total Revenue		**$1,223, 289**

Table 0-3 - B&V Estimated Project Costs 2008

Item	% of Total	Cost
Labor	27%	$1,084,892
Maintenance	9%	$353,232
Laboratory Costs	2%	$84,000
Manure Hauling	19%	$794,765
Chemicals	10%	$420,000
Fiber Disposal	15%	$630,000
Permits and Fees	12%	$468,905
Utilities	6%	$240,000
Total Costs		**$4,075,794**

The subsidy for the RP-5 SHF facility for 2008 was estimated to be $2,852,505.

Conclusion from Technical and Economic Review of Manure Digestion

The RP-5 SHF and REEP facility is non-viable, using manure as the primary feed based on conventional economics. B&V further recommend that manure be abandoned as a feed stock for digestion.

B&V Review of Grant and Incentive Funds Received

B&V reviewed the Grant and Incentive Funds received by the Agency for these projects.

According to documents provided by IEUA, funding and incentive sources for the Project included the following:

- California Energy Commission ("Commission") – Phases I ($5,000,000) and II ($3,000,000)
- US Department of Agriculture/Natural Resources Conservation Service - Phase I ($4,900,000)
- Department of Energy – REEP Cooperative Agreement ($2,326,000)
- Gas Company Self-Generation Incentive Program REEP ($1,000,000)

- Western United Resources Development, Inc. – Phase IB ($773,175)

California Energy Commission Phases I and II

A review of Agreement No. AGR-00S-001 indicates that with the exception of the clause noted below, all the terms and conditions of AGR-00S-001 appear to have been met by IEUA.

Section 12 of the AGR-00S-001 specifically notes that when equipment is "no longer needed for the original project or program, the recipient shall contact the Commission Project Manager for disposition instructions." Black & Veatch recommends that even with the expiration of the Agreement, IEUA should contact the Commission Project Manager as required under Section 12 for instructions on equipment disposition.

USDA/Natural Resources Conservation Services Phase I

IEUA received $4,900,000 under Grant No. 69-9104-1-199 for Phase IA of the Project. Phase IA was completed and all the terms and conditions of the Grant appear to have been met by IEUA.

Department of Energy REEP Cooperative Agreements

IEUA received $2,326,000 under Agreement No. DE-FC26-NT41475 for the Project. Under this Agreement, the Project is considered complete, but the three-year audit period for records is still active. As such, IEUA, at a minimum must still maintain all records related to the Project to meet the administrative requirements of the Agreement.

Gas Company Self-generation Incentive Program

Under the Self-Generation Incentive Program, Reservation No. 2005-071, IEUA will only receive incentive payments (up to $1,000,000) once the following conditions are met: Payment is contingent on running one unit at 1,000 kW connected to a live load with no more than 25 percent natural gas fuel. If the equipment is not permanently installed for the useful life of the equipment and does not run on less than 25 percent of fossil fuel for at least three years IEUA is not eligible for the $1,000,000.00 incentive. In the event that the Project is cancelled or shut down and the demonstration terms are not met, the Gas Company is not obligated to provide incentive funding. No funds have been received to date under this program.

Black & Veatch suggests that IEUA may wish to research the ability to transfer the grant reservation number for the previous project to the current one if incentives monies are still desired.

Western United Resources Development, Inc. Phase IB

Under Grant Agreement 248-I, IEUA has only invoiced Western United Resources Development, Inc. (“WURD”) for $45,101 out of a possible $773,175. The terms and conditions of this grant agreement have several areas for which IEUA may be required to return any incentive payments received if the project does not meet production levels and/or if the project is shutdown prior to the end date of the agreement (5 years from the execution date). The grant agreement allows up to five years after sustained gas production has been achieved for the collection of this payment.

Given the potential for a financial obligation on the part of IEUA under this grant agreement, Black & Veatch recommends that further legal counsel be sought regarding this contractual matter, particularly in the event that a Third Party is provided access to the equipment for commercial purposes.

B&V Review of South Coast Air Quality Management District Permitting

B&V reviewed the air emissions permitting issues for these projects. The RP-5 Facility is a Title V facility. However, more stringent air quality regulations are enforced in the South Coast Air Quality District because of non-attainment status in the South Coast basin.

1. The SCAQMD Rule 1110.2 – Emissions from Gaseous and Liquid-Fueled Internal Combustion Engines is applicable to the REEP and Desalter engines. The NOx/VOC/ CO limits in the Rule are 11/20/250 parts per million by volume on a dry basis (ppmvd) respectively. If these engines are operated they will be subject to all emission limits, including NOx, of subparagraph (d)(1)(F) of the Rule (Table IV of the Rule). These limits may change based on further technology assessment that will be completed by the SCAQMD, and presented by July 1, 2010.

2. To meet the 11 ppm NOx level a post combustion control technology will be needed. The REEP and Desalter engines do not have this post combustion control technology.
3. Exceptions from the above requirements are allowed for biogas-fired engines that comply with subparagraph (d)(1)(C) of the Rule, which requires that the monthly average heat input on a HHV basis from biogas be greater than 90 percent. This exception is only available until July 1, 2012 at which point all stationary engines are required to meet the lower emission levels.
4. SCAQMD would allow engines that operate on a biogas/natural gas blend an exemption from the 90 percent biogas heat input requirement (i.e., fuel heat input may be less than 90 percent biogas) if these engines were to meet the more stringent levels.
5. The REEP facility has not yet been commissioned completely and the two engines have been operated for less than 30 hours each. Given that these engines have been shutdown for an extended period of time, if they have to be brought online, they will likely need SCAQMD approval with an updated Best Available Control Technology (BACT) analysis. This needs to be confirmed with SCAQMD since it is not clear what SCAQMD's reactivation policy is for emission units that have been shutdown for greater than a year. Typically, a "long-term" shutdown would require a new permit and the engines would need to meet the most current BACT. The definition of long-term however is not clear. US EPA specify an 18 month hiatus as "long term" and this is copied in the North Coast Unified AQMD but SCAQMD do not appear to have formal policy in respect to this outage duration.
6. The IEUA RP-5 SHF was considered an essential public service by SCAQMD, therefore the emission credits received at the time of permitting came out of the Priority Reserve without charge. Therefore voiding of the current permit and shutting the engines down on a permanent basis will not result in a recovery of any monetary benefit or emission reduction credits.
7. SCAQMD currently has a permit moratorium in place since November 2008. Therefore, emission offsets from the Priority Reserve or exemptions from offsets requirements are currently not available.
8. SCAQMD personnel also indicated that any private operation of the RP-5 SHF would not be considered an essential public service. Therefore emission offsets will need to be purchased in the open market for any projects requiring air emissions to be approved.

Option 1: Conversion of RP-5 SHF to Municipal Co-Digestion Facility

B&V developed an option of converting the RP-5 SHF to a municipal co-digestion facility.

The RP-2 digesters while adequate when all units are in service do not have process redundancy. This is essential in a digester as grit and other solids collect and reduce active digester volume and ultimately prevent good solids stabilization and biogas production. Furthermore, the property on which the RP-2 facility is constructed is not owned by IEUA. The property is occupied on the basis of a long term lease from the Corps of Engineers. The lease was recently re-negotiated providing IEUA access to the property until 2032. Therefore there are compelling reasons for the Agency to consider expanding any solids stabilization capacity for municipal sludge using RP-5 SHF equipment.

A reasonable alternative would be to consider phasing the stabilization of RP-5/RP-2 sludge and co-digestion of Fats, Oil and Greases (FOG) and other imported food wastes at the RP-5 SHF. Phasing of the facilities would optimize capital already invested and reduce the need for additional investment until growth or other economic factors support the expenditures. One possible phasing scenario is as follows:

- Phase 1 – Convert RP-5 SHF digesters to mesophilic anaerobic digesters for RP-5 sludge stabilization.
- Phase 2 – Import FOG and other food wastes to both RP-2 and RP-5 to supplement biogas production and produce enough gas to operate RP-2, and possibly REEP engines.
- Phase 3 – Construct additional digestion capacity (or install advanced digestion systems) at RP-5 SHF and relocate all RP-5 and CCWRF sludge from RP-2 to RP-5, continue food importation for biogas production.

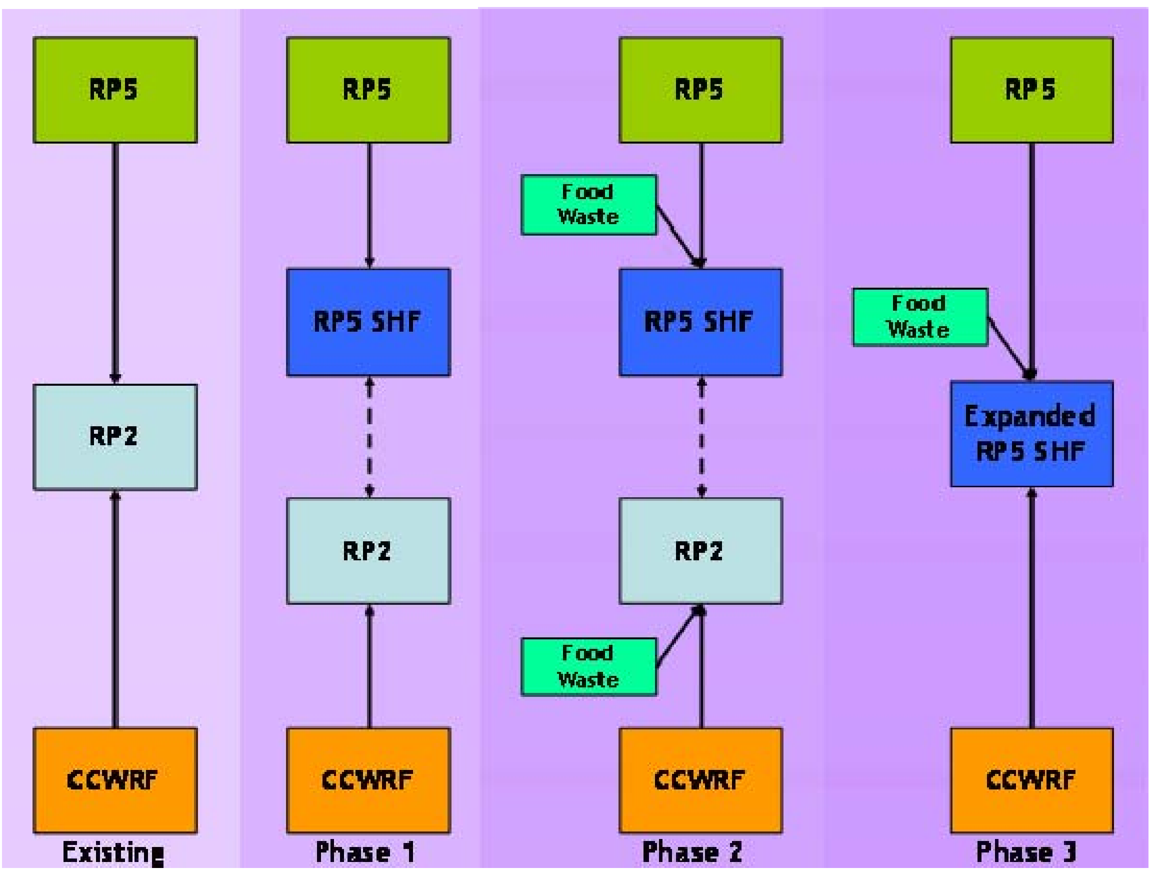


Figure 0-2 - Proposed RP-5 SHF Digestion Phasing Schematic

Option 1: Conversion of RP-5 SHF to Municipal Co-digestion - Phase 1

A conceptual process schematic has been prepared incorporating the RP-5 SHF digesters as follows:

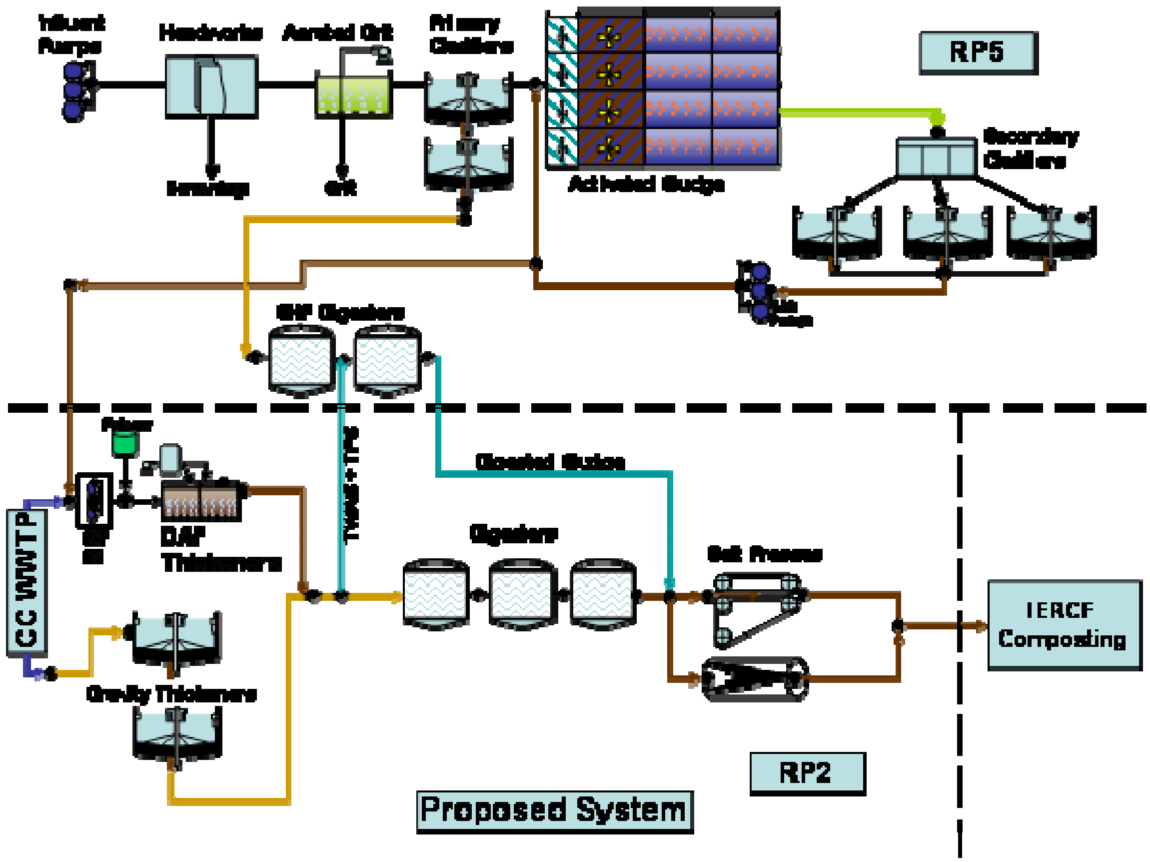


Figure 0-3 - Proposed RP-5/RP-2 Digestion System Schematic

Conversion of the two vertical digesters will provide significant capacity for digesting RP-5 primary and waste activated sludge when both tanks are in service, but insufficient capacity at RP-5 when either tank is out of service. This analysis is based on conventional mesophilic digestion process kinetics after 2011/2012. Biogas in this option will be used at RP-2. IEUA has a number of alternatives for dealing with redundancy at RP-5.

i) A third digester could be constructed
ii) Some RP-5 flow could be diverted to RP1 for treatment, reducing load at RP-5
iii) Some sludge from RP-5 could be diverted to RP-2 for stabilization while RP-2 remains in service for digesting CCWRF sludge (Table 0-6 indicates significant RP-2 capacity becomes available)
iv) Advanced digestion technology could be employed to increase the capacity of the installed vertical digesters (see section 0)

Given the options of flow and sludge diversion, additional digester capacity should not be constructed at this stage. Maintenance and process reliability can be provided with diversions.

The estimated capital costs for Phase 1 of Option 1 are $1,966,000. Required, maintenance repairs to the flare for combusting any excess biogas have not been estimated. Incremental operating costs will include operation and maintenance of the two RP-5 SHF digester mixers, new biogas compressor(s) with lower energy consumption (the existing gas compression system could also be used with pressure reduced to 75 psi) and new pump station at RP-2 for transfer of thickened sludge. The total incremental costs for operating the RP-5 digesters are estimated to be $250,000 per annum.

Based on the incremental capital investment, and the increased utility and maintenance costs for RP-5 SHF operation, conversion of RP-5 SHF to a municipal digester system for RP-5 sludge requires further analysis before a reliable recommendation can be made. However, it does not appear to be necessary to make the investment at this time for projected loads to RP-5 and CCWRF.

Option 1: Conversion of RP-5 SHF to Municipal Co-digestion - Phase 2

Imported food waste co-digested with municipal biosolids is expected to produce an additional 200 cfm of biogas. The total biogas production appears to be sufficient to supply one of the REEP engines, and may also provide the biogas needed for heating of the digesters, although some natural gas supplementation may be needed.

The engineering assumption that limits the biogas production is the target COD loading of 0.15 $lb/ft^3/d$. This is a medium loading rate for an industrial COD or pure food waste anaerobic digester design. However, municipal biosolids are typically more difficult to digest and operating at higher COD loading rates is not recommended. This digestion loading rate would need to be piloted for confirmation.

If the current difficulties with permitting of engine generators in the SCAQMD can be resolved through installation of BACT on the engine generators, importation of food waste could generate revenue from energy generation and possible tipping fees. The total capital cost of municipal co-digestion at RP-5 SHF and RP-2 is estimated to be $3.1 million. These costs do not include installation of a post combustion control technology on REEP engines, or repair of the BACT flare.

Municipal co-digestion should be further evaluated at RP-5/RP-2, specifically identifying food waste material that meets the assumed specification in Table 0-12. During this evaluation a detailed operating cost estimate must be prepared. However without any detail on the type of waste it is impossible to estimate operating costs accurately.

Option 1: Conversion of RP-5 SHF to Municipal Co-digestion - Phase 3

The process loads applied to the 2 RP-5 SHF vertical digesters exceed design practice for hydraulic detention time for all conditions. Therefore, this is not a realistic option without expansion of digester capacity or advanced digestion technology.

The cost of the additional 2 digester tanks is estimated to be $2,500,000 based on steel, lined tanks. In addition to these costs, expansion of the RP-5 SHF facility for both RP-5 and CCWRF biosolids will require construction and installation of solids thickening equipment, solids dewatering equipment, upgraded dewatered solids conveying equipment, gas storage and siloxane treatment equipment, upgraded odor control equipment, additional heat exchanger capacity (possibly relocated from RP-2), additional boiler capacity, new polymer and odor control chemical storage and dosing facility, instrumentation and control equipment and miscellaneous equalization tanks, and pump stations. The total capital cost of this conversion is $8,795,000 before contingencies. This capital cost does not include costs for post combustion emission control equipment on the REEP engines as insufficient gas will be generated for operation of these engines and supply of heat for digester temperature maintenance.

Conversion of RP-5 SHF to a municipal digestion facility when RP-2 requires major refurbishing or at the end of the lease period is an appropriate use of the equipment and is recommended.

Option 2: Conversion of RP-5 SHF to Municipal Co-Digestion Facility

In this option, it is proposed that IEUA elect to operate and maintain the RP-5 SHF as a food waste reception and treatment facility. Food waste for digestion will be defined specifically as indicated in Table 0-12.

The engineering assumption that limits the biogas production is the target COD loading of 0.15 $lb/ft^3/d$. This is a typical loading rate for an industrial COD or pure food waste anaerobic digester design. This digestion loading rate would need to be piloted for specific food wastes to confirm acceptability.

Importation of food waste could generate revenue from energy generation and possible tipping fees. The estimated biogas production is 535 cfm. This is sufficient for operation of 1 REEP engine if the SCAQMD issues are resolved.

Costs of converting the RP-5 SHF to a dedicated food waste digestion facility were not estimated as there are too many uncertainties. IEUA would need the following to complete this analysis:

- Source of food waste for the digesters
- Characterize the waste to ensure that it is not too high in nitrogen, and pilot digest the waste to ensure it produces biogas at reasonable purity and volume per lb of COD
- Negotiate a potential tipping fee for the food waste
- Negotiate with contractors for costs for digested waste haul and disposal

- Identify a preferred use for the biogas – probably injection into the gas supply main.

Food waste importation and digestion should be further evaluated at RP-5, specifically identifying food waste material that meets the assumed specification in Table 0-12. At present IEUA does not have any of the contractual relationships required to operate RP-5 SHF in this mode. This option requires IEUA to contract with food waste generators and haulers for supply of material to digest.

Economic Use of Biogas Produced from Anaerobic Digestion

In Phase 1, the total biogas produced (RP-2 and RP-5) is estimated to be 300 cfm. Biogas produced is insufficient for operation of the REEP 1.5 MW engines (450 cfm), and the Desalter engines are no longer available. Initially therefore, the biogas may only be useful for fueling the boilers at RP-2 and RP-5 and for the RP-2 engine-generator. After using biogas as a digester heating source, excess biogas available is approximately 125 - 150 cfm depending on ambient temperatures and the need for supplying heat.

In Phase 2, importing and co-digesting food waste with municipal biosolids is expected to produce an additional 430 cfm of biogas.

Given the uncertainty in the permitting process in the South Coast AQMD, it is expected to be extremely difficult to use the gas in any power generation process involving combustion. As mentioned in section 0, fuel cell technology in California appeared to be an attractive alternative based on grant funding. Fuel cells are currently being evaluated by the Agency.

For the RP-5 SHF operating with RP-5 and CCWRF sludge, the following calculations summarize economics:

Table 0-4 - RP-5 Expansion Fuel Cell Economics: 15 Year Project Life

Fiscal Year	Value*	Commentary
Excess Biogas Production (cfm)	150	Some biogas is used for heating sludge
Estimated Energy of Biogas (Btu/ft^3)	600	Common assumption used for digester biogas
Total Biogas Energy (Btu/hr)	5,400,000	
Fuel Cell Energy Rating Btu/kW.hr	7,000	Includes allowance for inefficiency
Electrical Production (kW.hr)	771	
Value of annual electrical production (12c/kW.hr)	$810,925	
Annual Cost of Fuel Cell maintenance	($420,000)	
Annual Estimate of Biogas Cleanup	($100,000)	
Annual Bond Repayment for initial investment at 4% (after 50% grant funding)	($400,000)	Total Capital value of fuel cells is estimated to be $9,000,000 (including IEUA costs)

* - Values extracted from a proposal received BY IEUA.

Based on current information, the most reliable use of the biogas at present is likely to be cleanup, compression and injection into the gas supply system as a "green energy". The cost of a gas cleanup system is estimated to be approximately $1.5 million dollars. The annual cost of biogas cleanup is estimated to be $100,000. Natural gas prices are highly volatile. For economic analysis purposes, a natural gas price of $3/MMBtu is suggested. This value is historically low, and does not include any "green premium". Therefore the excess biogas annual revenue as a natural gas replacement is $141,912. The cost of the annual bond funding (with 0% grant) and maintaining the biogas cleanup system is $234,910. Therefore production of natural gas quality biogas for fuel will cost IEUA $93,000 per annum. This is an investment with substantially lower risk, given the technology for biogas cleanup is proven. In addition, it provides future potential for fuel cell implementation, and if grant funding is received (or natural gas prices increase) may generate income for the Agency.

The excess biogas could be incinerated in a BACT flare as presently occurs at RP-2. However, while this may be the least cost alternative, it is contrary to one of the key missions of IEUA – "Renewable Energy through methane gas and solar energy".

The excess biogas could also be cleaned and used as compressed natural gas (CNG) to fuel Agency vehicles. The Agency presently does not operate CNG vehicles therefore this would require a fleet replacement program. The cost of this program will not be economic.

The excess biogas could also be used to make low pressure steam for stripping of ammonia from centrate/pressate at RP-2. The economic justification for this would be to avoid SARI disposal costs. The boiler would also require permitting by SCAQMD. A separate analysis would be required to determine if steam stripping is economic at IEUA.

Existing Equipment Reuse Potential / Salvage Value

Preliminary evaluation of the salvage value of the existing RP-5 SHF and REEP equipment has been undertaken. Determining costs for de-commissioning and salvage values for the RP-5 and REEP equipment was difficult and is not expected to be reliable. In the event IEUA elect to decommission and salvage equipment, scrap and used equipment dealers will purchase specific items at very low recovery rates based on previous B&V experience. In Table 0-1, some of the equipment has been identified as having value for other IEUA facilities as shown. The total salvage value of the facility was estimated at $250,000. This excludes the manure vactor trucks.

REEP Engine Generators Salvage Value

More detailed inquiries were made regarding some of the main components of the project including the Caterpillar G3608 lean burn gas IC engine generator, the heat recovery muffler, spiral heat exchangers, plate-type heat exchangers, load balance radiators, and associated switchgear. Johnson Power Systems disclosed that the original cost of the IC engine generator system and the associated items was approximately $3 million for the IEUA RP-5 SHF/REEP. Due to the fact that much of the equipment was customized for IEUA operations and the lack of a need for pipeline feed generation equipment of that size in the United States, any future users of this equipment would be located overseas, most likely in South America. This option would have to be examined further, for the actual cost of purchasing the used generators would most likely be quite comparable to the actual cost of installing brand new generators, once the shipping, labor, and ancillary equipment costs are added to the resale value of the generators. These engine generators may only have value as scrap metal. For the salvage value estimate above, it was assumed that the two engines could be sold for $100,000.

Manure Vacuum Trucks Salvage Value

The manure collection equipment includes:

- Eight (8) Loewen Honey-Vac trailers, having an estimated aggregate value of approximately $100,000 to $150,000
- Five (5) Keith Huber vacuum tankers, having an estimated value of approximately $300,000 -$350,000.

The estimated values were obtained from dealers specializing in the sale of new and used manure collection equipment and are thought to be somewhat reliable.

Third Party Operation of RP-5 SHF and REEP

Outreach has been made to potential stakeholders who may serve as third-party operators of the RP-5 SHF/REEP. Several of these interested parties attended a workshop held at the Agency Headquarters on June 10, 2009, and the list of attendees is included in the following table.

Table 0-5 - Workshop List of Attendees

Name	Company	Phone Number	E-mail
Mike Popichak	CR&RR	661-979-3276	cacoolmike@aol.com
Reg Renaud	STI Engineering	714-649-4422	
Dave Parry	CDM	425-453-8383	
Randy Bick	SRJR Consulting In	909-985-6677	randy@srjrconsulting.com
Ryan Begin	Feed Resource Recovery	857-362-7499 (T) 339-222-6076 (C)	ryan@feedresource.com
Chris Seney	Nursery Products	760-272-1224	nurseryproducts@charter.net
John Richardson	CR&RR	818-767-6000	jrichardson@communityrecycling.net
Guy Burgess	STI Engineering	310-796-6415	Guy.burgess@yahoo.com
Chuck Tobin	Burrtec Waste	909-641-3824	ctobin@burrtec.com

Those interested in serving as third-party operators of the RP-5 SHF/REEP were provided with guidelines for submitting a statement of interest. In addition to the Statement of Interest letters, IEUA staff met with Third Party Proponents to determine specific deal points for further discussion and evaluation of proposals.

Conclusions and Recommendations

Conclusions

1) The RP-5 SHF and REEP achieved the original goals of a full scale demonstration facility. Non-operation of the REEP engines prevented confirmation of the desired goal of 65% energy recovery.

2) The February 2008 amendment to SCAQMD Rule 1110.2 pertaining to air emissions permits for biogas engines impacted the project severely. There is currently no beneficial use for biogas generated at the RP-5 SHF given the constraints of the AQMD Rule 1110.2 amendment.

3) The production of biogas was inadequate for continuous operation of a single 1.5 MW REEP engine due to insufficient food waste quantities, and the estimates made of biogas production were too optimistic.

4) There is a significantly reduced potential use of biogas for future production of electricity at the RP-5/Headquarters building because the new solar facility installed and in operation since 2009 has reduced average electrical demand significantly.

5) The subsidy presently applied to manure hauling represents in excess of 55% of the value of the potential electricity that can be generated from this manure.

6) The disposal costs for liquid wastes, chemical costs for H_2S control and solids dewatering, and labor costs for operations and maintenance were

underestimated. In addition, the environmental credits presently available to IEUA are insignificant. As a result, the subsidy for the RP-5 SHF facility for 2008 was estimated to be $2,852,505.

7) All grants and incentives received by the RP-5 SHF and REEP projects were analyzed, and key summary findings from this review include the recommendation that IEUA contact the CEC Commission Project Manager for instructions on equipment disposition, that IEUA may wish to research the ability to transfer the SGIP grant reservation number for the previous project to the current one, and that IEUA seek further legal counsel regarding the return of monies received if the project is completely halted or particularly in the event that a Third Party is provided access to the equipment for commercial purposes.

8) Conclusions from the options developed for alternative use of the RP-5 SHF and REEP facilities are as follows:

   a. The RP-5 SHF should not be converted to a municipal sludge digestion facility for RP-5 sludge at this stage.
   b. The option of converting the RP-5 SHF to a municipal sludge facility and importing food waste to both RP-5 and RP-2 should be further evaluated.
   c. An appropriate use of the equipment would be for the conversion of the RP-5 SHF to a municipal digestion facility, for implementation at RP-2 when the facility requires major refurbishing or at the end of the RP-2 lease period, or if real estate development restarts.
   d. Conversion of the RP-5 SHF to a food waste reception and treatment facility operated by IEUA could generate revenue for the Agency, but contracts with food waste generators must be put in place. It may be economic for third party operators who have existing contracts with food waste producers to operate the RP-5 SHF and REEP.
   e. Based on current information, the most reliable use of the biogas at present is likely to be cleanup, compression, and injection into the gas supply system as a “green energy” source.
   f. The salvage value of the RP-5 SHF and REEP equipment and vehicles is less than $0.75 million.
   g. Outreach has been made to potential stakeholders who may serve as third party operators of the RP-5 SHF/REEP. Commercial operation of the facility could be economically viable but will not be highly profitable.

Recommendations

1) The RP-5 SHF and REEP facility is non-viable, using manure as the primary feed based on conventional economics.

2) Black & Veatch recommends that IEUA further develop the concept of third party operation of the RP-5 SHF and REEP facility in the short term – less than 15 years.

3) Black & Veatch recommends that IEUA retain the option of converting RP-5 SHF to a municipal digestion facility in the long term (> 15 years) or sooner if other circumstances warrant.

BACKGROUND

Background

IEUA commissioned an Organics Management Study in August 2000.

Three key issues were identified in the Study as follows:

1. Salt, nitrogen, and organic material from dairy manure have historically leached into the underlying Chino Groundwater Basin - one of the largest groundwater basins in Southern California. The results of the historic leaching have been that the Chino Groundwater Basin is becoming increasingly impacted by the nitrogen and salts left behind by up to one million tons per year (tpy) of manure produced by the Dairy Industry. To protect groundwater quality and public health, the dairy manure needs to be either hauled from the basin or processed in a manner that eliminates its impact on groundwater.
2. Air emissions from the dairies are a significant source of odor, dust, ammonia, and volatile organic compounds (VOC), which are under the jurisdiction of the South Coast Air Quality Management District (SCAQMD).
3. The study also suggested that over 50 megawatts of electricity could be generated before the end of the decade using biogas generated from biosolids, green and manure wastes. To achieve these levels of electrical generation, IEUA hoped to recover energy from the more than one million tpy of organic waste generated in the service area, the majority of which is dairy manure. This scale of residual waste energy production was an order of magnitude larger than any of the other projects in the world.

From these issues, IEUA developed an Organics Management Policy Objective as follows:

> "The IEUA will develop and implement an Organics Management Program in its service area consistent with its mission to protect public health, the groundwater basin and the environment. To the extent it is economically feasible, the Program will seek to protect the Chino Groundwater Basin from infiltration of salts and nitrogen compounds generated on dairies so as to reduce the future cost of removing such contaminants from the groundwater. In pursuing this policy the IEUA calls upon its member communities to be active partners in achieving diversion of organic solids from landfill disposal and to be consumers of recycled organic products generated within the community".

This resulted in the release of an Organics Management Strategy Business Plan (Business Plan) dated May 31, 2001. The Business Plan proposed the acquisition of several sites for digestion and composting facilities. The facilities would be constructed in phases and expanded as necessary to accommodate the biosolids treatment and utilization needs of the IEUA.

The goal of the Organics Management Strategy Business Plan was to utilize all organics in a coordinated program to generate sufficient energy to make IEUA energy self-sufficient. The availability of economical energy was intended to ensure that the Desalter program (which cleans up groundwater) remains cost competitive, while the prompt removal of manure from the dairies reduce the groundwater impacts of percolating salts and nitrogen to the groundwater table. Furthermore, removal of high total dissolved solids (TDS) groundwater for potable purposes through operation of the Desalter allows more recharge of the basins with storm water and recycled water contributing to water independence and protection from droughts for the region. Prompt removal of manure from the dairies and the use of enclosed composting facilities will also realize a major improvement in air quality for the Basin through the reduction of ammonia and other emissions. Several biosolids processing facilities would also allow IEUA to maintain an economical and viable organics management system for the foreseeable future.

To achieve the energy recovery objectives, the Business Plan identified an integrated approach. The plan called for the construction of several anaerobic digesters and co-generation facilities at IEUA's wastewater treatment plants to provide treatment for collected dairy washwater - which contains high concentrations of manure. The biosolids from treatment of wastewater and washwater would then be anaerobically digested. The resulting biogas would be used to generate electricity through co-generation to power the treatment facility and eliminate or reduce the need to purchase electricity from the grid.

As part of the program to generate power from dairy manure in the region, several demonstration pilot plants were proposed to determine the economics of different technologies and resolve technical issues associated with these technologies.

The first phase of the program was construction of the Phase IA manure digester with grants from the U. S. Department of Agriculture/Natural Resources Conservation Service and California Energy Commission. The anticipated power generation was 500 kW. The RP-5 Phase IA Manure Digester was a plug-flow digester constructed adjacent to RP-5. The first stage of the plug-flow digester was placed in operation in December 2001. The design was modular and was intended to be easily expanded in phases to about four times its initial capacity if proven to be effective in providing economical power generation from manure. In the future, as dairies relocate out of the area, this facility could possibly be used for biosolids treatment. Expansion of this facility would most likely be funded by Federal and/or State grants

The next phase of the program was Phase IB. The plug flow digester was modified to a partially mixed digester with a grant from Western United Resources Development, Inc. The anticipated power generation was an additional 443 kW.

The third phase of the program was construction of Phase II digesters using European Technology with a grant from the California Energy Commission. The anticipated power generation was about 1,500 kW. Two main feed sources for biogas production, manure and food waste, were selected, and reception facilities were constructed for both substrates. A pressate balancing tank, two flare stacks (one flare stack was decommissioned), two sludge presses, boilers, heat exchangers and other digestion equipment were also provided.

The RP-5 Renewable Energy Efficiency Project (REEP) was established in April 2003 after securing a grant Cooperative Agreement with the Department of Energy (DOE) on July 12, 2002. REEP was conceived as a series of full-scale demonstration systems, designed to test and research innovative combinations of primary and secondary energy generation processes, using methane gas derived from local processing of food waste, dairy manure, and other organic material. The original goals of the project were as follows:

- To create renewable energy-based generation systems with energy efficiencies of 65% or more in the REEP project (not manure digesters).
- To develop a research and development project that has not been done before to determine feasibility
- To design an energy efficient system based on the generation demands at RP-5 (match loads) and provide power and recovered heat to the new Inland Empire Utilities Agency (Agency) headquarters complex
- To design a system that is cost effective and transferable to other public agencies and/or the private industry
- To have no environmental impacts and to produce significant clean air/water quality benefits

Process for Selection of Technologies

With the goals listed above, the Agency went through a rigorous selection process involving experts and outside consultants in the renewable energy field to establish which innovative technologies were expected to be most viable (CH2MHill, March 2003). The selection process clarified the focus of the project and assisted the Agency in selecting only those technologies that met the project objectives listed above.

Innovative technologies were evaluated and either included or excluded from the project using one or more of the following reasons: high and unjustifiable capital cost, high maintenance cost, extensive maintenance frequency, significant environmental impact, poor performance, and unproven technologies.

The results of this evaluation process are summarized in Table 0-1.

Table 0-1 – Technologies Considered and Evaluation Result Summary

TECHNOLOGY	EVALUATION RESULT
Internal combustion (IC) engines as primary power generation	*Included for demonstration testing*
Stirling engines for primary power generation	Included (but project cancelled when supplier declared backruptcy)
Stirling engines for secondary (bottoming) power generation	Excluded
Direct-fired Stirling engines	Excluded
Absorption chillers	*Included for demonstration testing*
Thermal ice storage	Excluded
Fuel cells as primary power generation	Excluded
Organic Rankine Cycle (ORC)	*Included for demonstration testing*
Flexible microturbine	Excluded
Small and large scale ice storage	Excluded
Biogas gasification of green waste	Excluded
Bio-reactor systems	Excluded
Steam turbine system	Excluded

Selection of Biogas Production Technology

Two main feed sources for biogas production, manure and food waste, were selected, and reception facilities were constructed for both substrates. The biogas was generated in two different types of digesters: a modified completely-mixed plug flow digester and vertical aboveground digesters based on European technology. A balancing tank, two flare stacks, and two sludge presses were provided. In addition an interconnecting biogas header joining the RP-2 and the Desalter Plant with the RP-5 SHF and REEP, provided additional biogas for energy recovery.

Selection of Energy Recovery Technologies

Details of the technologies and systems selected for the energy recovery portion of the project at RP-5 were as follows. For the energy recovery portion of the project at RP-5, two 1,500 kW IC engine generator sets with jacket water and exhaust heat recovery and one 220 kW ORC bottoming cycle or secondary generation unit that would utilize exhaust heat from the engines were selected. In addition, a thermal energy storage system to generate and store chilled water during the off-peak hours for use during on-peak daytime hours was incorporated to provide a significant energy savings. Other aspects of the energy recovery portion included a plant secondary effluent cooling system for the IC engines and ORC unit with zero flow rejection, a fogging system for the generator room cooling in lieu of standard evaporative cooling, and a sophisticated control system to shift energy, gas, and heat recovery as required for added flexibility, reliability, and increased performance. To ensure flexibility and optimum energy savings, multi-fuel capabilities, including manure gas, municipal digester gas, supplemental natural gas, and diluted natural gas with air, and a net energy metering capability, which would enable the project to produce power in excess of the RP-5 plant demand and export the excess power to the utility grid were integrated into the system, as well.

Project Funding and Rebates

The REEP and RP-5 SHF projects were funded by the six following grants and incentive programs:

1. Gas Company-Self Generation Incentive Program - $1,000,000
2. Department of Energy - $2,326,000
3. U.S. Department of Agriculture/Natural Resources Conservation Service (Phase I) - $4,900,000
4. California Energy Commission (Phase I) - $5,000,000
5. Western United Resources Development, Inc (Phase IB) - $773,175
6. California Energy Commission (Phase II) - $3,000,000

Implementation

The project was constructed at the 15 million gallons per day (MGD) RP-5 located in Chino, California, adjacent to the Agency headquarters building. There were four phases of construction. Phase IA involved the construction of one rectangular, below grade plug flow digester with 1.2 million gallon (MG) capacity, which was built in 2001-2002. During Phase IB, the plug flow digester was converted to a completely-mixed digester in 2005, and in Phase II, two steel, aboveground completely-mixed digesters with 1.2 MG capacity each were constructed. These two new digesters were based on European technology, and they were built in 2005-2006 and commissioned in May 2007. Lastly, construction of the REEP cogeneration facility was completed in June 2007. The REEP consisted of the following major systems and components:

- Two (2) 1,500 kilowatt (kW) Caterpillar lean burn gas internal combustion engine generators
- One (1) 200 kW PureCycle secondary (bottoming) power generation unit utilizing exhaust gas from the Caterpillar engines
- Complete engine jacket and exhaust heat recovery system to serve the absorption chiller system for the two headquarter buildings
- Complete cooling water system utilizing RP-5 secondary effluent
- Complete 200 pounds per square inch (psi) gas compression system for digester and natural gas, which is located north of the RP-5 SHF and consists of:
    a) Three (3) 500 standard cubic feet per minute (scfm), 200 psi V-shaped gas compressors
    b) Two (2) 4,100 cubic feet high pressure storage tanks
    c) Enclosed cooling tower cooling system

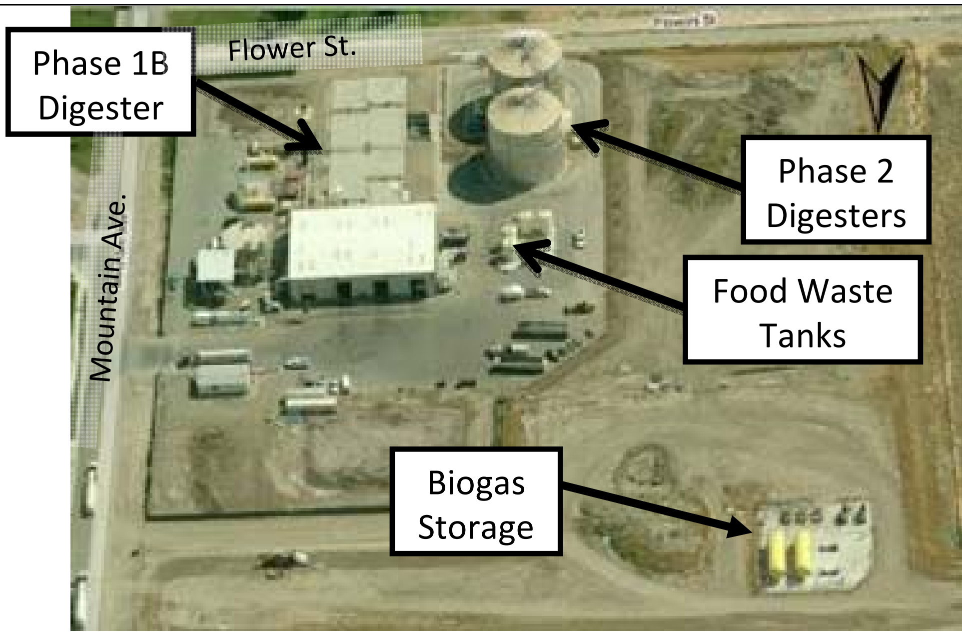


Figure 0-1 – RP-5 Solids Handling Facility

The RP-5 SHF and REEP project experienced a number of challenges that influenced the project schedule and cost. Some major challenges experienced during implementation of the project are summarized in the following sections.

Regulatory and Utility Company Negotiations

1. South Coast Air Quality Management District (SCAQMD)

The RP-5 Facility is a Title V facility. Title V is a federal requirement, whenever a facility emits greater than 10 ton/yr of criteria pollutants (NOx, CO, PM10, VOC, etc). SCAQMD is required to enforce the federal requirement. Title V designation requires more reporting (quarterly, semiannual, and annual) from facility and SCAQMD to EPA. However, more stringent air quality regulations are enforced in the South Coast Air Quality District because of non-attainment status in the South Coast basin.

Despite early coordination with the submission of the application, permitting language issues arose, thus requiring permit modifications. Project commissioning and startup was delayed due to ambiguity in the "gas cleaning system" described in the Permit to Construct issued by SCAQMD. The Agency resolved this issue with SCAQMD by obtaining a Stipulated Order of Abatement which allowed moving forward with engine commissioning while complying with the stipulated operating conditions.. The initial SCAQMD permit for the REEP engine allowed the use of natural gas up to 40% by volume; however, a recent notification by SCAQMD - Rule 1110.2 Amendment limited the natural gas usage to 10%, requiring a minimum 90% biogas to 10% natural gas blend.

2. Interconnecting agreement with local utility power company, Southern California Edison (SCE)

Stringent regulations, repeated design drawing reviews, numerous site visits, and strict relay settings with a very narrow margin resulted in adverse compromises to the project schedule.

3. Natural gas supply agreement with the local utility gas company, Southern California Gas Company

This agreement required an early start and preliminary negotiations prior to project implementation, and continuous correspondence and communications for the complex requirements and timely installation(s) proved to be quite a challenge for the project.

Equipment Supply and Pricing

Several issues arose in regards to the equipment for the RP-5 SHF/REEP. There was a delay in the delivery of the equipment due to Hurricanes Katrina and Rita and the war in Iraq, both of which shifted resources and efforts to their respective causes, thus affecting equipment and material delivery to the project site.

In addition, material prices rose to unprecedented levels, and the first project bid had to be rejected due to inconsistent and unrealistic pricing estimates. Therefore, the project was divided into thirteen separate bid packages and re-bid, which resulted in approximately $2 million in cost savings. In an effort to reduce costs, the role of General Contractor was performed by the Agency itself during the project construction phase. Although these changes made project construction more difficult to manage and execute, the Agency was able to gain extensive experience due to the complexity of the project, and now, the Agency possesses a thorough knowledge of handling a multi-contract project, from contract awards all the way through to commissioning.

Lastly, late cancellation of the Stirling engine project complicated things further. The manufacturer of the engine, STM Power, went out of business and liquidated the company due to the lack of funds prior to testing of the Stirling engine. Stirling engine projects in the United States were taken over by another company.

Startup and Operation

The RP-5 SHF/REEP facility was started in 4 phases:

Table 0-2 - Phased Startup Schedule

Phase	Operator	Design Schedule	Actual Startup
Phase 1A	Synagro – 2001/2003 IEUA Operations – 2003		March 2002
Phase 1B	IEUA Operations	June 2005	December 2005
Phase 2	IEUA CM & Engineering	December 2005	May 2007
REEP	IEUA Operations		May 2008 – Jan 2009
REEP	IEUA CM & Engineering	May 2006	Jan 2009[a]

[a] The REEP facility commissioning started in late 2007; however, due to SCAQMD permitting delays and exhaust system damage caused by detonation in the early stage of engine commissioning using digester gas, the REEP commissioning activities were significantly delayed. Commissioning has not been completed as the Board suspended operations.

Decision to Suspend Operation

The Agency's Board decided to suspend operation at RPRP-5 SH5/REEP on February 18, 2009, after an internal review of project economics indicated that operational costs exceeded revenue. (Minutes for the Meeting of the Board of Directors of the Inland Empire Utilities Agency, Wednesday, February 18, 2009.

Board Decision M2009-2-8 was as follows:

1. Defer construction/start-up service for the RP-5 REEP engines;
2. Suspend acceptance of manure deliveries due to inadequate deliveries for minimum operation of the RP-5 Solids Handling Facility; and
3. Approve the development of a plan to address surplus dairy manure project equipment (tankers and Honey-vacs).

Other Developments Post Project Suspension

There have been other developments material to the RP-5 SHF and REEP review since the Board Suspension.

- The 1 MW and (0.82 MW Standby) engine generators at the Desalter facility utilized biogas from the RP-5 SHF while REEP engines were unavailable for the generation of power for this facility.
- The Desalter facility is owned by the Chino Desalter Authority (CDA) but was operated by IEUA. The Desalter engines also fall under the new SCAQMD Rule 1110.2, requiring the natural gas usage to be limited to 10%, requiring a minimum 90% biogas to 10% natural gas blend.
- CDA determined that the cost of complying with SCQAQMD Rule 1110.2, complying with future permit provisions for more stringent air emissions is

uneconomic. These engine generators were stopped when the RP-5 SHF was suspended and are not intended to be operated.

KEY TECHNICAL ELEMENT REVIEW

Key elements of the project are reviewed to provide some understanding of the difficult operational challenges experienced, and some explanation for the poor economics.

Manure Digestion

Manure Digestion: Basis of Design

Table 0-1 – Manure Digesters Design Basis

Parameter	Design	Commentary
Phase IB Manure Load, wet ton/d*	138	
Phase II Manure Load, wet ton/d	277	(SCS 2005)
Phase IB Food Waste Load, ton/d	41	
Phase II Food Waste Load, ton/d	83	(SCS 2005)
Total Waste Load, ton/d	539	
Manure Solids Concentration, %	12%	(SCS 2005)
Food Waste Solids Concentration, %	20%	(SCS 2005)
Combined Waste Concentration, %TS	13.80%	(SCS 2005) :
VS % of manure, %	78%	(SCS 2005)
VS % of food waste, %	90%	(SCS 2005)
VS % of combined waste, %	82.2%	(SCS 2005)
VS Load, ton/d	61	
Phase IB Digester Volume, m^3 (mg)	4,540 (1.2)	
Phase II Digester Volume, m^3 (mg)	9,080 (2.4)	(SCS 2005) 2 digesters
Organic Loading rate, kg VS/m^3/d (VS/ft^3)	4.48 (0.28)	(SCS 2005) < 4.5 kg VS/m^3/d
Detention Time, days	25	
VS Destruction, %	59%	(SCS 2005)
Biogas Yield per lb Manure VS input, ft^3/lb VS	6.4	(SCS 2005)
Biogas Yield per lb Food Waste VS input, ft^3/lb VS	11	(SCS 2005)
Biogas Production, ft^3/d	988243	
Biogas Production, cfm	686	
CH_4%	60%	(SCS 2005)
Biogas Energy, Btu/ft3	550	(K. Kapphahn, 2008)
Biogas Energy Production, MMBtu	22.6	

Biogas Energy Production, MW.hr	6.6	
Mixers		
Number	2	
Motor rating, kW.hr		
Hot Water Boilers, MMBtu	3.75 (x 2)	(K. Kapphahn, 2008)
Heat Exchangers		

* - All ton units are metric ton.

Manure and Food Waste Digestion: Operations History

After commissioning of the Phase II digesters in June 2007, the facility was operated by IEUA. The average manure and food waste volumes received each month and average biogas produced each month were as follows:

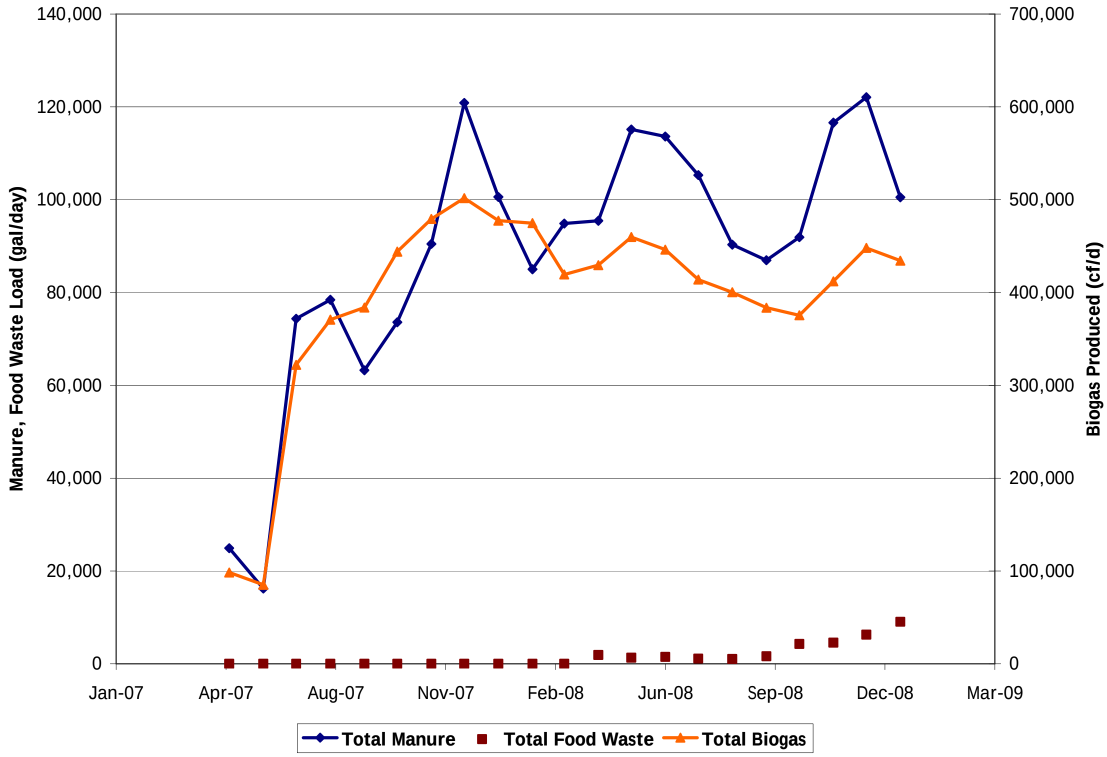


Figure 0-1 - RP-5 Manure and Food Waste Load versus Biogas Production

The average daily manure load was approximately 100,000 gpd. Therefore the facility was operated at an average digester hydraulic retention time (HRT) of 3,600,000 gallons/100,000 gpd or 36 days. This HRT exceeds the SCS Engineers 25 day HRT design basis. However the theoretical calculation does not consider the impact of collected grit in the digesters. Collected grit was a significant problem and has the impact of reducing effective digestion volume. Therefore it is likely that the actual effective HRT approximated the SCS Engineers design basis.

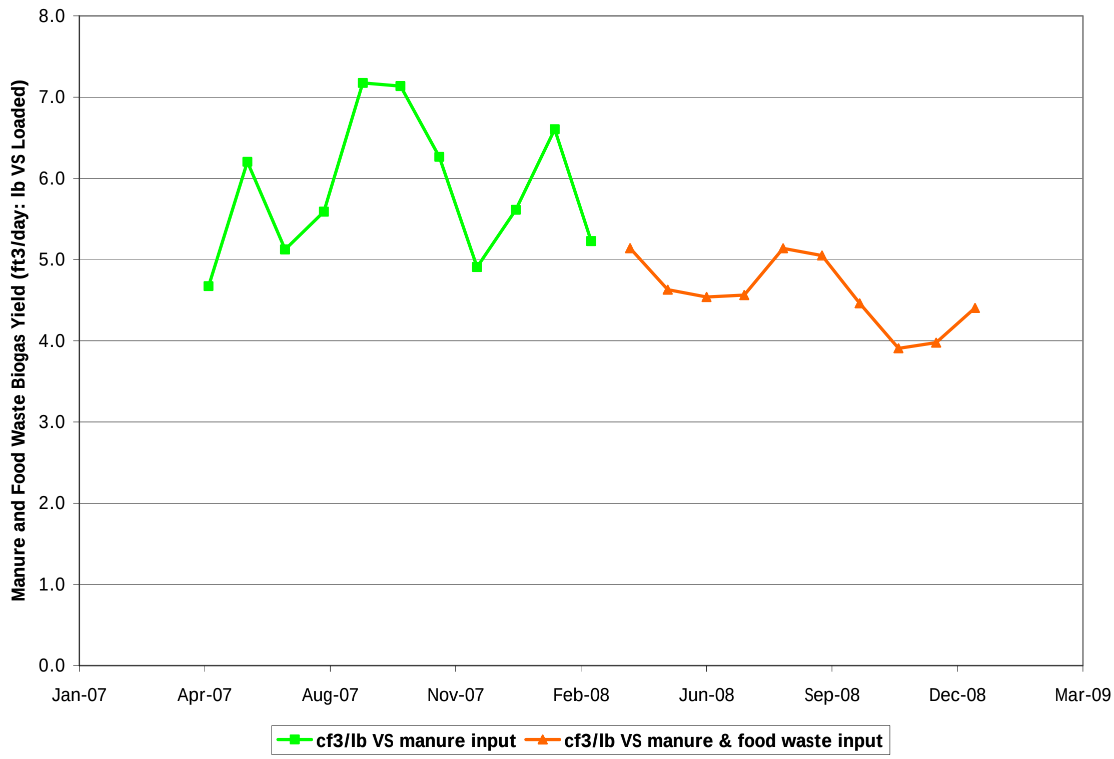


Figure 0-2 - RP-5 Manure and Food Waste Biogas Yield

The biogas yield for manure solids initially agreed with the SCS Engineers design basis (assuming the manure solids were at 13% TS and 78% VS of TS) but once food waste was added the combined biogas yield was significantly lower than the SCS Engineers design basis (assuming the food waste was at 20% TS and 90% VS of TS).

There is insufficient information to explain the observation that biogas yield appeared to decrease with the addition of food waste. Some of the reasons could be operational as there were occasions when the digesters could not be maintained in the mesophilic range, or grit could have accumulated. Alternatively the digesters anaerobic biomass may not have acclimatized fully to imported food waste, particularly since this food waste was not reliable. Further, the SCS design basis assumed average characteristics for food waste VSS and biogas production – this is likely to be very dependent on the type of food waste and can not be averaged.

Manure Digestion: Technical Challenges

<u>Substrate Supply</u>
Initial gas production estimates including food waste at the RP-5 SHF Phases IB and II were documented (Clifton 2007) as follows:

- Phase IB: 300 scfm (432,000 cfd)
- Phase II: 600 scfm (864,000 cfd)

The above gas estimates do not agree with the biogas estimates for Phase II prepared by SCS Engineers. The gas estimates are significantly less than the actual average biogas production provided in Figure 0-1 . The total biogas production estimates were based on adding approximately 30% food waste to the manure digesters. For Phase II this represents 6,000 t/yr of 20% food waste solids. However the Agency was unable to secure a reliable food waste source. The maximum amount of food waste added to Phase II digesters was only 12% by mass. Acceptance of food waste was highly desirable for increasing biogas production, in particular de-proteinized whey from the cheese industry was found to be an excellent substrate.

Manure and Food Waste Handling

Manure handling from the dairies to the receiving tanks at the RP-5 SHF is a challenging process. Some lessons learned were as follows:

a) Manure deliveries must be consistent and timely to prevent digesters operating unstably in a feast-and-famine mode of operation. Consistent and continuous feed of manure and food waste to the dairy digesters produces acceptable biogas quality and quantity.
b) Debris, rocks, ropes and other trash in the manure caused significant process problems, including pumps plugging, mixing systems clogging, and other equipment being damaged. Therefore, screening equipment must be effective and robust, and will require frequent and extensive maintenance

Biogas System

The Biogas system comprises iron sponges for H_2S removal, high pressure compressors, storage tanks, biogas coolers (after compression) and transfer pipework.

Biogas System: Basis of Design

Table 0-2 – Biogas System Design Basis

Parameter	Design	Commentary
Biogas H_2S removal – Iron Sponges Number Capacity each, lbs H_2S	 4 	2 Large units for Phase IB 2 Smaller units for Phase II
Biogas Compressors Number Capacity, scfm Discharge pressure, psig Motor rating, Hp	 3 (2+1) 500 200 200	Unusual to use high pressure compressors for biogas facilities.
Biogas Storage Tanks Number Capacity each, ft^3	 2 4,100	 24/48 hour storage capacity for biogas.
Compressor cooling tower Number Operating setpoint, F	 1 125	For compressor jackets cooling and after cooling

The transfer pipework for biogas is complex. It is illustrated in Figure 0-3. The transfer system provides excellent flexibility for operations.

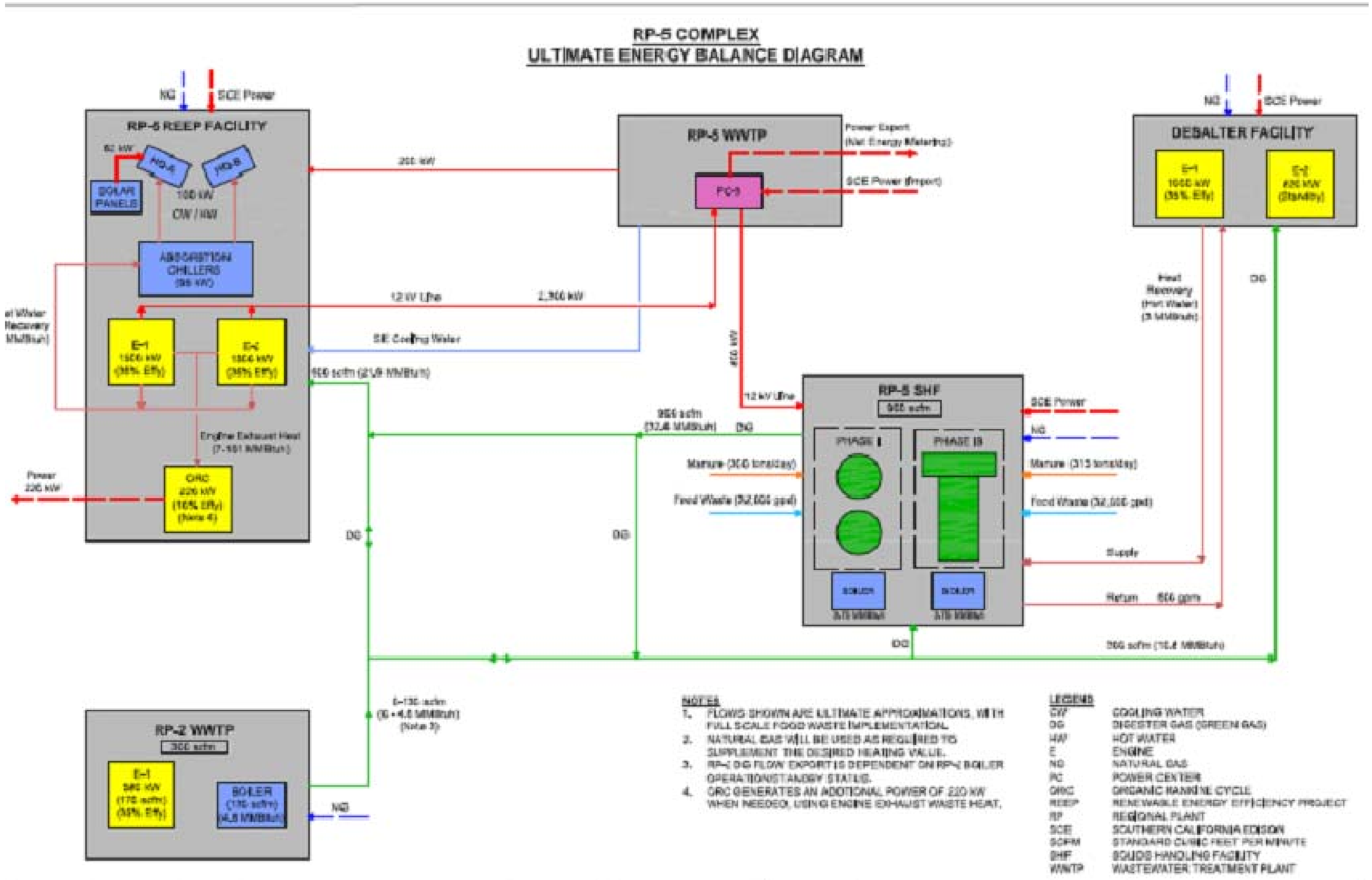


Figure 0-3 - RP-5 Complex Biogas Transfer and Energy Balance

Biogas System: Technical Challenges

Biogas produced from manure and food waste digestion has elevated hydrogen sulfide (H_2S) content, but very low siloxane levels. H_2S was relatively easily removed using iron sponge technology in combination with the air injection system for Phase II. However, the oxygen sensor had persistent problems due to high H2S level and could not perform as designed.

The key technical challenge with the biogas system as installed was the extremely high electrical power demand from the biogas compressors. The reason for the high pressure system was to reduce biogas storage tank volumes. Transfer pipelines were not optimized for high pressure biogas as the system had to accommodate the low pressure gas from RP-2. Using the ideal gas law relationship, a storage tank at low digester gas pressure and temperature (0.58 psig, 39C), versus high gas pressure and temperature (200 psig, 52C) would require over 330 times the installed volume.

However the electrical demand from a single operating compressor, 200 kW.hr, can be calculated using the following assumptions:

a) Biogas average heating value = 550 BTU/ft^3 (or 550 x 0.00029 kW.hr/ft^3)
b) Engine generator guaranteed efficiency of biogas to electrical energy conversion = 35.9%

Biogas required for one 200 kW.hr compressor = 200/(550 x 0.00029 x 35.9%)
= 3,492 ft^3/hour or 58 ft^3/min

This electrical demand (in biogas equivalent volume) represents more than 10% of the compression capacity (58/500 cfm = 11.6%). The energy used for cooling the compressors is additional to this demand. Considering the RP-5/SHF produced a maximum of approximately 380 scfm, the energy lost in operating a single gas compressor was considerable (58/380 = 15.2%). The choice of high pressure biogas storage and transmission was based on a Master Plan for Biogas Facilities prepared by Parsons. High pressure biogas storage is seldom used in municipal facilities.

The biogas flare also proved problematic. This flare is a Best Available Control Technology (BACT) system, required by SCAQMD. It is defined as a LAER (Lower Achievable Emission Rate) flare providing compliance with the Title V classification for the RP-5 facility. The only manufacture that committed to comply with SCAQMD BACT was John Zink. The flare is not a venturi type, but requires a blower to operate. Multiple, individual burners are located in “cans” to contain the flames for combustion heat retention. The cans continuously failed. The flare was highly unreliable requiring continuous maintenance, including instrument panel failures and other mechanical failures. John Zink indicated that the flare was oversized by a multiple of three. This was a key factor that made the flare unreliable and inefficient at low flows.

Energy Recovery Systems

The REEP energy recovery system includes two IC engine/generators, each rated for 1.5 MW, and the ORC PureCycle 200 power unit, rated for 200 KW. These power units are supported by a series of subsystems that recover and reuse the energy created by REEP. These systems include the fuel gas, exhaust, cooling water, chilled water, and jacket water systems.

Energy Recovery: Basis of Design

Details for equipment installed for the energy recovery system are provided in Table 0-3.

Table 0-3 - Energy Recovery System Design Basis

Parameter	Design	Commentary
Engines		
Number	2 (1+1)	Engines are large for municipal application but sized for one duty/one standby and with capacity for future growth.
Capacity each, kW.hr	1,517	
Biogas demand, ft^3/min	450	
Biogas Energy, BTU/ft^3	550 +/- 25	
Jacket Water Heat Rejection, BTU/min	17,840	
Exhaust Heat Rejection, BTU/min	73,050	
Lube Oil Heat Rejection, BTU/min	22,600	
Generators		
Number	2 (1+1)	
Capacity each, kW.hr	1,600	
Power Factor	0.8	
Efficiency at PF=0.8	96%	
Organic Rankine Cycle Units		
Type, Refrigerant/Water Cooled	UTC 200	
Number	1	
Capacity each, kW.hr	200	
Inlet Temperature, F	950/450	
Outlet Temperature, F	450/300	
Chilled Water System		
Number of Tanks	1	
Tank Capacity, gal	79,600	
Number of Pumps	2	
Pump Capacity (each), gpm	290	
Absorption chillers, 30 ton nominal capacity each, 680 MMBtu	4	

Operating Philosophy

It was anticipated that the RP-5 REEP would initially be operated in a mode whereby the generators' output matches the RP-5 facilities electrical load. When the RP-5 facilities load exceeds the running generator's output, the balance is imported from the SCE grid to make up the shortfall. Future operation included a "net metering" mode in which two engines could be operated at the same time and the excess power generation would be metered and credited against electrical usage at the Agency's other qualifying facilities (K Kapphahn, 2008). At full output, one IC engine generates sufficient power to equal the average power demand of the RP-5 Water Reclamation

Facility, not including headquarters buildings and RP-5 SHF. This is no longer true as the new solar facility has reduced average electrical demand as Figure 0-4 illustrates.

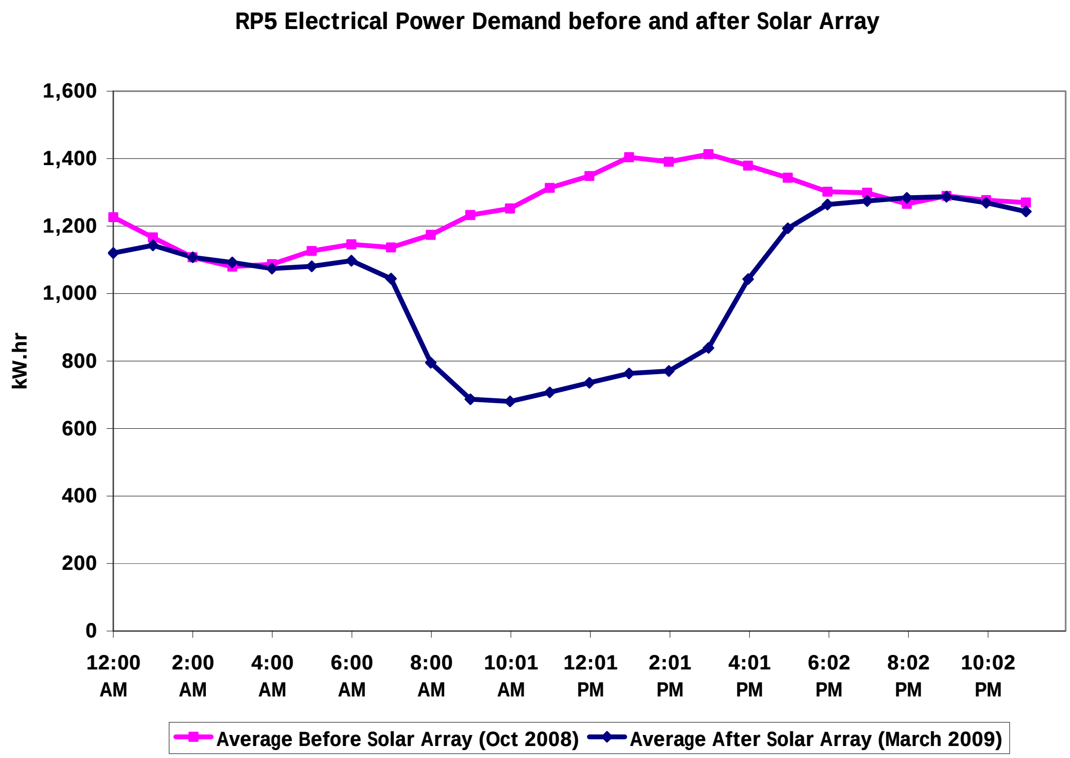


Figure 0-4 – RP-5 Electrical Load Profile before and after Solar Array Installation

Heat rejected from the engine jacket water and exhaust will be utilized to support absorption chillers at the Chiller/Boiler Plant via the load heat exchanger. In turn, the chillers will charge the Thermal Energy Storage (TES) chilled water storage system to level the HVAC load. The PureCycle 200 power system operates when the exhaust heat recovery is not needed for the chillers. The electricity generated by the PureCycle 200 power unit was expected to offset most of parasitic RP-5 REEP loads related to the engines.

Energy Recovery: Technical Challenges

The initial technical challenge with the REEP system as installed was upgrading the exhaust system pipework to include pressure relief valves (PRVs) to protect against detonations in the pipework. The reasons for the explosion were determined to be post combustion detonation. The engine could not be operated until pipework was repaired and PRVs installed. Modifications to the system also included changes to the exhaust duct configuration, duct support, and an air purge system to purge the residual digester gas from the exhaust ducting before engine start.

A second technical challenge was the fact that the engine was relatively large, requiring 450 cfm of fuel. Initially the intention was to operate this engine with 270 cfm (60%) biogas, and use natural gas 180 cfm (40%)to make up the rest of the fuel supply. However, as mentioned in section 0, the SCAQMD regulatory change resulted in a minimum biogas need of 405 cfm, which was substantially greater than the normal RP-5 SHF production capacity.

The potential challenges associated with operating the ORC UTC200 system are unknown as these systems were not able to operate without engine heat. Chillers have been operating since June 2003 without problem. Chillers utilize heat from either the boilers or the engine heat recovery system.

A new challenge is that the RP-5 electrical demand has been substantially reduced by the commissioning of the solar array. Therefore, local demand at the RP-5 MCC for electricity has been reduced. However, the metering agreement provides for the opportunity of selling excess electricity back to SCE if it is generated but only when gas is generated from manure.

Residuals Screening and Dewatering

The raw manure is screened with bar screens before digestion. The screenings are disposed to landfill. The digested manure is dewatered in rotary screw presses. The dewatered biosolids are transported to a privately operated compost site for final disposal. The pressate containing high levels of ammonia, TKN and suspended solids is discharged to the Santa Ana Regional Interceptor (SARI) line for disposal.

Residuals Screening & Dewatering: Basis of Design

Table 0-4 – Residuals Screening and Dewatering System Design Basis

Parameter	Design	Commentary
Manure Screens Number Bar Spacing	 2 6 mm	
Dry Polymer Makeup Number	 1	
Rotary Screw Presses Number	 2	Total number of channels = 10 (6+4)
Sludge Conveyor Number	 1	

Residual Screening & Dewatering Challenges

Reception and handling of manure from the dairies was a challenge. Multiple modifications were made to facilitate handling of this material including installation of the bar screens, large capacity solids handling mixing pumps, and operating a reception tank in a fill and draw mode in an attempt to settle most of the grit in the manure. The Screenings handling equipment would also tend to bind up. The installed mixing pumps kept grit in suspension sending it downstream. This plugged digester feed lines and pumps. The volume of the mix tanks was insufficient. Often there were tankers lined up to unload waiting until the mix tanks could be emptied.

Improvements and operating techniques were not entirely successful as in early 2009, after the project was halted, the vertical digesters were drained and significant quantities of grit and other fiber material remained in the tanks.

Transfer of manure solids was also problematic. The pipeline plugged if the solids concentration was allowed to climb much above 12%. From an operational perspective, screening and handling of manure required constant operator attention.

The solids dewatering facilities once optimized performed well. However, the two rotary screw presses fed one conveyor for lifting the digested manure cake into trucks. The conveyor was designed with a vertical section and a horizontal truck distribution section. The vertical auger was subject to multiple failures that resulted in the complete stop of the dewatering process. The auger required extensive man-hours in repair time. The conveyor would also occasionally plug requiring operator and maintenance attention.

ECONOMIC ANALYSIS

IEUA Summary Revenue and Costs 2008

The following summary project revenues and project costs for 2008 were presented to the IEUA Board on January 21, 2009.

Table 0-1 - Estimated Project Revenues 2008

Item	% of Total	Revenue	Estimated Revenue (2007)
Energy	82%	$574,000	
Food Waste Tipping Fee	3%	$21,000	
Manure Haul/Tipping Fee	12%	$84,000	
Environmental Credits	3%	$21,000	$213,000
Grant	0%		
Total Revenue		**$700,000**	

Table 0-2 - Estimated Project Costs 2008

Item	% of Total	Cost	Estimated Cost (2007)
Labor	38%	$1,596,000	
Maintenance	7%	$294,000	
Laboratory Costs	2%	$84,000	
Manure Hauling	16%	$672,000	
Chemicals	10%	$420,000	
Fiber Disposal	15%	$630,000	$75,000
Permits and Fees	7%	$294,000	$144,000
Utilities	5%	$210,000	
Total Costs		**$4,200,000**	

The average annual cost savings estimated during the design phase was $3,687,788. There is a discrepancy of $3,687,788 + $3,500,000, for a total project reversal of approximately $7.2 million.

Detailed Cost Analysis

In the following sub-sections, Black and Veatch have independently analyzed cost and revenue data using existing operating and cost documentation provided by IEUA.

Labor Costs

The organization chart for operations staff at the RP-5/SHF was established based on the following:

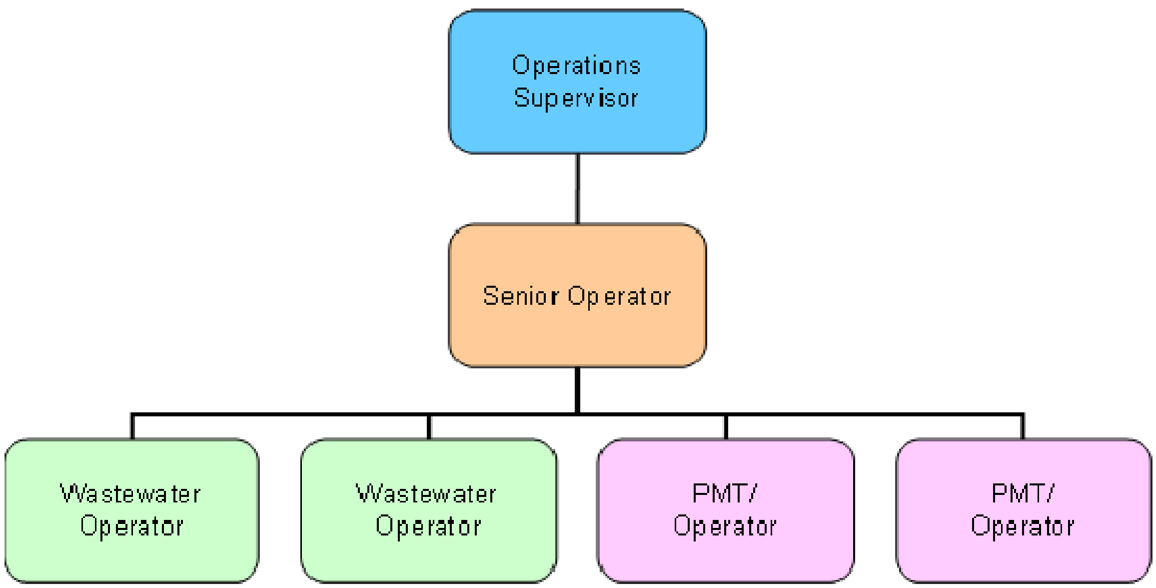
- RP-5/SHF is not a facility that is licensed by the Regional Water Quality Control Board (RWQCB) under Title 23, Article 2, Classification of Wastewater Treatment Plants and Agency Reporting Requirements § 3675. Classification of Wastewater and Water Recycling Treatment Plants. Therefore classified operators are not required to operate the facility.
- The facility is operated 7 days a week, from 06h00 to 20h00.
- Operators are on-call to respond to emergency call-out. This is approximately 10 hrs per week, (or an overtime factor of 50/40 = 1.25)
- In the organization chart below, operators are RWQCB certified, Plant Maintenance Technicians (PMT) are not certified.
- 

Table 0-1 – Organization Chart: RP-5 Operations and Dedicated Maintenance Staff

B&V estimated labor costs using the following resources:

- Inland Empire Utilities Agency, Fiscal year 2009/10, estimated hourly rates, *Including Wages, Benefits, and Department Overhead*
- Overtime was calculated at time and a half

Table 0-3 - Estimated Annual Operations Labor Costs

Position	All Inclusive Hourly Rate	Overtime Factor	# of Employees	Annual Cost
Deputy Manager of Operations	$113.34	1.0	0.25	$58,937
Operations Supervisor	$93.24	1.25	1	$266,666
Jr Operations Assistant	$72.97			
Senior Operator V & III	$76.66	1.25	1	$219,248
Operator IV	$73.06			
Operator III	$69.58	1.25	2	$343,725
Operator I	$60.10			
Plant Maintenance Technician	$39.74	1.25	2	$196,316
Operator in Training	$51.92			
TOTAL OPERATIONS LABOR COST				**$1,084,892**

Maintenance Costs

Maintenance costs (labor hours and materials) are tracked with a commercial software package. The summary of maintenance materials and labor hours (L Vanderpool, 2009) is provided in Table 0-4. The dedicated maintenance personnel were supported by specialist trades and other technicians. The labor costs were based on Inland Empire Utilities Agency, Fiscal year 2009/10, estimated hourly rates, *Including Wages, Benefits, and Department Overhead.* Where multiple skill levels exist in a craft, an average cost was determined. No overtime was assumed for maintenance.

Table 0-4 - Estimated Annual Maintenance Labor and Material Costs

Craft	Hours	Labor Cost	Material $
Collections	240.5	$15,221	
Distributed Control Systems	630	$52,668	$5,370
Electrical	431	$30,295	$5,899
HVAC	2	$130	
Instrumentation	200	$13,618	$5,539
Mechanical	988.5	$53,626	$121,880
Plant Maintenance Technician	733.2	$30,596	$18,390
Total	**3,225.20**	**$196,154**	**$157,078**

The total annual maintenance costs for the RP-5/SHF facility was $353,232.

Laboratory Costs

The estimated annual laboratory costs for the RP-5 SHF facility was $84,000. This was based on $200 fixed cost and 10 samples at $20 per sample.

Manure Hauling Costs

Background
Manure was hauled from 7 dairies to the RP-5 SHF for digestion. The location of participating dairies is shown in Figure 0-1. A load of manure typically contains 3,500 gallons of 13% - 16% total solids by weight. The hauling was contracted to two companies : Marquez Dairy hauled their own manure, and the rest of the dairy manure was hauled by Misty Morning Dairy. Marquez was paid $70/load and Misty Morning Dairy $80/load for delivery to RP-5/SHF. The vehicles used for hauling are owned by IEUA. The two companies paid a nominal leasing fee for use of the vehicles.

The issue of manure hauling was discussed in detail at an IEUA Board meeting in February 2009 (Minutes of the Regular Meeting of the Board of Directors and Drought Planning Board Workshop of the Inland Empire Utilities Agency, Wednesday, February 4, 2009).The minutes documented the following key issues:

- Initially the dairies agreed to a rate of $80/load for hauling and $8.10 for disposal or tipping - $88.10 total
- As an incentive to sign on more dairies, the Agency reduced the transport rate from $80/load to a $1.90/load, for a total $10/load delivered and tipped at RP-5.
- This is the current rate and a significant subsidy ($78.10/load) for hauling and disposal.
- The hauling contracts expired at the end of 2008.
- The Agency attempted to negotiate a revised hauling and disposal rate with the dairies, however a mutual agreement on rates could not be negotiated.
- The Agency is no longer willing to subsidize this hauling cost, and the Board decided to re-instate the original $80/load for hauling.

All dairies, except one dairy which was court mandated to deliver manure, refused to pay the increased hauling cost for manure and therefore with no fuel source operation of the RP-5 facility was suspended.

The costs for manure hauling for 2008 were estimated at $794,765 assuming 3,500 gallons per load and $75/haulage cost.

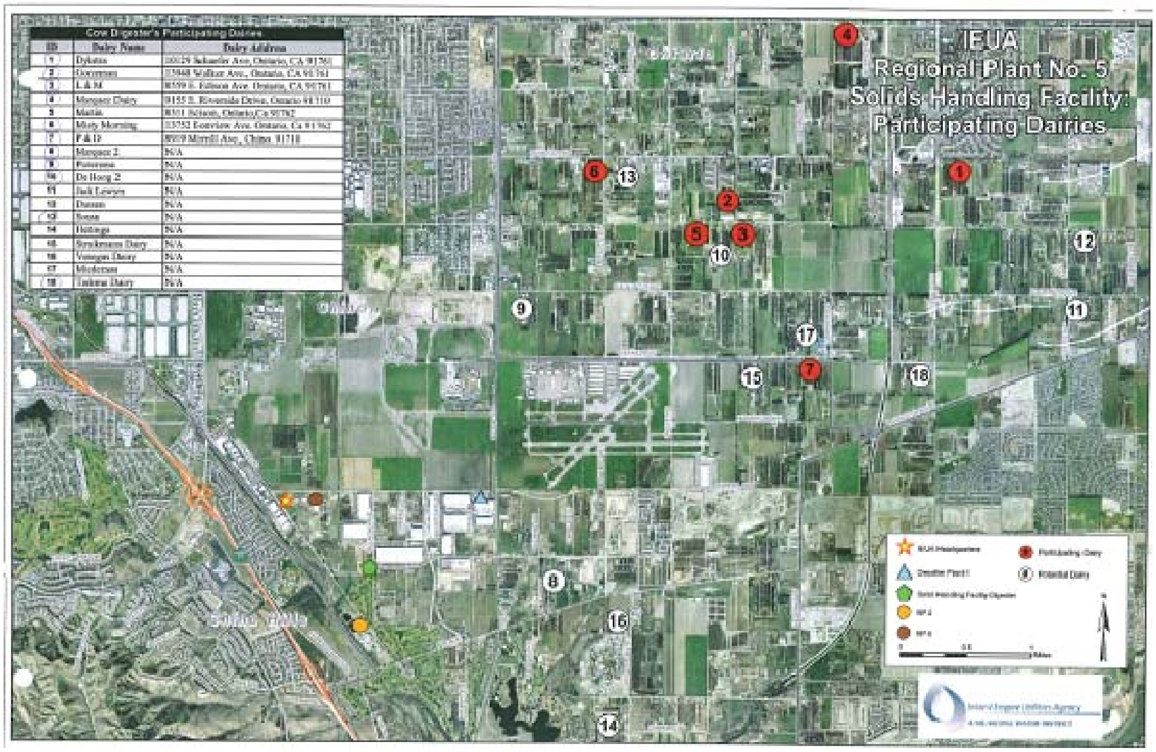


Figure 0-1 - Participating Dairies in Manure Hauling

Analysis

In the following Table 0-5 the theoretical electrical value of a single load of manure was determined at current SCE rates. This is an important analysis as the Summary Revenue and Costs analysis in the section 0 indicate that 82% of 2008 revenue came from electrical energy generation.

Table 0-5 - Theoretical Electrical Value of Hauled Manure

Parameter	**Value**	**Unit**
Load Hauled	3500	gallons
Manure Solids %	13%	%TS (typical)
Volatile Solids % of TS	78%	%VS (typical)
Volatile Solids/load	2960	lbs
Digester Efficiency	50%	VS destruction
VS destroyed	1480	lbs/load
Biogas produced per lb of VS input (SCS 2005)	6.40	cf/lb VS
Biogas produced per load of manure	18943	cf/load
Energy produced per ft^3 of biogas	550	Btu/ft3
Energy produced per load of manure	10	MMBTU/load
Guaranteed biogas to electrical conversion efficiency	35.90%	
Electrical Energy produced per load of manure	3.7	MMBtu/load
Gross Energy produced per ft^3 of biogas	0.16	$kW.hr/ft^3$
Net Electrical Energy generated per load of manure	1088	kW.hr
Value of Electrical Energy at IEUA	12	c/kW.hr
Ideal Electrical Value of a Load of Manure	**$ 130.57**	**$/load**

This analysis indicates that for the Phase II digesters capacity of 101,178 m^3/yr (SCS Engineers et. al., 2005), the total theoretical revenue could potentially have been :
101,178 m^3/annum /13.25 m^3/load x 112.21 = $857,003 per annum.

Similarly, the plug flow digester was anticipated to have a manure capacity of 50,000 m^3/annum . The total theoretical electrical revenue for this load could potentially have been $428,500.

The actual biogas produced per lb of VS input averaged 5.9 ft^3/lb VS (assuming the manure solids were at 13% TS and 78% VS of TS). This biogas yield is 8% less than the anticipated production and would result in an 8% reduction in the calculation of the ideal electrical value of a load of manure in the table above.

Chemicals

Chemical costs are incurred for:

- Control of H_2S in the biogas using iron based adsorption.
- Polymer used in the dewatering of digested sludge

The estimated cost for this operation in 2008 was $420,000.

The H_2S concentration in the biogas is high – between 2,000 and 4,000 ppm. The engines require a maximum H_2S concentration of 40 ppm, therefore between 1,960 – 3,960 ppm H_2S must be removed from the biogas stream. The capacity and costs of the iron sponge facilities (Cambiaso, June 2009) are as follows:

- Phase 1B Iron Sponge
  - Design Parameters - Marcab O&M Manual
    - Gas flow = 500 cfm
    - Average Inlet H2S concentration = 2,500 ppm
    - Media Life = 45 days
    - Media Life with two regenerations = 90 days
    - Number of vessels = 2
    - Volume = 756 ft^3/vessel

- Phase 2
  - Design Parameters - Marcab O&M Manual
    - Gas flow = 500 cfm
    - Average Inlet H2S concentration = 1,000 ppm (Actual Average Inlet H2S concentration = 3,000 – 4,000 ppm)
    - Oxygen concentration = 1%
    - Media Life (continuous regenerations from Oxygen enriched gas) = 90 days (Actual Media Life = 10 days)
    - Number of vessels = 2
    - Volume = 210 ft^3/vessel

- Marcab Media
  - 1 bag = 33.75 bushels (42 ft^3)
  - Cost = $19.5/cft

Figure 0-2 – Iron Sponge H_2S Absorbers

Polymer is applied to the digested manure and food waste stream to assist in dewatering of the solids. The dry polymer is diluted before application to the rotary presses. Polymer details (Cambiaso, June 2009) are as follows:

- Type of Polymer = Dry Polymer (CIBA ZETAG 7557)
- Dose = 16 lbs of polymer/dry tons of sludge
- Polymer cost = $1.788/lbs of polymer

Figure 0-3 – Rotary Dewatering Presses and Sludge Conveyor

Fiber Disposal

Dewatered fiber is trucked by Synagro Transport for disposal as compost amendment. The cost of trucking this material is $13.85/wet ton. The rotary presses would dewater the manure fiber between 25 - 30% by weight.

The total fiber disposal cost of $630,000 represents approximately 45,500 wet tons or 13,650 dry tons of fiber.

Permits and Fees

All liquid wastes from the SHF are disposed to the SARI line. Costs for use of the SARI line in 2008 (Aguilar, June 2009) were as follows:

Table 0-6 – Liquid Waste Disposal to SARI Line – 2008 Costs

Period	Discharge Volume	Total SARI cost
	(MG)	($)
Jan-08	4.39	$74,360.44
Feb-08	3.06	$62,454.67
Mar-08	3.18	$66,334.08
Apr-08	3.31	$40,624.47
May-08	3.80	$26,076.56
Jun-08	3.76	$15,861.22
Jul-08	3.27	$30,846.73
Aug-08	2.81	$29,305.54
Sep-08	2.71	$25,035.05
Oct-08	2.82	$33,003.82
Nov-08	3.34	$21,918.28
Dec-08	3.83	$43,084.98
Max	4.39	$74,360.44
Avg	3.36	$39,075.49
Min	2.71	$15,861.22
TOTAL	**40.28**	**$468,905.85**

Utilities

Imported utilities include electricity and natural gas. The costs for these utilities were as follows (Aguilar, June 2009):

Electricity = $333.33/day
Electricity = $10,000/month (SCE invoice)
Natural Gas = $240.00/day
Natural Gas = $10,000/month (invoice)

Total Utility costs for 2008 were estimated at $240,000.

Detailed Revenue Analysis

Revenue from the RP-5 SHF facilities was expected in the form of electricity generated, food waste and manure tipping fees, environmental credits and the SGIP grant (section 0).

Electrical Energy

Electrical energy could not be produced in the REEP facility for reasons previously mentioned. However, biogas produced at the RP-5 SHF was combusted in the 1 MW and 0.82 MW (standby) engine generators installed at the desalting facility. The value of this electrical energy was estimated using the SCS design basis assumptions (550 BTU/ft^3, 35.9% electrical efficiency) and a 12 c/kW.hr cost for electricity. This biogas resulted in avoided electrical costs of $1,077,167 for 2008.

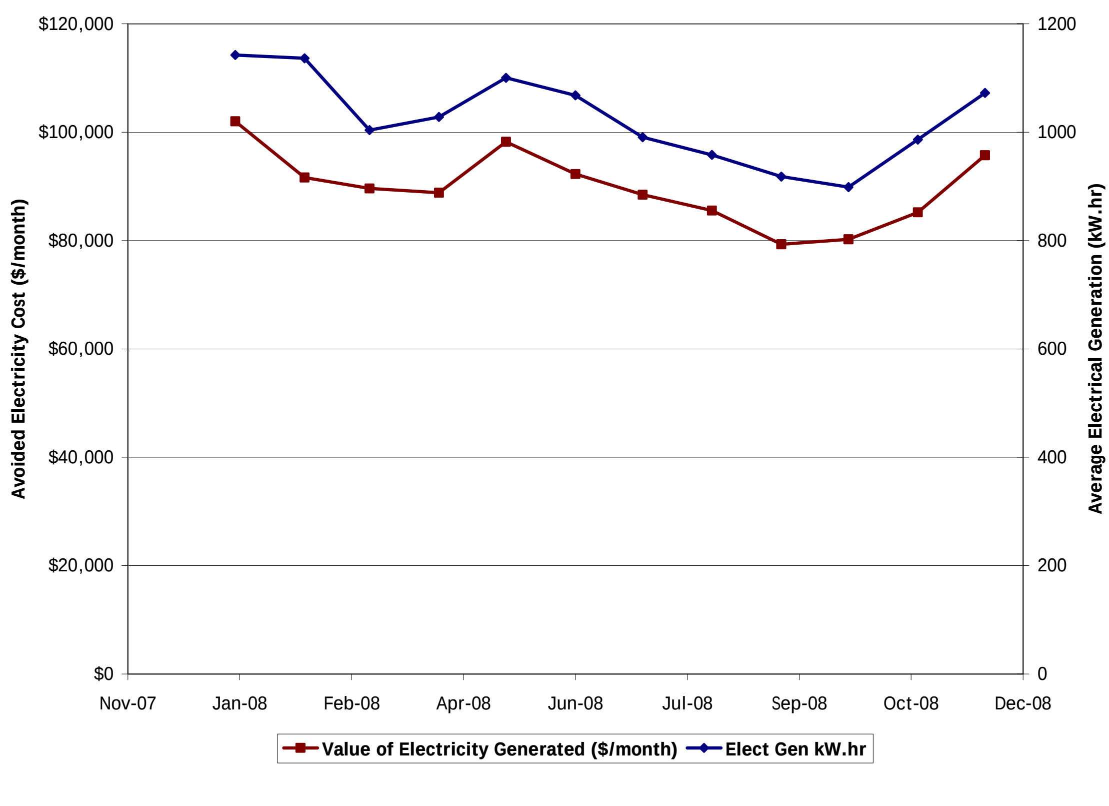


Figure 0-4 - Electrical Generation and Avoided Electrical Costs in 2008

Manure Tipping Fee

The subsidy on manure hauling discussed previously meant that Dairies paid $10/load for tipping manure at the RP-5 SHF. Assuming a typical manure load of 3,500 gallons, the tipping fee revenue for 2008 was estimated to be $105,969.

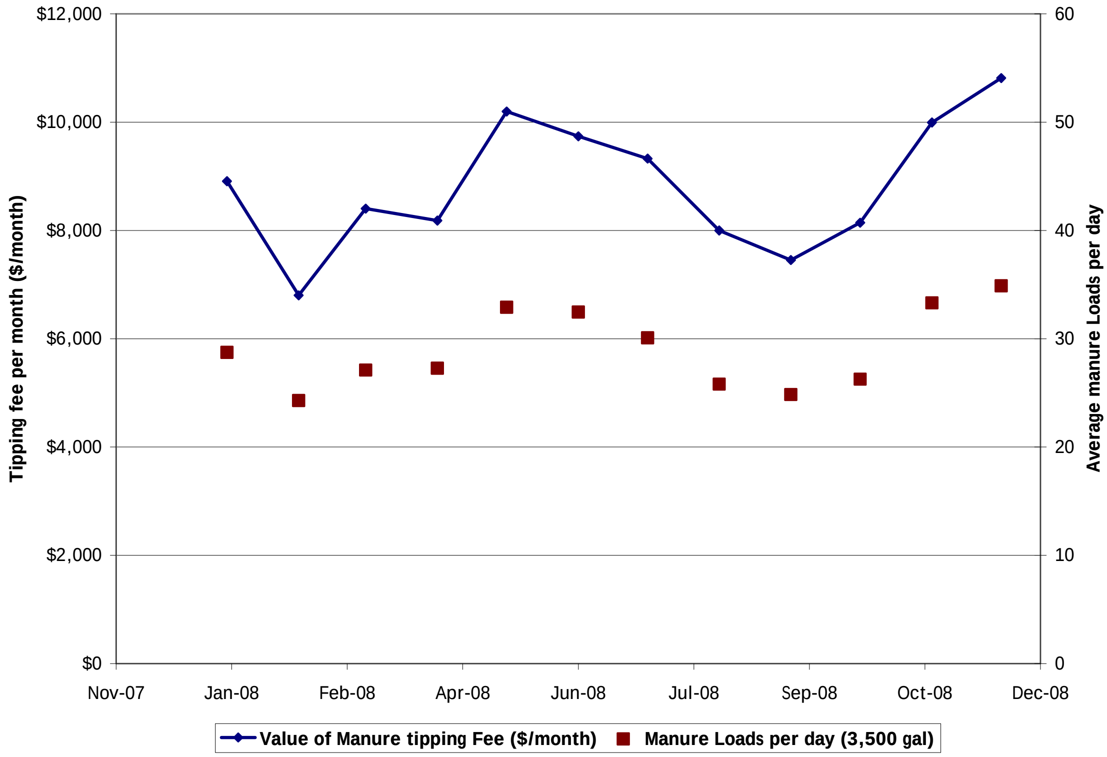


Figure 0-5 - Average daily manure loads and estimated tipping fees in 2008

Food Waste Tipping Fee

The tipping fee for food waste was estimated at $50/load. Assuming a typical food waste load of 3,500 gallons, the tipping fee revenue for 2008 was estimated to be $10,296.

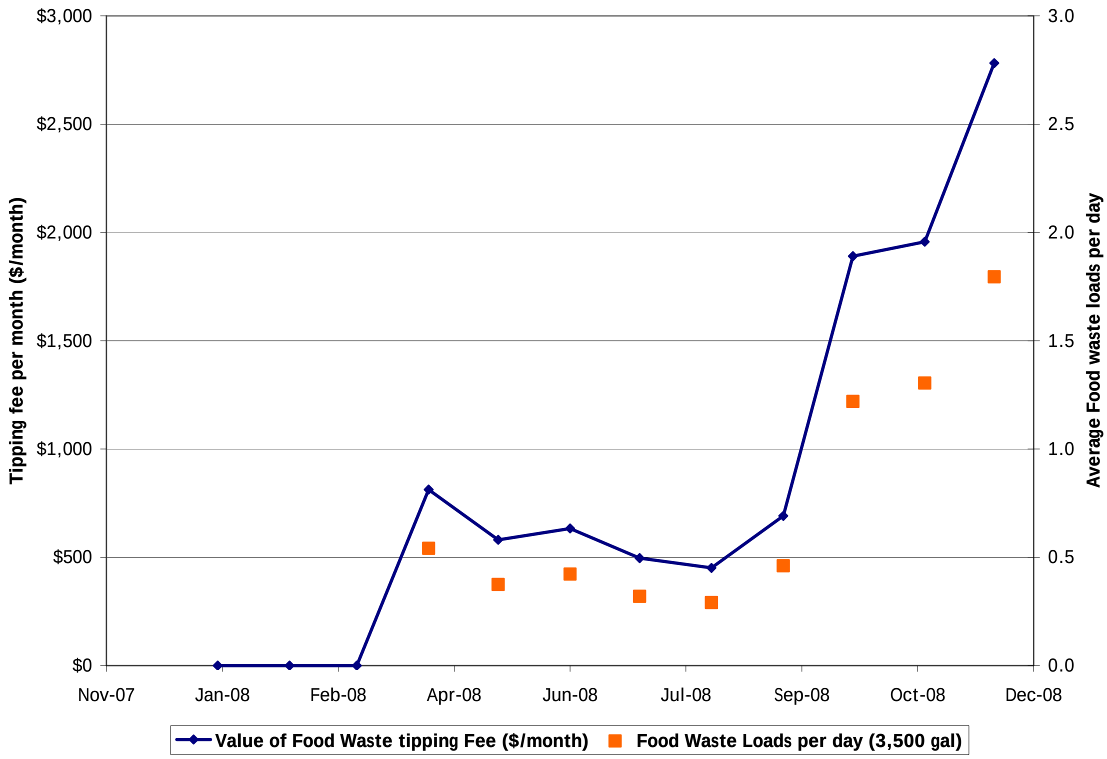


Figure 0-6 - Average daily food waste loads and estimated tipping fees in 2008

Environmental Credits

IEUA currently receives revenue for South Coast Emission Reduction Credits (ERC) for carbon dioxide. The ERCs were estimated as follows:

- Emission Reduction Credits = 1.61 tons CO2 eq/manure load/day
- Greenhouse Gas Cost = $1.75/tons CO2 eq

The total annual value of the CO_2 ERC for 2008 was estimated to be: $29,857.

No value has been realized for the potential PM_{10} emission reduction credits as a result of manure digestion. An analysis conducted by ENVIRON International Corporation in March 2009 (Lester J, 2009) suggested that the value of emission reduction credits for the ammonia removed from the environment by manure digestion could be significant.

The SCAQMD calculated an emission factor of ammonia of 0.005 ton NH_3/per year per ton of manure for a typical adult dairy cow(SCAQMD, Aug, 2004). The solids concentration of manure was not specified in this document, therefore it is difficult to directly apply the emission factor to operating data from RP-5 SHF. However, if the manure is assumed to be defined as 100% solids, then the ammonia emission factor in the diverted manure in 2008 was 550 lbs/day (101,497 gal/day x 8.34 x13% x 0.005 lbs NH3/lb manure). The ENVIRON presentation suggests a trading ratio of between 5 and 6 lbs NH3 per lb PM_{10}. Therefore the potential PM_{10} ERC could be 92 to 110 lbs PM_{10} per day. However, it may prove difficult to obtain this credit considering that the filtrate from the manure digestion process is discharged to the SARI line and this filtrate will contain most of the diverted NH3. ENVIRON were asked why a dairy farmer could not claim this diverted NH_3-N PM_{10} credit directly, rather than digesting the manure at RP-5. ENVIRON indicated that this was unlikely as it would be difficult to quantify the diversion from a farm, whereas a public agency has an operating permit that could be monitored. In addition ENVIRON indicated that the dairy farmer would need to prove that the manure was hauled to an area outside the air emission influence of SCAQMD. This seems a very remote possibility for IEUA. SCAQMD has indicated its reluctance to include ammonia as a criteria pollutant considering possible public/small business outcry. It is likely that SCAQMD would also need EPA's approval for this approach.

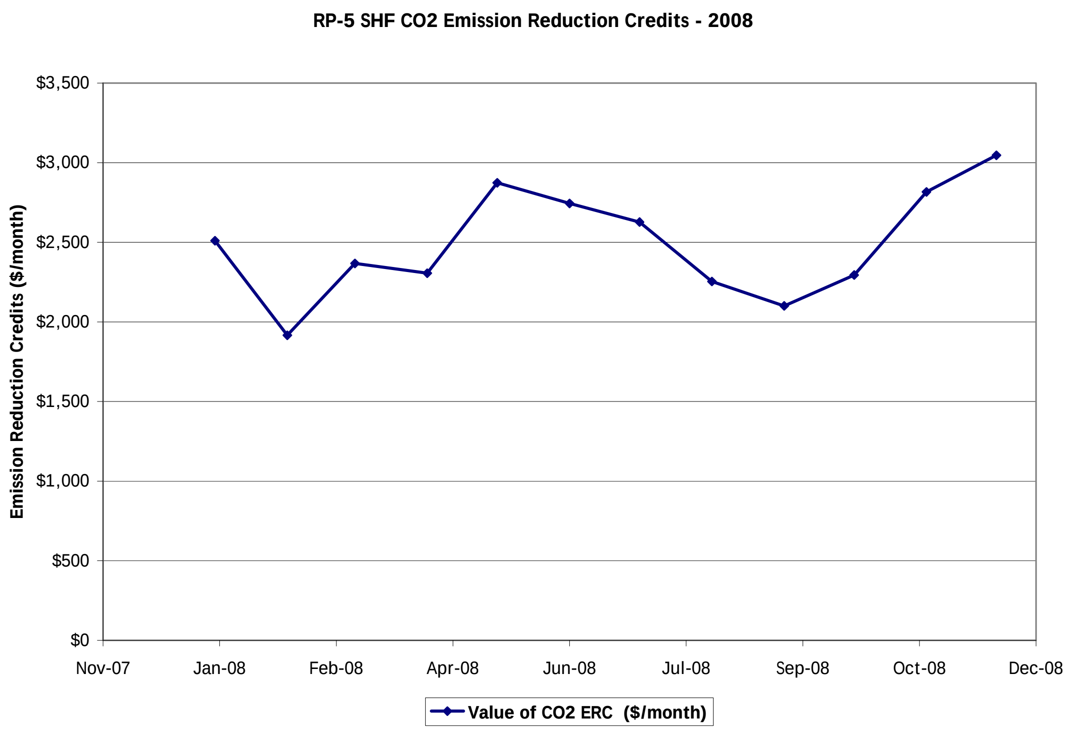


Figure 0-7 – Average Monthly CO_2 Emission Reduction Credits in 2008

Grants

IEUA did not receive any grant funding in 2008. IEUA will be eligible to receive $1 million for the SGIP grant if the biogas engine generators operated for three years and ran on no more than 25% of fossil fuel.

B&V Summary Revenue and Cost Analysis for 2008

B&V has calculated the following summary project revenues and project costs for 2008.

Table 0-7 - B&V Estimated Project Revenues 2008

Item	% of Total	Revenue
Energy	88%	$1,077,167
Food Waste Tipping Fee	1%	$10,296
Manure Haul/Tipping Fee	9%	$105,969
Environmental Credits	2%	$29,857
Grant		
Total Revenue		**$1,223, 289**

Table 0-8 - B&V Estimated Project Costs 2008

Item	% of Total	Cost
Labor	27%	$1,084,892
Maintenance	9%	$353,232
Laboratory Costs	2%	$84,000
Manure Hauling	19%	$794,765
Chemicals	10%	$420,000
Fiber Disposal	15%	$630,000
Permits and Fees	12%	$468,905
Utilities	6%	$240,000
Total Costs		**$4,075,794**

The subsidy paid by the Agency for the RP-5 SHF facility for 2008 was estimated to be $2,852,505.

B&V Conclusions from Manure Digestion Analysis

B&V have drawn the following conclusions from the economic and technical analysis of the RP-5 SHF digestion project:

- The estimated manure biogas yields from the digestion facility agreed with the design basis within expected limits for a biological process.
- The accepted food waste quantities in 2008 were insufficient to assess biogas yield.
- The biogas production from manure was significantly less than assumed in the economic analysis used in justifying the project.
- The digesters cannot produce sufficient biogas to operate a single 1.5 MW engine generator using manure as a digester feed source.
- The 1.5 MW engine-generators were sized for projected biogas quantities that were not achieved.
- The subsidy presently applied to manure hauling represents in excess of 55% of the value of the potential electricity that can be generated from this manure.
- The disposal costs for liquid wastes, chemical costs for H_2S control and solids dewatering were underestimated.
- Labor costs for operations and maintenance were underestimated.

- Environmental credits presently available to IEUA are insignificant. Emission Reduction Credits for ammonia may potentially be a possible source of additional revenue.

The RP-5 SHF and REEP facility is non-viable, using manure as the primary feed based on conventional economics. B&V further recommend that manure be abandoned as a feed stock for digestion.

GRANT FUNDING EVALUATION

Background

This chapter provides a review of the grants and incentive programs received by the Inland Empire Utilities Agency ("IEUA") supporting the Regional Plant ("RP") No. 5 Solids Handling Facility and the REEP Facility (collectively, the "Project").

Disclaimer

The opinions expressed herein do not represent legal advice and should not be construed as such. Black & Veatch strongly recommends IEUA to seek the guidance of its legal counsel regarding any legal interpretations of contractual matters.

Review of Grant and Incentive Programs - Received

IEUA started design and construction of the Project in 2001 and completed the Project in March 2002 (Phase I startup date) and December 2005 (Phase IB startup date). Startup for Phase II occurred in May 2007. According to documents provided by IEUA, funding sources and incentives pursued for the Project included the following:

- California Energy Commission ("Commission") – Phases I ($5,000,000) and II ($3,000,000)
- US Department of Agriculture/Natural Resources Conservation Service - Phase IA ($4,900,000)
- Department of Energy – REEP Cooperative Agreement ($2,326,000)
- Gas Company Self-Generation Incentive Program REEP ($1,000,000)
- Western United Resources Development, Inc. – Phase IB ($773,175)

California Energy Commission Phases I and II

IEUA received $5,000,000 under Agreement No. AGR-00S-001 for Phase I of the Project and another $3,000,000 for Phase II under Agreement No. 400-05-002. An amendment to the Phase II agreement extends the terms of the agreement from March 31, 2006 to March 31, 2007.

A review of Agreement No. AGR-00S-001 indicates that the majority of the terms and conditions associated with the Project are valid for a period of three (3) years from the formal conclusion of the Project or when final payment is received, whichever is later. Black & Veatch's understanding is that more than three years have passed for both the formal conclusion of the Project (Phase IA and IB) and final payment of the grant monies. Thus, with the exception of the clause noted below, all the terms and conditions of AGR-00S-001 appear to have been met by IEUA.

Section 12 of the AGR-00S-001 specifically notes that when equipment is "no longer needed for the original project or program, the recipient shall contact the Commission Project Manager for disposition instructions." Black & Veatch recommends that even with the expiration of the Agreement, IEUA should contact the Commission Project Manager as required under Section 12 for instructions on equipment disposition.

With respect to Agreement No. 400-05-002, the only condition that may have an impact on IEUA resides in Exhibit C, Section 4. Audit. This clause requires that IEUA maintain records on the Project for a period of three (3) years after the Project for audit purposes.

USDA/Natural Resources Conservation Services Phase I

IEUA received $4,900,000 under Grant No. 69-9104-1-199 for Phase IA of the Project. The terms and conditions of the grant specify under Section 15 that upon "acceptance of the work from the contractor(s), assume responsibility for operation and maintenance for a period of five years." Phase IA operated for over 5 years. IEUA appear to have no outstanding obligations under the terms of the Grant Agreement.

Department of Energy REEP Cooperative Agreements

IEUA received $2,326,000 under Agreement No. DE-FC26-NT41475 for the Project. Under this Agreement, the Project is considered complete, but the three-year audit period for records is still active. As such, IEUA, at a minimum must still maintain all records related to the Project to meet the administrative requirements of the Agreement.

Gas Company Self-generation Incentive Program

Under the Self-Generation Incentive Program, Reservation No. 2005-071, IEUA will only receive incentive payments (up to $1,000,000) once the following conditions are met: Payment is contingent on running one unit at 1,000 kW connected to a live load with no more than 25 percent natural gas fuel. If the equipment is not permanently installed for the useful life of the equipment and does not run on less than 25 percent of fossil fuel for at least three years IEUA is not eligible for the $1,000,000.00 incentive. These conditions are summarized under Section 7 Renewable Fuel Levels and Section 9 Permanent Installation. In the event that the Project is cancelled or shut down and the demonstration terms are not met, the Gas Company is not obligated to provide incentive funding. No funds have been received to date under this program. Black & Veatch suggests that IEUA may wish to research the ability to transfer the grant reservation number for the previous project to the current one if incentives monies are still desired.

Since the SGIP application in 2005, the Agency has maintained constant communication with the Southern California Gas Company (SCGC) to receive a rebate

for the RP-5 REEP. The project has qualified to receive up to $1,000,000 from the California Public Utilities Commission (through the SCGC) following inspection and startup. This will help defray the unexpected increase in materials cost.
The main qualifying requirements include the following:

- Use of renewable fuel gas with no more than 25% natural gas blend
- Use of heat recovery in an efficient manner
- Generation and connection to the RP-5 facility electrical bus
- Rebate maximum power generation is 1,000 kW
- Valid interconnecting agreement and permit to construct and operate

The clauses from the contract that specify this are listed below in full:

7.0 RENEWABLE FUEL LEVELS – For Level 3-R and Level 1 fuel cells running on renewable fuel, Applicant and Host Customer shall not, for the applicable period described below or the life of the applicable SG Unit, whichever is shorter, use fossil fuel for more than 25% of its total annual fuel requirement for such SG Unit in any calendar year

- Five years for Level 1 fuel cells(S)
- Three years for Level 3-R

7.1 In the event the Applicant or HOST Customer fails to comply with Section 7.0 above, then Applicant and Host Customer shall, within 30 days of receipt of a written demand from Program Administrator, reimburse Program Administrator all incentive payments paid by Program Administrator pursuant to the Program and this Contract. Such reimbursement shall be in the form of a certified check or cash payable to Program Administrator.

9.0 PERMANENT INSTALLATION
Equipment installed under this program is intended to be in place for the duration of its useful life. Only permanently installed systems are eligible for incentives. This means that the Applicant or Host Customer must demonstrate to the satisfaction of the Program Administrator that the generating system has both physical and contractual permanence prior to Program Administrator paying any incentive.

Western United Resources Development, Inc. Phase IB

Under Grant Agreement 248-I, IEUA has only invoiced Western United Resources Development, Inc. (“WURD”) for $45,101 out of a possible $773,175. The terms and conditions of this grant agreement have several areas for which IEUA may be required to return received incentive payments if the project does not meet production levels and/or if the project is shutdown prior to the end date of the agreement (5 years from the execution date). The grant is an incentive program whereby payment is made based on electricity generated above a baseline on a quarterly basis. The electricity generated is calculated from a formula based on how much gas has been produced and if electricity is actually being generated. The grant agreement allows up to five years after sustained gas production has been achieved for the collection of this payment.

The specific sections that trigger the repayment of monies in the event of termination are as follows:

Section 22. Termination of Agreement (e)."However, if the RECIPIENT terminates this agreement after commencing but prior to completing the PROJECT, the provisions of Section 34(j) will apply."

Under Section 34(j), Failure to Complete the PROJECT, "If the RECIPIENT fails to complete the PROJECT and generate electricity, any AWARD received by the RECIPIENT must be returned to WURD. WURD has full and complete discretion to waive and enforce this provision." In addition to the conditions noted under Sections 22 and 34, IEUA should also note that Section 16, Equipment requires that any encumbrance of property acquired by the RECIPIENT for the Project must occur only with WURD's approval. Given the potential for a financial obligation on the part of IEUA under this grant agreement, Black & Veatch recommends that further legal counsel be sought regarding this contractual matter, particularly in the event that a Third Party is provided access to the equipment for commercial purposes.

Section 34,i Notification of Nonoperation. RECIPIENT shall notify WURD in writing immediately if RECIPIENT has reason to believe that the PROJECT may become nonoperational within five years of the date of this agreement.

Section 16. Equipment

Title to equipment acquired by the RECIPIENT with AWARD shall vest in the RECIPIENT. The recipient shall use the equipment in the PROJECT for which it was acquired as long as needed, whether or not the project or program continues to be supported by AWARD and shall not encumber the property without WURD's approval.

Review of Grants and Incentive Programs - AVAILABLE

There are a number of sources of grant funding that are available to waste to energy projects. Some of these have already been accessed by the Agency for the existing facilities. The conversion of an existing facility that was previously grant funded for one application, and converted to a different application may make it ineligible from some funding sources.

Grant funding can be in the form of low interest loans or grants to cover a proportion of construction costs. As the manure digester project has already experienced, many of these have conditions that need to be met. Three general sources are available :

- Federal funds from the Department of Energy and EPA
- California funds from CEC, CPUC, CDWR and CA Waterboards SRF
- California Power Utilities from Southern California Edison

The Federal sources include the Climate Change Technology Program; Renewable Energy Production Incentive; Loan Guarantee Program and EPA Air grants.

California has more specific programs. Depending upon that final option selected and if fuel cells are part of the solution, the facility may be eligible for a grant from the CEC Rebate program for Wind and Fuel Cell Renewable Energy Generating Systems. Low interest loans are available through the CEC Energy Efficiency and Energy Generation Project. The CPUC offers feed in tariffs and there is a current agreement in place for the existing manure facility that would need to be amended or resubmitted if another feed source is used. The CPUC self generation program has already been used a source of grant funding and the revised project may still be eligible for funding. California also has the State Revolving Funds and the Prop 50 funding that provides funding for sewage waste to energy programs. Although the project has missed the deadlines for the Recovery Act funding that was administered through these programs, it can be submitted as a project to be added to the list of projects for future years of funding.

Finally, there are Power Utilities that offer self-generation grants. There remains the potential grant money from Southern California Edison Self Generation Program this still being available if the facility is re-commissioned. In addition to these grants, power generators such as Sempra Energy have been keen to provide funding for waste to energy projects as part of an agreement so that they can claim green credits against the project so that they can meet their own carbon reduction targets.

EVALUATION OF REEP PERMITS and EMISSION REDUCTION CREDITS

Background

The REEP facility has not yet been commissioned completely and the two engines have been operated for less than 30 hours each. Due to engineering issues associated with digester gas production, and Board suspension of commissioning and operations the two 1.5 MW spark ignition dual fuel digester gas/ natural gas engines are currently not operational.

Value of Emission Credits

Given that these engines have been shutdown for an extended period of time, if they have to be brought online, they will likely need SCAQMD approval with an updated BACT analysis. Moreover, since IEUA RP-5 SHF is considered an essential public service by SCAQMD, under Essential Public Service (Rule 1309.1), the emission credits came out of the Priority Reserve without charge, therefore voiding of the current permit and shutting the engines down on a permanent basis will not result in a recovery of any monetary benefit or emission reduction credits.

Re-commissioning Engines

As mentioned above, restarting engines may have to go through a SCAQMD approval again. This needs to be confirmed with SCAQMD since it is not clear what SCAQMD's reactivation policy is for emission units that have been shutdown for greater than a year. Typically, a “long-term” shutdown would require a new permit and the engines would need to meet the most current BACT. The definition of long-term is not clear. US EPA specify an 18 month hiatus as “long term” and this is copied in the North Coast Unified AQMD but SCAQMD do not appear to have formal policy in respect to this outage duration. Furthermore, SCAQMD has a permit moratorium in place since January 2009. Emission offsets will need to be purchased in the open market for projects to be approved. Emission offsets from the priority reserve or exemptions from offsets requirements are currently not available.

AQMD Rule 1110.2

Rule 1110.2 Emissions from Gaseous - and Liquid-Fueled Internal Combustion Engines, is applicable to the engines. If these engines have to be restarted they will be treated by the SCAQMD as new engines, and they will be subject to all emission limits, including NOx, of subparagraph (d)(1)(F) of the Rule (Table IV of the Rule).

TABLE IV - EMISSION STANDARDS FOR NEW ELECTRICAL GENERATION ENGINES
Pollutant Emission Standard (lbs/MW-hr)

NOx: 0.07
CO: 0.20
VOC: 0.10

Exceptions from the above requirements are allowed for biogas-fired engines that comply with subparagraph (d)(1)(C) of the Rule, which requires that the monthly average heat input on a HHV basis from biogas be greater than 90 percent. For engines meeting the NOx/VOC/ CO limits of 11/20/250 ppmvd requirement respectively, these limits are not yet set in stone. They may change based on the technology assessment.

SCAQMD would allow engines meeting these low emission limits an exemption from the 90 percent biogas heat input requirement (i.e., fuel heat input may be less than 90 percent biogas). To meet the 11 ppm NOx level a post combustion control technology will be needed, but as pointed out earlier, these low emission limits may be revised up based on a technology assessment study that will be conducted by the SCAQMD, results of which will be presented by July 1, 2010.

TABLE III CONCENTRATION LIMITS FOR LANDFILL AND DIGESTOR GAS-FIRED ENGINES		
NO_x (ppmvd)[1]	VOC (ppmvd)[2]	CO (ppmvd)[1]
bhp ≥ 500: 36 x ECF[3] bhp < 500: 45 x ECF[3]	Landfill Gas: 40 Digestor Gas: 250 x ECF[3]	2000
CONCENTRATION LIMITS EFFECTIVE JULY 1, 2012		
NO_x (ppmvd)[1]	VOC (ppmvd)[2]	CO (ppmvd)[1]
11	30	250

1 Parts per million by volume, corrected to 15% oxygen on a dry basis and averaged over 15 minutes.

2 Parts per million by volume, measured as carbon, corrected to 15% oxygen on a dry basis and averaged over the sampling time required by the test method.

3 ECF is the efficiency correction factor.

Option 1: CONVERSION OF RP-5 SHF to MUNICIPAL CO-DIGESTION FACILITY

Existing Solids Stabilization System at RP-2

Municipal biosolids (primary sludge and waste activated sludge) from RP-5 and Carbon Canyon are pumped to RP-2 for anaerobic digestion stabilization in separate dedicated lines. Digested sludge is dewatered and trucked to the IERCF for composting and disposal, dewatering pressate and centrate are disposed to the SARI line.

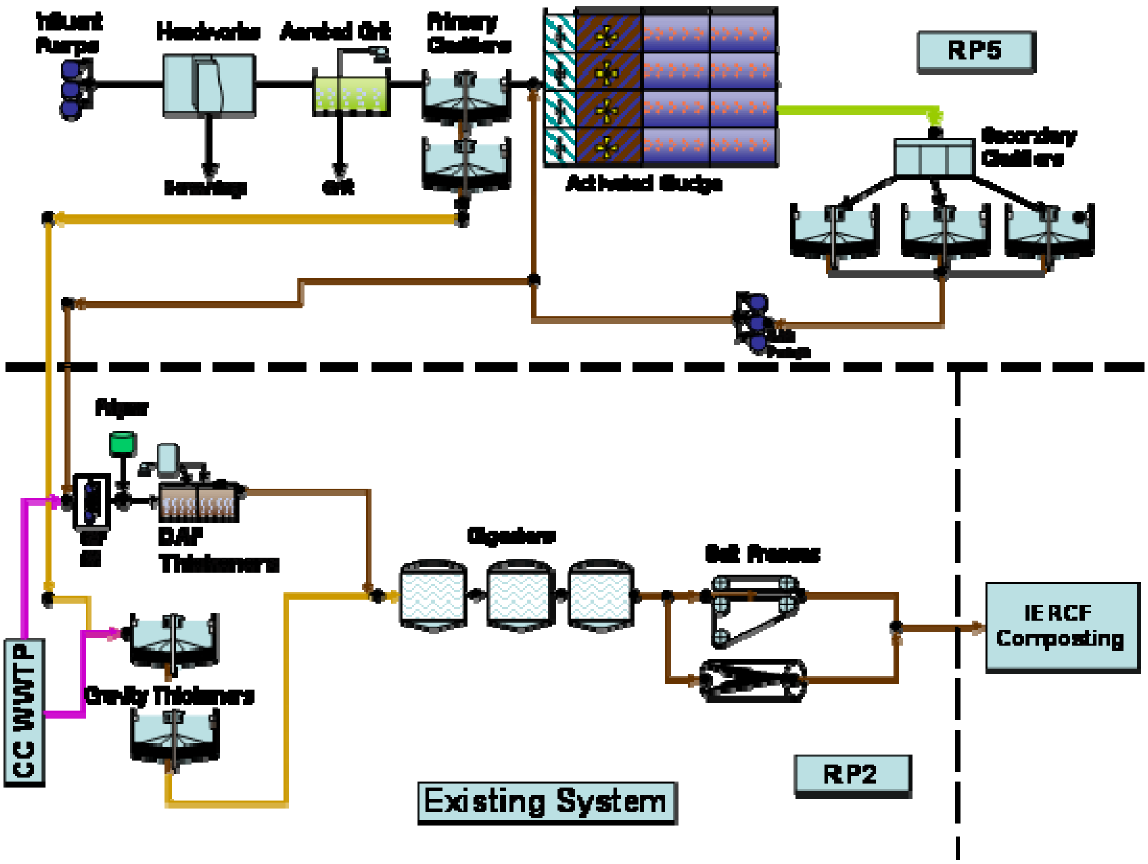


Figure 0-1 - Existing Biosolids Stabilization Schematic at RP-2

Current Loading

Carbon Canyon Water Reclamation Facility (CCWRF) treats wastewater from more dwelling units than RP-5. However a bypass sewer from RP1 provides the Agency the ability to shift wastewater load from RP1 to RP-5. Flow can also be bypassed from CCWRF. In addition, RP-5 also receives recycle flow from RP-2 that is pumped back for treatment. The recycle flow consists of gravity thickener supernatant, dissolved air floatation underflow, wash water, and miscellaneous utility water used at RP-2. In addition some flow from the Butterfield Ranch Housing development is pumped back to RP-5 with RP-2 returns. Centrate and pressate from the dewatering of digested sludge is sent to the SARI line for disposal. Therefore the two WWTPs treat approximately the same volume of wastewater at the present time.

RP-2 Capacity Assessment – Need for Additional Capacity

A comprehensive assessment of the Regional Plant 2 digestion facility was prepared in late 2007 (DeCoite et.al, Nov 2007). The conclusions from this assessment were that RP-2 was currently operating without adequate redundancy in key thickening unit processes; the anaerobic digestion system could not be operated in the designed thermophilic mode due to heat transfer constraints; and the biosolids dewatering systems were constrained by solids conveying equipment issues. In addition, this assessment using conventional process design operational criteria, indicated that key unit processes are expected to reach 100% of design capacity within the next 8 years. This information is summarized in Table 0-1 below, extracted from the technical memorandum by DeCoite et. al.

Table 0-1 - Summary of RP-2 Unit Process Loading Capacity based on EDU Projections prepared in 2007

RP-2 Unit Process	No. of Units Available	Design Operational Criteria	Fiscal Year to Reach 100% of Design Capacity	Fiscal Year Maintenance Process Redundancy Needed On-line	Maintenance/ Process Operational Redundancy	
					Available	Risk Impact
Gravity Thickening	1	20 – 30 Lbs/Ft2/Day	FY06/07	FY06/07	No	Very High
DAFT Thickening	2	0.42 – 0.83 Lbs/Ft2/Hr	FY12/13	FY08/09	No	Medium
Anaerobic Digestion*	3	0.10 – 0.30 LbsVS/ft^3/Day 24 – 30* HDT, Days	FY16/17 (53%) (24 Days)* FY06/07	>FY06/07	No	Very High
Solids Dewatering	1 Centrifuge 1 BFP	6,470 Lbs/Hr	>FY16/17	>FY16/17 (88%)	Yes	Low

*** Assumes Digester No. 2, 3 and 4 in mesophilic mode. Also assumes 85% active digester volumetric capacity**

The gravity thickening capacity of RP-2 was increased as a result of this analysis in 2009.

Revised projections of EDU growth in the service area were prepared in 2009 (IEUA staff, June 2009) to account for the slowdown in new home construction in the RP-5, Carbon Canyon (and other) collection areas. These projections are significantly lower than those prepared at the height of the housing boom in 2007. Flow resulting from these projections for Carbon Canyon and RP-5 were projected based on actual base load population increase and transfers of sewage between IEUA treatment facilities as shown in Figure 0-2.

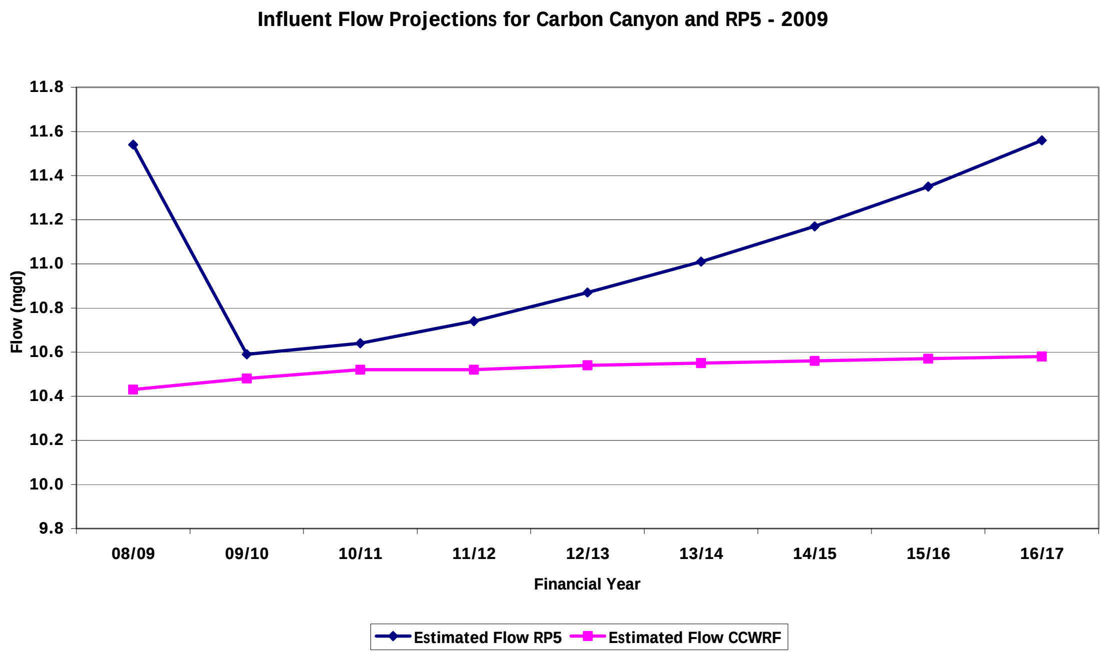


Figure 0-2 - Flow Projections for RP-5 and CCWRF

B&V applied the reduced population growth assumption to the key unit processes at RP-2 and estimated when:

- the unit processes would reach design capacity,
- maintenance process redundancy would be required
- operational redundancy would be required.

These estimates are provided in Table 0-4.

Table 0-2 - Summary of RP-2 Unit Process Loading Capacity based on EDU projections prepared in 2009

RP-2 Unit Process	No. of Units Available	Design Operational Criteria	Current Operational Criteria	Fiscal Year to Reach 100% of Design Capacity	Fiscal Year Maintenance Process Redundancy Needed On-line	Maintenance/ Process Operational Redundancy	
						Available	Risk Impact
Gravity Thickening	2	20 – 30 Lbs/Ft2/Day	15 $lbs/ft^2/d$ both in service	>FY16/17	>FY16/17	Yes	Low
DAFT Thickening	2	10 – 25 $Lbs/ft^2/d$	12 $lbs/ft^2/d$ both in service	>FY16/17	2009	No	Medium
Anaerobic Digestion*	3	0.10 – 0.30 $LbsVS/ft^3/Day$ 15 – 30* HDT, Days	0.14 $lbsVS/ft^3/d$ All in service 18.5 days	>FY16/17	2009	No	Very High
Solids Dewatering	2 Centrifuge 2 BFP	6,470 Lbs/Hr	4,980 lbs/hr for 8 hr shift	>FY16/17	>FY16/17	Yes	Low

*** Assumes Digester No. 2, 3 and 4 in mesophilic mode. Also assumes 85% active digester volumetric capacity**

This analysis still indicates that the RP-2 digesters while adequate when all units are in service do not have process redundancy. This is essential in a digester as grit and other solids collect and reduce active digester volume and ultimately prevent good solids stabilization and biogas production. The DAF thickeners do not have process redundancy, however the downtime associated with maintenance of a DAF is not as long as a digester cleanout, and the impact of poor DAF subnatant can be handled in the short term by RP-5.

The property on which the RP-2 facility is constructed is not owned by IEUA. The property is occupied on the basis of a long term lease from the Corps of Engineers. The lease was recently re-negotiated providing IEUA access to the property until 2032. However construction of capital intensive, long life (40 year) civil works like digesters on the RP-2 site may not be advantageous in the long term.

Therefore there are compelling reasons for the Agency to consider expanding solids stabilization capacity for municipal sludge using RP-5 SHF equipment.

Phasing of RP-5 Digestion Facility

A reasonable alternative would be to consider phasing the stabilization of RP-5/RP-2 sludge and co-digestion of FOG and other imported food wastes at the RP-5 SHF. Phasing of the facilities would optimize capital already invested and reduce the need for additional investment until growth or other economic factors support the expenditures. One possible phasing scenario is as follows:

- Phase 1 – Convert RP-5 SHF digesters to mesophilic anaerobic digesters for RP-5 sludge stabilization.
- Phase 2 – Import FOG and other food wastes to both RP-2 and RP-5 to supplement biogas production and produce enough gas to operate RP-2, (and possibly REEP) engines.
- Phase 3 – Construct additional digestion capacity (or install advanced digestion systems) at RP-5 SHF and relocate all CCWRF sludge from RP-2 to RP-5, continue food importation for biogas production.

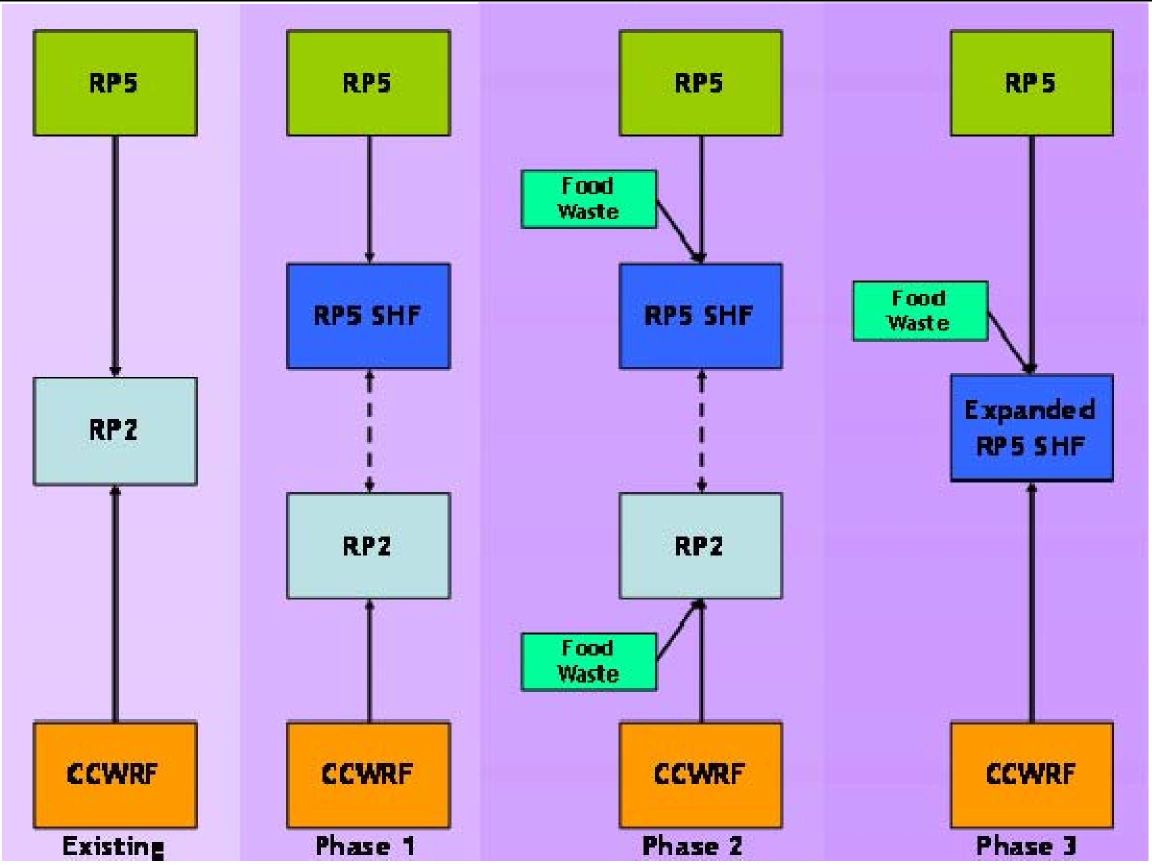


Figure 0-3 – Proposed RP-5 SHF Digestion Phasing Schematic

Phase 1: Conceptual RP-5 Digestion Facility

Future Loading

IEUA has multiple connections between WWTPs enabling flow and load to be shifted between facilities. For RP-5 influent flow and load is made up of base load flow, flow that is bypassed from RP1, flow that is bypassed from CCWRF and RP-2 recycle flow.

For this conceptual evaluation, the following key process design parameters were assumed:

Table 0-3 – Key Process Design Assumptions

Assumption	Value	Unit	Commentary
Flow per EDU	200	Gal/EDU	IEUA staff, 2009
Influent TSS/EDU	0.75	Lbs/EDU	De Coite et.al.
Primary Solids/EDU	0.4875	Lbs/EDU	65% Solids Capture
WAS/EDU	0.26	Lbs/EDU	De Coite et.al.
Gravity Thickener Recovery	90%	%TSS	B&V
DAF Recovery	95%	%TSS	B&V
Average Digester Feed Solids	4.86%	%TS	De Coite et.al.

The recycle flow from RP-2 to RP-5 was assumed to have a negligible load for the purposes of calculating bioisolids production.

Table 0-4 – RP-5 and CCWRF Projected Solids for Stabilization and Hauling: 2009 to 2017

Fiscal Year	09/10	11/12	13/14	15/16	16/17
Solids Loadings (ppd)					
RP-5 Primary Solids	21,791	19,476	19,841	20,499	21,328
RP-5 WAS Solids	11,622	10,387	10,582	10,933	11,375
RP-5 Thickened Primary Solids	19,612	17,528	17,857	18,449	19,195
RP-5 Thickened WAS	11,041	9,868	10,053	10,386	10,806
RP-5 Total Solids to Digester	30,653	27,396	27,910	28,836	30,002
RP-5 Volatile Solids to Digester	25,442	22,738	23,165	23,934	24,901
RP-5 Solids to Dewatering	16,914	15,117	15,401	15,912	16,555
RP-5 Solids to Hauling	16,069	14,361	14,631	15,116	15,727
CCWRF Primary Solids	25,423	25,545	25,643	25,716	25,764
CCWRF WAS Solids	13,559	13,624	13,676	13,715	13,741
CCWRF Thickened Primary Solids	22,881	22,991	23,078	23,144	23,188
CCWRF Thickened WAS	12,881	12,943	12,992	13,029	13,054
CCWRF Total Solids to Digester	35,762	35,933	36,070	36,173	36,242
CCWRF Volatile Solids to Digester	29,682	29,825	29,938	30,024	30,081
CCWRF Solids to Dewatering	19,733	19,828	19,904	19,960	19,998
CCWRF Solids to Hauling	18,747	18,837	18,908	18,962	18,998

Table 0-5 – RP-5 and CCWRF Projected Solids Flow for Stabilization: 2009 to 2017

Fiscal Year	09/10	11/12	13/14	15/16	16/17
Sludge Flow(gpd)					
RP-5 Primary Solids Flow	48,386	43,245	44,056	45,518	47,358
RP-5 Thickened WAS Flow	27,240	24,345	24,802	25,625	26,661
CCWRF Primary Solids Flow	56,451	56,721	56,938	57,100	57,208
CCWRF Thickened WAS Flow	31,780	31,932	32,054	32,145	32,206

Sludge Thickening Prior to Digestion

The RP-5 SHF does not include any equipment for solids thickening as the manure was delivered at high solids concentration (11 – 13% TS). The primary and waste activated sludge streams from RP-5 are presently thickened at RP-2. Gravity thickeners thicken primary sludge and DAFTs thicken WAS for both Carbon Canyon and RP-5 sludges.

DAF, rotary drum screens, gravity belt thickeners or other mechanical thickening systems could be used to thicken primary sludge or WAS. Any of these mechanical thickeners could be installed in the RP-5 SHF building. An economic alternative would be to use DAF or gravity belt thickeners to co-thicken primary sludge and WAS. The benefit of co-thickening is reduced process equipment.

Alternatively primary sludge could be thickened at RP-5 to the maximum concentration possible in the primary clarifiers, and WAS could be thickened using the existing equipment at RP-2 and then the thickened WAS (TWAS) pumped back to RP-5 SHF for digestion. (TWAS was pumped back from RP-2 at the time RP-5 was commissioned). The TWAS could be pumped back using the primary sludge line. This would save the expense of constructing one sewer line. The cost of constructing a sewer line needs to be compared in detail to the cost of installing mechanical thickening equipment for primary sludge and WAS. However for the purposes of this report it will be assumed that WAS will be thickened at RP-2.

Reuse of RP-5 SHF Digesters

The RP-5 SHF Phase IB horizontal digester is not suitable for use as a municipal digester. The high surface to volume ratio means that it will be virtually impossible to control foaming due to the presence of cleaning surfactants, *Nocardia* and other filamentous foaming microorganisms. The Phase IB digester could be used as a covered aeration basin for treatment of pressate/centrate instead of disposal to the SARI line.

The Phase II vertical digesters are suitable for either mesophilic or thermophilic digestion of municipal sludge.

Anaerobic Digestion Evaluation

Using the same process design values in the Decoite et.al, 2007 assessment, Table 0-6 illustrates digester process loading with both RP-5 SHF digesters in service, at 85% effective volume, and solids feed concentration of 4.86% in conventional mesophilic operation.

Table 0-6 - RP-5 and RP-2 Projected Digester Process Loads: 2009 to 2017

Fiscal Year	09/10	11/12	13/14	15/16	16/17
Solids Loadings (ppd/ft^3)					
RP-5 VS (all in service)	0.08	0.08	0.09	0.09	0.09
RP-5 VS (one out of service)	0.17	0.17	0.18	0.18	0.19
RP-2 VS (all in service)	0.06	0.07	0.07	0.07	0.07
RP-2 VS (one out of service)	0.12	0.12	0.12	0.12	0.12
Hydraulic Detention Time (d)					
RP-5 HDT (all in service)	30.2	29.6	28.7	27.6	26.9
RP-5 HDT (one out of service)	15.1	14.8	14.3	13.8	13.5
RP-2 HDT (all in service)	38.83	38.68	38.57	38.50	38.46
RP-2 HDT (one out of service)	21.48	21.40	21.34	21.30	21.28

Conversion of the two vertical digesters will provide significant capacity when both tanks are in service, but insufficient capacity at RP-5 when either tank is out of service based on conventional mesophilic digestion process kinetics after 2011/2012. IEUA has a number of alternatives for dealing with redundancy at RP-5.

v) A third digester could be constructed
vi) Some RP-5 flow could be diverted to RP1 for treatment, reducing load at RP-5. (RP1 is currently taking all potential flow from RP-5 - there is no by-pass flow to RP-5 at this time).
vii) Some sludge from RP-5 could be diverted to RP-2 for stabilization while RP-2 remains in service for digesting CCWRF sludge (Table 0-6 indicates significant RP-2 capacity becomes available)
viii) Advanced digestion technology could be employed to increase the capacity of the installed vertical digesters (see section 0)

Given the options of flow and sludge diversion, additional digester capacity should not be constructed at this stage. Maintenance and process reliability can be provided with diversions.

Detailed heat balance calculations have not been performed on the boilers or heat exchangers. However simple calculations suggest that the two boilers will have adequate capacity for duty/standby operation in heating the digesters to mesophilic temperatures. Both boilers may be required to operate for thermophilic operation.

Biosolids Dewatering and Disposal

Existing rotary presses used for dewatering digested manure could be re-used for digested municipal biosolids. However, tests were conducted by IEUA of these units on IEUA municipal digested sludge and performance was not as good as the dewatering centrifuges (Craig Parker, personal communication). Additional tests will need to be conducted to prove performance of these units on municipal sludge, otherwise mechanical dewatering equipment like centrifuges or belt filter presses will be required.

Alternatively digested solids could be pumped back to RP-2 for dewatering in the existing belt filter presses and centrifuges at this facility. Analysis of the dewatering capacity at RP-2 was based on the assumption that the centrifuges and belt filter presses (BFP) would be operated for an 8 hr shift each day. At the present time only 1 centrifuge is in service at RP-2. Repair of the second centrifuge has not been scheduled.

In the analysis shown in Table 0-7, 2 centrifuges and 1 BFP need to operate for the combined RP-5 and RP-2 digested sludge loads.

Table 0-7 - RP-2 (including RP-5) Projected Solids Dewatering Capacity Loads: 2009 to 2017

Fiscal Year	08/09	09/10	11/12	13/14	15/16	16/17
Solids to Dewatering						
Forecasted Loading (lbs/day)	39,834	37,984	38,374	38,991	39,732	40,184
Loading (lbs/hr) (8-hr day)	4,979	4,748	4,797	4,874	4,966	5,023
Max. Design Capacity (lbs/hr) @2.2% TS						
2 Centrifuge/2 BFP	8,470	8,470	8,470	8,470	8,470	8,470
2 Centrifuge/1 BFP	6,470	6,470	6,470	6,470	6,470	6,470
1 Centrifuge/1 BFP	4,235	4,235	4,235	4,235	4,235	4,235
2 Centrifuge	4,470	4,470	4,470	4,470	4,470	4,470
2 BFP	4,000	4,000	4,000	4,000	4,000	4,000
Percent Capacity Utilization (%)						
2 Centrifuge/2 BFP	59	56	57	58	59	59
2 Centrifuge/1 BFP	77	73	74	75	77	78
1 Centrifuge/1 BFP	118	112	113	115	117	119
2 Centrifuge	111	106	107	109	111	112
2 BFP	124	119	120	122	124	126

All dewatered solids will be hauled to the IERCF in Rancho Cucamonga.

Biogas Production and Treatment

The biogas produced from RP-5 sludge was calculated based on the DeCoite, Nov 2007, assumptions and typical values from mesophilic digestion (15 ft^3 biogas/lb $VS_{destroyed}$). Table 0-8 indicates the expected biogas production.

Table 0-8 - RP-5 Projected Biogas Production: 2009 to 2017

Fiscal Year	09/10	11/12	13/14	15/16	16/17
RP-5 Volatile Solids (ppd)	22738	23165	23934	24901	25499
RP-5 Volatile Solids Destroyed (ppd)	12279	12509	12924	13447	13769
RP-5 Biogas (cfm)	128	130	135	140	143

The RP-5 SHF iron sponge capacity is easily sufficient for the H_2S produced using municipal sludge as the digester feed. However, the RP-5 SHF biogas system does not include any siloxane removal system. This will be required for continued reliable operation and reduced maintenance of the RP-2 engine-generator. Costs for a siloxane adsorber are not strictly associated with the conversion of RP-5 and therefore while required, these costs have not been included.

Use of biogas is covered in section 0.

Phase 1: Concept Process Schematic

A conceptual process schematic has been prepared incorporating the RP-5 SHF digesters as follows:

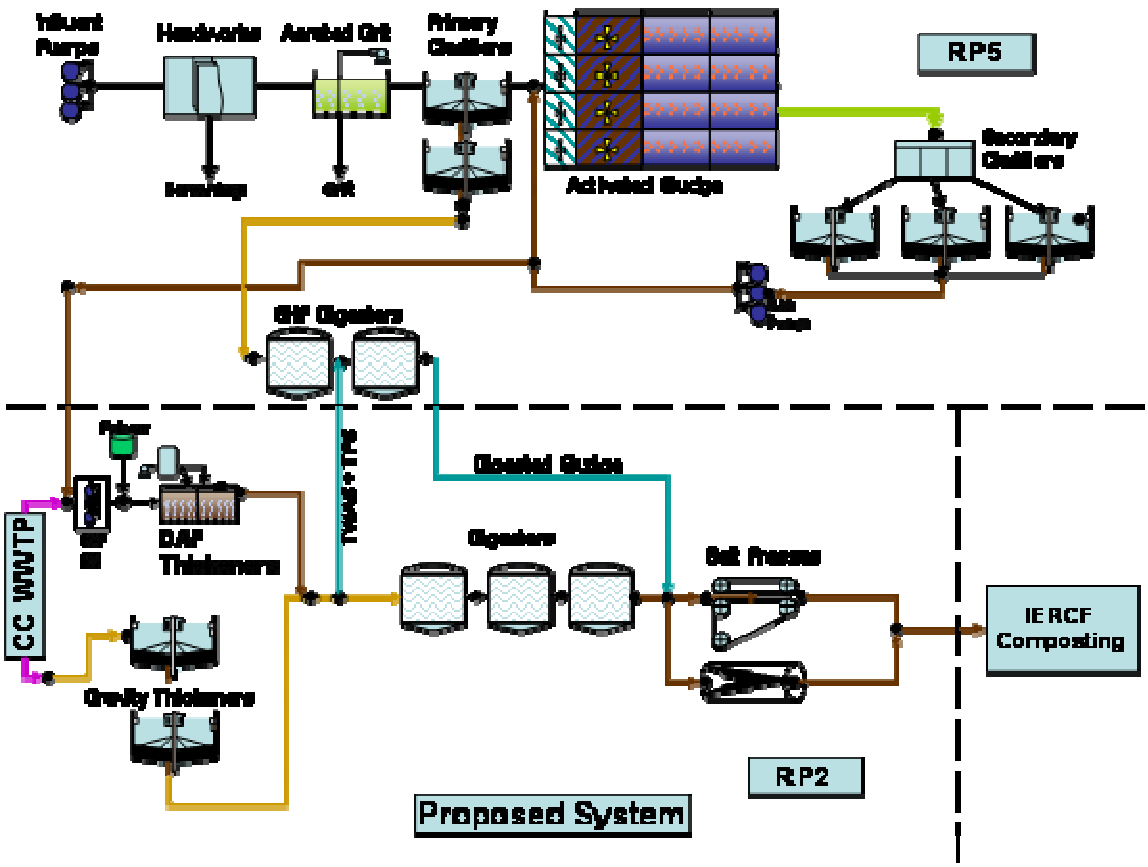


Figure 0-4 - Proposed RP-5/RP-2 Digestion System Schematic

Estimated Capital and Operating Costs for Phase I Conversion of RP-5 SHF

For Phase I capital costing purposes, new pipelines between RP-5 and RP-2 will be constructed rather than using existing pipelines. If existing pipelines are used sludge thickening equipment will need to be installed at RP5. This equipment will also need to be operated separately from the RP-2 equipment and therefore will be more expensive than pipelines. New pipelines could also be utilized for sending digested sludge, DAFT/GT sludge either way between RP-2 and RP-5 SHF.

Table 0-9 - Phase 1 Capital Costs for Conversion of RP-5 SHF

Item #	Description	Cost Opinion
1	Force main pipeline for thickened PS and TWAS from RP-2 to RP-5: 6 inch diameter, 0.6 miles	$411,000
2	Pump station for thickened PS and TWAS from RP-2 to RP-5: TDH = 70 ft	$115,000
3	Gravity pipeline for digested sludge from RP-5 to RP-2: 6 inch diameter, 0.6 miles long	$477,000
4	Duty/Standby compressor for biogas transport from RP-5 to RP-2 (350 cfm at 75 psi each) installed	$495,000
5	Relining of Vertical Digesters (18,000 ft^2 @ $13/$ft^2$ for steam cleaning and reapplication of coal tar epoxy)	$468,000
	TOTAL	$1,966,000

Incremental operating costs will include operation and maintenance of the two RP-5 SHF digester mixers, new biogas compressor(s) and new pump station at RP-2 for transfer of thickened sludge. Maintenance repairs required to make the flare operational for combusting excess biogas have not been estimated.

Table 0-10 - Phase 1 Utility Costs for Conversion of RP-5 SHF

Electrical Demand	Installed Power (kW)	Factor *	Averaged Demand (kW)
Incidental Pumps	15	0.33	5
Digester Agitator MX-210	22	1	22
Digester Agitator MX-220	22	1	22
Gas Blower and Flare	5	1	5
Process Control	5	1	5
Gas Compressor	50	1	50
Other	15	1	15
Totals			*124*
Average Annual Electrical Cost (12c/kW.hr)			*$130,350*

* The "Factor" contains the utilization of the installed power and the fraction of time when it is used.

It is reasonable to assume that existing RP-2 operators can operate the remote RP-5 digesters. However maintenance of mechanical and instrumentation equipment will be required. The costs have not been accurately determined. A reasonable estimate would be 33% of the 2008 costs to maintain the SHF/REEP facility or $120,000 per annum.

The incremental costs for operating the RP-5 digesters would total $250,000 per annum.

Phase 1: Conceptual RP-5 Digestion Facility : Conclusion

Based on the incremental capital investment, and the increased utility and maintenance costs for RP-5 SHF operation, conversion of RP-5 SHF to a municipal digester system for RP-5 sludge requires further analysis before a reliable recommendation can be made. Based on current knowledge it does not appear to be necessary to make the investment at this time for projected loads to RP-5 and CCWRF.

Phase 2: Sludge Digestion at RP-5 and RP-2 with Food Waste

Background

As mentioned previously, the biogas production solely from a municipal sludge fed RP-5 SHF digestion facility is inadequate for operation of the installed engine-generators. There are other additional potential sources of digester feed material: food waste; fats, oils, and greases (FOGs) that could be considered.

Fats, Oils and Greases (FOGs)

FOGs are an excellent source of energy and are highly recommended for boosting digester gas production, but due to these benefits and their environmental appeal, they have become much less readily available and in some cases, quite costly to obtain. A preliminary assessment by Environmental Engineering & Contracting, Inc., (EEC, 2009) indicated that while many of the member agencies within the Agency's service area have established FOG collection and control programs, the existing private and publicly owned treatment works disposal sites have more than sufficient capacity to receive all current and future projected waste grease generated in the Agency's service area.

EEC suggested that between 3.5 million and 5 million gallons of waste FOG may be available in the IEUA collection area for treatment. EEC indicated that a waste grease to energy program at RP-1 may be feasible and cost effective, although the estimates used for operations and maintenance did not appear to include costs for possible odor control, additional engine maintenance and additional biogas cleanup, so require further analysis.

Therefore, given the need for additional biogas generation capacity at RP1, and a large electrical demand, it is recommended that the Agency pursue the option of FOG co-digestion at RP1 rather than diverting this substrate to the RP-5 SHF/REEP.

Food Waste

Food waste is a viable source of energy; however, additional surveys would need to be completed in order to characterize the types of food waste and the quantities available to the Agency, due to the large variability in the energy content of the diverse food waste types. There are existing reception facilities for liquid food waste, but rigorous pre-treatment facilities are recommended for screening, mixing, and grinding other non-liquid food wastes prior to digestion in order to eliminate any foreign objects from disrupting operations and to provide a more consistent and uniform feed source into the digesters. A list of some of the current food waste type dischargers in the Agency's service area is included in the following table.

Table 0-11 – Food Waste Dischargers in IEUA Service Area

Industry	Description	Regional, North-NRWS or South-NRWS
American Beef Packers	Slaughter house	Regional
CC Graber	Olive canning	S-NRWS
Clement Pappas	Juice Manufacturer	S-NRWS and N-NRWS
Cliffstar Corporation	Juice Manufacturer	Regional
Coca Cola	Soda Manufacturer	N-NRWS and Regional
E & M Ranch	Egg production	S-NRWS
Frito Lay	Corn snack manufacturer	N-NRWS
Ludford's	Juice Manufacturer	S-NRWS
Mizkan Americas	Vinegar Manufacturer	S-NRWS and N-NRWS
Nestle Waters	Water bottling facility	N-NRWS and Regional
Niagara Bottling	Water bottling facility	N-NRWS - 2 facilities
Nong Shim Foods	Noodle Manufacturer	Regional
Scotts Brothers Dairy	Dairy	Regional
Sunkist	Juice Manufacturer	N-NRWS - closing down
Ventura Foods	Salad dressing manufacturer	S-NRWS and N-NRWS

Food Waste as Digester Substrate

Food waste is a miscellany of liquid and solid material from the food and drink industry that is surplus, spoiled or a discard. Therefore defining "food waste" as a general substrate for anaerobic digestion is invalid. For the purposes of this evaluation, food waste for digestion will be defined specifically in Table 0-12 as follows. This definition will eliminate many of the restaurant and other vegetable food wastes. The definition is designed to capture wastes from wineries, soda and juice manufacturers, and de-proteinated whey.

Table 0-12 - Food Waste Definition

Parameter	Value	Commentary
Solids Content	30 – 100 g/L	Dilute solids feed increases volume, reduces HRT, and increases SARI discharge costs and heating costs. Concentrated solids impact mixing energy and results in inefficient digestion
Volatile Solids Content	> 85%	Solids must be digestible not inert. VS% is a surrogate for digestibility.
Chemical Oxygen Demand	0.15 – 1.0 kg/L	COD is a surrogate for predicting digestibility. However some high COD streams are non-digestible, or require long acclimation periods. COD will also measure the soluble biodegradable components of the waste.
Total Kjeldahl Nitrogen:COD ratio	1:100	TKN is a measure of protein and other reduced nitrogenous wastes. TKN converts to ammonia. Unionized ammonia becomes toxic to methanogens at high concentrations. Limiting TKN is important.
Total Phosphorus: COD ratio	1:500	Total Phosphorus is a concern for Struvite formation, and if digester centrate/pressate is recycled and ultimately irrigated.

For these types of wastes the following digestion process values have been assumed:

Typical COD removal – 80%
Typical Municipal Sludge Biogas Yield – 11 ft^3/lb COD
Typical Food Waste Biogas Yield – 11 ft^3/lb COD
Target Co-digestion COD Loading– 0.15 ppd/ft^3

No attempt has been made in this analysis to estimate food waste COD or TSS concentration. This will be highly specific to the generator and may require some form of thickening (or dilution) to optimize hydraulics for digestion.

Table 0-13 - RP-5 and RP-2 Projected Digester Process Loads: 2009 to 2017

Fiscal Year	09/10	11/12	13/14	15/16	16/17
Biosolids COD to RP-5 (ppd)	30,924	31,505	32,550	33,866	34,679
Biosolids COD to RP-2 (ppd)	40,562	40,716	40,832	40,910	40,949
Food Waste COD to RP-5 (ppd)	17,204	16,624	15,579	14,263	13,450
Food Waste COD to RP-2 (ppd)	21,109	20,955	20,839	20,761	20,722
*Biogas Produced (cfm)**					
RP-2 + RP-5 without Food Waste	*296*	*299*	*304*	*309*	*313*
RP-5 with Food Waste	233	232	229	227	225
RP-2 with Food Waste	296.3	296.0	295.8	295.6	295.5

* - In this analysis all digesters are assumed to be in service. Under maintenance or failure conditions, food waste loads will need to be reduced or temporarily halted.

The engineering assumption that limits the biogas production is the target COD loading of 0.15 lb/ft^3/d, and 11 ft^3 of biogas/lb COD destroyed. These are medium loading rates for an industrial COD or pure food waste anaerobic digester design. However, municipal biosolids are typically more difficult to digest and operating at higher COD loading rates is not recommended. This digestion loading rate would need to be piloted for confirmation. Costs of converting the RP-5 SHF to a food waste digestion facility are expected to be minor. Cost of the conversion is estimated as $600,000 (including costs for connecting the Phase II boilers to the biogas line). This is in addition to the cost of converting the facility to municipal sludge for a total $2,600,000. No estimate has been prepared for implementing food waste digestion at RP-2. It is likely that an additional $500,000 will be required for this equipment. Use of biogas is covered in section 0.

Phase 2 RP-5 and RP-2 Co-Digestion with Food Waste: Conclusion

If the current difficulties with permitting of engine generators in the SCAQMD can be resolved through use of BACT, importation of food waste could generate revenue from energy generation and possible tipping fees. Municipal co-digestion should be further evaluated at RP-5/RP-2, specifically identifying food waste material that meets the assumed specification in Table 0-12.

At present IEUA does not have any of the contractual relationships required to operate RP-5 SHF in this mode. This option requires IEUA to contract with food waste generators and haulers for supply of material to digest. Without identified food waste sources it is unrealistic to estimate project economics.

Phase 3: Conceptual RP-5 Digestion Facility for RP-5 and CCWRF Sludge

Loading and Process Loads with no Expansion

The process loads applied to the 2 RP-5 vertical digesters exceed design practice for hydraulic detention time for all conditions. Therefore, this is not a realistic option without expansion of digester capacity or advanced digestion technology.

Table 0-14 – RP-5 Projected Digester Process Loads: 2009 to 2017

Fiscal Year	09/10	11/12	13/14	15/16	16/17
Solids Loadings (ppd/ft^3)					
RP-5 VS (all in service)	0.19	0.19	0.19	0.19	0.20
RP-5 VS (one out of service)	0.37	0.38	0.38	0.39	0.39
Hydraulic Detention Time (d)					
RP-5 HDT (all in service)	13.54	13.40	13.19	12.94	12.80
RP-5 HDT (one out of service)	6.8	6.7	6.6	6.5	6.4

Loading and Process Loads with required Expansion

The digester capacity at RP-5 will need to be expanded to include 2 additional, 1.2 million gallon tanks for process redundancy and reliability.

Table 0-15 – Expanded RP-5 Projected Digester Process Loads: 2009 to 2017

Fiscal Year	09/10	11/12	13/14	15/16	16/17
Solids Loadings (ppd/ft^3)					
RP-5 VS (all in service)	0.09	0.09	0.10	0.10	0.10
RP-5 VS (one out of service)	0.12	0.13	0.13	0.13	0.13
Hydraulic Detention Time (d)					
RP-5 HDT (all in service)	27.08	26.80	26.38	25.88	25.59
RP-5 HDT (one out of service)	20.3	20.1	19.8	19.4	19.2

The cost of the additional 2 digester tanks is estimated to be $2,500,000 based on steel, lined tanks. In addition to these costs, expansion of the RP-5 SHF facility for both RP-5 and CCWRF biosolids will require construction and installation of solids thickening equipment, solids dewatering equipment, upgraded dewatered solids conveying equipment, gas storage and siloxane treatment equipment, upgraded odor control equipment, additional heat exchanger capacity (possibly relocated from RP-2), additional boiler capacity, new polymer and odor control chemical storage and dosing facility, instrumentation and control equipment and miscellaneous equalization tanks, and pump stations. Maintenance repairs required to make the flare at RP-5 SHF operational for combusting excess biogas have not been estimated.

Table 0-16 – Phase 3 Estimated Capital Costs for Conversion of RP-5 SHF for RP-5 and CCWRF Biosolids

Item #	Description	Design Basis	Cost Opinion
1	2, 1.2 mg Steel, lined, digesters		$2,500,000
2	Dissolved Air Floatation Thickeners: 2 @ 36 ft diameter (1Duty/1Standby)	25 ppd/ft^2	$280,000
3	Gravity Thickeners: 2 @ 45 ft diameter (1Duty/1Standby)	30 ppd/ft^2	$350,000
4	Dewatering Centrifuges: 3 @ 2,500 lb/hr (2Duty/1Standby)	8 hour dewatering	$2,000,000
5	Solids Conveying Equipment	Allowance	inc
6	Odor Scrubbers NaOH/NaOCl and acid (H_2S & NH_3)	Allowance	$500,000
7	Heat Exchangers	Allowance	$500,000
8	Chemical Storage and Dosing Facility	Allowance	$1,000,000
9	Gas Piping and Siloxane Treatment		$1,500,000
10	Flare Replacement (for higher gas flows)	SCAQMD BACT	$1,100,000,
	TOTAL		**$9,700,000**

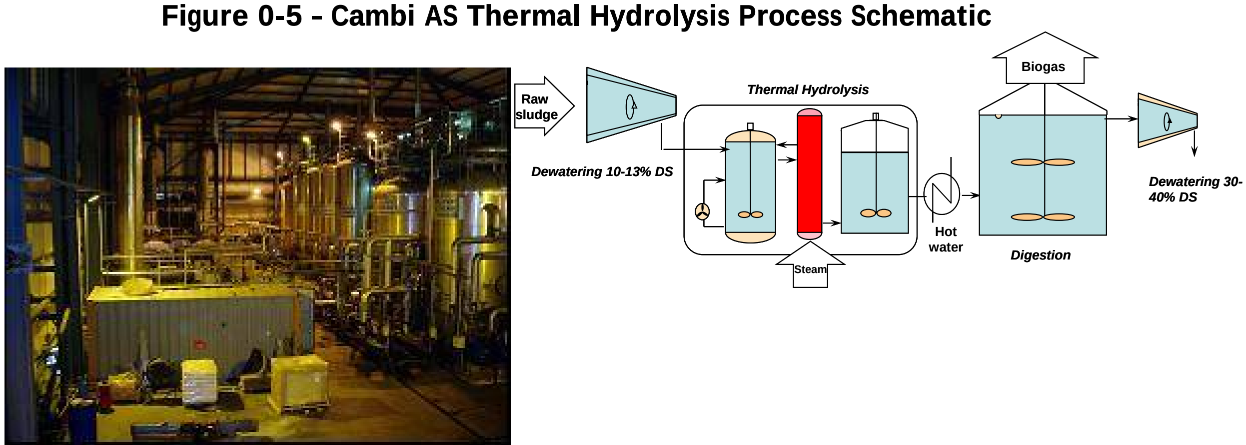
Use of biogas is covered in section 0.

RP-5 SHF Expansion for RP-5 and CCWRF with Advanced Digestion

As an alternative to expanding mesophilic digestion capacity at RP-5, advanced digestion processes could be employed. There are a wide range of digestion processes that are available for municipal sludge digestion at RP-5 SHF/REEP. Thermophilic processes may enhance the gas production of digesters; and have been operated at lower HDT and higher VS loading, however, due to the greater amount of energy required to heat the sludge to a higher temperature, the benefits compared to mesophilic processes are usually quite minimal. In addition, producing a class A sludge is not required considering the sludge will be further stabilized at the Inland Empire Regional Composting Facility (IERCF) in Rancho Cucamonga.

A viable alternative for the RP-5 SHF would be the use of an advanced thermal process - Cambi™ Thermal Hydrolysis Process (THP) that achieves some key objectives. The Cambi™ THP process requires partial dewatering of solids to a concentration of approximately 10 to 13%. Municipal sludge solids at this concentration are normally not digested as the rheology or fluid properties of a 13% stream is not conducive to mixing or digestion. The THP process mechanically and then thermally activates these thick solids in batch reactors operated at 165°C and 6 bar gauge pressure. After a short pasteurization period, the solids are rapidly flashed to atmospheric pressure. The sudden release of pressure causes activated sludge bacteria and other cellular material in the sludge to rupture, releasing easily degradable cellular components. Mesophilic digestion of this pre-treated material has multiple benefits including optimizing biogas production by additional volatile solids destruction, high feed solids (10 – 13% TS) digestion as the rheology of THP sludge is similar to a normal 3% digested sludge, and reduced digester tank volume. The Cambi™ process also produces a Class A product but this is not of importance at IEUA at the present time. However, this advantage may become important as the IERCF approaches capacity. The Cambi™ process comes as a pre-engineered package treatment system that is completely designed by Cambi and arrives ready for installation.

Figure 0-5 – Cambi AS Thermal Hydrolysis Process Schematic



The main disadvantages with the Cambi™ include the requirements for 10 bar boilers and a steam system, pre-thickening of the sludge (although this is required in any event), critical odor control as the foul gases produced through the hydrolysis process are very odorous, and no history in the USA. Currently a 350 tpd facility is being planned for installation in Washington DC but no operating facilities are available for inspection in the USA or Canada.

There are other advanced digestion systems including sonic disruption pre-treatment, but B&V have not had direct experience with these other technologies and would not recommend another experimental process for IEUA, at this facility.

In Table 0-17, digester loading has been calculated using 10% thickened sludge feed. Cambi AS typically guarantees performance with an even higher solids feed concentration.

Table 0-17 – RP-5 with Advanced Digester Technology Process Loads: 2009 to 2017

Fiscal Year	09/10	11/12	13/14	15/16	16/17
Solids Loadings (ppd/ft^3)					
RP-5 VS (all in service)	0.19	0.19	0.19	0.19	0.20
RP-5 VS (one out of service)	0.37	0.38	0.38	0.39	0.39
Hydraulic Detention Time (d)					
RP-5 HDT (all in service)	33.56	33.22	32.69	32.08	31.72
RP-5 HDT (one out of service)	16.8	16.6	16.3	16.0	15.9

These values are all within normal Cambi AS digester design values.

The budget cost for an installed Cambi AS, thermal hydrolysis process will be $7 million for a 12,000 metric ton dry solids /annum facility. The combined RP-5 and CCWRF sludge is projected to be 10,720 metric ton dry solids/annum in 2016/2017.

Based on the fact that the RP-5 facility is not space constrained, and lined steel digesters can be installed for significantly less than $7 million, Cambi AS thermal hydrolysis is not recommended for expansion of the RP-5 SHF to treat RP-5 and CCWRF sludge.

Phase 3 RP-5 SHF Expansion for RP-5 and CCWRF Sludge: Conclusion

Conversion of RP-5 SHF to a municipal digestion facility when RP-2 requires major refurbishing or at the end of the lease period is an appropriate use of the equipment and is recommended.

Economic Use of Biogas Produced from Anaerobic Digestion

For all alternatives considered at RP-5 SHF, an economic use for the biogas must be found. Given the uncertainty in the permitting process in the South Coast AQMD, it is expected to be extremely difficult to use the biogas in any power generation process involving combustion.

Phase 1 and 3 – Economics of Biogas Use

In Phase 1, the total biogas produced (RP-2 and RP-5) is estimated to be 300 cfm. Biogas produced is insufficient for operation of the REEP 1.5 MW engines (450 cfm), and the Desalter engines are no longer available. Initially therefore, the biogas may only be useful for fueling the boilers at RP-2 and RP-5 and for the RP-2 engine-generator. After using biogas as a digester heating source, excess biogas available is approximately 125 - 150 cfm depending on ambient temperatures and the need for supplying heat.

One alternative for biogas use is fuel cell technology. This appeared to be particularly attractive in California based on grant funding. SCAQMD permitting would not be an issue if the Agency pursued fuel cell technology due to the ultra low emission rate compared to internal combustion engines. SCAQMD has favorable view of fuel cell technology. Currently, fuel cells are being evaluated by the Agency.

For the RP-5 SHF operating with RP-5 and CCWRF sludge, the following calculations summarize fuel cell economics:

Table 0-18 - RP-5 Expansion Fuel Cell Economics: 15 Year Project Life

Fiscal Year	Value*	Commentary
Excess Biogas Production (cfm)	150	Some biogas is used for heating sludge
Estimated Energy of Biogas (Btu/ft^3)	600	Common assumption used for digester biogas
Total Biogas Energy (Btu/hr)	5,400,000	
Fuel Cell Energy Rating Btu/kW.hr	7,000	Includes allowance for inefficiency
Electrical Production (kW.hr)	771	
Value of annual electrical production (12c/kW.hr)	$810,925	
Annual Cost of Fuel Cell maintenance	$420,000	
Annual Estimate of Biogas Cleanup	$100,000	
Annual Bond Repayment for initial investment at 4% (after 50% grant funding)	$400,000	Total Capital value of fuel cells is estimated to be $9,000,000 (including IEUA costs)

* - Values extracted from a proposal received BY IEUA.

Based on current information, the most reliable use of the biogas at present is likely to be cleanup, compression and injection into the gas supply system as a "green energy". The cost of a gas cleanup system is estimated to be approximately $1.5 million dollars. The annual cost of biogas cleanup is estimated to be $100,000. Natural gas prices are highly volatile. For economic analysis purposes, a natural gas price of $3/MMBtu is suggested. This value is historically low, and does not include any "green premium". Therefore the excess biogas annual revenue as a natural gas replacement is $141,912. The cost of the annual bond funding (with 0% grant) and maintaining the biogas cleanup system is $234,910. Therefore production of natural gas quality biogas for fuel will cost IEUA $93,000 per annum. This is an investment with substantially lower risk, given the technology for biogas cleanup is proven. In addition, it provides future potential for fuel cell implementation, and if grant funding is received (or natural gas prices increase) may generate income for the Agency. The volume of gas production for phase 1 and phase 3 is probably too low and no economies of scale are available.

The excess biogas could be incinerated in a BACT flare. However, while this may be the least cost alternative, it is contrary to one of the key missions of IEUA – "Renewable Energy through methane gas and solar energy".
The excess biogas could also be cleaned and used as compressed natural gas (CNG) to fuel Agency vehicles. The Agency presently does not operate CNG vehicles therefore this would require a fleet replacement program. The cost of this program will not be economic..

Alternative treatment of digested sludge centrate/filtrate

The excess biogas could also be used to make low pressure steam for stripping of ammonia from centrate/pressate at RP-2. The economic justification for this would be to avoid SARI disposal costs. The centrate/filtrate liquids typically contain elevated levels of NH_3-N, TKN and other dissolved salts. For this reason, recycle of the liquid to RP-5 could overload the activated sludge system and result in excursions in the effluent nitrogen limits. One method of ammonia removal that could be attractive is steam stripping.

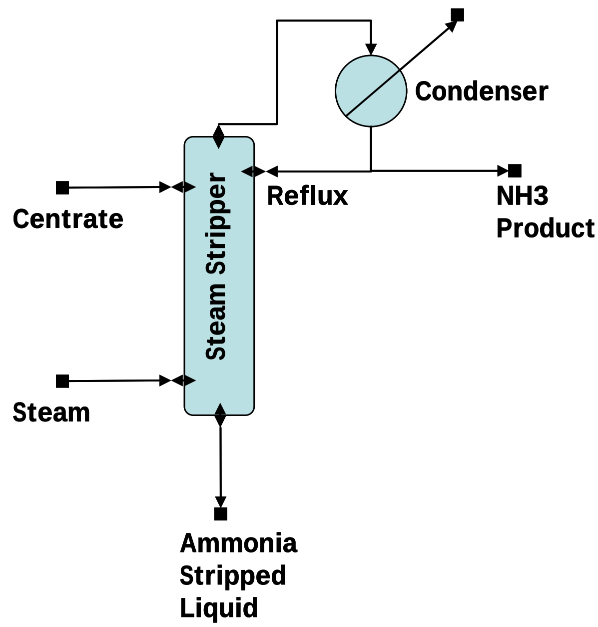


Figure 0-6 – Steam Stripping System Schematic

This process is designed to remove nitrogen directly from the centrate/pressate waste stream before it is discharged to the influent of the treatment plant. Operationally, the steam stripper would receive preheated centrate from a heat exchanger. In some systems supplemental alkalinity is added. The centrate enters the top of the steam stripping column, and steam is injected at the base of the column. The steam is typically saturated 1 barg pressure. The steam strips the ammonia from the centrate into the gas phase and then condenses the ammonia in the heat exchanger/condenser. Some of the ammonia solution is recycled as reflux to the column to build a more concentrated ammonia solution. The nitrogen is then removed in the form of aqua ammonia from the reflux stream, and the stripped centrate is pumped to the WWTP headworks. This configuration is a relatively small footprint technology that can be combined with the biological systems at treatment plants to achieve high levels > 70% of total nitrogen removal without alkalinity addition.

For RP-5 SHF, the biogas produced could be used as fuel for generation of steam. Low pressure steam generators (1 barg) typically do not require specialist boiler operators or steam engineers. The State of California does not have a boiler license requirement. Only the City of Los Angeles requires boiler operators to be licensed if the capacity of the system exceeds certain gas flow and pressure values.

Phase 2 – Economics of Biogas Use

In Phase 2, importing and co-digesting food waste with municipal biosolids is expected to produce an additional 430 cfm of biogas. This volume of biogas will likely make production of natural gas quality biogas economic for IEUA.

Option 2: CONVERSION OF RP-5 SHF to FOOD WASTE DIGESTION FACILITY

Background

In this option, it is proposed that IEUA elect to operate and maintain the RP-5 SHF as a food waste reception and treatment facility. As mentioned previously, for the purposes of this evaluation, food waste for digestion will be defined specifically as before in Table 0-12.

The actual organic load will depend on the anaerobic digestion technology used, and the type of food waste that is treated. The three common technologies and the COD loadings rates for food waste digestion are:

- Upflow Anaerobic Sludge Blanket reactor technology (UASB) 5 – 15 kg COD/m^{3}d (0.3 – 0.9 lbCOD/ft^3/d)
- Anaerobic Filter Technology (AFT) – 5 to 20 kg/m^3/d (0.3 to 1.2 lbCOD/ft^3/d)
- Suspended Anaerobic Digestion (AD) – 1 to 5 kg COD/m^3/d (0.06 to 0.3 lbCOD/ft^3/d)

The steel digestion tanks could be converted to UASB technology, but for the purposes of this analysis, a suspended anaerobic digestion process has been assumed with the following design assumptions:

COD removal – 80%
Food Waste Biogas Yield – 20 ft^3/lb COD
Maximum COD Loading– 0.15 ppd/ft^3

A food waste COD and TSS concentration has to be estimated in order to determine the potential tipping fee that the facility could anticipate. However the actual concentration of food wastes will be highly specific to each generator and is likely to require some form of thickening (or dilution) to optimize hydraulics for digestion. The assumption used by SCS Engineers was as follows:

- Total solids 20.0%
- Volatile solids 90.0% of TS

Depending on the waste, the total solids value is likely to be high and variable, therefore a more conservative assumption of 5% TS is proposed. The COD:VS ratio for food waste is also likely to vary widely. A value of 1.36 lb:lb has been assumed.

Table 0-1 - RP-5 Food Waste Process Load

Fiscal Year	Value
Anaerobic Digestion Volume (ft^3)	320,800
Maximum Food Waste COD to RP-5 (ppd)	48,128
Maximum Food Waste Lbs VS to RP-5 (ppd)	35,388
Food Waste Delivered Volume (gpd)	90,000
Food Waste COD Loading rate (ppd/ft^3)	0.15
Food Waste VS Loading rate (ppd/ft^3)	0.13
Digester HRT (days)	21.6
Biogas Production (cfm)	588
Biosolids Production (ppd)	13,762

This biogas production would allow reliable operation of 1, 1.5 MW engine generator, with the rest of the biogas used for maintaining mesophilic operating temperatures.

If this theoretical waste was available and transported to the site in tankers similar to the manure units, 27 loads per day would be delivered. The existing food waste storage facility of 4 x 15,000 gallon storage tanks may be adequate, although if food waste is not delivered on weekends, buffer storage tanks would be required.

An economic analysis of this concept is of no real value as there are too many uncertainties. IEUA would need the following to complete this analysis:

- Source of food waste for the digesters
- Characterize the waste to ensure that it is not too high in nitrogen, and pilot digest the waste to ensure it produces biogas at reasonable purity and volume per lb of COD
- Negotiate a potential tipping fee for the food waste
- Negotiate with contractors for costs for digested waste haul and disposal
- Identify a preferred use for the biogas – probably injection into the gas supply main.

Digestion of Food Waste Conclusion

Importing and digesting of food waste is likely to make production of natural gas quality biogas economic for IEUA. However, this endeavor is peripheral to the mission of a municipal Agency, and it is unlikely to be successful without investment of significant time and effort.

This conceptual analysis indicates that it may be economic for third party operators who have existing contracts with food waste producers to operate the RP-5 SHF and REEP.

EXISTING EQUIPMENT REUSE POTENTIAL / SALVAGE VALUE

Preliminary evaluation of the salvage value of the existing RP-5 SHF and REEP equipment has been undertaken. Determining costs for de-commissioning and salvage values for the RP-5 and REEP equipment was difficult and is expected to be indicative rather than contractual. In the event IEUA elect to decommission and salvage equipment, scrap and used equipment dealers will purchase specific items at very low recovery rates based on previous B&V experience. In Table 0-1, some of the equipment has been identified as having value for other IEUA facilities as shown.

Table 0-1 - RP-5 SHF/REEP Equipment Salvage List

Item No.	Quantity	Description	Value
1	1	Below-grade, completely-mixed, plug flow digester – 1.2 MG capacity	Sold for salvage value.
2	2	Steel, aboveground, completely-mixed European digesters – 1.2 MG capacity, each	Sold for salvage value.
3	2	1,500 kW Caterpillar lean burn gas internal combustion engine generator	
4	1	200 kW PureCycle secondary (bottoming) power generation unit utilizing exhaust gas from the Caterpillar engines	
5	1	Complete engine jacket and exhaust heat recovery system to serve the absorption chiller system for the two headquarter buildings	
6	1	Complete cooling water system utilizing RP-5 secondary effluent	
7	3	500 scfm, 200 psi V-shaped gas compressors	
8	2	4,100 cu. ft. high pressure biogas storage tanks	
9	1	Enclosed cooling tower cooling system	
10	1	79,600 gal tank – chilled water system	Presently in Use
11	2	290 gpm pumps – chilled water system	Presently in use
12	2	1,600 kWh Rotary Screw Presses	Sold for salvage value.
13	1	7500 gal Blending Gas tank	
14	1	Flare stack (plus 1 decommissioned)	
15	1	Manure Reception Facility with raked bar screen and transfer pumps	
16	1	Food Waste Reception Facility (4-15,000 storage tanks and transfer	Relocate to RP1 for FOG

Item No.	Quantity	Description	Value
		pumps)	
17	2	3.75 MMBtu Hot Water Boilers	Relocate to other facilities
18	4	Sludge Mixers (plug flow digester)	Sold for salvage value.
19	2	Top mounted mechanical mixers (one each European digesters)	
20	3	500 scfm Iron Sponges (for H_2S removal)	Relocate to other IEUA facilities
21	2	250 psi Caterpillar engines air start compressors	Sold for salvage value.
22	2	120 psi air compressor for natural gas air dilution with air receivers	
23	2	155 scfm, 80 psi, natural gas compressors	
24	1	14,400,000 Btuh natural gas/ air blending station	
25	1	Complete 12kV switchgear system	Reuse equipment
26	1	Complete SCADA and DCS system	Reuse equipment
27	1	140,000 gal filtrate/buffer tank with 6 unused pumps (2 progressive cavity, 2 Vaughan submersible, 2 Landia SS end suction pump)	Reuse pumps at other facilities
28	1	Engine fresh oil and waste oil tanks and pumps	Sold for salvage value.
29	1	125 kW Flare standby diesel generator (480 V)	

The total salvage value of the facility was estimated at $250,000. This excludes the manure vactor trucks and 2 sets of NOx and CO Continuous Emission Monitoring Systems (CEMS). There will be a market for these instruments as SCAQMD is requiring more engine emission monitoring..

There is also significant value in the REEP building. This building could be reused as a maintenance facility.

Note: The two Desalter engines are not on this list as these engines are owned by CDA.

REEP Engine Generators Salvage Value

More detailed inquiries were made regarding some of the main components of the project including the Caterpillar G3608 lean burn gas IC engine generator, the heat recovery muffler, spiral heat exchangers, plate-type heat exchangers, load balance radiators, and associated switchgear. Johnson Power Systems disclosed that the original cost of the IC engine generator system and the associated items was approximately $3 million for the IEUA RP-5 SHF/REEP. Due to the fact that much of the equipment was customized for IEUA operations and the lack of a need for pipeline feed generation equipment of that size in the United States, any future users of this equipment would be located overseas, most likely in South America. This option would have to be examined further, for the actual cost of purchasing the used generators would most likely be quite comparable to the actual cost of installing brand new generators, once the shipping, labor, and ancillary equipment costs are added to the resale value of the generators. These engine generators may only have value as scrap metal. For the salvage value estimate above, it was assumed that the two engines could be sold for $100,000.

Manure Vacuum Trucks Salvage Value

The manure collection equipment includes:

- eight (8) Loewen Honey-Vac trailers, having an estimated aggregate value of approximately $100,000 to $150,000
- five (5) Keith Huber vacuum tankers, having an estimated value of approximately $300,000 -$350,000.

The estimated values were obtained from dealers specializing in the sale of new and used manure collection equipment and are thought to be somewhat reliable.

THIRD PARTY OPERATION OF RP-5 SHF and REEP

Outreach has been made to potential stakeholders who may serve as third-party operators of the RP-5 SHF/REEP. A workshop was advertised on the Agency's BidNet to members of the public and some parties were contacted directly. Several of these interested parties attended a workshop held at the Agency Headquarters on June 10, 2009, and the list of attendees is included in the following table.

Table 0-1 – Workshop List of Attendees

Name	Company	Phone Number	E-mail
Mike Popichak	CR&RR	661-979-3276	cacoolmike@aol.com
Reg Renaud	STI Engineering	714-649-4422	
Dave Parry	CDM	425-453-8383	
Randy Bick	SRJR Consulting In	909-985-6677	randy@srjrconsulting.com
Ryan Begin	Feed Resource Recovery	857-362-7499 (T) 339-222-6076 (C)	ryan@feedresource.com
Chris Seney	Nursery Products	760-272-1224	nurseryproducts@charter.net
John Richardson	CR&RR	818-767-6000	jrichardson@communityrecycling.net
Guy Burgess	STI Engineering	310-796-6415	Guy.burgess@yahoo.com
Chuck Tobin	Burrtec Waste	909-641-3824	ctobin@burrtec.com

Those interested in serving as third-party operators of the RP-5 SHF/REEP were provided with guidelines for submitting a statement of interest. The guidelines are included in the following table.

Table 0-2 Statement of Interest Guidelines

Key Dates and Information:

- Planned Site Visit: June 17, 2009, afternoon
- Statement of Interest due: 2:00 PM on Friday, June 26, 2009
- Statement of Interest must be submitted to:
  - o Peter Sheckleford-Lister, P.E.
    Project Manager
    Black & Veatch
    15615 Alton Parkway, Suite 300
    Irvine, CA 92618
    Tel. 949-788-4216

Statement of Interest Guidelines:

- Organization Name, Address
- Person(s) Authorized to Contract
- Bonding Capacity
- Insurance Requirements
- Technical Concept of Proposal:
  - o Environmental Impact (emission, permits, emission credits, etc.)
  - o Experience in Similar Projects
  - o Schedule
- List of Equipment Intended to be Leased from Agency
- Financial Concept of Proposal
- Any Financial Support Expected from Agency
- Staffing:

	o Proposed Organization Chart o Annual Fulltime Equivalent (FTE) Staffing Level for the Facility (ops and maintenance) o Policy of Operation (e.g., 24 hr per day manning?) o Safe Working Policies

A summary of the Statements of Interest has been prepared in Table 0-3.

In addition to the Statement of Interest letters, IEUA staff has conducted a series of meetings with each of the four third party proponents to assist in determining specific deal points for further discussion and evaluation of the proposals.

Table 0-3 Statement of Interest Summary

Company	Organization Name, Address	Person(s) Authorized to Contract	Fuel Source	Source Contract in Place	Financial Concept	Technical Concept of Proposal	Gas Volume and Useage	Existing Equipment to be leased from Agency	Bonding Capacity	Insurance Requirements
Feed	Feed Resource Recovery (No address provided)	Ryan Begin	Food Waste and supplemental sludge, if required	Yes	Lease Agreement or Partnership 1. Lease Agreement for 30 years for annual fee 2. Third Party solely responsible for process upgrade costs and operation and maintenance and disposal of waste 3. IEUA municipal sludge treatment 4. Earnings from power generation, rec, grants and fertilizer would be owned by third party	Hydraulic shearing and Hygenization Reactor for food stream prior to Existing CSTRs, post treatment with filter treatment facilities. Products: renewable energy (80% methane for existing IC engine generators) and organic fertilizer	Run existing 2 No. 1.5 MW Engine-Generators for IEUA use or export under ppa.	Yes	Yes	TBC
STI Engineering, Inc.	STI Engineering, Inc. P.O. Box 792 28281 Silverado Canyon Rd Silverado, CA 92676-0792 714-649-4422 (tel) 714-649-4423 (fax) www.landfillengineering.com	Reg Renaud	Cow manure, food waste, green waste, ag waste or combination	In Progress	*Concept 1* Basic Approach to provide enough gas for existing engine generators 1. Third party process upgrade investment cost 2. Annual revenue from electric sales less operating cost 3. Tipping fee *Concept 2* Proposal includes option for expanding facility 1. Third party process upgrade investment cost 2. Annual revenue from electric generation, CNG to pipeline, CNG to retail, liquefied CO2, Dry ice IEUA can be investor, vendor or landlord.	Retrofit existing digesters and expand solids handling capacity to use patented steam biomass reactor technology; Install new green and organic waste handling facilities; install cat converter and CO2 sequester to generator exhaust; install new pipeline to boilers; install new boilers, if required. Pilot study conducted at Miramar Landfill using horizontal application	Concept 1 Run existing 2 no. 1.5MW Engine-Generators to produce 3MW Concept 2 Use as Concept 1 plus CNG to pipeline; CNG to retail; liquefied CO2 and Dry Ice	Yes	TBC	TBC
Burrtec Waste Industries, Inc.	Burrtec Waste Industries, Inc. 9890 Cherry Ave Fontana, CA 92335 909-429-4200 (tel) 909-429-4290 (fax)	Cole Burr	Processed food waste (plus other sources if required)	Yes	Lease and operate facility to generate 3MW electricity from existing Engine-Generators and sell this to IEUA at a price equal or less than current non-renewable rates.	Use existing digesters; substrate: mainly foodwaste, supplemented with clean dairy manures, liquid food waste, and possibly shredded paper. "Methane production proven to be 3 times more that municipal wastewater solids" from Burrtec trials	Volume not provided but anticipate sufficient gas volume to generate 3MW electricity from existing Engine-Generators	Yes	Yes	Yes
Community Recycling & Resource Recovery, Inc.	Community Recycling & Resource Recovery, Inc. 9189 De Garmo Avenue P.O. Box 1082 Sun Valley, CA 91352 818-767-6000 (tel1) 323-875-0587 (tel2) 818-768-0541 (fax)	John Richardson	Food organic waste streams	Yes	10 year lease. Renovate the facility with a capital investment in new equipment. Revenue stream from tipping fees and sale of electricity to IEUA at SCE rate. Additional revenue may be generated from carbon credit trading.	Use existing facilities to digest organic waste streams in theromphilic mode. Capital investment to enlarge receiving building, install processing equipment, modify thickening and truck loading system, modify spill and odor control, expand gas cleaning system, install engine-generator emission controls, install filtrate treatment and expand existing biofilter.	Run both generators at full load.	Yes	Yes	Yes

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1. The Regional Water Reclamation Facility No. 5 (RP-5) Solids Handling Facility (SHF) and Renewable Energy Efficiency Project (REEP) achieved the original goals of a full scale demonstration facility researching innovative combinations of primary and secondary energy generation processes, using methane gas derived from local processing of food waste, and dairy manure. Non-operation of the REEP engines prevented confirmation of the desired goal of 65% energy recovery.
2. The February 2008 amendment to SCAQMD Rule 1110.2 pertaining to air emissions permit for biogas engines impacted the project severely. Rule 1110.2 made two significant changes: 1) It made air emissions more stringent for all engines; 2) It temporarily (until July 2012) relieved any landfill or biogas engine from meeting these limits provided that the engines operate on a minimum 90% biogas feed as fuel source. After July 2012 the more stringent emission levels will apply. The REEP and CDA Desalter engines were not designed to comply with these more stringent emission levels. Furthermore, digester gas supply from the RP-5 SHF was insufficient to continuously supply 90% of one engine's fuel requirements. There is currently no beneficial use for biogas generated at the RP-5 SHF given the constraints of the AQMD Rule 1110.2 amendment.
3. The production of biogas was inadequate for continuous operation of a single 1.5 MW REEP engine. Biogas volumes were low because acceptable food waste quantities in 2008 were insufficient, and estimates made of biogas production from were too optimistic.
4. The new solar facility installed and in operation since 2009 has reduced average electrical demand significantly. Therefore there is a significantly reduced potential use of biogas for future production of electricity at the RP-5/ Headquarters building even if SCAQMD Rule 1110.2 compliant equipment is installed.
5. The subsidy presently applied to manure hauling represents in excess of 55% of the value of the potential electricity that can be generated from this manure.
6. The disposal costs for liquid wastes, chemical costs for H_2S control and solids dewatering were underestimated. Labor costs for operations and maintenance were underestimated. Environmental credits presently available to IEUA are insignificant. The subsidy for the RP-5 SHF facility for 2008 was estimated to be $2,852,505.
7. All grants and incentives received by the RP-5 SHF and REEP projects were analyzed. Key summary findings from this review are 1) that even with the expiration of the Agreement, IEUA should contact the CEC Commission Project Manager as required under Section 12 for instructions on equipment disposition, 2) IEUA may wish to research the ability to transfer the SGIP grant reservation number for the previous project to the current one if incentives monies are still desired, 3) for the WURD grant it is recommended that further

legal counsel be sought regarding return of monies received if the project continues to be halted or particularly in the event that a Third Party is provided access to the equipment for commercial purposes.

A number of options were developed for alternative use of the RP-5 SHF and REEP facilities. Conclusions from these options are as follows:

8. Converting RP-5 SHF to a municipal sludge digestion facility for RP-5 sludge should not be implemented at this stage. IEUA have multiple options of flow and sludge diversion, and maintenance and process reliability can be provided with these diversions.
9. Converting RP-5 SHF to a municipal sludge facility and importing food waste to both RP-5 and RP-2, should be further evaluated at RP-5/RP-2, specifically identifying food waste material that meets the assumed specification in Table 0-12. If the current difficulties with permitting of engine generators using BACT in the SCAQMD can be resolved, importation of food waste could generate significant revenue from energy generation and possible tipping fees.
10. An appropriate use of the equipment is the conversion of RP-5 SHF to a municipal digestion facility when RP-2 requires major refurbishing or at the end of the RP-2 lease period, or if real estate development restarts.
11. Conversion of the RP-5 SHF to a food waste reception and treatment facility, operated by IEUA could generate revenue for the Agency. A challenge will be identifying food waste material that meets the assumed specification in Table 0-12. Importing and digesting of food waste, is likely to be a financially economic proposition. However, this endeavor is peripheral to the mission of a municipal Agency, and would require expertise in food waste contracting which IEUA presently does not have. This conceptual analysis indicates that it may be economic for third party operators who have existing contracts with food waste producers to operate the RP-5 SHF and REEP.
12. For all alternative uses of the RP-5 SHF, uncertainty in the permitting process in the South Coast AQMD, is expected to make the use of biogas in any power generation process involving combustion extremely difficult. As mentioned in section 0, fuel cells are currently being evaluated by the Agency. Also, based on current information, the most reliable use of the biogas at present is likely to be cleanup, compression and injection into the gas supply system as a "green energy".
13. The salvage value of the RP-5 SHF and REEP equipment and vehicles is low. The estimate of value is less than $0.75 million.
14. Outreach has been made to potential stakeholders who may serve as third-party operators of the RP-5 SHF/REEP. Several of these interested parties attended a workshop held at the Agency Headquarters on June 10, 2009. Four parties provided Statement of Interest letters. IEUA staff has met with Third Party Proponents to determine general deal points for further discussion and evaluation of proposals. Based on the analysis conducted by B&V for the digestion of food waste, commercial operation of the facility could be economically viable but will not be highly profitable. Unique circumstances may enhance third party profitability like regulatory demands to reduce landfill load rates or lucrative local collection agreements. But SCAQMD requirements

may limit engine operation particularly if the RP5 SHF is no longer considered an essential public service.

Recommendations

4) The RP-5 SHF and REEP facility is non-viable, using manure as the primary feed based on conventional economics.

5) Black and Veatch recommend that IEUA further develop the concept of third party operation of the RP-5 SHF and REEP facility in the short term – less than 15 years.

6) Black and Veatch recommend that IEUA retain the option of converting RP-5 SHF to a municipal digestion facility in the long term (> 15 years) or sooner if other circumstances warrant

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