FINAL TECHNICAL REPORT:
Brown Grease to Biodiesel Demonstration

PROJECT INFORMATION

DOE award number: DE EE0000621

Name of recipient: San Francisco Public Utilities Commission

Project title: San Francisco Biofuel Program

Name of project: Brown Grease to Biodiesel Demonstration

Director/principal investigator: Domenec Jolis

Consortium/teaming members:
- Environmental Protection Agency (EPA)
- California Energy Commission (CEC)
- URS Corporation

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EXECUTIVE SUMMARY

Municipal wastewater treatment facilities have typically been limited to the role of accepting wastewater, treating it to required levels, and disposing of its treatment residuals. However, a new view is emerging which includes wastewater treatment facilities as regional resource recovery centers. This view is a direct result of increasingly stringent regulations, concerns over energy use, carbon footprint, and worldwide depletion of fossil fuel resources. Resources in wastewater include chemical and thermal energy, as well as nutrients, and water. A waste stream such as residual grease, which concentrates in the drainage from restaurants (referred to as Trap Waste), is a good example of a resource with an energy content that can be recovered for beneficial reuse.

If left in wastewater, grease accumulates inside of the wastewater collection system and can lead to increased corrosion and pipe blockages that can cause wastewater overflows. Also, grease in wastewater that arrives at the treatment facility can impair the operation of preliminary treatment equipment and is only partly removed in the primary treatment process. In addition, residual grease increases the demand in treatment materials such as oxygen in the secondary treatment process. When disposed of in landfills, grease is likely to undergo anaerobic decay prior to landfill capping, resulting in the atmospheric release of methane, a greenhouse gas (GHG).

This research project was therefore conceptualized and implemented by the San Francisco Public Utilities Commission (SFPUC) to test the feasibility of energy recovery from Trap Waste in the form of Biodiesel or Methane gas. The research goals are given below:

- To validate technology performance;
- To determine the costs and benefits [including economic, socioeconomic, and GHG emissions reduction] associated with co-locating this type of operation at a municipal wastewater treatment plant (WWTP);
- To develop a business case or model for replication of the program by other municipal agencies (as applicable).

In order to accomplish the goals of the project, the following steps were performed:

1. Operation of a demonstration facility designed to receive 10,000 to 12,000 gallons of raw Trap Waste each day from private Trap Waste hauling companies. The demonstration facility was designed and built by Pacific Biodiesel Technologies (PBTech). The demonstration facility would also recover 300 gallons of Brown Grease per day from the raw Trap Waste. The recovered Brown Grease was expected to contain no more than 2% Moisture, Insolubles, and Unsaponifiables (MIU) combined.
2. Co-digestion of the side streams (generated during the recovery of 300 gallons of Brown Grease from the raw Trap Waste) with wastewater sludge in the WWTP's anaerobic digesters. The effects of the side streams on anaerobic digestion were quantified by comparison with baseline data.

3. Production of 240 gallons per day of ASTM D6751-S15 grade Biodiesel fuel via a Biodiesel conversion demonstration facility, with the use of recovered Brown Grease as a feedstock. The demonstration facility was designed and built by Blackgold Biofuels (BGB). Side streams from this process were also co-digested with wastewater sludge. Bench-scale anaerobic digestion testing was conducted on side streams from both demonstration facilities to determine potential toxicity and/or changes in biogas production in the WWTP anaerobic digester.

While there is a lot of theoretical data available on the lab-scale production of Biodiesel from grease Trap Waste, this full-scale demonstration project was one of the first of its kind in the United States.

The project's environmental impacts were expected to include:

- Reduction of greenhouse gas emissions by prevention of the release of methane at landfills. Although the combustion product of Biodiesel and Methane gas produced in the Anaerobic digester, Carbon Dioxide, is also a greenhouse gas; it is 20 times weaker for the same amount (per mole) released, making its discharge preferable to that of Methane.
- The use of Biodiesel in place of fossil-fuel derived Diesel was expected to reduce net Carbon Dioxide, Ash Particulate, Sulfate, Silicate, and Soot emissions, thereby improving air quality.

Project Outcomes

Although the main technical goal of the project- to recover Brown Grease from restaurant Trap Waste and convert the Brown Grease to Biodiesel- was not fully met, the idea that WWTPs can serve as resource recovery centers was validated for Brown Grease recovery.

The recovery of Brown Grease was accomplished by a similar technology as that used in the preliminary stages of wastewater treatment, and hence was relatively easy for WWTP operators to manage. The utilities required for the operation of the Brown Grease recovery demonstration facility were heat (for grease and water separation) and electricity (for operation of mechanical parts), both of which were readily available at the WWTP, making the process highly feasible to operate. The Biodiesel demonstration facility, however, required numerous raw materials that raised safety concerns at the WWTP. The Biodiesel conversion demonstration facility also contained more specialized equipment, such as reactors, flash drums, distillation columns, filter presses, and evaporators. These units required more specialized personnel for operation, therefore restricting the operation of the demonstration facility at the WWTP.

The Brown Grease recovery process also showed promise of economic feasibility. A 5-cent charge for each gallon of Trap Waste received was instituted during the demonstration period. The revenue from this fee was beneficial as it contributed towards the salary of a full-time operator for the Brown Grease recovery facility. The side streams produced during the dewatering process also augmented digester gas production, therefore saving natural gas costs for the Oceanside facility.

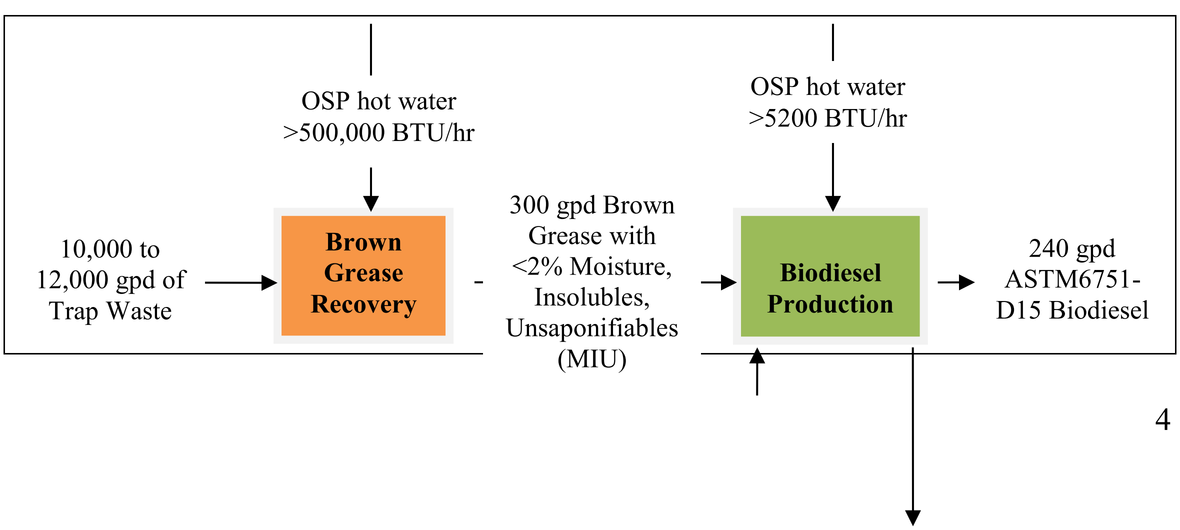
The recovery of Brown Grease was evaluated over a 6-month period using a mass balance approach, and overall monthly grease recovery was found to range from about 21 percent to 54 percent. The recovery was lower than required to produce 300 gallons of Brown Grease per day i.e. greater than 60 percent. The recovered Brown Grease met the specification of 2% MIU. The decanting technology demonstrated by PBTech appears relatively mature, and ready for replication at a similar or larger scale.

Improvements in digester gas production in the anaerobic digester were noted as a result of co-digestion of the recovery side streams. Biogas production showed an increase from 10.3 standard cubic feet (scf) per pound of Volatile Solids (VS) destroyed to 16 scf per pound of VS destroyed.

Although the chemistry of the Biodiesel conversion process appears to work, the Biodiesel production process was subject to numerous operational issues and ancillary equipment part failures during the demonstration period. As a result, there was insufficient operational data to evaluate and validate the system performance, and a business case study based on this technology could not be performed.

PROJECT ACTIVITIES

Project activities involved data collection and daily observation that enabled the project team to evaluate the performance of the technologies used in both processes (Brown Grease Recovery and Biodiesel conversion); determine the costs and benefits of co-location at the WWTP, and to develop a business case model for program replication. An overview of the demonstration project is shown in Figure 1.



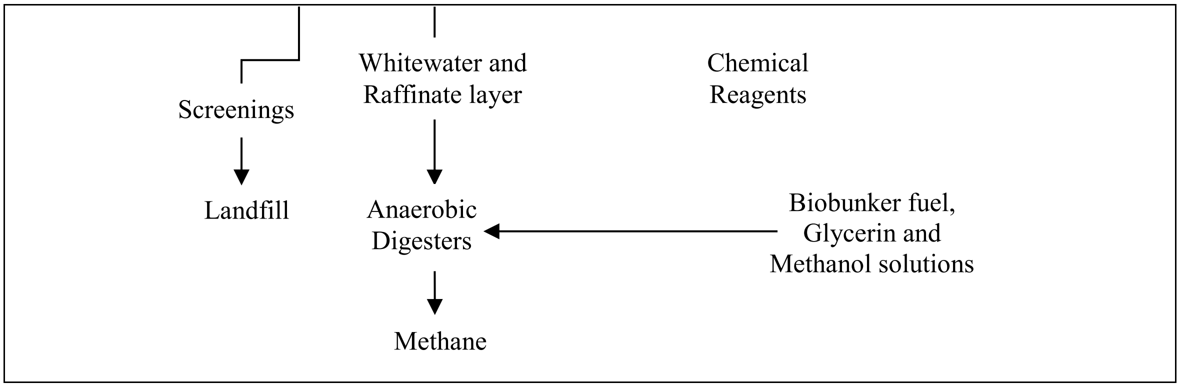


Figure 1: Demonstration Project Overview

Figure 1 shows an overview of the processes required to accomplish the goals of the demonstration project. The streams labeled Whitewater and Raffinate Layer represent waste streams produced during the Brown Grease recovery process.

The Biodiesel Conversion facility required Brown Grease to react with Methanol in the presence of a catalyst, to produce Biodiesel. Several other chemicals were used to refine the Biodiesel to meet ASTM 6751 quality. Biobunker fuel is a waste stream from the distillation of crude Biodiesel. The other waste streams produced from the process are Glycerin and Methanol, both are side products of the chemical reaction between Grease and Methanol.

<u>Brown Grease Recovery Demonstration Project Activities and Observations</u>
Based on the project demonstration goals for the Brown Grease Recovery Facility, the following design criteria were developed:

- Capacity of Demonstration facility: 10,000 gallons per day of grease Trap Waste;
- Output flow: 300 gallons per day of Brown Grease (assuming the Trap Waste contains at least 5 percent Brown Grease);
- Brown Grease quality specification: ≤ 2 percent MIU;
- Equipment specifications:
  - Must be factory-tested, modular equipment, to facilitate construction, start-up and expansion,
  - Must meet all local codes, including design for Seismic Zone 4,
  - Operation must be fully-automated for Trap Waste hauler unloading, separation, and transfer so that no additional personnel shall be required to operate the facility,
  - Must meet project specifications based on using available site utilities for heating,
  - Required site modifications should be minimal.
- Equipment delivery: By November 2009 (within 3 months of RFP publication);

Several policies and procedures were developed and implemented to regulate operations at the facility:

- Procedures for permitting and managing grease Trap Waste haulers;

- Standard operations and maintenance procedures;
- Health and safety procedures for minor and major spillage;
- Spill Prevention Control and Countermeasures Plan (SPCC);
- Staffing plan;
- Digester Transfer procedures; and
- Testing and sampling plan.

Figure 2 shows the project schedule for construction and installation of the Brown Grease Recovery facility.

Operation of the Brown Grease recovery facility began in October 2010. Figure 3 shows a picture of the demonstration facility; While Figure 4 gives an overview of the Brown Grease recovery process.

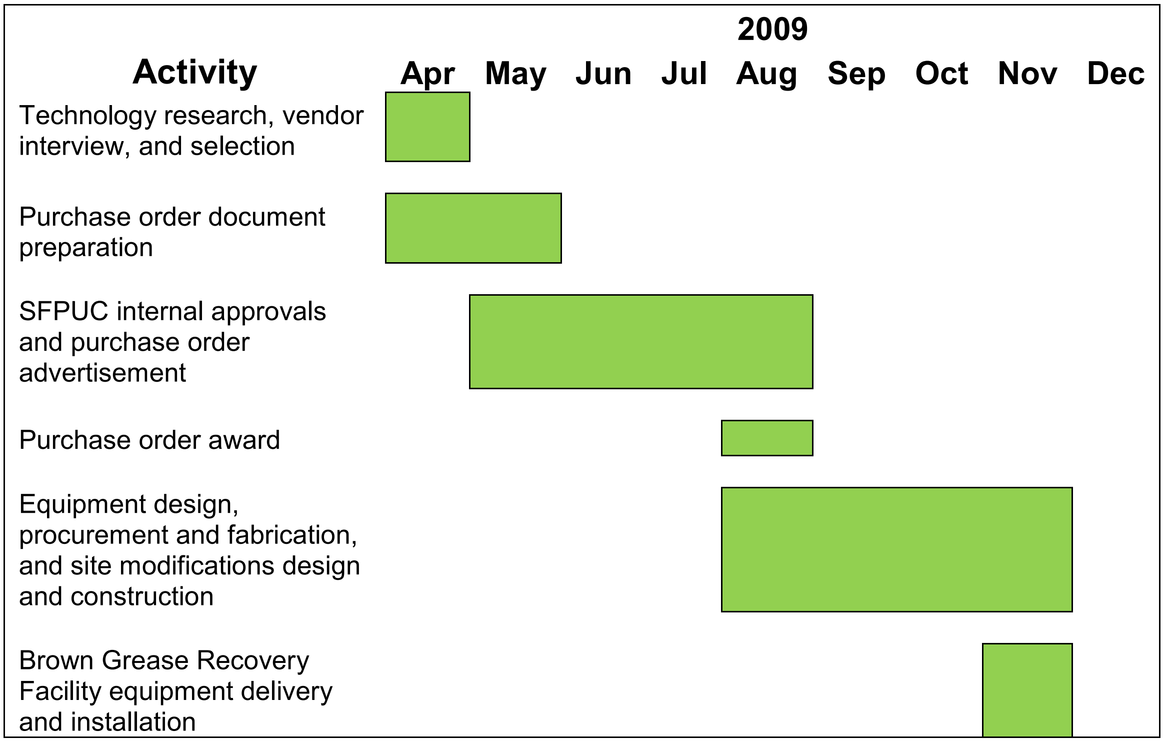


Figure 2: Project Schedule for Construction, Installation, and Operation of the Brown Grease Recovery Facility

Figure 3: Brown Grease Recovery Demonstration Facility

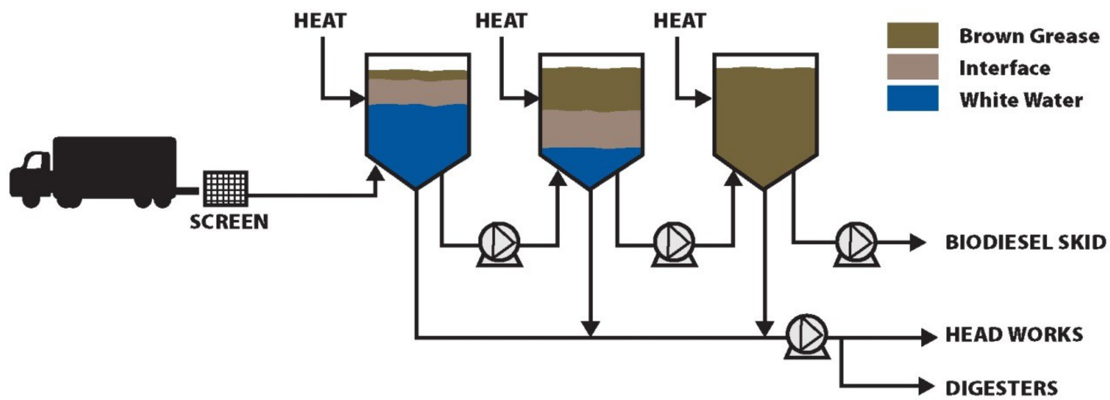


Figure 4: Overview of Brown Grease Recovery Process

The Brown Grease Recovery Facility made use of a screening process to remove large solids from the grease, and eight tanks for sequential heating and gravity separation of the grease, water, and smaller solid materials present in Trap Waste. During operation, several problems were encountered that threatened the process feasibility. Table 1 shows a summary of such issues and the measures taken to overcome them.

Table 1: Challenges faced and modifications made to the Brown Grease Recovery Facility

Problem	Counteractive measure taken
Open-top hopper screening process proved labor intensive, caused odor problems, and led to the loss of a significant amount of solidified grease that could not pass through the screens.	An enclosed screening system, equipped with a heated jacket, was designed and installed; reducing screening volume from about 100 gallons per day to less than 100 gallons per week; and reducing unloading time from a minimum of 1 hour to a minimum of 20 minutes.
Rancid Trap Waste odor released from the process tank during transfers; leading to complaints from plant staff.	A manifold pipe structure that connected all process vessels to a drum containing odor removing Carbon material was installed. Since the modification, there have been no major odor complaints from plant staff.
Discharge piping on the demonstration facility was frequently clogged as a result of the nature of the Trap Waste.	Hot water injection points were installed in the transfer pipes. The hot water (at 150 °F and 80 psi) was used to flush the pipes and unclog the lines when needed, allowing the lines to be unclogged within 5 minutes.

Problem	Counteractive measure taken
Sampling of Trap Waste proved difficult, as the Trap Waste, by nature was heterogeneous and required mixing for homogenization. Mixing, however, worked against the goal of Brown Grease recovery.	A comparative study was performed to determine the optimum amount of time required to mix the Trap Waste in the separation tanks. The resulting time was long enough to create a homogenous mixture, but short enough not to affect the separation process.

Other problems faced and observations made during the testing program, which could not be counteracted, include the following:

- Although the design requirements included automatic operation of the process, the WWTP operations department did not allow installation of a fully automated system that could be operated from the Oceanside plant control for security reasons. Therefore, lack of automation in general made operation of the system time consuming and required specially trained and dedicated operators, and well written, easy to follow standard operating procedure (SOPs).
- Heat was supplied to the Brown Grease recovery facility by a closed loop that was heated by the WWTP's Heating, Ventilation, and Air Conditioning (HVAC) system. It was quickly discovered that the temperature of the HVAC system varied during the day, depending on the plant management's preference for controlling the onsite boilers. The temperature at the facility ranged anywhere between 90 and 190 degrees F. The SFPUC determined that hot water temperatures on the higher end of the range, as well as higher flow of heating water were required to improve Brown Grease recovery.
- A guided wave radar level sensor was used, but as a result of the orientation of the instrument, it was not able to measure the bottom portion of the tank interior that contained approximately 230 gallons of Trap Waste and related materials. The sensor readings were also affected by accumulation of solid materials (such as rags and strings) that might be present in the Trap Waste. As a result, tank readings occasionally had to be confirmed by visual inspection of the tank. The SFPUC recommended that another measurement technique, such as ultrasonic sensing should have been selected for this application.
- The transfer pumps (trash pump types) on the Brown Grease recovery facility were occasionally clogged by rags, strings, and other solid materials present in the Trap Waste. In the future, a more robust pump type (designed for handling fluids with a high concentration of solids) would have been more effective for use on the Brown Grease recovery facility. Figure 5 shows a picture of solid material that obstructed the operation of the transfer pumps.


Figure 5: Material Removed During Rebuilding of Transfer Pump

- The Brown Grease recovery system made use of butterfly valves, which easily caught rags and other debris from the Trap Waste. As a result, there were several instances in which the valves were clogged. These clogs restricted flow and sometimes caused the recovery facility to be shut down. A less sensitive valve (such as gate valves) would have been a more effective design choice for use in the future. Figure 6 shows a picture of the debris affecting the operation of the butterfly valves.

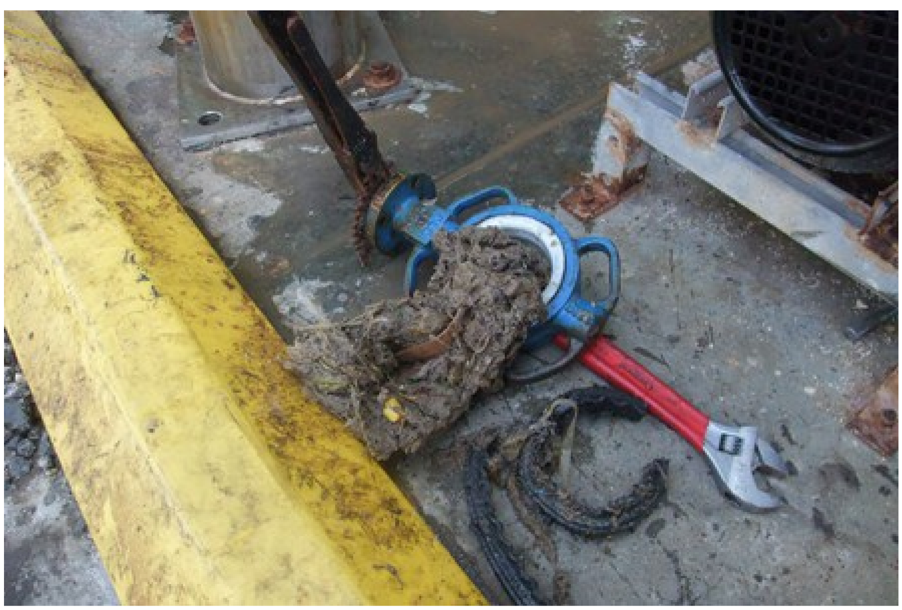


Figure 6: Debris Caught in Butterfly Valve

- Hours of operation is an important criterion to consider when operating a Trap Waste receiving station, because the haulers service restaurants during the night

and prefer to drop off their load(s) in the early morning hours. Operating during the early morning hours would have been preferable to daytime hours, as the increase in truck traffic during the day was considered a nuisance by some plant personnel.
- The pavement in the area surrounding the recovery facility was stained by Trap Waste, as a result of truck fluid and small Trap Waste spillages.

Biodiesel Conversion Demonstration Project Activities and Observations

The specifications below were given for design of the Biodiesel Conversion Facility, based on the project goals:

- Demonstration facility shall be capable of:
    - Processing up to 300 gallons per day of Brown Grease feedstock containing less than 2 percent MIU
    - Producing up to 240 gallons per day of Biodiesel that meets ASTM D6751-S15 requirements;
- Equipment shall be factory-tested, and modular for easy construction, start-up and expansion;
- Equipment shall meet all local codes, including design for Seismic Zone 4;
- The conversion of the Brown Grease into Biodiesel shall be fully automated;
- No additional personnel must be required to operate the facility;
- Equipment must be capable of meeting the specifications while using available site utilities for heating;
- Equipment must be delivered by November 2009 (within 3 months of RFP publication); and
- Installation must require minimal site modifications.

The siting criteria were as follows:

- Sufficient space for installation of the facility's equipment, and for Biodiesel tankers to load and park;
- Close proximity to existing utilities; to Brown Grease Recovery Facility for Brown Grease transfer; and to anaerobic digesters for by-product discharges;
- Minimal site modifications;
- Sufficient clearance for access, cleaning, maintenance; from existing major utilities; and from existing traffic

Figure 7 shows the project schedule for construction and installation of the Biodiesel Conversion facility at the WWTP.

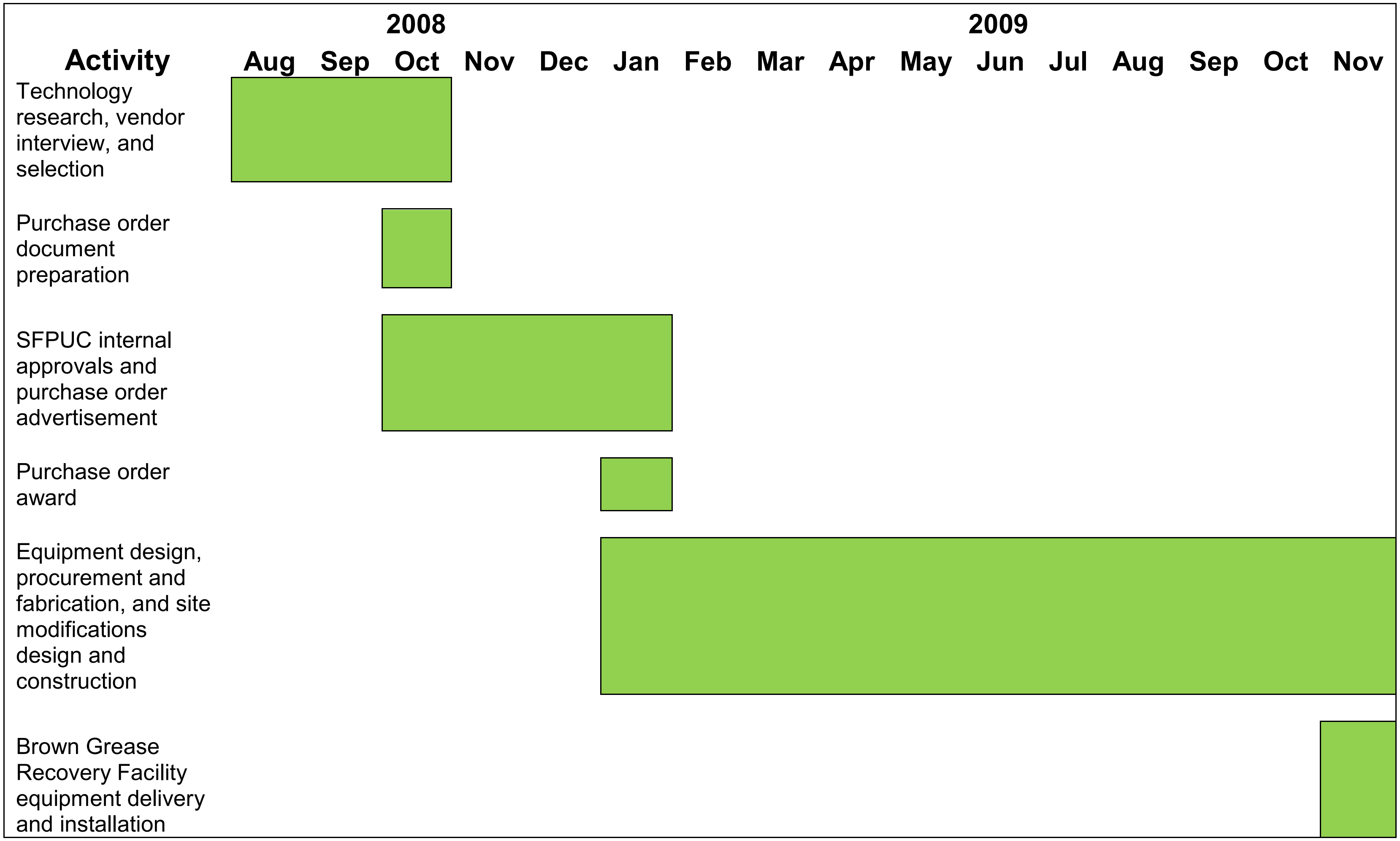


Figure 7: Project Schedule for the Construction and Installation of the Biodiesel Conversion facility

In order to operate the Biodiesel Conversion facility, there were a number of health and safety measures taken at the WWTP:

- Extensive safety evaluations (focused on the storage and handling of methanol) were performed by both SFPUC Health and Safety Program staff and independent consultants TetraTech and Golden Gate Environmental, in order to assure compliance with applicable occupational and safety regulations. Plant staff training materials were also developed and administered by Golden Gate Environmental.
- Personal methanol meters were required for all operators of the facility. Two stationary methanol meters were also installed at the facility. Other safety equipment installed at the facility were fire extinguishers and eyewash stations.
- Potential ignition sources were controlled within a 10-foot parameter around the conversion facility.
- The installation was isolated by a more than 30-linear-foot set-back from property lines.
- Storage of methanol was kept below trigger value of 4400 gallons.
- A Spill Prevention, Countermeasures, and Control (SPCC) plan was developed. The SPCC Plan contained the proper preventative actions that should be taken to minimize the risk of harm to waters of the United States in the event of release of petroleum from the WWTP per the requirements of 40 CFR 112.7.
- The Biodiesel installation was classified as a Class 1, Division 1, Group D installation in accordance with the National Electrical Code (NEC) Sections 500 et al. Consequently, a spherical hazardous area with a three-foot radius, centered at the vent of any equipment with the potential to vent methanol vapors to the atmosphere, was established.
- Points of potential leakage were considered to be Class 1, Division 2, Group D installations. In compliance with NEC requirements, a semi-spherical hazardous area with a three-foot radius from the potential source was established.

A Hazardous Materials Business plan for the WWTP, a requirement by the Hazardous Materials Unified Program Agency (HMUPA), was modified in 2010 to include the new chemical storage facilities and related stored quantities.

A picture of the Biodiesel conversion facility is shown in Figure 8.

Figure 8: Photo of Biodiesel Conversion Facility

The Biodiesel production process is constituted of the following steps:

- Reaction of Brown Grease and Methanol via esterification and transesterification, in the presence of a catalyst
- Free Fatty Acid, Methanol and Glycerin (Byproduct) removal
- Biodiesel distillation
- Methanol recovery (via distillation)

Between the completion of installation in April 2010 until December 2011, the Biodiesel Production Facility encountered several problems that affected start-up and operation. Below are some of the most prominent issues encountered:

- The initially installed hot oil system was not designed for outdoor use, as it allowed atmospheric humidity to enter the system through its air purge system. The hot oil system manufacturer, Mokon, took the unit off-site for retrofits. The hot oil system was re-installed, and a dry compressed air system was added to the skid.
- The initial catalyst feed pump was oversized. The pump had to be retrofitted with a gear reducer.
- Seven pressure sensors were removed from the skid in 2010 after two of those sensors had failed. A more 'rugged' type was selected and installed to better withstand the site's corrosive atmospheric conditions.
- The vacuum system required troubleshooting and modification in order to protect the vacuum pump from fouling due to mist. Ultimately, a coalescing filter had to be used to serve this purpose.

- A number of different pumping and mixing methods were tested to allow for continuous flash removal of methanol and water before ultimately identifying and installing new equipment.
- Troubleshooting and testing of the distillation column used for Methanol recovery took place before it was decided that the column should be replaced
- Modifications were difficult as a result of tight internal clearances between equipment, that were difficult to maintain in the extremely tight skid layout
- The WWTP's process water (used as cooling water on the demonstration facility) was about 10°F warmer than specified temperature and sometimes contained particulates that caused fouling of the facility's cooling system
- The Brown Grease feedstock was sometimes contaminated with debris, causing line blockages, and resulting in shut downs of the facility.

The problems listed above can be attributed to three main factors in the design of the conversion unit:

- Miniaturization of unit operations- The units were likely not intended for repeated outdoor use and made equipment cleaning and maintenance difficult to accomplish.
- Unavailability of steam- A hot oil system was used, thereby elevating temperatures above those available if steam was used. The elevated temperatures were also likely to have caused degradation of organic compounds, and may have contributed to the observed equipment fouling.
- Insufficient space in the skid- It was a challenge to fit an automated Biodiesel process including several unique purification systems required to handle the Brown Grease, in a skid with the dimensions of a standard shipping container. In addition to insufficient access for maintenance, it resulted in problematic pumping conditions, which is typically solved by providing additional height. While the decision to construct the unit in a single skid was completely BGB's, budget constraints have played a role in this decision.

As a result of the above listed problems, BGB was not able to run the Biodiesel conversion unit for any prolonged time period during the demonstration period from December 2010 through May 2011, and during the extension period from June to December 2011. Therefore, the intended evaluation of Biodiesel production and lifecycle costs for such a unit could not be determined.

Table 2 shows the lab analysis report of a Biodiesel sample obtained in June 2011. The table clearly shows that the Biodiesel met all ASTM 6751-D15 specifications except those of Sulfur and Glycerin.

Table 2: Results of Laboratory Analysis of Biodiesel

Analyte	**Procedure**	**Standard**		**Results 6/1/11**	**Pass as B100**
Calcium & Magnesium, combined	EN 14538	5 maximum	ppm (µg/g)	2.5	Y
Flash Point	D93	130 minimum	°C	132	Y
Water & Sediment	D2709	0.05 maximum	% vol.	0.01	Y
Kinematic Viscosity, 40 C	D 445	1.9 – 6.0	mm2/sec.	4.3	Y
Sulfated Ash	D 874	0.02 maximum	% mass	<0.005	Y
Sulfur, S 15 Grade	D 5453	0.0015 max. (15)	% mass (ppm)	0.0024	**N**
Copper Strip Corrosion	D 130	No. 3 maximum		1a	Y
Cetane	D 613	47 minimum		56.3	Y
Cloud Point	D 2500	report	°C	7	Y
Carbon Residue 100% sample	D 4530*	0.05 maximum	% mass	0.01	Y
Acid Number	D 664	0.5 maximum	mg KOH/g	0.25	Y
Free Glycerin	D 6584	0.020 maximum	% mass	0.046	**N**
Total Glycerin	D 6584	0.240 maximum	% mass	0.081	Y
Phosphorus Content	D 4951	0.001 maximum	% mass	<0.0001	Y
Distillation	D 1160	360 maximum	°C	356	Y
Sodium/Potassium (combined)	EN14538	5 maximum	ppm (µg/g)	2.4	Y
Oxidation Stability	EN15751	3 minimum	hours	8.6	Y
Cold Soak Filtration	D7501	360 maximum	seconds	30	Y

ACTUAL ACCOMPLISHMENTS VS. GOALS

Validation of technology performance

The Brown Grease recovery demonstration facility was able to produce Brown Grease at 2% MIU. Although the actual recovery rate of Brown Grease from restaurant Trap Waste (21 to 54%) proved to be lower than expected (60%). However, increased Brown Grease recovery can be made possible by increasing the volume of the incoming Trap Waste. The technology was validated and data from the six-month demonstration of the facility helped to determine the costs and benefits associated with co-locating this operation at a municipal WWTP.

The Brown Grease to Biodiesel conversion process, however, was not validated as the pilot plant faced a number of operational issues, including the following:

- Improperly sized components
- Components susceptible to the corrosive, salty atmosphere near the Pacific Ocean, that exhibited fouling of heated surfaces and
- Components in tight internal clearances, that were difficult to maintain in the extremely tight skid layout
- Caking of glycerin in one of the process tanks. The equipment used for this step had to be redesigned and replaced to eradicate this problem.

The quality of Biodiesel produced did not always meet the ASTM 6751 D-15 requirement:

- The Sulfur levels in the produced Biodiesel consistently exceeded the required levels to meet ASTM 6751 D-15 specifications

There were also some problems associated with integration at the OSP and the shared responsibilities between contractor and SFPUC staff. For example;

- The plant's final effluent (used as process cooling water for the Biodiesel Conversion Process) was about 10°F warmer than specified and at times contained particulates that caused fouling of the facility's cooling system.
- The Brown Grease supplied to the facility, was sometimes contaminated with debris, clogging lines on the Biodiesel conversion demonstration facility.

As a result, the Biodiesel facility was not able to run continuously on a daily basis. Therefore, the technology could not be validated.

Determination of the costs and benefits of co-location

Based on data collected during the demonstration period and a smaller pilot digester study, it was determined that there is significant value in municipal WWTPs receiving and processing Trap Waste, although this value may be site dependent. Measured benefits include the following:

• Waste heat from the treatment plant operations can be used to aid in recovery of the Brown Grease

• On-site processing of Trap Waste and related side-streams (separate from the incoming wastewater stream) enabled lower energy recovery of Trap Waste's thermal energy.

• Brown Grease Recovery Facility side-streams are high in COD and volatile solids content and when added to the treatment plant's anaerobic digester(s), a measurable increase in biogas production is observed

• WWTP facilities operate 24 hours per day, 7 days per week and have the ability to accept Trap Waste at all hours

• WWTP operations personnel have the required training and aptitude needed to operate a receiving and/or processing facility and manage impacts to the treatment plant unit operations

The following measures would need to be implemented at the treatment plant in order to support a long-term Trap Waste receiving and processing operation:

• Odor control when unloading trucks (e.g., vacuum connection to facility)

• Local hot water connection for daily cleanup

• Pre-mixing of side-streams in digester recirculation pipeline

Co-location of Biodiesel facilities were never deemed advantageous to the WWTP, as the process of conversion of Brown Grease to Biodiesel involved some equipment and chemicals that were unfamiliar to the wastewater treatment plant operators and would therefore require more specialized training for operation. In addition, there were a number of safety hazards involved with the operation of the Biodiesel production facility.

<u>Development of a business case or model for program replication by other municipal agencies</u>

A business-case analysis (available upon request) was performed. The analysis included a review of the California Biodiesel market including:

- Regulatory drivers
- Analysis of potential site locations based on available brown and yellow grease
- Selection of business case scenario
- Study of economic feasibility for a selected business case was performed

PRODUCTS DEVELOPED AND TECHNOLOGY TRANSFER ACTIVITIES

<u>Interviews and Articles in Trade Publications</u>

- 2/4/09 "Biodiesel Plant Project" CBS 5 News

- 2/4/09 “San Francisco Receives Grant for Biodiesel Project” *KCBS Radio*
- 2/5/09 ”SF to Convert Guckiest Cooking Grease to Fuel” *San Francisco Chronicle*
- 2/5/09 “SF Mayor Announces $1.2 Million Grant” *San Francisco Examiner*
- 2/5/09 “S.F. Lands $1.2M in State and Federal Grants for New "Brown Grease" Biodiesel Plant” *California Chronicle*
- 2/5/09 “Oil Gusher Discovered in San Francisco by Black Gold Biofuels” *Market Watch (NPR)*
- 2/6/09 “San Francisco Receives Grant for Bio-Diesel Plant” *Sacramento Bee*
- 2/6/09 “San Francisco to Convert ‘Brown Grease’ into Fuel” *San Jose Mercury News*
- 2/9/09 “San Francisco to Convert ‘Brown Grease’ into Fuel” *MSNBC*
- 2/9/09 “San Francisco Turns Potty Power Green” *Greenbiz*
- 2/11/09 “Biodiesel’s Leaps” *San Francisco Bay Guardian*
- 2/11/09 “San Francisco to Use BlackGold Biofuel’s Technology”*Biodiesel Magazine*
- 2/13/09 “SF Launches First City-Wide Brown Grease Program” *Sustainable Business*
- 2/27/10 “Philly Co. Partners with San Francisco PUC to Produce Biofuel” *Empowered Municipality*
- 4/10 “What to do with Brown Grease?” *Plumbing Systems and Design*
- 11/10 “Tenderloin a Potential Gusher for Biodiesel” *Central City Extra*
- 10/1/10 “Brown Grease Demo Biodiesel Plant Starts Up” *Biodiesel Magazine*
- 10/6/10 “Plant to Create Biodiesel from Grease” *Commercial Building Products*
- First Quarter, 2011 “Trap Grease Biodiesel -San Francisco Turns Brown Grease Into Renewable Fuel” *Biofuels Journal*
- 3/21/11, “Water's Scarcity Spells Opportunity for Entrepreneurs” *New York Times*

<u>Media Event</u>

- 2/4/09 – event with the Mayor (press release sent by the Mayor’s Office)

<u>Conference and Workshop Participation</u>

- CWEA San Francisco Bay Section, 4/15/08
- Pacific Organics and Residuals conference, 10/2/08
- CWEA conference, 11/21/08
- Olof Hansen “Creating Biodiesel Out of FOG” U.S. EPA Region 9. November 2008.
- Sustainable Biodiesel Conference, 1/26/09
- National Biodiesel Board Annual Conference, Opening Plenary Session, 2/09
- P3S Conference, Monterey, 3/2/09
- CWEA Annual Conference, 3/31/09
- Greening Wastewater Infrastructure Workshop, sponsored by Maricopa Association of Governments, 2/1/10
- Innovative Energy Management (webcast), sponsored by U.S. EPA Region IX, 6/10

- WEFTEC 2010, October 2010
- Karri Ving, Emily Landsburg "FOG Best Practices, including FOG to Fuels program" presentation at the Be Sewer Smart Summit on 10/25/11. Summit website: http://www.sewersmart.org/summit.html.
- A presentation was made to the American Public Works Association (APWA) Annual Conference on 11/9/11.
- CWEA Biosolids Specialty Workshop, 1/12
- Sierra, N., M. Noibi, and B. Jones (2012) "Does the Addition of High Strength Waste Affect Biosolids Quality?", WEF Residuals and Biosolids Conference 201

Outreach Materials
- PowerPoint presentations (can be provided on CD by request)
- 2-page graphic/summary of demonstration project

Informal Industry and Stakeholder Updates
- Update at Tri-TAC (Advisory Group consisting of members of League of Cities, CWEA, and CASA) Land Committee, 6/10

General Inquiries
- Conference call with Miami-Dade Utilities, 7/9/09
- E-mail exchange with Honolulu, 1/10/11
- Information exchange Central Marin Sanitation Agency 3/22/12

Research Awards
- CWEA San Francisco Bay Section Research Award, 2011
- CWEA Statewide Research Award, 2011

Presentations
- Wastewater CAC, 7/16/2009
- Digester Task Force, 1/6/2010
- Wastewater CAC, 2/10/2011
- Carollo Engineers, 3/11/11

Reports to Consortium/Teaming members
- Martis, Mary C., and Jolis, Domènec. *Financial Feasibility and Socioeconomic effects Associated with Co-locating a FOG to Biodiesel Refinery at a Municipal Wastewater Treatment Plant*. U.S. Environmental Protection Agency, West Coast Collaborative, 2010
- San Francisco Public Utilities Commission and URS Corporation, "Demonstration of Brown Grease Recovery for Biodiesel Production: Performance Certification Test Plan." California Energy Commission, PIER Renewable Energy Technologies Program. CEC-500-2010-02, 2010

- URS Corporation "Wastewater Sector State of the Industry Report: Conversion of Brown Grease to Biofuel", 2010
- URS Corporation and San Francisco Public Utilities Commission "Demonstration of Brown Grease Recovery for Biodiesel, Oceanside Water Pollution Control Plant Baseline Summary", (URS Corporation and SFPUC, 2011
- Martis, M. C., D. Jolis, and H. Leverenz. *GHG Emissions Comparison between Multiple Scenarios Involving the Collection and Processing of Waste Fats, Oils and Grease.* U.S. Environmental Projection Agency, West Coast Collaborative, 2011
- Business Case Associated with FOG Dewatering at a Municipal Wastewater Treatment Plant and Subsequent Conversion to Biodiesel, 2012