TOSA

Township of Ocean Sewerage Authority

REPORT ON

HOLDING TANK CONVERSION TO DIGESTERS

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Prepared By:

Michael J. McClelland
Professional Engineer
New Jersey License No. 32468

Henry L. Johnsen
Professional Engineer
New Jersey License No. 13855

Our File No: PO500311.01

Consulting & Municipal ENGINEERS
ASSOCIATES
Parlin • Howell • Monmouth Junction • Marlton • Pleasantville
P: 732.727.8000 www.cmeusa1.com

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SECTION 1 - Project Overview

This report is in response to the Authority's application to the BPU under the Renewable Energy Incentive Program (REIP) for financial assistance to investigate the merits of resuming anaerobic digestion using their existing sludge holding tanks. The report will quantify sludge hauling changes, digester gas production, power and heat production as it relates to the overall O&M budget for the Authority.

Since its inception in the 1960's the Township of Ocean Sewerage Authority (TOSA) has maintained the Treatment Plant and made upgrades as deemed necessary. The conversion of the digesters to sludge storage in the year 2000 was determined to be practical and cost effective at that time.

SECTION 2 - Current Operations

Previously the Authority retained Greeley and Hansen to prepare a process evaluation of the treatment plant. We take no exceptions to their report as it relates to operation of the various systems.

SECTION 3 - Solids Handling

Screenings and Grit

The majority of the screenings are removed in the head works and conveyed to a container for offsite disposal. Grit is removed by the grit chambers and dewatered by the classifiers. The dewatered grit is co-mingled with the screenings at the head works for off-site disposal.

Sludge

Settleable solids which accumulate in the primary settling tanks are pumped to the gravity thickeners. The thickened sludge at 3-5% is then transferred to the holding tanks for off-site disposal.

Sludge from the secondary system is wasted to the rotary drum thickeners. The drums thicken the sludge to approximately 4% and it is then transferred to the sludge holding tanks. The co-mingled sludge is then removed from the site via tank trucks for offsite processing and disposal.

A Bio-filter constructed in the summer of 2012 is currently in operation and replaces previously installed carbon absorbers for odor control.

SECTION 4 - Holding Tanks Conversion to Digesters

History

The existing sludge holding tanks were originally designed as anerobic digesters when the plant was constructed in the late 1960's. In early 2000 a decision was made by the Authority to convert two (2) digesters to waste sludge holding tanks. This was accomplished by removing the floating gas-holders; gas piping and safety equipment; sludge heat exchanger and related equipment. The abandoned equipment was replaced with fixed covers; a pumped sludge mixing system; a carbon filter system for odor control and related equipment.

Tank Conditions

The exterior condition of the holding tanks were found to be in good condition, with the exception of minor brick re-pointing and some re-roofing of the control building between the two (2) tanks.

Conversion Steps

The conversion to digesters will include demolition of the existing fixed covers; piping and nozzles in each tank as well as piping and mixing pumps in the control building. The demolition will have to be performed in two phases in order to keep the plant in operation.

The new facilities will include; floating gas holders or fixed membrane covers; digester gas mixers in each tank; combination gas mixers and heat exchangers or external hot water to sludge heat exchangers; hot water boiler; piping; hot water supply and return pumps; sludge recirculation pumps; digester gas safety equipment and an enclosed waste gas flare. The conversion will have to be performed in two phases in order to keep the plant in operation. It is anticipated that the new facilities will be housed within the footprint of the existing tanks and control buildings.

Process Changes

Sludge

Upon start up of the first digester it is recommended that both primary and secondary sludge be co-mingled in the existing thickener; therefore the bio-filter should remain in service for odor control. The digester sludge could be thickened using the existing rotary drum thickeners prior to trucking offsite.

The volatile content of the sludge will be reduced by the digestion process. Assuming a volatile solids content of the sludge at 75-80% and a destruction rate of 60%, the net amount of sludge to be disposed will be reduced by approximately one half. A by- product of the solids destruction is digester gas which can be used in a dual fueled boiler for heating the digesters and adjoining buildings. The alternative fuel would be natural gas. The amount of gas generated is typically adequate for heating the digesters in moderate climates such as central and southern NJ. Excess gas in warmer months will be flared to the atmosphere or used as fuel for a combined heat and power system (CHP).

SECTION 5 - Combined Heat and Power (CHP)

A CHP system could be integrated with the digestion system to utilize the excess gas generated to fuel an engine driven generator and recovery of heat with exhaust gas and jacket water heat exchangers. The excess gas may only be available during warmer months (April to October) when the amount of heat needed could be matched to take the place of the boiler during the period. The excess heat would be discharged to the atmosphere via radiators.

Equipment required includes a dual-fueled engine-generator; jacket water and exhaust heat exchangers; interconnecting piping and controls connected to digester heating system; gas scrubbers for removal of hydrogen sulfide and siloxane; electrical switch gear and a connection to the plant electrical system.

Digester Gas

Historical records indicate that TOSA produced approximately 60,000 cuft/day when the digesters were in operation. This amount is consistent with a base population of 44,000 plus commercial connections. Typically this amount of gas would be enough to heat the digesters during cold weather. Some excess gas would be available for other uses such as a Combined Heat and Power (CHP) during warmer months of the year.

Digester Gas Enhancement

Digester gas production enhancement may be done in several ways such as the addition of F.O.G. (fats, oils and grease) most of which is generated by restaurants. A receiving facility would have to be constructed to inspect and re-pump liquid to the digesters. The down side to this is that it may turn out to be an odor generator. When F.O.G. is delivered it is primarily water; therefore the quantity is limited to prevent dilution of the sludge in the digesters. Food wastes as an additive will have similar limitations.

The Joint Meeting (JM) Wastewater Treatment plant in Elizabeth, NJ has been used as a base line for TOSA. Currently the JM accepts approximately 10,000 gal per day of FOG. By proportion based upon the volume of the respective digesters TOSA could accept 1230 gal/day or 37,400 gal per month. At 10¢ per gal this could generate a revenue of $45,000/year. Gas production increased 18% at the Joint Meeting. Assuming a 15% increase at TOSA would yield an increase to 69,000 cuft/day, as shown on Tables 1 & 2. A receiving facility with screening would have to be added to the plant at an estimated cost of $200,000 as shown on Table 3.

In addition the Joint Meeting uses a chemical additive known as "peat-humic extract." Gas production data shows a 15% increase on top of the FOG increase. Assuming a 10% increase at TOSA would yield an increase to 75,900 cuft/day, as shown on Tables 1 & 2. Based upon an application rate of 0.5 gal/mgd at $45 per gal the O+M cost would increase by $33,000 per year as shown on Table 3.

Enhancement additives may not work for all treatment plants. Therefore, a pilot plant study is recommended. Tables 1 & 2 show the affects of gas production enhancement on fuel available and CHP performance.

Table 1
Estimated Fuel Available

	Standard Digestion	Enhance With Additives	
		F.O.G.	Peat
Cuft/day	60,000	69,000	75,900
Therms/hr	14.5	16.6	18.3

Table 2
CHP Fuel Demand

	Standard Digestion 80% Load	Enhanced Digestion 100% Load
Power kW	144	160
Fuel Therms/hr	14.5	16.91
Heat recovery Therms/hr	6.52	8.6
Heat load (calculated) (1) Therms/hr	6.11	6.11

(1) This amount represents the heat load for the digester tanks; the control building and the heat demand for raw sludge.

SECTION 6 – Renewable Energy Certificates

Renewable Energy Certificates (RECs) also knows as Renewable Energy Credits are tradable, non-tangible energy commodities in the United States that represent proof that 1 megawatt-hour (MWh) of electricity was generated from a renewable energy resource. Biogas produced by anaerobic digesters meets the criteria.

The value of these credits has dropped dramatically since their inception. Currently the Joint Meeting sells their RECs at $2.56 per MWh. If TOSA generated 160 kW for 6 months per year this would equate to approximately $1600-$2000 per year additional renew as shown on Table 3.

SECTION 7- Options

General

In Sections 4 and 5 of this report, the equipment and changes required to convert back to sludge digestion and the addition of CHP were outlined. A summary of the net annual costs for each Options described herein is included at the end of this Section.

Option 1 – Status Quo

Maintaining the status quo or doing nothing has negative consequences. TOSA is a pro-active Authority; therefore this option can be ignored. The annual operational cost for 2012 was as follows:

Sludge Disposal Cost		$381,000
Labor		$940,000
Operation and Maintenance		$675,000
	TOTAL	$1,996,000

This amount will form the baseline annual operating cost for the remaining options presented on Table 3.

Option 2 – Maintain Bio-Filter

If the Bio-Filter operation continues to be successful, it should be maintained and/or expanded for odor control for the sludge thickener and sludge holding tanks. On Table 3, an amount of $100,000 has been used as a place-holder for future expansion of the Bio-Filter or conversion to a wet scrubber as suggested by Greeley and Hansen. In addition an amount of $25,000 per year has been included for O & M. These items will increase the annual operating cost to $2,029,000 as shown in Table 3.

Option 3 – Digester Conversion

The conversion from sludge storage tank to anerobic digestion will include significant demolition and reconstruction costs. On Table 3 an amount of $3,300,000 has been estimated to complete this work. Other costs include engineering, debt service, labor for 24/7 operation, O & M and power. The only significant offset is the 50% reduction in sludge hauling cost. The net annual cost will increase by $365,000 per year to $2,394,000. Note that the summary is accumulation from Option 1 to Option 3. The continued use of the Bio-Filter will be required for the thickener if the holding tanks are converted to digestion.

Option 4 – Combined Heat & Power (Standard Digestion)

The addition of a CHP system could have some benefit as a backup for the boiler to heat the digester and other buildings; the excess digester gas not needed in warmer months could be utilized to generate electricity; if natural gas prices remain low, the run time on the generator could be increased to provide both heat and power during winter months.

On Table 3 an amount of $1,500,000 has been estimated to add a CHP system to the facility. Other costs include engineering, debt service, labor, the 24/7 operation and O & M for the engine and gas scrubbing system. The savings in power cost is based upon excess digester gas available during warmer weather when heat demand is low. The net annual operating cost will be increased by $210,400 to $2,604,400. Note that the summary is accumulation from Option 1 to Option 4 because all systems will be required to operate the CHP.

For this cost estimate an engine was selected based upon digester gas production so that it can run continuously. The unit selected will be rated at 180 kW at full power. In order to meet the gas production it will be backed-off to 80% as shown on Table 2.

Option 5 – Combined Heat & Power (Enhanced Digestion)

A CHP system with more gas to burn will operate in the same manor as stated in Option 4.

On Table 3 the construction cost has been increased to $1,700,000 to account for a FOG receiving facility. Other cost includes engineering, debt service, labor, O&M for engine and gas scrubbing system and the purchase of peat extract. There are deducts for FOG revenue and power production. The net annual operating cost will be increased by $204,000 to $2,598,000. Note that the summary is an accumulation from Option 1 to Option 3 plus Option 5.

SECTION 8 – Recommendations

The basis of this report was to investigate the feasibility of converting the holding tanks back to the digestion process as originally intended in order to reduce energy consumption at the Plant through the use of methane gas which can be generated by the biological process of digestion.

The cost of going back to digestion is very high for a small plant as it relates to additional labor required and operational and maintenance costs. Accordingly, the conversion is not recommended at this time.

The Authority recently made a significant investment in a bio-filter which appears to be working. Enhancement of that operation or expansion may be in your best interest for the present.

TABLE 3

OPTIONS

Description	Status Quo **Option 1**	Maintain Bio-Filter **Option 2**	Digester Conversion **Option 3**	Combined Heat & Power **Option 4**	CHP with Enhanced Gas **Option 5**
Construction Cost	0	$100,000	$3,300,000	$1,500,000	$1,700,000
Engineering Cost	0	$20,000	$660,000	$300,000	$340,000
TOTAL COST	0	$120,000	$3,960,000 (2)	$1,800,000 (3)	$2,040,000 (4)
Debt Service 4%/20y	0	$8,000	$243,000	$110,000	$125,000
Additional Labor Cost	0	0	$150,000	$100,000	$100,000
Additional O & M Cost	0	$25,000	$135,000	$65,000	$72,000
Sludge Disposal Cost	0	0	($190,000)	0	0
Renewable Energy (REC) Cost	0	0	0	($1,600)	($2,000)
Gas Enhancement Peat Extract Cost	0	0	0	0	$33,000
F.O.G. Revenue	0	0	0	0	($45,000)
Power Cost (1)	0	0	$27,000	($63,000)	($79,000)
TOTAL ANNUAL COST	0	$33,000	$365,000	$210,400	$204,000
Options included	1	1+2	1+2+3	1+2+3+4	1+2+3+5
Summary Annual Cost	$1,996,000	$2,029,000	$2,394,000	$2,604,400	$2,598,000

(1) Power costs are based upon average current billing from JCP&L of $.10/kwhr.

(2) Total Capital Cost 1+2+3 = $4,080,000

(3) Total Capital Cost 1+2+3+4 = $5,880,000

(4) Total Capital Cost 1+2+3+5 = $6,120,000