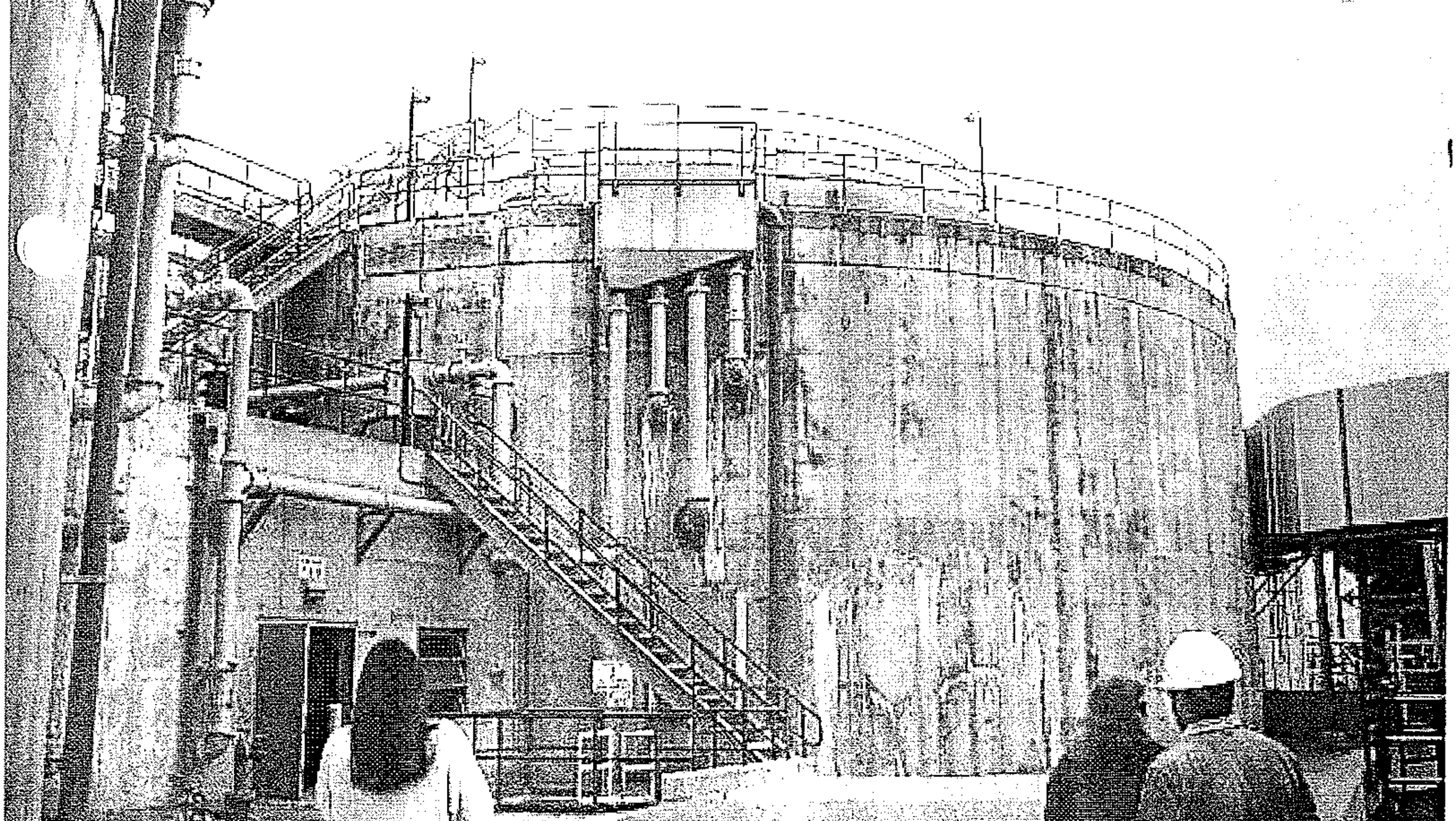
Orange County Sanitation District

In-Plant FOG Impact Study



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November 2002

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IN-PLANT FOG IMPACT STUDY

Prepared for:
ORANGE COUNTY SANITATION DISTRICT

November 2002

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INTRODUCTION

Problem Overview

The Orange County Sanitation District (OCSD) serves the northwest and central regions of Orange County, treating wastewater from 21 different cities and 3 special districts that have a combined population of approximately 2.4 million. Flows treated by the two OCSD wastewater treatment plants, Plant 1 and Plant 2, come from sources including residential, commercial, recreational and industrial users. As the OCSD sewer collection system has grown, there has been an increasing awareness of the impact that fats, oils and grease (FOG) have on the proper operation of the collection system. FOG builds up in layers in the gravity sewers and collects in manholes. This has the effect of reducing available sewer capacity, and can ultimately result in blocked lines causing sewage system overflows (SSOs). For this reason, the OCSD is developing a plan to reduce the amount of FOG discharged into the sewage collection system.

Project Objectives

This project addresses conditions for compliance with OCSD's Waste Discharge Permit order Number R8-2002-0014 issued by the Santa Ana Regional Water Quality Control Board, (RWQCB). The objectives of this project are to evaluate disposal options for fats, oil and grease (FOG) generated in the sewer system service area and assess in-plant impacts of these disposal options. Disposal options considered include use of existing anaerobic digestion and other off-site recycling methods.

Brown and Caldwell has been retained as a part of its WDR support contract, to (1) develop a plan to evaluate the feasibility of digesting FOG in existing anaerobic digesters and (2) assess alternate methods of recycling FOG, grease rendering and other disposal alternatives, including land filling, etc, within current codes and permit requirements. The purpose of this study is to identify alternative disposal and recycling options for handling FOG in the future and assess in-plant impacts of receiving greater quantities of FOG.

BACKGROUND

FOG Composition, Sources, and Chemical Characteristics

FOG present in wastewater is composed of animal fats, vegetable fats, and food solids of varying densities, and water and petroleum based oils and grease. Food based fats and grease are commonly discharged from restaurants and other food preparation facilities. Two common discharges of this type of FOG are in the form of waste cooking oil, grease trap and interceptor wastes. Petroleum-based oils and grease are typically discharged by businesses such as automotive repair facilities, gas stations and car washes. Petroleum-based FOG is relatively simple to regulate and control through industrial discharge and pretreatment permits. Food-based FOG is more difficult to control because of the large number of restaurants and fast food establishments. The focus of this report evaluates the impact of the FOG that would be controlled under new BMPs from restaurants and other food establishments.

Fats, whether food-based or petroleum-based, can be saturated or unsaturated and can be in either liquid or solid form. Because FOG is composed of materials of varying densities, generally less dense than water, it separates easily into several layers floating on the water when placed in a quiescent vessel like a grease trap or a grease interceptor (See Figure 1). Because of this natural tendency to float, when combined with other solids such as primary solids or waste activated sludge, FOG can provide an adhering effect that will capture these solids and float them as well. Until the density of the combined grease and solids is equal to or greater than water, this combined mass will float. This effect is like a reverse shear floc process which is used in water treatment – in a DAF the floc matrix moves upward and collects (or shears) particles, incorporating air and solids in a matrix This adhering effect can be beneficial to the DAF thickening process.

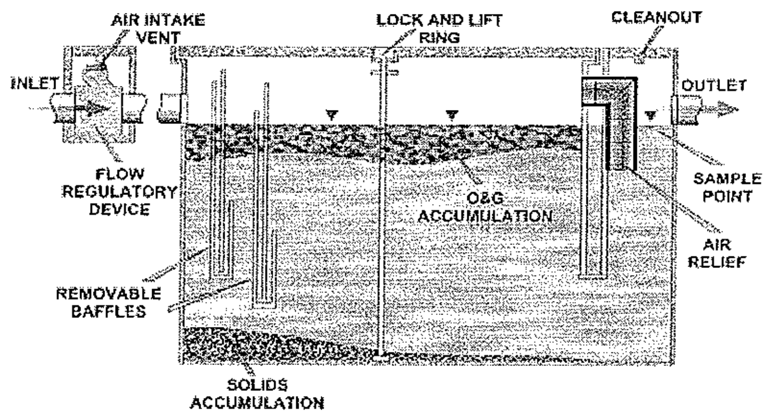


Figure 1. Typical Grease Interceptor

FOG from animal fats contains esters (compounds of alcohol) or glycerol (glycerin) and lipids (phospholipids). Phospholipids have long nonpolar "tails" and a small highly polar "head." Although FOG molecules contain both polar and nonpolar components they are generally considered to be polar. FOG that is petroleum-based is nonpolar in nature. Lipids, including phospholipids, are generally defined by biochemists as compounds that, upon hydrolysis (addition of water), will produce fatty acids. FOG fatty acids are generally longer chain molecules. In an anaerobic environment, these longer chain fatty acids are metabolized by hydrogen-producing acetogenic bacteria. Acid-loving (acetogenic, acetophilic) bacteria consume long chain fatty acids to produce Volatile Fatty Acids (VFA), commonly acetate. Methanogens, in turn consume VFAs to produce methane, etc., resulting in the formation of hydrogen, acetate, formate and carbon dioxide. One of the important end products from metabolism of these products is methane

To verify chemical characteristics of FOG being hauled to the Plant 1 dumping station, samples were collected on three separate days from randomly selected FOG haulers. Results of this sampling are summarized in Table 1

Table 1 – OCSD FOG Hauler Sample Summary

Sample Date	Chromium mg/l[a]	VS %	PH
June 10, 2002	0.49	6.2	6.85
June 12, 2002	0.69	6.06	6.85
June 13, 2002	0.37	6.77	5.48
Average	0.52	6.34	6.39

[a] Chromium was recommended by OCSD source control staff as an indicator for heavy metals. Chromium is not an element that is found commonly in wastewater, which make it a good indicator.

Method for Conducting Study

Brown and Caldwell collected and reviewed data in order to develop alternatives for handling FOG and assessing in-plant impacts of FOG treated on-site. Information sources include:

- OCSD staff and plant data.
- Brown and Caldwell archives and other related literature (see references for other related literature used in preparation of this report).
- Statement from commercial recyclers, rendering and landfill disposal companies.
- FOG samples collected from random FOG haulers and analyzed for volatile solids, total suspended solids, pH and total chromium (as an indicator for heavy metals). Future samples may want to be analyzed for copper since copper sulfate, when found in septic tanks, is commonly seen as an indicator of a mixed load.

A kick-off meeting was held in June 2002 to define some of the process issues related to on-site treatment of FOG and establish evaluation criteria. This meeting also served as a brain storming session to begin to develop alternatives. Dedicated anaerobic digestion was introduced as an alternative by OCSD staff as a result of bench scale testing that had been performed many years before. Alternatives have been developed for both on-site and off-site disposal options. These alternatives address the issues noted in the Waste Discharge Permit renewal requirements.

Capital cost estimates have been prepared for each alternative for economic comparison. A non-economic comparison of each alternative has been made based on criteria established at the kick off meeting held with OCSD staff. These criteria included: Operational/process impacts, maintenance task impacts, staffing impacts, traffic impacts, economic/lifecycle impacts and environmental impacts. A workshop was held on October 9, 2002 with OCSD staff to determine which impacts hold greater weight, then rank each alternative by evaluating them and summing the weighted values for each evaluation criteria. When OCSD confirms selection of a preferred alternative an implementation schedule will be developed.

Related Studies

Orange County FOG Control Study. A parallel study is being conducted by another engineering firm under contract to the OCSD by Environmental Engineering and Contracting, Inc. to investigate ways FOG can be controlled at the source and keep FOG from entering the collection system. They will be developing Best Management Practices (BMPs) and evaluating chemicals or other materials that break down FOG, as well as other new technologies. Phase 1 of this investigation is scheduled for completion by February 2003 with a subsequent Phase 2 study dependant on the results of Phase 1. To mitigate SSOs and other operational challenges, it is important that a comprehensive pretreatment ordinance, enforcement and grease trap sizing be implemented. Future FOG quantities collected and disposed of at the Plant No. 1 will likely increase as a result of implementing any new ordinances.

Advanced Digestion Study. Brown and Caldwell recently prepared a report for OCSD, Project No. 5809003, that evaluated alternative advanced anaerobic digestions methods. That report has been used for background data relative to digester performance, digester capacity and future digester expansion needs. To simplify digester feeding and provide homogeneous solids loading to the digesters, Brown and Caldwell proposed a heated solids blending tank that would blend primary solids and thickened waste activated sludge. One of the alternative advanced digestion processes recommended was a series thermophilic/mesophilic arrangement. This blending tank would also serve as a "wet well" to feed the digesters and provide a place for heat recovery from the thermophilic phase of digestion prior to the mesophilic phase. The thermophilic phase operates at approximately 135 ° F and the mesophilic phase operates at approximately 95 ° F. To cool the sludge going from the thermophilic digester to the mesophilic digester, sludge cooling heat exchangers would recapture heat energy. Since the recommendations of the Advanced Digestion Study have not been adopted yet by the OCSD, it is assumed that the current mesophilic mode of digestion will continue for several more years.

Project Limitations and Assumptions

FOG Quantities and Treatment. The OCSD Strategic Plan written in 1999 only addressed FOG that enters the plant under normal flow via the collection system. This present study supplements the 1999 plan to address process and other impacts on the treatment plants as a result of FOG quantities diverted from entering the collection system and discharged directly at the treatment facility. The future FOG load being diverted from the collection system could vary from 45,000 to 180,000 gallons a day or 30 to 120 trucks per day assuming an average truck size of 1,500 gallons. This estimate assumes FOG is collected from approximately 7500 restaurants with 750-gallon FOG interceptors pumped out from 2 to 12 times per year. Typically restaurants will have their interceptors pumped out when business is slow or when they are closed. This could result in peak FOG flows which are considerably higher than average, and occurring on Mondays or Tuesdays when some restaurant are closed.

The BMP study is intended to reduce FOG flow entering the sewer collection system through the use of FOG interceptors, use of chemicals or enzymes to break down FOG or other FOG reduction methods. Recommendations from that study will be given to OCSD and contributing agencies to pass ordinances to control the discharge of FOG to the collection system. Installation of FOG interceptors and periodic inspection of these interceptors will ensure that they are being properly maintained and pumped out. This in-plant FOG impact study assumes that future FOG ordinances would be passed requiring FOG interceptors and FOG being hauled to the OCSD dumping station. This would result in the greatest impact to the plant site. Since the BMP study will not be completed until the beginning of 2003, no estimate is available currently for future FOG quantities in the collection system. A gross estimate of increased FOG quantities could be assumed to be parallel to the projected wastewater flow growth rate of 4% used in the OCSD Strategic Plan. Increase future FOG quantities being hauled is assumed to be a direct result of number of restaurants in business and improved compliance and enforcement of any FOG ordinance issued as a result of the BMP study. The on-going BMP study will include projections of FOG quantities diverted from the sewer system as a result of implementing various BMP plans When a more accurate estimate of FOG delivered to the treatment facility is available, the number used in this study will need to be revised. Future FOG quantities play a small part in development of treatment and disposal alternatives. Future FOG quantities only factor in to the assessment of in-plant impacts on various processes that may be called upon to treat the FOG. Alternatives utilizing existing anaerobic digestion capacity will not be impacted because there is substantial excess digester capacity and FOG quantities are small in relation to projected future sludge flows. As noted above, depending on how well the BMP plan is implemented and enforced, truck traffic both inside and outside the plant could be significantly impacted. Since Plant No. 1 has the facility to receive trucked FOG, on-site treatment of FOG will be limited to Plant 1 where the FOG haulers currently discharge their loads with the exception of Alternative 1A that continues current disposal practices.

FOG REMOVAL PRACTICES

Current FOG Quantities

Currently, several FOG haulers throughout the OCSD collect FOG from existing grease traps and interceptors. OCSD Operations staff reported that most FOG collected is not mixed with other liquid waste such as septage, however, some mixed loads do come in from time to time. Companies that collect and are permitted to discharge FOG are listed in Table 2. Some of these FOG haulers also handle septage.

Typically, FOG hauler trucks have a capacity of approximately 1,500 gallons as regulated by CalTrans and local road weight limits. Plant 1 typically receives 27 trucks a day or approximately 40,000 gallons per day. As noted in this table, two of the permitted FOG haulers are also FOG processors (rendering companies).

Table 2. FOG Collection Companies

Permit Number	Waste Hauler
2	Orange County Septic
5	Inland Pumping
29	Minuteman Pumping
34	The FOG Company/Baker Commodities (**Rendering company**)
52	Primer Processors
92	Ryker Commodities
117	Darling International (**Rendering company**)

Current FOG Process Description

Liquid waste (septage) and FOG are presently disposed of at a dumping station located at the north end of Plant 1 adjacent to the Ellis Avenue entrance. Haulers enter the plant at this location, drop off a copy of their manifest outside the plant gate, and then proceed to the dumping station. The dumping station can accommodate two trucks at a time in two separate waste hookups. Each waste hookup has a solid metal cover over a 4-inch quick connect fitting. When a haulers arrive at the dump station, they connect one end of their discharge hose to their truck and the other end to the quick-connect fitting at the dump station and finally open their discharge valve allowing the load to flow by gravity. All trucks are equipped with reversible pumps that can vacuum the waste from grease traps and pressurize the tank to discharge faster or discharge into a receiving tank.

Operations staff reported that an occasional load of spoiled olive oil is received from a local olive processing facility. The haul truck's reversible pump can be used to discharge this spoiled olive oil directly into a digester through a pipe fitting on the cleaning hatch on the side of the digester.

FOG-laden wastewater is typically discharged from the haul truck at the dumping station and flows to the influent diversion structure by gravity. City water is used to flush the solids along the line, similar to flushing a toilet. At the diversion structure, the FOG is diverted to Plant 2. Operations staff reported that there is sufficient flow in the trunk line to Plant 2 to prevent FOG from coating this line. Figure 2 shows a schematic of current base case FOG treatment practices.

At the diversion structure the discharged FOG combines with other wastewater flow and proceeds through the normal treatment process at Plant 2. Some FOG has a tendency to form grease balls and chunks that are removed mechanically at the barscreens or manually removed at the aerated grit tanks. After screening and degritting at the headworks, floatable material is removed in the primary sedimentation tanks by the scum collection system. The collected scum consists of the FOG that was dumped by the FOG haulers as well as FOG transported to the plant from the wastewater collection system. The scum is periodically pumped and combined with primary sludge. This mixture then flows to the anaerobic digesters. Grease present in the scum/primary sludge has a tendency to coat the primary sludge lines. Consequently constrictions in the pipe results in higher head loss, which reduces flow to the digesters. To alleviate this problem, parallel bypass piping has been provided to allow for periodic steam cleaning of the primary sludge line.

Operations staff indicated that gas production at the digesters increases somewhat when FOG, mixed in with the primary sludge, reaches the digesters, although no specific data was provided. The City of Oxnard which uses similar methods for receiving FOG has cited a figure of approximately an additional 50 cubic feet of methane gas per 1,400-gallon truckload of FOG. Unless a digester is well mixed and has a way of removing surface floating material, digesters have a tendency to form mats at the top from a combination of hair, rags and scum. Operations staff reported that there is not a noticeable problem with matting in the anaerobic digesters. This would imply that the existing digesters have adequate mixing or good scum removal or both and are suitable for treating FOG discharged at the treatment plant.

In-Plant FOG Impacts and Mitigation Measures

In-Plant FOG Impacts. Depending on how and where FOG enters the treatment system, there can be greater or lesser degrees of impacts on the plant process operation and maintenance. FOG that enters the treatment system at the head of the plant would have the greatest impact effecting each process it goes through. Because of its natural tendency to float, FOG would separate easily in aerated grit tanks and primary sedimentation tanks. Grease balls that form in these locations may need to be manually removed when surface-skimming equipment isn't provided such as aerated grit chambers. Primary scum troughs and scum pumping pits can also become clogged with grease as well.

Just as FOG can plate gravity sewer lines in the collection system, FOG can also coat and clog conveyance pumping systems and the plant piping. This can result in more frequent maintenance of sludge pumps and piping to remove FOG plated on equipment. Typically, lines that convey FOG are small in size (4 to 6 inches) and are routed behind larger piping. This arrangement makes these lines less accessible for cleaning and could result in less frequent maintenance. The number of joints, bends and elevation changes of lines conveying FOG can also have a negative effect on FOG accumulation. Joints and fittings are generally grooved and gasketed which provide an ideal for grease to get "caught on." When the ultimate treatment process to handle FOG is anaerobic digestion, the distance between the point of application and the digesters is also a contributing factor to plating FOG on pipelines.

Odors can also be a major consideration, especially in Southern California where warmer temperature prevails. The greatest odor problems will occur during cleaning operations because these lines and equipment are generally inside buildings or pipe tunnels that need to be properly ventilated.

Implementation of a BMP program to reduce the amount of FOG entering the collection system may increase the quantity of FOG being collected and hauled to Plant No. 1. As mentioned earlier, this could result in over 100 trucks per day delivering FOG to the dumping station or other discharge point. Traffic both on and off site could be significantly impacted by the increased number of trucks.

In-Plant FOG Impact Mitigation. There are several ways to mitigate the impacts described above. Selection of the discharge point for FOG is an important factor to consider when developing alternatives for treating FOG on-site. As noted above, FOG that is discharged at the head of the plant would have the greatest impacts on the treatment system. To avoid clogging primary scum collection and pumping systems, changes to increase the capacity of tipping troughs and surface sprays may be needed. Hot water sprays may also be advisable.

As with thickened sludge lines, glass-lined steel piping has proven to be the most resistant to accumulations. Making individual pieces of pipe as long as possible to reduce joints would lessen the sites that grease could be caught on. Providing dedicated steam lines for cleaning is advisable as well as placing cleanouts in places that are easily accessible would facilitate more efficient maintenance. Reducing the distance between the application point and the digesters will reduce the possibility of FOG plating.

To maintain the "food product" classification of FOG, it should be kept separate from other waste streams (septage, primary sedimentation and secondary clarifier scum lines, grit and screening wash water lines). The sole purpose of doing this would be to allow the plant the option of contracting with a rendering contractor to remove it and allow them to recycle or treat it. The cost of this "insurance" would be a "rock solid" way to ensure the plant's ability to handle a wide array of possibilities. The surest way to reduce the amount of odors is to keep the FOG contained, have direct connection to odor collection equipment where FOG is discharged and arrange for portable odor control facilities during maintenance activities. Traffic impacts could be mitigated by having a separate entrance dedicated for FOG deliveries only. The entrance could also be equipped with a card reader to control access and document loads as they enter the plant site. Careful consideration of other traffic patterns on the plant site as well as truck staging will reduce the impact of increased truck traffic.

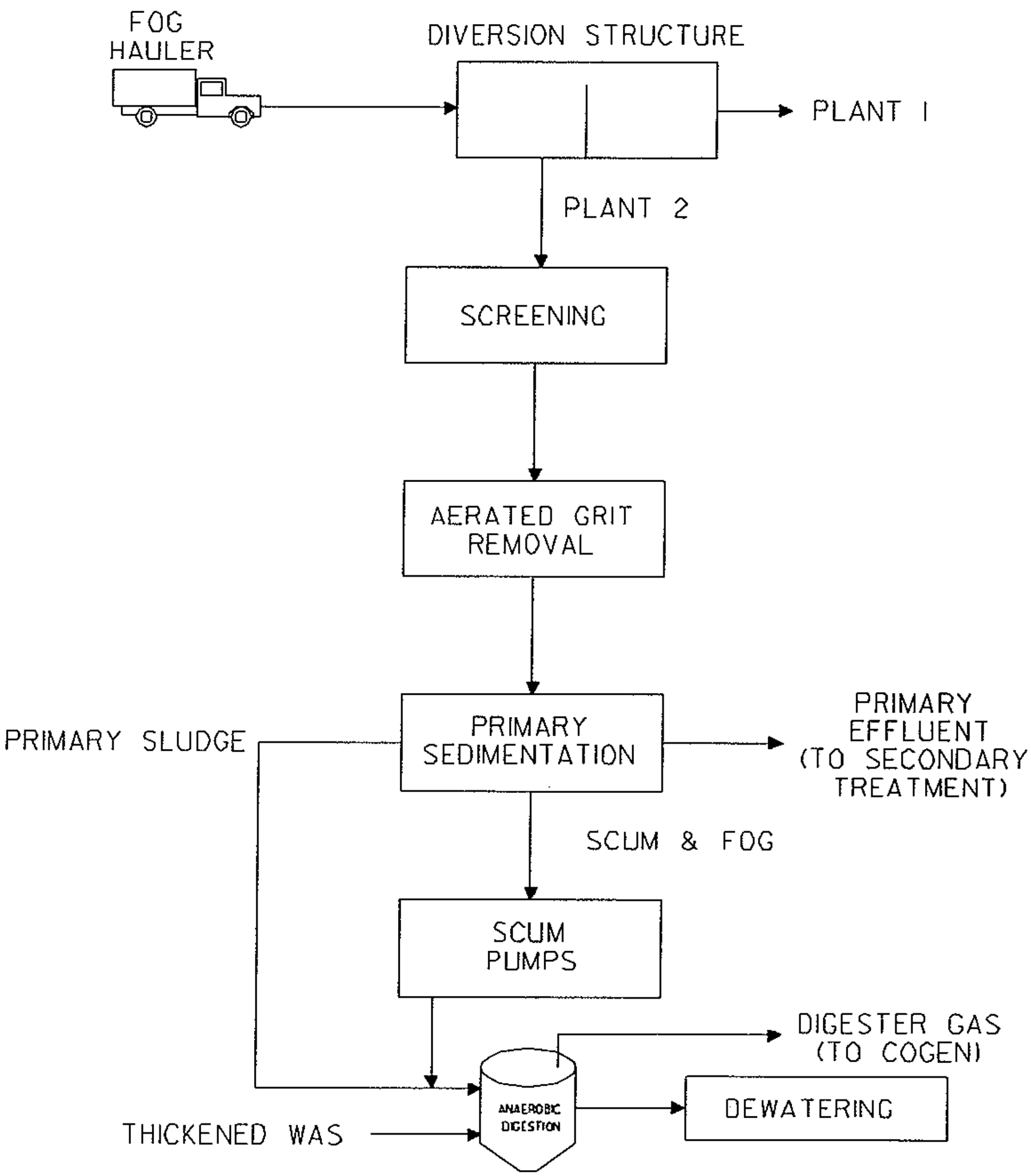
Future FOG Collection Practices

As noted earlier, the OCSD is in the process of developing a BMP program to reduce the amount of FOG being discharged into the sewer collection system in an effort to reduce sewer system overflows (SSOs). This program may result in an increased amount of FOG diverted from the collection system and disposed of at the OCSD treatment facility.

DEVELOPMENT OF PROCESSING AND DISPOSAL ALTERNATIVES

Processing and disposal alternatives for FOG received directly at the OCSD treatment plants are developed and discussed below. Impacts associated with their implementation are addressed in a subsequent section of this report. Each alternative assumes compliance with new FOG ordinances passed as a result of the BMP study. OCSD source control staff indicated that any alternative that brings FOG on site must include a card access system for plant entry control and load documentation. A separate gate for FOG haulers may also be considered. Alternatives that have been developed include:

ORANGE COUNTY SANITATION DISTRICT
CURRENT F.O.G. TREATMENT



ALTERNATIVE IA - BASE CASE (STATUS QUO)

BROWN AND CALDWELL SAN DIEGO, CALIFORNIA	SCALE : NONE	PROJECT NUMBER 22160	DATE	FIGURE 2
	PROJECT LOCATION	ORANGE COUNTY SANITATION DISTRICT F.O.G. TREATMENT ALTERNATIVE		

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1A. Base case – status quo (continue current practices of receiving FOG and disposal)
1B - D. On-site treatment using anaerobic digestion
2. Off-site recycling at a grease rendering facility
3. Off-site recycling as a bio-fuel
4. Off-site landfill disposal

Alternative 1A – Base Case (Status Quo)

This alternative would continue receiving FOG at the existing dumping station, removing FOG and scum at the primary sedimentation tanks, pump it to the digesters with the primary sludge and anaerobically digesting it. Divert other waste oils, such as waste olive oil or cooking oil, directly to a digester (partial implementation of Alternative 1D).

New glass lined piping is recommended to replace existing primary sludge piping. As noted in the mitigation measures discussed earlier upgrades to the scum collection system may be required to reduce expected increased maintenance. The plant would also continue their maintenance procedure of switching to a parallel primary sludge line while the other line is steamed cleaned. Increased maintenance of these sludge pipes is expected with the increased FOG quantities delivered to the site. Some change to traffic control or receiving schedules may be needed to accommodate increased truck traffic on City streets.

Alternative 1B-D – On-site Treatment Using Anaerobic Digestion

These alternatives would modify the current processing of FOG in the anaerobic digesters and assumes that the existing digesters are adequate to handle FOG without modifications. Possible variations of this alternative would include:

1B Modified FOG Receiving and Digestion (See Figure 3 for schematic) - Receive FOG at a new dumping station located closer to the digesters, pumping it to the digesters after the digester heat exchanger followed by anaerobic digestion. Injection at this point would liquefy the grease solids and reduce the possibility of fouling the heat exchangers. Locating a dedicated dumping station closer to the digesters would reduce the plating of FOG on the sludge feed lines.

1C Modified FOG Receiving, WAS thickening and Digestion (See Figure 4 for schematic) - Receive FOG at a new dumping station closer to the digesters, pumping it to the DAF thickener after thickening followed by anaerobic digestion.

1D Dedicated Digestion (see Figure 5 for schematic) - Pumping FOG directly into a dedicated digester followed by anaerobic digestion.

A discussion of each variation is further described below.

Alternate 1B – Modified FOG Receiving and Digestion. This alternative would involve the following new structures and equipment:

1. New receiving station with coarse solid/grit removal and FOG pumping located along the East Perimeter road north of Secondary Clarifier 2. Figure 3a shows a typical FOG pretreatment system.

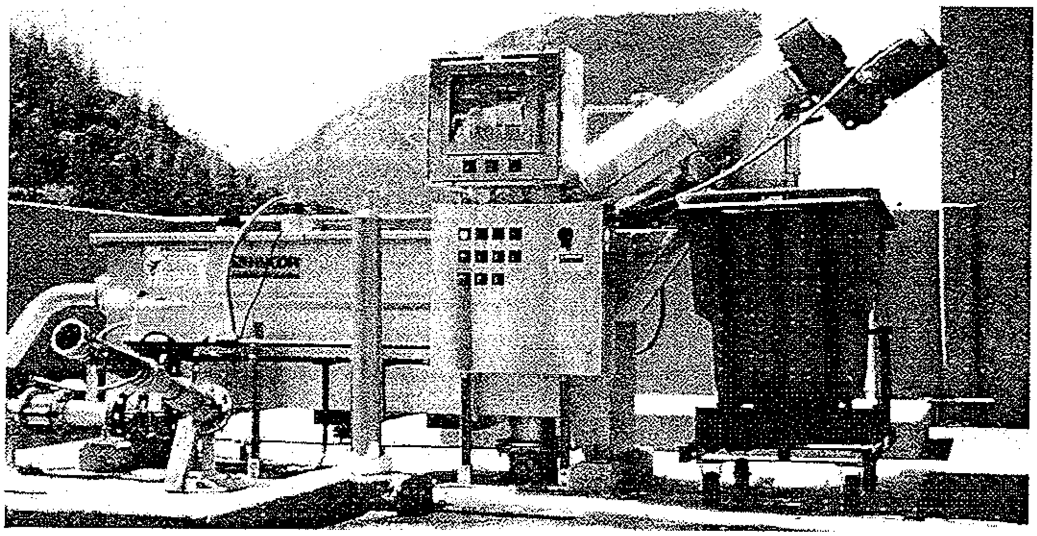


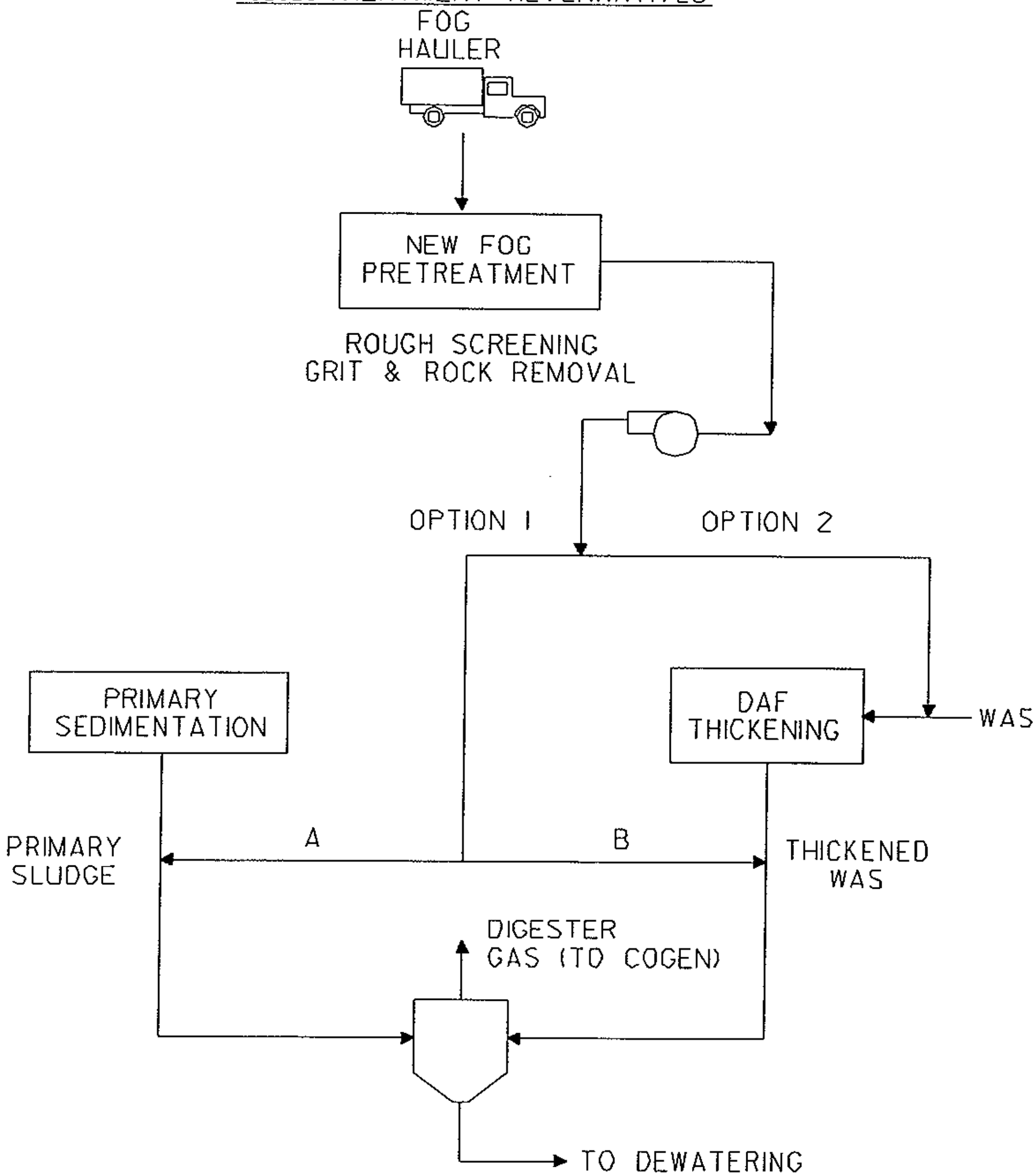
Figure 3a. Packaged FOG Receiving System

Note:

The FOG receiving system shown above may be equipped with an automated logging system to keep track of loads and haulers for billing purposes. Grit, rocks and other material would be scrolled up an inclined screening channel and dewatered prior to dumping in a roll off container. The new receiving station could be covered with foul air withdrawal and treatment to reduce odor control needs.

2. Glass lined ductile iron FOG distribution piping to existing digesters in existing pipe trenches.

ORANGE COUNTY SANITATION DISTRICT
F.O.G. TREATMENT ALTERNATIVES



ALTERNATIVE 1B - COMBINED DIGESTION
WITH PRIMARY SLUDGE OR WAS

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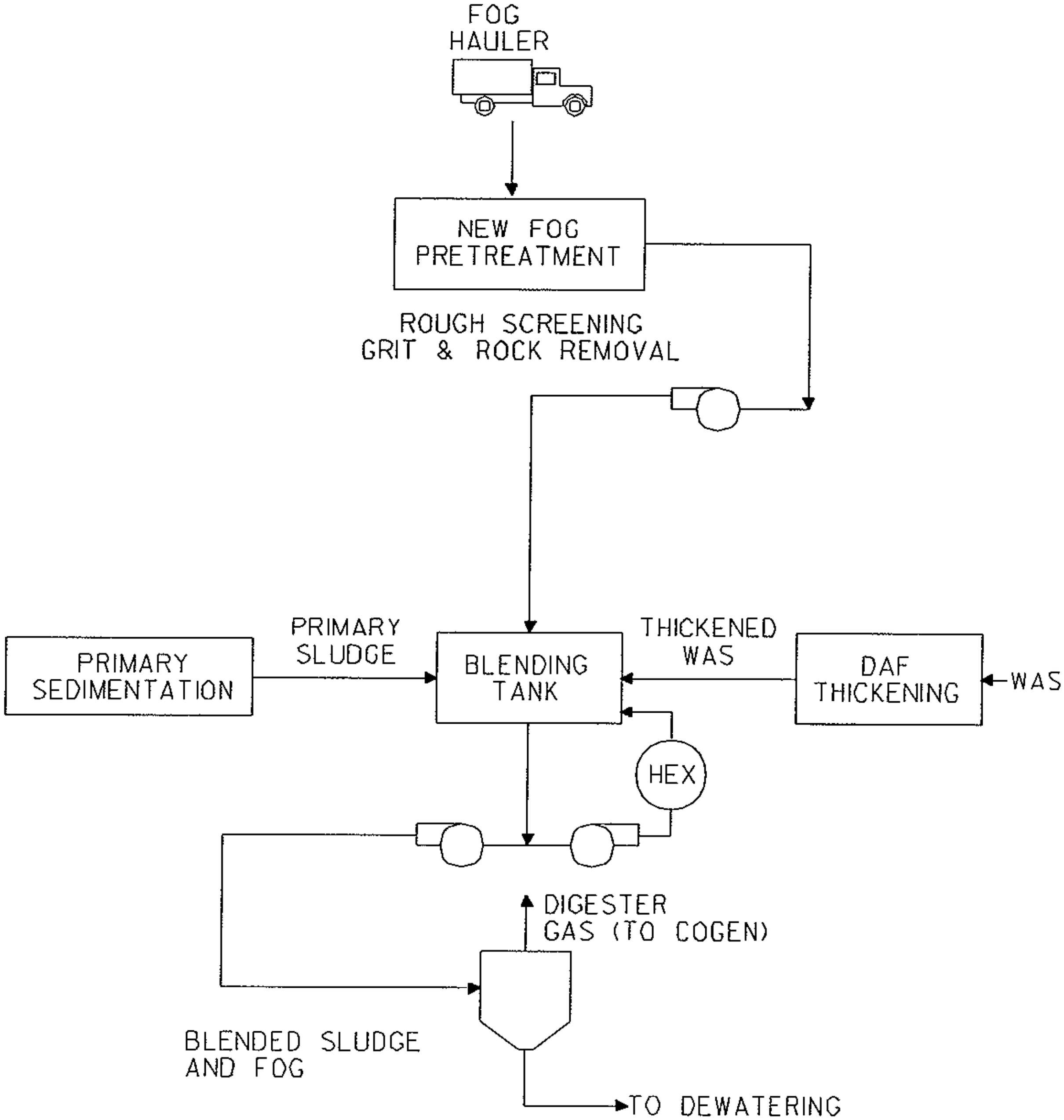
BROWN AND CALDWELL SAN DIEGO, CALIFORNIA	SCALE : NONE	PROJECT NUMBER 22160	DATE	FIGURE 3
	PROJECT LOCATION	ORANGE COUNTY SANITATION DISTRICT F.O.G. TREATMENT ALTERNATIVE		

ORANGE COUNTY SANITATION DISTRICT
F.O.G. TREATMENT ALTERNATIVES



ALTERNATIVE IC - COMBINED DIGESTION
FOG, PRIMARY SLUDGE & WAS WITH PREHEATING

BROWN AND CALDWELL SAN DIEGO, CALIFORNIA	SCALE : NONE	PROJECT NUMBER 22160	DATE	FIGURE 4
	PROJECT LOCATION	ORANGE COUNTY SANITATION DISTRICT F.O.G. TREATMENT ALTERNATIVE		

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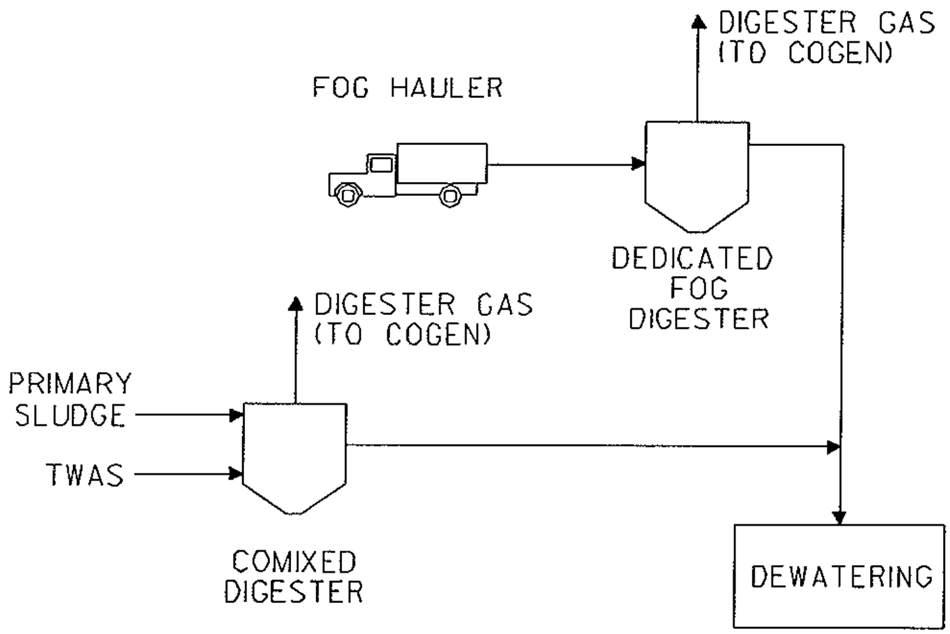
ORANGE COUNTY SANITATION DISTRICT
F.O.G. TREATMENT ALTERNATIVES



ALTERNATIVE ID - DEDICATED DIGESTION

BROWN AND CALDWELL SAN DIEGO, CALIFORNIA	SCALE : NONE	PROJECT NUMBER 22160	DATE	FIGURE 5
	PROJECT LOCATION	ORANGE COUNTY SANITATION DISTRICT F.O.G. TREATMENT ALTERNATIVE		

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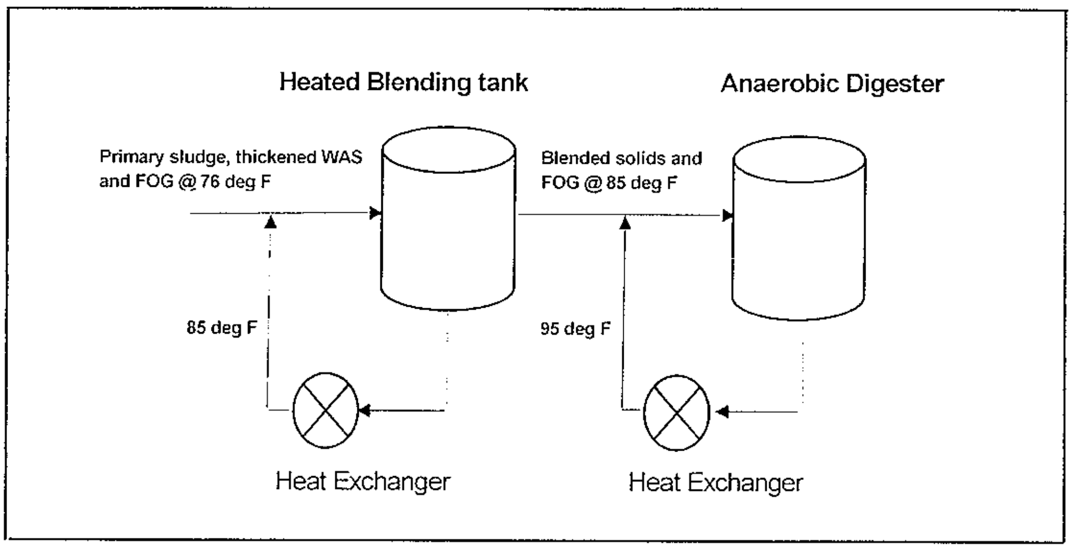
Alternate 1C – Modified FOG Receiving, Thickening and Digestion. This alternative would involve the following new structures and equipment:

1. New receiving station with coarse solid/grit removal, odor control and FOG pumping located along the East Perimeter road south of Secondary Clarifier 2 adjacent to the DAFs.

2. Heated sludge blending tank (heat to approximately 85 ° F) to receive raw Primary sludge, thickened WAS and FOG. Figure 6 shows a heated sludge blending schematic.

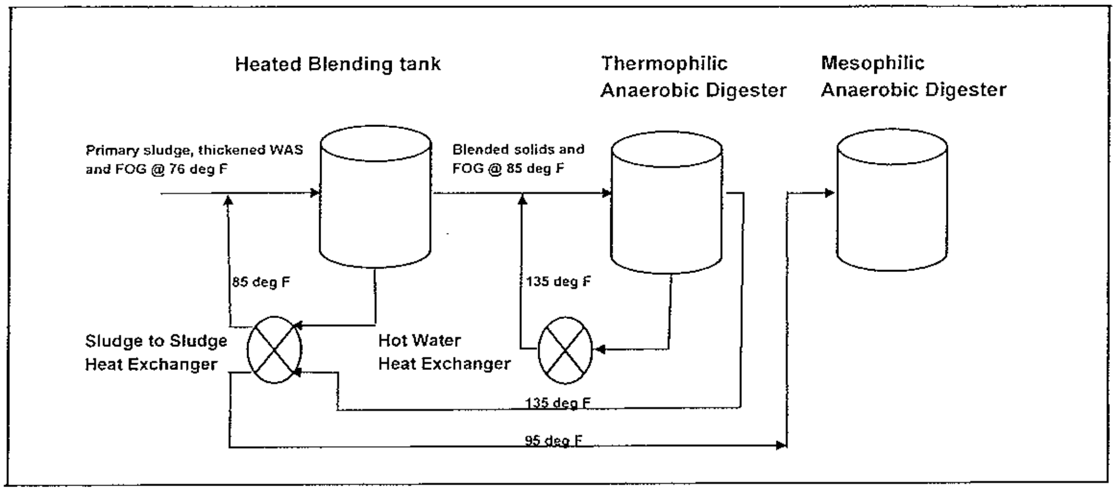
3. Glass lined ductile iron FOG piping to new heated blending tank, blended sludge pumps and piping to digesters.



Note: Temperatures shown to represent the concept of raw sludge preheating. Actual temperatures may vary.

Figure 6. Heated Sludge Blending Tank Schematic

The heated sludge blending structure will contain one shell and tube heat exchanger, centrifugal sludge pumps and sludge grinders (if chopper pumps are not used for raw solids circulation). This heated sludge blending tank would add a small amount to the heat load for mesophilic digestion due to some heat losses at the blending tank. The heat load at the digesters would be less because the incoming sludge would be preheated prior to digestion. If advanced digestion is implemented in the future, it could be used as a part of heat recovery following thermophilic digestion. Figure 7 shows a possible advanced digestion schematic.



Note: Temperatures shown to represent the concept of raw sludge preheating. Actual temperatures may vary.

Figure 7. Advanced Digestion Schematic

Alternate 1D – Dedicated Digestion. This alternative would involve using Digester 7 for dedicated anaerobic digestion. Digesters 5 and 6 are currently used for sludge holding prior to dewatering and Digester 8 currently doesn't have adequate automation to make it suitable for this alternative. Operations staff indicated that a bench scale pilot test of this alternative was performed about 20 years ago, but no data was kept from that test. This pilot test was fed exclusively from scum box material. They stated that it took about 2 weeks for the process to be established, but solids destruction and gas production continued thereafter. Once the culture was established digestion became rapid. About 65% of volatile solids in raw sludge digestion is converted to gas. Because of the high level of volatile solids destroyed, very little sludge production is expected. However, there is no empirical data to support this assumption. Before this alternative would be implemented, it would be wise to conduct this pilot test again using samples taken from FOG haulers to determine process performance and other design considerations.

FOG could be pumped directly into the existing digester via a nozzle connection located on the removable access hatch located near ground level or injected downstream of the existing heat exchanger. Operations staff stated that waste olive oil had been received in this manner in the past. It would be preferable to inject the FOG downstream of the heat exchanger to ensure the FOG is in liquid form when it enters the digester. No modifications to the existing digester are anticipated, however some paving and drainage modifications may be necessary to facilitate increased traffic flow in the area and capture possible liquid spills. Injection downstream of the heat exchanger would require some piping modifications to the sludge recirculation piping.

Alternative 2 – Off-site Treatment at a Grease Rendering Facility

FOG rendering is a process that converts animal processing wastes, including bone and fat, into usable products such as soap, cosmetics and animal feed. FOG collected from grease traps may also be recycled in this manner as a raw feed material. As noted earlier, Baker Commodities, one of the FOG haulers listed in Table 3, is one of the largest rendering facility operators in the Los Angeles area. Baker Commodities and Darling International indicated that there may not be sufficient capacity at their facility to handle all the FOG and that the tipping fee would be between 11 and 15 cents a gallon.

An article published by the Farm Bureau Federation dated December 20, 2000[1] described the crisis that faced the agriculture industry as a fallout of the national energy crisis. Rendering facilities use natural gas to heat slaughterhouse byproducts to separate the solids, liquids and fat. Skyrocketing gas and electricity prices could make the rendering business economically unfeasible or they will have to pass on these increased operating costs to their customers. One solution to this crisis could be using yellow grease, as a bio-fuel to run the boilers at the plant.

If OCSD chose this alternative, they may be forced to raise their dumping fee to offset the cost of disposal in this manner. Currently OCSD charges FOG haulers 3.5 cents a gallon to discharge at the treatment plant. Adding the cost of the rendering plant tipping fee of up to 15 cents per gallon would increase the cost of dumping at the treatment facility to 500% of the current cost. These costs may vary significantly due to changes in the market, making cost control for this alternative difficult to predict. This may have an adverse effect on the FOG haulers and may discourage collection of grease trap wastes.

Implementation of this alternative would involve constructing a storage tank at the plant to allow rendering companies to withdraw FOG waste for subsequent hauling to the rendering facility. If the rendering facility will not provide FOG waste pickup, OCSD would either have to contract this hauling operation to another FOG hauler or enter the hauling business at additional expense. Because there would be no reduction in liquid volume the amount of truck traffic to and from the site would double.

Alternative 3 – Off-site Recycling as a Bio-fuel

In response to the worldwide energy crisis, to reduce the United States' dependence on foreign fuels, and to promote a cleaner environment, the US government has provided incentives for development of other clean renewable fuel sources. One product that has emerged in the last decade is clean-burning bio-fuel called bio-diesel, produced from recycled vegetable oils.

Bio-diesel has physical and chemical properties very similar to petroleum diesel. However, because it is non-toxic, biodegradable and essentially free of sulfur and carcinogenic benzene, it produces a significantly improved emissions profile. In addition, the additional oxygen in bio-diesel improves

[1] Souza, Christine, "High energy prices send dairy industry into tailspin," California Farm Bureau Federation Ag Alert, www.cfbf.com/agalert/1996-00/2000/aa-1220g.htm, December 20, 2000

combustion and makes for a significantly cleaner burn. Bio-diesel is a very effective fuel additive mixing readily with petroleum diesel. In a 20% blend with diesel, emissions are significantly reduced. Pacific Bio-diesel located in Hawaii has reported using 100% bio-diesel with no reduction in engine performance. No engine modifications are needed to burn bio-diesel. Bio-diesel also has improved lubricity reducing maintenance of injectors and injector pumps. When compared to diesel fuel, bio-diesel may produce the following results (results are based on side by side diesel locomotive engine test):

- Reduce NOx by 5 to 14 percent,
- Lower particulates up to 65 percent, virtually eliminating black smoke
- Improve fuel efficiency by 5 to 13 percent.
- The same additive in gasoline can improve fuel efficiency and reduce NOx by proportionate amounts while reducing CO & HC by 60 to 70 percent.

Two bio-diesel companies, American Bio-Fuels, LLC and Southern States Power Company, Inc., have expressed an initial interest in forming a partnership with OCSD to produce useful bio-diesel fuel that could be used in OCSD's and other nearby cities' fleet of diesel powered vehicles and stationary equipment. OCSD could reap the benefits of improved engine performance, reduced air emissions, and reduced diesel consumption while doing its part in supporting this emerging technology.

Bio-diesel is produced predominantly from waste cooking oil. Since FOG collected from grease traps typically has a lower concentration of oil, this alternative would be most feasible if waste cooking oil could be collected separately. Currently Darling International has placed containers at a number of restaurants to collect waste cooking oil for their rendering process. The Bio-diesel refiner could offer the same service to these businesses or form a partnership with the rendering company to obtain this oil. Such an arrangement would be of no economic benefit to the District. It would be more economical for the refiner to pick up waste oil at a central location such as one of the treatment plants, however this would involve another handling step for a liquid waste hauler. American Bio-diesel is currently exploring opportunities in Mexico to operate a pilot facility to handle grease trap waste and would like to open discussions with the District to place a pilot facility at the plant site. Pilot testing of this process should confirm feasibility of producing yellow grease from grease trap waste within the next six months.

Other technologies are emerging to concentrate the yellow grease portion of FOG for use as a feed stock for the bio-diesel refining process. A byproduct of this process is a dark glycerin that must still be landfilled. No commercial operations using this technology handling grease trap wastes are currently in business on the mainland.

Alternative 4 – Landfill Disposal

Landfill disposal could be done by combining solidified grease with grit and rags removed at the headworks at the County landfill disposal site. This alternative is less desirable than others because it would be contrary to California's regulations requiring diversion of recyclable wastes from landfills. Disposing of FOG at a landfill would require other recyclable solids to be diverted.

Implementation of this option would require the same structures and equipment as Alternative 2. This would require some form of FOG concentrator, such as a gravity settling tank or a DAF. Increased odor emissions would be expected as well as increased traffic.

EVALUATION OF ALTERNATIVES

In this section each of the alternatives listed above are further evaluated based on the following criteria established at the June 2002 kickoff meeting. A workshop was held in October 2002 with OCSD staff to rate the relative impacts listed below:

- Operational impacts – Impact on treatment process unit operation and changes to Standard Operating Procedures
- Maintenance task impacts – Impact on type and number of maintenance tasks in the treatment facility
- Staffing impacts – Impact on staffing
- Traffic impacts – Impact on facility vehicular traffic
- Economic Impacts (treatment costs) – Impact on cost for treating FOG including revenue gained or lost by beneficial byproducts of FOG treatment (such as methane gas generation)
- Environmental Impacts – Permitting and other impacts on the environment at the plant site and point of discharge in the form of increased odors, increased oils to the ocean, exhaust emissions from trucks, etc.

Alternative 1A – Base Case (Status Quo)

The impacts of continued operation of the facility as it currently exists is provided as a basis for comparison to the other alternatives. Impacts of maintaining the current mode of operation are well known. Weekly sludge line cleaning is done of the primary sludge lines and periodic manual removal of grease balls is done in the aerated grit chambers and bar screen influent channels. Increased FOG quantities will increase the frequency of maintenance already occurring and possibly require additional maintenance attention in the primary scum collection and pumping as well.

Alternative 1B-D – On-site Treatment Using Anaerobic Digestion

As described above, this alternative may be implemented in several different ways: each having its own impacts. Because the current practice of FOG treatment in the anaerobic digesters appears to have no adverse process impact it's assumed that any variation of this alternative would have no adverse digestion process impact either.

Alternative 2 – Off-site Recycling at a Grease Rendering Facility

This alternative would require additional equipment that would add complexity to the operation and maintenance of the plant. While removing FOG from the treatment system may have a beneficial impact on treatment process operation and maintenance, added tipping fees and costs due to loss of a valuable product, methane gas, may make this alternative less desirable. Traffic in the plant could be significantly increased. Because there would be no reduction in liquid volume, traffic to and from the site would double. Due to fluctuations in the market there could be significant economic risk associated with this alternative.

Alternative 3 – Off-site Recycling as a Bio-fuel

This alternative could require a process to separate useable yellow grease from the grease trap waste. One of the bio-diesel companies has expressed an interest in siting a pilot facility for removing yellow grease at one of the treatment plants. If the BMPs currently being developed encourage separation of waste cooking oil from the rest of the FOG this alternative would be more desirable. Implementation of a pilot study for yellow grease separation and market analysis would require approximately six months to complete.

Alternative 4 – Off-site Disposal of FOG at a Landfill

This alternative would require some additional facilities that would increase the complexity of the operation and maintenance of the treatment facility. Combining solidified or concentrated FOG with grit and screenings would add another handling step that would complicate the disposal process and increase the amount of residuals hauled off site. Meeting the "paint filter" test for landfill disposal may also be difficult to accomplish.

Table 4 provides a more detailed comparison of impacts of all four alternatives including the four variations of Alternative 1.

Comparison of Alternatives

Evaluation Criteria Weighting. To better define the relative importance of each criteria, a workshop was held on October 9, 2002 with operations, compliance and source control staff (See figure 8 for evaluation matrix). In order of perceived importance by OCSD staff the impact criteria rated as follows from least important to most important:

1. Economic Impact
2. Environmental Impact
3. Staffing Impact
4. Traffic Impact
5. Maintenance task Impact
6. Operations/process Impact

	A	B	C	D	E	F	Score	Equiv %
A	X	2 / 1	3 / 1	3 / 1	3 / 1	2 / 1	5	13.0%
B		X	2 / 1	1 / 1	2 / 1	2 / 1	6	16.0%
C			X	1 / 2	3 / 1	2 / 1	9	24.0%
D				X	2 / 1	2 / 1	7	18.0%
E					X	2 / 1	11	29.0%
F						X	10	26.0%
TOTAL							38	100.0%

In each box, provide a score for the pertinent criterion when compared directly to the corresponding criterion for that box. 0 = Insignificant; 1 = Equal Significance; 2 = Slightly More Important; 3 = Significantly More Important

Criteria	Description
A	Operational/Process Impacts
B	Maintenance Task Impacts
C	Staffing Impacts
D	Traffic Impacts
E	Economic/Life cycle Impacts
F	Environmental Impacts

Figure 8. Evaluation Criteria Matrix

Non-Monetary Comparison. The alternatives developed for treatment and disposal of FOG were compared based on the impacts to the treatment facility as noted above. The impact criteria factors were rated on a scale of 5 to 1 for each alternative with 5 being the most desirable and 1 being the least desirable. The basis of the rating was degree to which the OCSD treatment facility would be impacted. Table 3 shows a comparison of alternative factoring in the criteria weighting noted above.

Table 3. Evaluation of Alternatives

	Operational Impact		Maintenance Impact		Staffing Impact		Traffic Impact		Economic Impact		Environmental Impact		Total	Ranking
Criteria weighting	6		5		3		4		1		2			
Alternative	Raw	Weighted	Raw	Weighted	Raw	Weighted	Raw	Weighted	Raw	Weighted	Raw	Weighted		
1A Base Case (Status Quo)	2	12	2	10	3	9	3	12	4	4	3	6	53	5
1B On-site digestion – Modified Liquid Receiving	4	24	4	20	4	12	2	8	4	4	5	10	78	2
1C On-site digestion – Modified Liquid Receiving, Thickening	3	18	3	15	3	9	2	8	3	3	4	8	61	4
1D On-site digestion – Dedicated digestion	4	24	4	20	4	12	2	8	4	4	5	10	78	2
2 Off-site treatment – FOG rendering	4	24	4	20	4	12	1	4	2	2	3	6	68	3
3 Off-site treatment – as Bio-fuel	5	30	5	25	5	15	2	8	4	4	5	10	92	1
4 Off-site disposal - Landfill	2	12	2	10	2	6	2	8	2	2	1	2	40	6

Capital Cost Comparison. Estimated capital costs have been prepared for each alternative. Table 6 shows the estimated capital costs for implementing each alternative. Estimated construction cost are considered to be "Order of Magnitude" estimates. The American Association of Cost Engineers defines an Order of Magnitude cost estimate as having an accuracy of within +50% or –30%:

Table 4. Comparison of Alternate Impacts

Evaluation Criteria	Alternative 1A Status Quo – "Base Case"	Alternative 1B Modified FOG Receiving and Digestion	Alternative 1C Modified FOG Receiving, Thickening and Digestion	Alternative 1D Dedicated Digestion	Alternative 2 Off-site Treatment at Rendering Facility	Alternative 3 Off-site Recycling as Bio-diesel	Alternative 4 Landfill Disposal
Operations Impacts	• Operation of new odor control at receiving station	• Operation of new screening, degritting and pumping of FOG • Operation of new odor control • Change to digester feeding operation • Reduced land for secondary treatment	• Operation of new screening, degritting and pumping of FOG • Change to digester operation • New blending process to operate • Improved heat distribution and solids feed to digesters • Possible improved DAF performance from FOG addition to solids feed • Reduced land for secondary treatment	• Operating dedicated digester could complicate process operation. • Reduced digester capacity for future use • Increased risk from reduced redundancy. • More operator attention • New chemical addition to digester for odor control	• Operation of new FOG storage tank for pickup by rendering facility • Operation of new odor control facility • Reduced land for secondary treatment	• No change to current operation. • Pilot testing to confirm separation of yellow grease from grease trap waste	• Change to current operation • Operation of heated storage • Operation of new odor control • Operation of grease concentrator for solid option • Additional handling to blend with grit and screenings • Reduced land for secondary treatment
Maintenance Impacts	• Continued sludge line cleaning • No change in primary scum • Increased mechanical cleaning • Maintenance of odor control	• Reduced sludge line cleaning • Reduced primary scum pumping • Reduced mechanical cleaning • New equipment to maintain • Additional screening and grit removal	• Reduced sludge line cleaning • Reduced primary scum pumping • Reduced mechanical cleaning • New equipment to maintain for FOG receiving and blending tank	• Reduced sludge line cleaning • Reduced primary scum pumping • Reduced mechanical cleaning • Additional digester to maintain	• Reduced sludge line cleaning • Reduced primary scum pumping • Reduced mechanical cleaning • New storage tank to maintain.	• Reduced sludge line cleaning • Reduced primary scum pumping • Reduced mechanical cleaning	• Reduced sludge line cleaning • Reduced primary scum pumping • Reduced mechanical cleaning • Maintenance of new heated storage • Maintenance of grease concentrator for solid option
Staffing Impacts	• Some staffing change to handle increased O&M for mechanical cleaning and odor control	• Possible increased security staff to monitor traffic through the plant • Increase in O&M staffing to operate and maintain new equipment	• Possible increased security staff to monitor traffic through the plant • Increased O&M staff to operate and maintain new process equipment	• Possible increased security staff to monitor traffic through the plant • Increased O&M staff to operate and maintain digester currently out of service	• Some staffing change anticipated	• Some staffing change anticipated • Possible increased monitoring	• Some staffing change anticipated for O&M of new heated storage, odor control and grease concentrator
Traffic Impacts	• Increased on-site traffic	• Increased plant process traffic to new FOG dumping facility	• Increased plant process traffic to new FOG dumping facility	• Increased plant process traffic to new FOG dumping facility at a digester. • Possible conflict with sludge hauling traffic	• Increase to plant process traffic due to pickup from rendering facility.	• Possible increase to plant process traffic if transfer to mobile storage is on site.	• Increase to plant process traffic
Economic Impacts	• Slight reduced natural gas purchase due to increased methane production • Moderate capital cost for addition of odor control	• Reduced natural gas purchase due to increased methane production • Increased operating cost for new FOG dumping equipment • Capital cost for new facilities	• Reduced natural gas purchase due to increased methane production • Increased operating cost for new FOG dumping and blending tank equipment • Capital cost for new facilities	• Reduced natural gas purchase due to increased methane production • Increased operating cost for additional digester • Additional future digester needed • Additional chemicals used for odor control in digester	• Increased natural gas usage due to loss of methane production • Additional tipping fee • Capital cost for new facilities • Cost controlled by market • Increased energy cost for heated storage.	• Increased natural gas usage due to loss of methane production • Possible increase collection cost for FOG haulers • Reduced diesel purchase replaced by bio-diesel • Cost controlled by market • Improved fuel efficiency • Reduced vehicle maintenance	• Increased natural gas usage due to loss of methane production • Additional tipping fee • Increased energy for heated storage • Capital cost for new facilities
Environmental Impacts	• Increased sampling • Increased truck emissions • Possible increased oil to ocean	• Increased sampling • Increased truck emissions • Better oil capture	• Increased sampling • Increased truck emissions • Better oil capture	• Increased truck emissions • Better oil capture	• Increased truck emissions from double trucking	• Reduced particulate, NOx, CO emissions diesel fleet vehicle emissions for vehicles operating with bio-diesel • Green energy production	• Reduced beneficial use • Reduced landfill capacity
Final Ranking	6	3	5	2	4	1	7

Actual project costs from similar wastewater projects, budget prices obtained from vendors, and cost curve data have been used to complete this analysis. A list of general economic and process assumptions for the treatment and disposal options is provided below. These assumptions, which are consistent with the recent advanced digestion study, include:

- Electrical and control costs are equal to 12 percent and 20 percent of mechanical and structural modifications respectively.
- Capital Cost mark ups:
    - Modification and coordination with existing facilities — 10 percent
    - Contractor overhead and profit — 15 percent
    - Permits, bonds, and insurance — 2.5 percent
    - Estimator's contingency — 40 percent
    - Sales tax — 7.75 percent
    - Engineering and administrative Costs — 30 percent
    - Markup for piping materials and installation in the existing tunnel systems at Plants 1 due to congestion. — 15 percent

Table 5. Alternative Capital Costs. (Millions)

Alternative	**Capital Cost**	
Alternative 1A – Base Case (Status Quo)	$	5.7
Alternative 1B – Modified FOG receiving		
Option 1 – tie in FOG line at digesters	$	1.1
Option 2 – tie in FOG line at DAF feed	$	0.9
Alternative 1C – Modified FOG receiving, thickened sludge blending	$	4.6
Alternative 1D – Dedicated digestion		
(Includes future digester cost)	$	4.8
(Without future digester cost)	$	.4
Alternative 2 – Off-site treatment at grease rendering facility	$	1.1
Alternative 3 – Off-site recycling as bio-fuel	$	0
Alternative 4 – Off-site disposal at landfill (solid disposal)	$	3.1

Detailed capital cost estimates for each alternative are included in Appendix A.

RECOMMENDATIONS

The seven alternatives developed for treating or disposing of FOG in the OCSD are:

- Alternative 1 – Onsite Digestion
  - Alternative 1A – Base Case (Status Quo)
  - Alternative 1B – Modified Liquid Receiving
  - Alternative 1C – Modified Liquid Receiving and Thickening
  - Alternative 1D – Dedicated Digestion
- Alternative 2 – Off-site treatment at a FOG rendering facility
- Alternative 3 – Off-site recycling as bio-fuel
- Alternative 4 – Off-site disposal at a landfill

The alternatives were ranked based on various impacts to the OCSD treatment facility. The ranking results indicate that Alternative 3 ranked the best, followed by Alternatives 1D and B. Although Alternative 3 ranked the highest, the risk associated with Alternative 3 depends heavily on a third party that currently is in the development stages.

Brown and Caldwell recommends that Alternate D be implemented until pilot testing and market analysis of Alternative 3 is completed. To verify performance and process design requirements for dedicated digestion, a pilot test using grease trap waste should be performed. To inject FOG downstream of the digester heat exchanger some minor piping changes would be necessary. Until this work can be completed, the OCSD can continue its current practice of receiving FOG, Alternative 1A.

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APPENDIX A

ALTERNATIVE CAPITAL COST ESTIMATES

OCSD Grease impact study
Alternative capital cost estimates

Work Required	quantity	cost	total
Alternative 1 - On-site digestion			
Alternative 1A - Base Case (Status Quo)		0	**$5,700,000**
Glass lined DIP primary sludge piping - 6" (including demo)	10000	200	$2,000,000
Modify existing primary scum collection (allowance)			$500,000
		Subtotal	$2,500,000
Modifiy and coordinate with existing			$250,000
Controls			$0
Electrical			$0
Misc Contractor indirects			$175,000
		Subtotal	$425,000
Contractor overhead			$438,750
Permits, bonds and insurance			$73,125
Estimator's contingency			$1,170,000
Sales tax			$226,688
Engineering and Administration			$877,500
		total	$5,711,063
Rounded Estimate			$5,700,000
Alternative 1B Modified Receiving			
Option 1A & B - tie in grease line at digesters			**$1,100,000**
Grease receiving station - packaged system	2	$100,000	$200,000
Grease pumping - 300 gpm	2	$15,000	$30,000
Grease piping to digesters - 8" Glass lined	1000	$120	$120,000
		Subtotal	$350,000
Modifiy and coordinate with existing			$35,000
Controls			$35,000
Electrical			$105,000
Misc Contractor indirects			$24,500
		Subtotal	$199,500
Contractor overhead			$82,425
Permits, bonds and insurance			$13,738
Estimator's contingency			$219,800
Sales tax			$42,586
Engineering and Administration			$164,850
		total	$1,072,899
Rounded Estimate			$1,100,000

Option 2 - tie in grease line at DAF feed			**$900,000**
Grease receiving station - packaged system	2	$100,000	$200,000
Grease pumping - 300 gpm	2	$15,000	$30,000
Grease piping to DAFs - 8" Glass lined	600	$120	$72,000
		Subtotal	$302,000
Modifiy and coordinate with existing			$30,200
Controls			$30,200
Electrical			$90,600
Misc Contractor indirects			$21,140
		Subtotal	$172,140
Contractor overhead			$71,121
Permits, bonds and insurance			$11,854
Estimator's contingency			$189,656
Sales tax			$36,746
Engineering and Administration			$142,242
		Total	$925,758
Rounded Estimate			$900,000
Alternative 1C Modified Receiving & Blending			**$4,600,000**
Grease receiving station - packaged system	2	$100,000	$200,000
Grease pumping - 300 gpm	2	$15,000	$30,000
Heated blendign tank	1	$650,000	$650,000
Blended sludge heating and pumping equipment	1	$320,000	$320,000
Blended sludge & grease piping	1500	$200	$300,000
		Subtotal	$1,500,000
Modifiy and coordinate with existing			$150,000
Controls			$150,000
Electrical			$450,000
Misc Contractor indirects			$105,000
		Subtotal	$855,000
Contractor overhead			$353,250
Permits, bonds and insurance			$58,875
Estimator's contingency			$942,000
Sales tax			$182,513
Engineering and Administration			$706,500
		total	$4,598,138
Rounded Estimate			$4,600,000

Alternative 1D Dedicated Digestion	**W/replacement digester**		**$400,000**
	w/o replacement digester		**$4,800,000**
Modify existing recirculation piping	1	2000	$2,000
Asphalt paving - sq yds	2200	$50	$110,000
6 inch drain	200	$50	$10,000
6 inch concrete curb	140	$15	$2,100
Digester - 90 ft diameter*	1	$1,500,000	$1,500,000
		Subtotal	$1,622,100
Modifiy and coordinate with existing			$162,210
Controls			$162,210
Electrical			$486,630
Misc Contractor indirects			$113,547
		Subtotal	$924,597
Contractor overhead			$382,005
Permits, bonds and insurance			$63,667
Estimator's contingency			$1,018,679
Sales tax			$197,369
Engineering and Administration			$764,009
		total	$4,972,426
Rounded Estimate			$4,800,000
* Digester included for capacity lost from dedicated			
digestion for grease			
Alternative 2 Off-site treatment at grease rendering			**$1,100,000**
80,000 gal storage tank w/mixing pumps	1	$500,000	$500,000
Modifiy and coordinate with existing			$50,000
Controls			$0
Electrical			$0
Misc Contractor indirects			$35,000
		Sutotal	$85,000
Contractor overhead			$87,750
Permits, bonds and insurance			$14,625
Estimator's contingency			$234,000
Sales tax			$45,338
Engineering and Administration			$175,500
		Total	$1,142,213
Rounded Estimate			$1,100,000

Alternative 3 Off-site recycling as biofuel (waste oil only)			**$0**
Alternative 4 Off-site disposal at Landfill			
Solid disposal			**$3,100,000**
80,000 gal storage tank w/mixing pumps, FOG concentrator	1	$1,000,000	$1,000,000
Modifiy and coordinate with existing			$100,000
Controls			$100,000
Electrical			$300,000
Misc Contractor indirects			$70,000
		Sutotal	$570,000
Contractor overhead			$235,500
Permits, bonds and insurance			$39,250
Estimator's contingency			$628,000
Sales tax			$121,675
Engineering and Administration			$471,000
		Total	$3,065,425
Rounded Estimate			$3,100,000