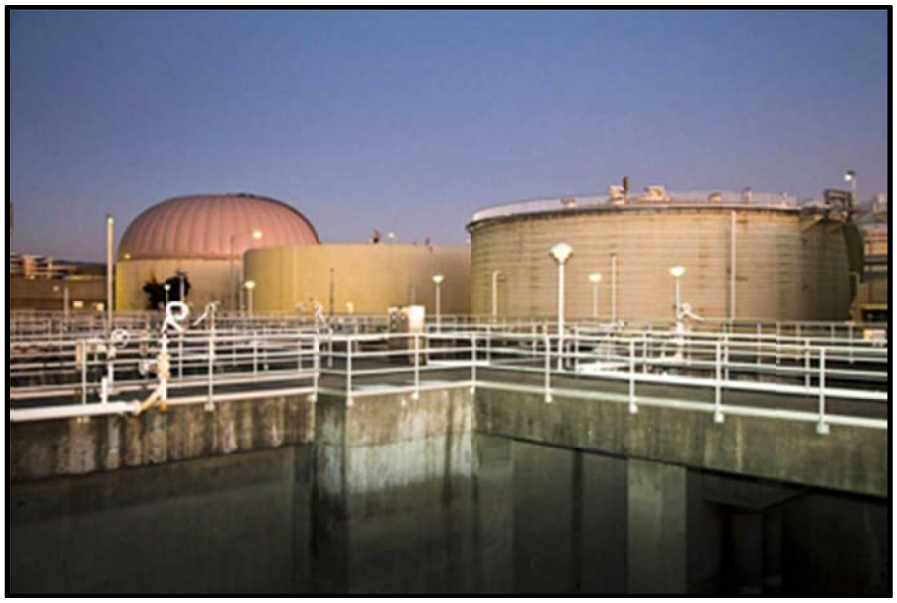
California Environmental Protection Agency

Air Resources Board

Low Carbon Fuel Standard (LCFS) Pathway for the Production of Biomethane from the Mesophilic Anaerobic Digestion of Wastewater Sludge at a Publicly-Owned Treatment Works (POTW)



Stationary Source Division
Fuels Evaluation Section

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AIR RESOURCES BOARD

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Table of Contents

I. Executive Summary 1

II. Introduction to Life Cycle Analysis 5

III. System Boundary, Reference and Alternative Cases, and System Credits 9

IV. Feedstock and Process Characterization 17

V. Life Cycle Analysis of Energy Consumption and GHG Emissions Impacts 20

VI. Applicable Credits, Well-to-Wheels GHG Emissions, and Proposed CI 37

VII. References 46

Appendix A 47

List of Tables

Table ES-1: Summary of Life Cycle GHG Impacts and Proposed CIs 4

Table IV-1: Wastewater Sludge Feedstock and Digestion Characteristics 18

Table IV-2: Biogas and Biomethane Emissions Rates 19

Table V-1: GHG Emissions from Thermal Energy Demand for Anaerobic Digestion (Small-to-Medium POTW) 22

Table V-2: GHG Emissions from Electrical Energy Demand for Anaerobic Digestion (Small-to-Medium POTW) 23

Table V-3: GHG Emissions from Electrical Energy Demand for Anaerobic Digestion (Medium-to-Large POTW) 25

Table V-4: GHG Emissions from Electrical Energy Demand for Digestate Management (Small-to-Medium POTW) 26

Table V-5: GHG Emissions from Electrical Energy Demand for Digestate Management (Medium-to-Large POTW) 27

Table V-6: GHG Emissions from ULSD Fuel Use in California (Fuel Cycle Emissions) 29

Table V-7: GHG Emissions from Distribution of Biosolids 30

Table V-8: Total GHG Emissions from ULSD Fuel Use 31

Table V-9: GHG Emissions from Electrical Energy Demand for Stage-1 Biogas Refining (Small-to-Medium POTW) 33

Table V-10: GHG Emissions from Electrical Energy Demand for Stage-1 Biogas Refining (Medium-to-Large POTW) 34

Table V-11: GHG Emissions from Electrical Energy Demand for Stage-2 Biogas Refining (Small-to-Medium POTW) 35

Table V-12: GHG Emissions from Electrical Energy Demand for Stage-2 Biogas Refining (Medium-to-Large POTW) 36

Table VI-1: Avoided Biogas Flaring Emissions Credit for Alternative Cases 1 and 2 38

Table VI-2: GHG Emissions Credit from the Export of Surplus Cogenerated Electricity 39

Table VI-3: Summary of Total WTT GHG Emissions Impact for Small-to-Medium POTW 40

Table VI-4: Summary of Total WTT GHG Emissions Impact for Medium-to-Large POTW 42

Table VI-5: TTW GHG Emissions from Combustion of Biomethane in a Natural Gas-Fired Vehicle 44

Table VI-6: Total WTW GHG Emissions and Proposed Carbon Intensities for Biomethane 45

List of Figures

Figure III-1: Schematic of the Reference Case for a POTW with System Boundary 10

Figure III-2: Schematic of the Alternative Case for a Small-to-Medium POTW 12

Figure III-3: Material and Energy Balance for a Small-to-Medium POTW 13

Figure III-4: Schematic of the Alternative Case for a Medium-to-Large POTW 15

Figure III-5: Material and Energy Balance for a Medium-to-Large POTW 16

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I. Executive Summary

Staff is proposing a Low Carbon Fuel Standard (LCFS) pathway for the production of biomethane from the mesophilic anaerobic digestion of wastewater sludge at a wastewater treatment plant (WWTP) located at a publicly-owned treatment works (POTW). The biomethane produced would be used for vehicle fuel and could be dispensed on-site through a compressed gas vehicle fueling station (for example, a CNG fueling station for transit buses or refuse hauling vehicles), or may be injected into the natural gas pipeline system ("common carrier pipeline") for dispensing at an off-site compressed gas vehicle fueling station.

Wastewater sludge is generated from the primary and secondary treatment processes designed for the municipal wastewater that flows into the WWTP. Since the wastewater sludge content is primarily organic material, California State and local laws require further treatment of the wastewater sludge prior to discharge or disposal of the material as an effluent, or disposal in a landfill or in a land application site. One of the most common processes for the treatment of wastewater sludge at a POTW is the anaerobic digestion of the sludge under mesophilic operating conditions (35 degrees Celsius). Anaerobically digesting the wastewater sludge destroys part of the organic matter and produces biogas, a mixture comprised of methane (CH_4) and carbon dioxide (CO_2), along with some trace impurities such as hydrogen sulfide, siloxanes, and vinyl chloride. Since both major components of biogas are heat-trapping greenhouse gases (GHG), the biogas produced is further destroyed by flaring (methane capture and destruction), or used in a device that generates electricity from the combustion of the biogas.

An alternative fate for the biogas, which is comprised of approximately 58 percent methane by volume, is to further refine the biogas to remove the carbon dioxide, and other trace impurities to produce near-pure biomethane (greater than 99 percent CH_4). This biomethane could then be compressed and sold as a vehicle fuel either on-site, or injected into the common carrier pipeline for fueling at an off-site location. Some POTWs may continue to use part of the biogas or biomethane in compliant energy-producing devices for the production of renewable power, and only allocate a fraction of their biogas produced toward transportation fuel uses. These alternate fates for the biogas produced from the mesophilic anaerobic digestion of the wastewater sludge at a POTW are the basis for the LCFS fuel pathways in this report.

This document presents the results for the life cycle analysis (LCA) of energy use and GHG emissions impacts assessed on the wastewater sludge-to-biomethane pathway described above. Those impacts are then presented per unit of fuel energy and as the carbon intensity (CI) value of the biomethane transportation fuel produced. In order to estimate the GHG impacts of these pathways, staff utilized two versions of the Greenhouse Gases, Regulated Emissions, and

Energy Use in Transportation life cycle analysis model: CA-GREET and GREET1[1]. For wastewater sludge treatment processes that include anaerobic digestion, digestate and supernatant management, biogas cleaning, refining, compression, dispensing and distribution, staff found that worksheets available in the GREET1 Model closely estimated the energy use and material flow rates, and therefore the GREET1 Model was used as a basis to estimate the proposed CI for biomethane in CA-GREET.

Based on a survey administered to over 250 California POTWs by the California Association of Sanitation Agencies (CASA, 2013), staff determined that over 150 POTWs operate anaerobic digesters to destroy part of the organic component of wastewater sludge. Of those found to be digesting wastewater organics, the majority of them (more than 90 percent) were found to be operating at mesophilic temperatures. Approximately 90 percent of those facilities digesting wastewater sludge were also using the biogas to produce renewable power for plant consumption or for export to the public grid, or both. Approximately half of those POTWs producing power were doing so by use of internal combustion engines (ICE) and generators. The ICEs have come under increasing regulatory scrutiny, subject to more stringent emissions standards for stationary sources by local air districts in order to attain air quality standards. The production of a transportation fuel, however, presents a viable solution to the regulatory constraints facing the POTWs. Detailed results of the CASA survey can be found in Appendix A of this report.

Staff has estimated the CIs for biomethane produced under two alternative scenarios. The first is an estimate for biomethane produced at a Small-to-Medium POTW (Alternative Case 1) with wastewater inflows of 5-20 million gallons per day (MGD). In this model, only a small parasitic load on the biogas produced is used to heat the digesters. Grid-based electricity, using the California Marginal mix of electrical generating assets, is assumed to power the wastewater sludge treatment, and biogas cleaning, compression, and fuel dispensing processes. The second is an estimate for a Medium-to-Large POTW (Alternative Case 2) with wastewater inflows of 21-100 MGD. In this model, the majority of the biogas is allocated to the production of renewable power using a compliant device (such as a gas-fired turbine with an exhaust heat recovery system). The balance of the biogas produced in the digesters is allocated to an "application" which may include on-site vehicle fueling, or compression and distribution through the natural gas grid for purposes of off-site vehicle fueling. Heat recovered from the exhaust of the combustion gases produced by the compliant device is adequate to sustain the mesophilic thermal requirements of the anaerobic digesters. The electrical demand for the wastewater sludge treatment and biogas cleaning, compression, and dispensing processes is

[1] The CA-GREET model (Version 1.80b, December 2009) and the GREET1 Model (Revision 2, December 2012) were developed by Argonne National Laboratory (ANL). The CA-GREET model has been adapted for use in California (Life Cycle Associates and ARB Staff). Some emission factors listed in GREET1 and not available in CA-GREET were incorporated by reference.

provided by the renewable power generated on-site by the compliant device. This alternative scenario also predicts that surplus electrical power[2] will be generated, and that this power will be exported, displacing California Marginal electricity on the electrical grid. Therefore, this model accrues an additional LCFS credit for lowering the GHG impacts of grid-based California Marginal electrical generation.

Common to both models (Alternative Cases 1 and 2) is a credit for avoided flaring emissions. Staff assumes that due to regulatory and air quality non-attainment considerations, flaring of the biogas to achieve near complete destruction of the volatile components in the biogas with high global warming potentials is the only available option for the reference case. Therefore, any productive use of the biogas, such as for vehicle fuel or the production of renewable electrical power, avoids the emissions and energy loss caused by flaring of the biogas. The avoided flaring emissions accrue as an LCFS credit in the pathway CI analyses.

The modeled CI results that estimate the life cycle impacts of GHG emissions from energy use (Alternative Cases 1 and 2), along with the applicable avoided flaring emissions credit (Alternative Cases 1 and 2), and the credit for displaced grid-based electrical generation (Alternative Case 2 only) are presented in Table ES-1 below. The CI estimate for each alternative case presented is obtained by first estimating the total well-to-tank (WTT) GHG impacts, which arise from the anaerobic digestion, digestate management and transport, biogas conditioning and refining, renewable power production, and biomethane compression, distribution, and dispensing. To this estimate is added the tank-to-wheels (TTW) GHG impacts, which arise when the finished fuel is combusted in a vehicle to derive motive power. This results in the total well-to-wheels (WTW) GHG emissions impacts, which, when expressed per unit of transportation fuel energy produced, represents the CI of the fuel.

As shown in Table ES-1, the resulting CIs are 10.86 g CO_2e/MJ and -65.27 g CO_2e/MJ for Alternative Cases 1 and 2, respectively. In both cases, staff estimated the CIs for compressing biomethane for on-site vehicle fueling. The CIs are also applicable to biomethane produced and injected into the common carrier pipeline.[3]

[2] The GREET1 Model estimates that electrical power surplus to the system boundary defined for the life cycle analysis of the scenario (Alternative Case 2) will be available for export. This amount of power is then considered to displace grid-based electrical generation.

[3] In most cases, the compression pressure required for pipeline injection (600-800 psi) is lower than the compression pressure required for on-site, high-speed vehicle fueling (3,600 psi). This determination was made pursuant to staff conversation with Jack Dunlap, PG&E, on December 29, 2011.

Table ES-1
Summary of Life Cycle GHG Impacts and CIs for
Biomethane Derived from Anaerobic Digestion of Wastewater Sludge

Parameter	Small-to-Medium POTW (Alternative Case 1)	Medium-to-Large POTW (Alternative Case 2)
Total WTT GHG Emissions Impacts (g CO_2e/day)	(5,051,355.72)	(101,477,229.25)
Total TTW GHG Emissions Impacts (g CO_2e/day)	7,748,625.74	20,403,793.71
Total WTW (WTT + TTW) GHG Emissions Impacts (g CO_2e/day) **(A)**	2,697,270.02	(81,073,435.54)
Allocation of Biomethane for Vehicle Fueling (m^3/day)	6,931.35	34,656.77
Allocation of Biomethane for Vehicle Fueling (scf/day)	133,366.58	351,182.80
Biomethane LHV (Btu/scf)	962.00	962.00
Biomethane Energy Value (MJ/day) **(B)**	248,414.33	1,242,071.63
Proposed Biomethane CI (g CO_2e/MJ) (A/B)	**10.86**	**- 65.27**

II. Introduction to Life Cycle Analysis

The use of life cycle analysis (LCA) to estimate the carbon intensity (CI) of a transportation fuel requires a full well-to-wheels (WTW) accounting of the GHG emissions from the production, processing, distribution, and combustion of that fuel. The system boundary within which this accounting takes place includes the upstream (fuel cycle) emissions from the energy consumed to produce and distribute the process fuels such as petroleum based diesel, and electricity used to power the wastewater sludge digestion process. A WTW analysis is comprised of two components:

- A Well-to-Tank (WTT) component, which accounts for the energy use and emissions from the delivery of the feedstocks to the facility; processing, production, and refining of the fuel, and the distribution of the final product; and

- A Tank-to-Wheels (TTW) analysis, which accounts for the emissions from the actual combustion of the fuel in a motor vehicle used for motive power. For this pathway, combustion of the fuel is assumed to occur in a heavy-duty, natural-gas-fired vehicle (NGV).

WTT emissions are sometimes referred to as well-to-pump emissions, while TTW emissions are sometimes referred to as pump-to-wheels emissions. Staff has conducted a WTW analysis for biogas produced from the anaerobic digestion (low solids or wet fermentation) of wastewater sludge at a publicly-owned treatment works (POTW). Under this pathway, the biogas produced is purified to biomethane, which could then be compressed and dispensed onsite or injected into the natural gas common carrier pipeline.

USE OF CA-GREET AND GREET1 MODELS FOR LIFE CYCLE ANALYSIS

A California-specific version of a LCA model called the Greenhouse Gases, Regulated Emissions, and Energy use in Transportation (GREET) model, originally developed by Argonne National Laboratory and Life Cycle Associates (Argonne National Laboratory and Life Cycle Associates LLC, 2009), was the source of some of the energy use and greenhouse gas (GHG) emissions data used to develop the CI for the wastewater sludge-to-biomethane pathway. The California-specific version of the model, known as CA-GREET, contains California-specific emission factors, electrical generation energy mixes, and transportation distances. The analytical methodology inherent in the original GREET model was not changed. Staff used the CA-GREET model to calculate GHG emissions from the wastewater sludge-to-biomethane pathway whenever the necessary emissions factors were present in the model.

For wastewater sludge treatment processes which include anaerobic digestion, digestate, supernatant, and biosolids management and transport, biogas

conditioning and refining, renewable power production, biomethane compression, distribution, and dispensing, staff found that the GREET1 Model (ANL, 2012) closely estimated the energy use and material flow rates, and therefore the GREET1 Model was used as a basis to estimate the GHG emissions impacts for the fuel pathway.

The analysis that follows uses conventions and technical terms with specific meanings that are defined here:

- Some emission values in CA-GREET are calculated recursively. This happens when a fuel is used in the process that produces that same fuel. Diesel fuel, for example, is used to extract and transport crude oil. This means that the CI of diesel contributes to the CI of crude oil. Since diesel is refined from crude, the CI of diesel plays a role in its own CI. The CIs of crude oil and diesel fuel are recursively calculated in CA-GREET. If a new CI for diesel is entered into the model, that CI will be used to calculate a new CI for crude oil. The result of that calculation will be used to calculate a new CI for diesel. This iterative recalculation process will continued a fixed number of times.

- Btu/mmBtu is the energy input necessary in British Thermal Units or Btus, to produce one million Btus of a finished (or intermediate) product. This description is used consistently in GREET for all energy calculations.

- g CO_2e/MJ provides the total greenhouse gas emissions on a CO_2-equivalent basis per unit of energy (MJ) in a given fuel. Methane (CH_4) and nitrous oxide (N_2O) are converted to a CO_2-equivalent basis using Intergovernmental Panel on Climate Change (IPCC, 2007) global warming potential (GWP) values and included in the total. The CA-GREET model assumes that VOC and CO are converted to CO_2 in the atmosphere and includes these pollutants in the total CO_2 value using ratios of the appropriate molecular weights.

- Process Efficiency for any step in CA-GREET is defined as the ratio of energy output to the sum of the energy output and energy consumed.

- Note that rounding of values has been minimized in several tables in this document. This is to allow stakeholders executing runs with the GREET model to compare actual output values from the CA-GREET or GREET1 models with values in this document.

- As used in this document, the term “upstream” refers to the energy use and emissions associated with the inputs supplied to the fuel production process. In the case of most fuels, the two upstream processes considered in the WTT analysis are the production of diesel fuel, and the generation of electricity. In the case of diesel fuel, the energy used to extract, process, and transport the

fuel is quantified. In the case of electrical generation, the energy needed to produce and transport the fuels used to generate the electrical energy is considered. In both cases, the expenditure of this energy results in GHG emissions.

The fuel production process can yield what are known as co-products. The biodiesel production process, for example, yields glycerin as a co-product. If that glycerin is sold, it displaces glycerin from other sources. The GHGs associated with the production of glycerin from those other sources could be greater than the GHGs associated with the biodiesel co-product. As an example, glycerin from the production of biodiesel sometimes displaces glycerin produced from petrochemicals. This indicates that biodiesel should be credited for the GHG reduction associated with this displacement. In this pathway, the potential co-product produced from the low solids anaerobic digestion of wastewater sludge is renewable electricity, which is assumed to displace fossil-fuel based grid generation, and soil amendment or fertilizer if the biosolids produced by the process are deemed to be rich in inorganic nutrients and free of pathogens.

- Production and feedstock production emissions are also adjusted to reflect material losses incurred during the production process. These are accounted for through the use of a capture efficiency, or estimated to be a fraction of the volume throughput.

The CI estimate for each scenario presented is obtained by first estimating the total WTT GHG impacts, which arise from the anaerobic digestion; digestate, supernatant, biosolids management and transport; biogas conditioning and refining; renewable power production; and biomethane compression, distribution, and dispensing. The application of credits for avoided flaring emissions, and for cogeneration and export of surplus electricity are also applied to the WTT estimates.

To this WTT estimate is added the TTW GHG emissions which arise when the finished fuel is combusted in a vehicle to derive motive power. This results is the total WTW GHG emissions impacts which, when expressed per unit of the transportation fuel energy produced, represents the CI of the fuel.

Section III of this report presents a system boundary within which the life cycle GHG impacts are assessed. A system boundary defines the universe of GHG emission increases and decreases (debits and credits) to be considered in the WTW analysis. Lastly, the production of transportation fuel are presented as alternative cases to the reference case which assumes that the purpose of the wastewater sludge treatment process is to destruct the organic matter in the sludge as much as possible. Section IV of this report presents the characteristics of the feedstock and the wastewater sludge-to-biomethane production process. Section V presents the derivation of the actual life cycle energy consumption and GHG emissions impacts. Section VI contains the compilation of the WTT and TTW estimates. Along with the applicable credits that lower these emissions impacts, staff then proposes the CIs for the alternative cases.

III. System Boundary, Reference and Alternative Cases, and System Credits

In traditional life cycle analysis, a system boundary around the pathway elements in which the transport of all material inflows and outflows, as well as energy inputs and outputs is accounted for. The universe of energy and material flows to be considered in the life cycle analysis is defined by the establishment of this system boundary.

While the generation of wastewater sludge, the primary feedstock used for the production of biogas, commences at the influent channels and settling basins associated with the wastewater treatment plant (WWTP), all existing wastewater treatment processes are not considered to be within the wastewater sludge-to-biomethane system boundary because those processes are required for the effective treatment and discharge of the wastewater influent. Similarly, wastewater sludge treatment processes, such as anaerobic digestion, biogas conditioning and cleaning, biogas flaring, digestate management, and biosolids and supernatant transport and disposal, are also required for the effective treatment and discharge of the wastewater residuals. The question that arises is how do we measure the emissions impact of the pathway elements if all processes are attributable to existing regulations that require adequate treatment of the wastewater prior to discharge?

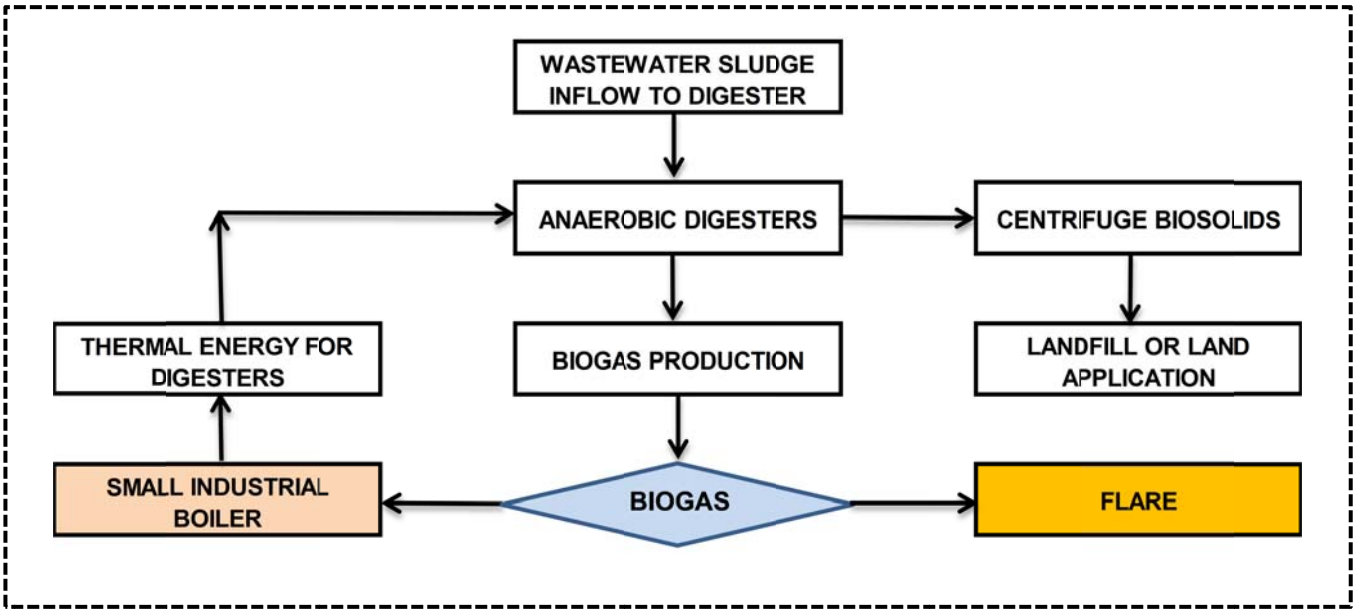
The life cycle analysis of greenhouse gas emissions impacts is therefore performed by assessing a change from the business-as-usual, baseline, or reference case to an alternative case that necessitates the production and consumption of the fuel for purposes of deriving motive power or renewable electricity. However, both reference and alternative cases still require the establishment of system boundaries around the appropriate set of life cycle pathway elements to be considered in the analysis.

a. Establishing a Reference Case for a POTW

Figure III-1 below depicts the Reference Case for the wastewater sludge-to-biomethane LCFS pathway. In this case, an assumption is made that wastewater sludge enters the anaerobic digesters after primary and secondary treatment processes have been implemented. In the digesters, biogas is produced from the anaerobic digestion of the wastewater sludge. The rate of biogas production, and correspondingly the rate of organic matter destruction, is dependent upon the operating temperature of the digesters. The biogas that is generated is collected in the digester header space. Part of the biogas may be combusted in a small industrial boiler for process thermal requirements (such as heating of the digesters to mesophilic operating temperatures), and the remainder of the biogas is assumed to be flared to achieve near complete destruction of the volatile components of the biogas and to reduce the global warming impacts of the gases produced to the environment. The digestate that remains in the

digesters after the anaerobic digestion process is complete is sent to centrifuges where separation of the biosolids and the supernatant takes place. The dewatered biosolids are disposed off-site in a landfill, or they can be used for land application purposes (for example, alternative daily cover, or as soil amendment, or as non-food crop fertilizer). The end application of the biosolids is dependent upon the level of pathogen reduction achieved and the level of nutrients that remain in the biosolids.

Figure III-1
Schematic of the Reference Case for a POTW with System Boundary



In terms of assessing the "fate" of the wastewater sludge in the Reference Case, the end objective is to reduce the organic content of the wastewater sludge so that the material may be safely discharged, emitted, or recirculated into the process without causing any harm to the public health or the environment. Therefore, any use or treatment of the feedstock that achieves the same end goals while proactively capturing the energy value of the products and by-products from the treatment process is an Alternative Case to the established Reference Case.

b. **Establishing an Alternative Case for a Small-to-Medium POTW with 5 to 20 MGD Average Daily Wastewater Inflows (Alternative Case 1)**

The Alternative Case for a Small-to-Medium POTW with 5-20 MGD wastewater inflows (Alternative Case 1) assumes that, due to regulatory constraints, the use of non-compliant combustion devices for the production of renewable electricity, or the flaring of the biogas that was generated in the anaerobic digesters is forbidden. A viable and sustainable project that achieves the same goals as the Reference Case

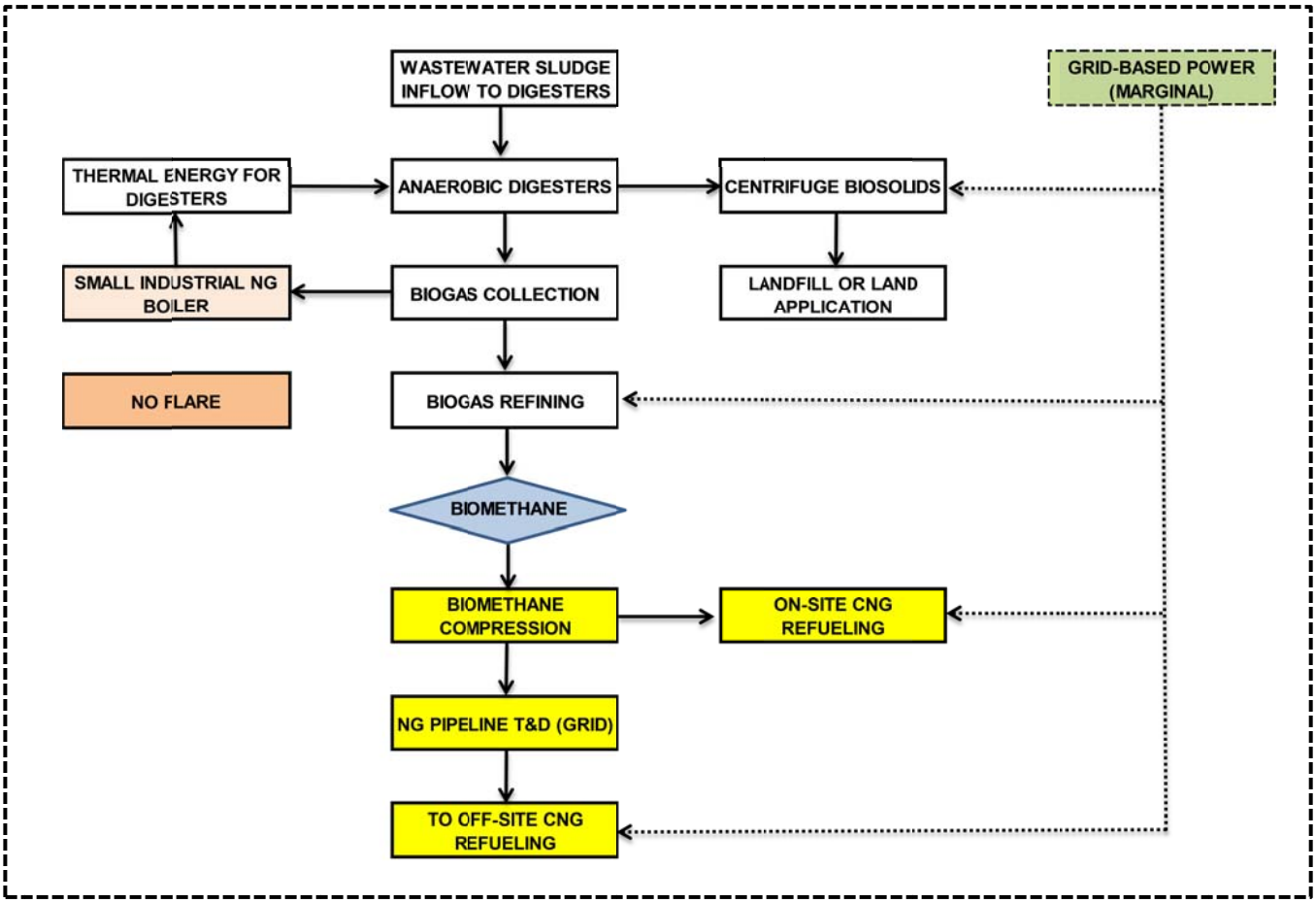
(i.e., reduction or destruction of the organic matter to safely discharge, or emit the products of the treatment process without causing a public nuisance, or endangering human health, or the environment), while also capturing the latent energy value of the product gas, is the production of a transportation fuel to derive motive power.

Biogas production processes are assumed to be identical to the Reference Case, with the thermal energy demand of the digesters being supplied by a small parasitic load on the digester biogas output used in a small industrial gas-fired boiler to produce steam. Since the biogas must be conditioned and refined prior to use in a vehicle, the system boundary includes an additional biogas refining unit for biomethane production, compression, and on-site vehicle fueling, or for direct injection into the natural gas grid for purposes of distributing the biomethane to an off-site vehicle fueling station. Electrical energy requirements for wastewater sludge treatment process operations are assumed to be provided by the public grid.

The Alternative Case for a Small-to-Medium POTW accrues a credit for avoiding flaring emissions of the Reference Case. This credit manifests itself by lowering the total GHG emissions impacts from energy use by the wastewater sludge-to-biomethane production processes.

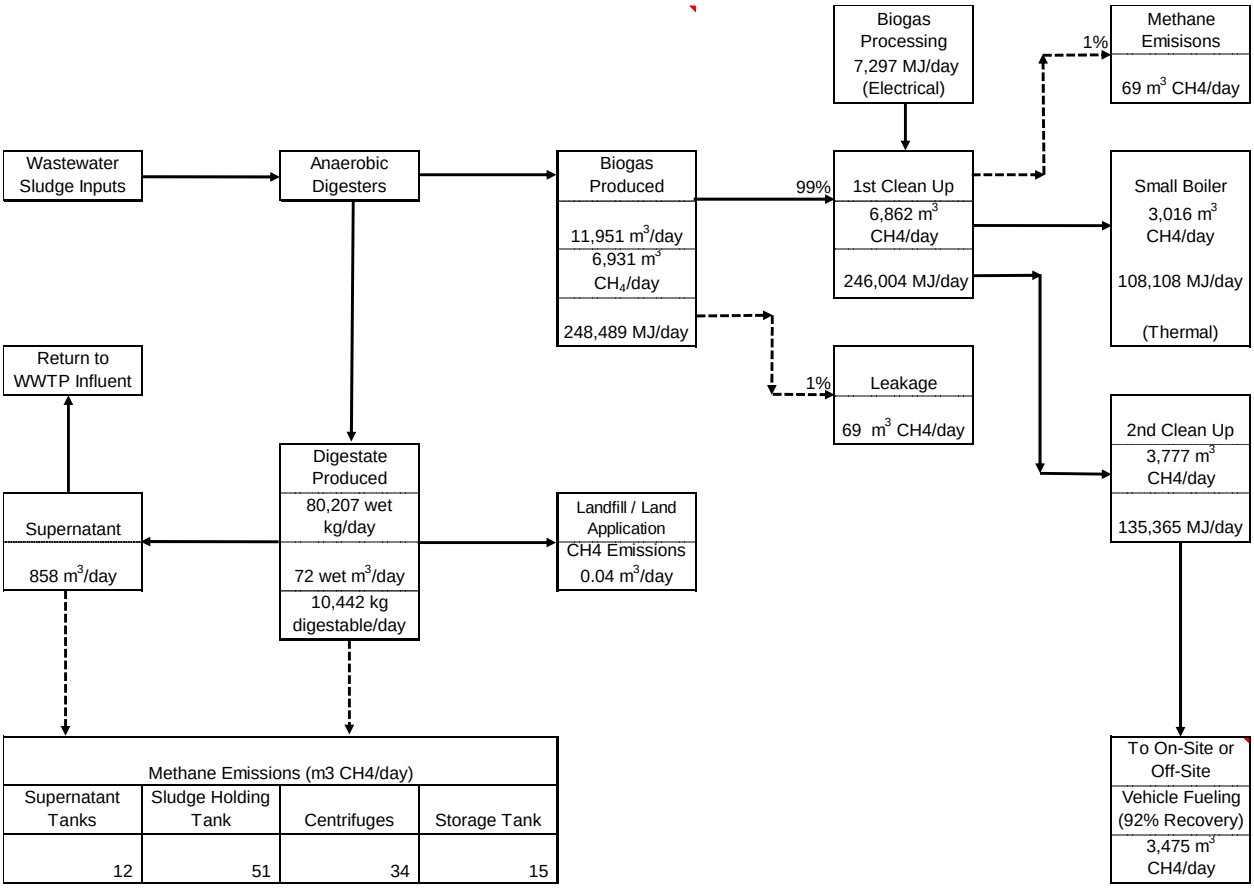
The system boundary for the Alternative Case for a Small-to-Medium POTW (Alternative Case 1) is depicted in Figure III-2 below:

Figure III-2
Schematic of the Alternative Case for a Small-to-Medium POTW with System Boundary



A schematic of the material and energy flows within the system boundary established for the Alternative Case for a Small-to-Medium POTW (Alternative Case 1) is presented in Figure III-3 below:

Figure III-3
Material and Energy Balance for a Small-to-Medium POTW (Alternative Case 1)



c. Establishing an Alternative Case for a Medium-to-Large POTW with 21 - 100 MGD Wastewater Inflows (Alternative Case 2)

The Alternative Case for a Medium-to-Large POTW with greater than 20 MGD and up to 100 MGD wastewater inflows (Alternative Case 2) assumes a more complex scenario than the Alternative Case for Small-to-Medium POTWs (Alternative Case 1). The large amount of biogas generated in the digesters presents additional options for use of the biogas, and an allocation between uses is made.

The Alternative Case 2 also assumes that due to regulatory constraints, the production of electricity with non-compliant combustion devices powering generators, or the flaring of the biogas generated in the anaerobic digesters is forbidden. A viable and sustainable use of the biogas under Alternative Case 2 is the production of renewable electrical power from a compliant combustion device such as a natural gas-fired

turbine with generator. The amount of biogas allocated to the production of renewable electrical power is a quantity that recovers enough heat from the combustion exhaust to meet the thermal energy demand of the digesters. The remaining quantity of biogas is then allocated to the production of transportation fuel. This use constitutes Alternative Case 2.

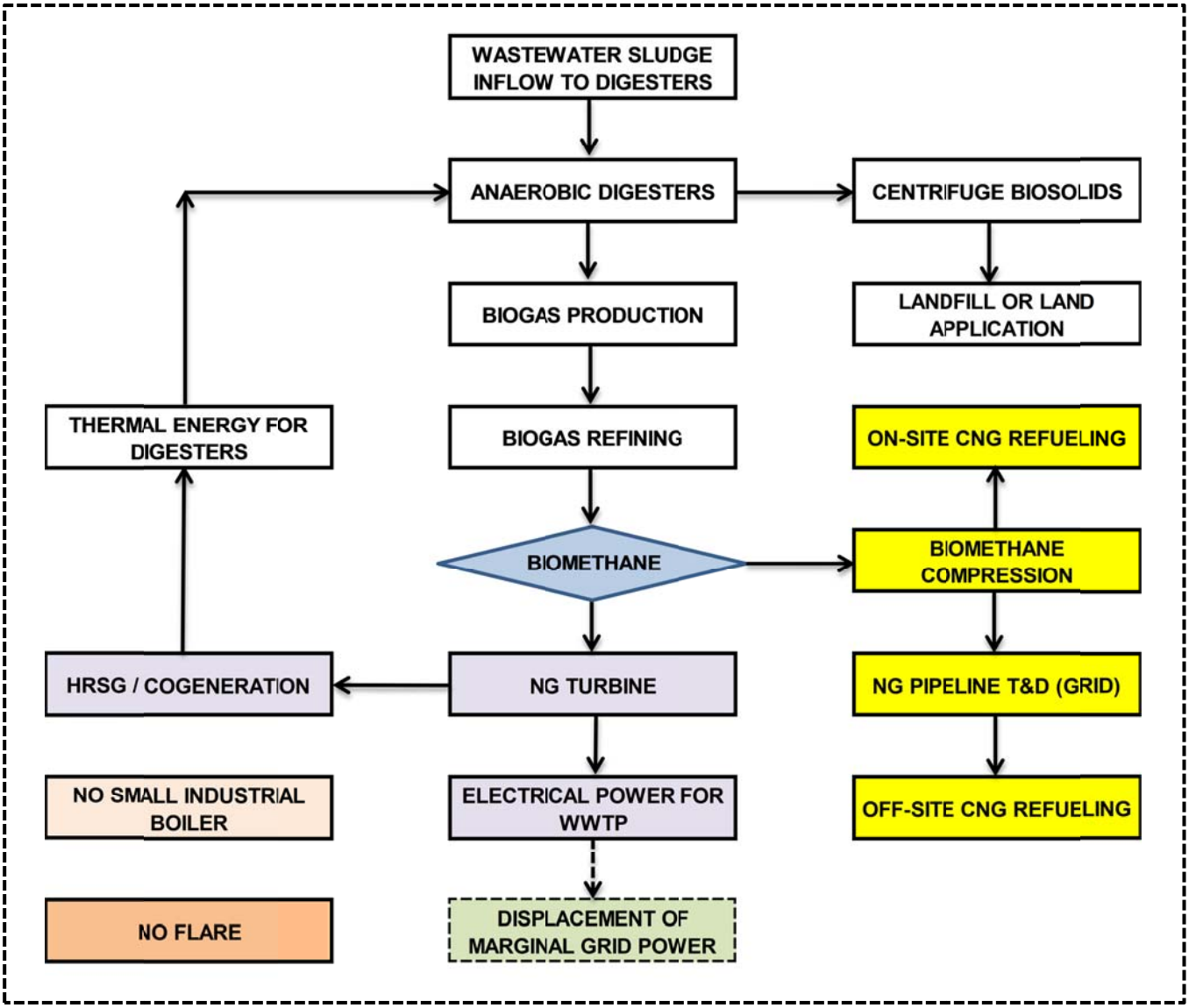
Biogas production processes are assumed to be identical to the Reference Case, except that there is no need for a digester parasitic load as an adequate amount of heat is recovered from the combustion gases that exit the compliant-fuel combustion source. Since the biogas must be conditioned and refined prior to use in a vehicle, the system boundary includes an additional biogas refining unit for biomethane production, product compressors, and either an on-site vehicle fueling station, or a system to directly inject the biomethane into the natural gas grid for purposes of distributing transportation fuel to an off-site vehicle fueling station.

Electrical energy requirements for both the wastewater sludge treatment process operations and the biogas conditioning, refining, and compression are assumed to be provided by the on-site biogas/biomethane-fueled compliant device (for example, a gas-fired turbine) with generator. For the case of establishing the system boundary for Alternative Case 2, the life cycle model also predicts that, based on the quantity of biogas generated in the digesters and the electrical energy requirements of the process units, surplus electrical power produced by the gas-fired device and generator would be available for other wastewater treatment plant operations, or would be available for export to the public grid. Both the WWTP process units and the public electrical grid are external to the system boundary established for the Alternative Case for Medium-to-Large POTWs. Therefore, the Alternative Case 2 accrues an LCFS credit for displacing grid-based electrical generation. This credit manifests itself by lowering the total WTT GHG emissions impacts from energy use by the wastewater sludge-to-biomethane production processes.

In addition, the Alternative Case 2 also accrues a credit for avoiding flaring emissions that occur in the Reference Case. This credit manifests itself by lowering the total GHG emissions impacts from energy use by the wastewater sludge-to-biomethane production processes.

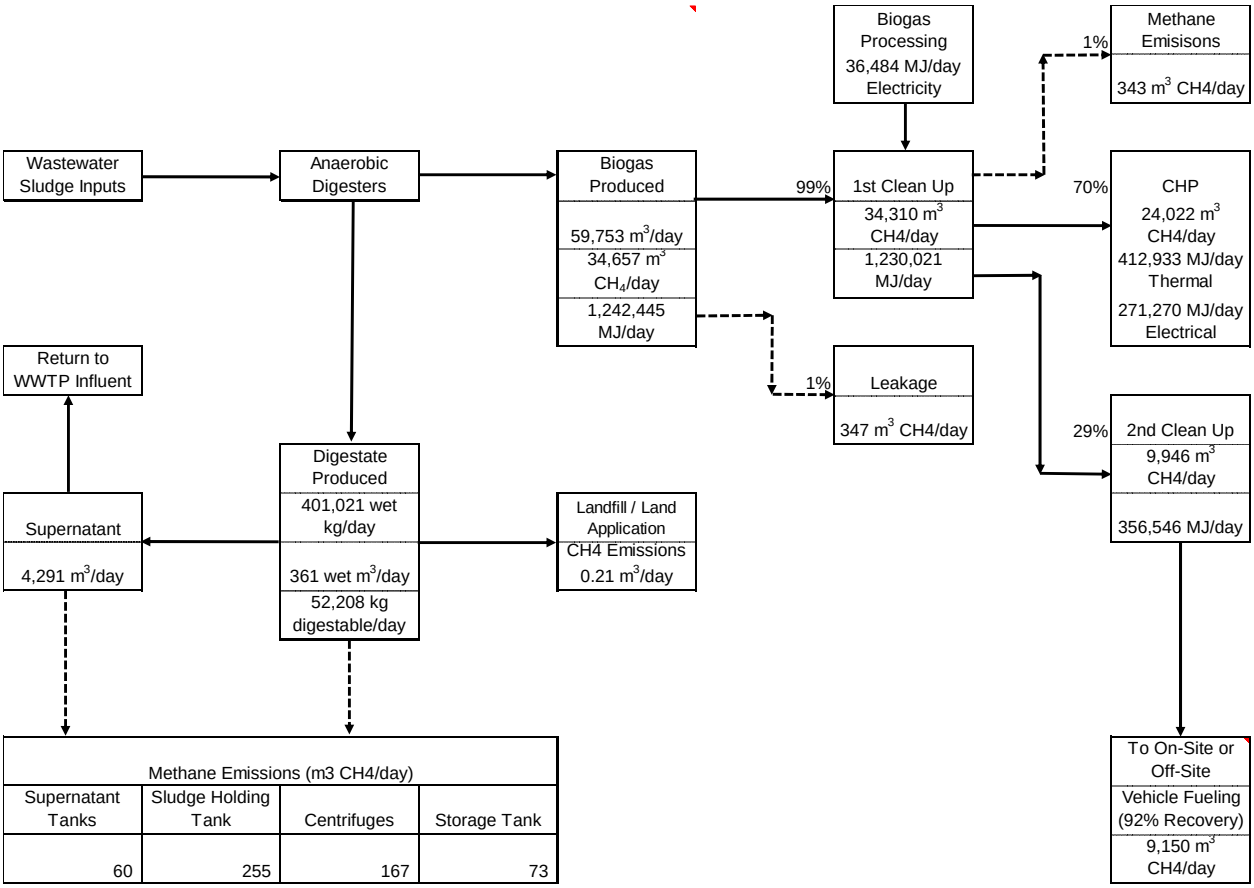
A schematic of the system boundary for the Alternative Case for a Medium-to-Large POTW (Alternative Case 2) is depicted in Figure III-4 below:

Figure III-4
Schematic of the Alternative Case for a Medium-to-Large POTW with System Boundary



A schematic of the material and energy flows across and within the system boundary established for the Alternative Case for Medium-to-Large POTWs (Alternative Case 2) is presented in Figure III-5 below:

Figure III-5
Material and Energy Balance for a Medium-to-Large POTW
(Alternative Case 2)



Staff notes that the material throughput, biogas production, and point source and fugitive (leakage) methane emissions rates depicted above were obtained from the GREET1 Model for the Alternative Case for a Medium-to-Large POTW with greater than 20 MGD and up to 100 MGD wastewater inflows. The second stage biogas refining efficiency (92 percent) is the estimated typical capture efficiency for a biogas refining unit employing pressure swing adsorption (PSA) technology (ARB, 2012).

IV. Feedstock and Process Characterization

The wastewater sludge that is generated from the primary and secondary treatment processes at the POTW is the only feedstock for biomethane production. As discussed previously, the system boundary for the proposed pathway is established where the wastewater sludge enters the anaerobic digesters. The question that arises is whether all municipal wastewater sludges used as feedstock for the production of biomethane can be considered to be equal in physical and chemical aspects.

Staff understands that the physical and chemical properties of municipal wastewater sludge are more or less identical across treatment plants. However, their characteristics may be influenced by factors such as process design, or co-digestion of energy-rich wastes such as pre-consumer industrial food wastes, fats, oils, and greases (FOGs), and other high-strength wastes. Staff will therefore attempt to characterize the wastewater sludge in terms of some commonly measured parameters. These characteristics were obtained from the GREET1 Model[4] for test cases of 20 MGD and 100 MGD municipal wastewater inflows, and up to 2-stage mesophilic anaerobic digestion of wastewater sludge. For the purposes of this pathway, co-digestion of the wastewater sludge with food wastes was not assumed to be occurring. The material and energy balances presented in Section III of this report, therefore, reflect the physical and chemical characteristics defined in Table IV-1 below.

Although the pathways developed in this document assume that the dewatered digestate (biosolids) are disposed off or used as an alternative daily cover in a landfill, proactive use of the digestate can earn a co-product credit as a fertilizer or soil amendment. These uses are not assumed in this document because most POTWs do not currently manage their biosolids for these applications. Concerns about the pathogen content in the biosolids have generally prevented their application on soils where food crops are cultivated. However, POTWs that do manage their biosolids as a fertilizer or soil amendment are however invited to apply under the LCFS Method 2 application process for a pathway in which the application of biosolids earns a GHG credit for displacing synthetically produced fertilizers. This credit is normally calculated on the basis of nutritional content of the biosolids relative to the synthetically produced fertilizer. The biosolids are assumed to displace an amount of fertilizer having equivalent available nitrogen, phosphorous, and potassium content. In such cases, the displacement effect is assumed to accrue a credit in the proposed pathway by lowering the GHG impacts from producing synthetically fertilizer. The GREET1 Model can value the GHG impacts offset from this displacement effect.

[4] ANL, 2012. Greenhouse Gases, Regulated Emissions, and Emissions in Transportation (GREET1 Model), Argonne National Laboratory, Revision 2, December 2012.

Table IV-1
Wastewater Sludge Feedstock and Digestion Characteristics

Anaerobic Digester Characteristics	**Units**	**Small-to-Medium POTW (20 MGD)**	**Medium-to-Large POTW (100 MGD)**
Total Sludge Entered to Digester	(kg/day)	37,220.83	186,100.00
Volatile Solid Loading Rate	(kg VS/day)	23,720.00	118,600.00
Volatile Solid Reduction	(VSR, %)	0.56	0.56
Biogas Production Rates	(m^3 biogas / kg VS destroyed)	0.90	0.90
Methane Share in Biogas	(% vol.)	0.58	0.58
Daily Biogas Production Rate	(m^3/day)	11,950.61	59,753.05
Total Electrical Energy Requirement	(MJ/day)	8,709.00	43,546.00
Total Thermal Energy Requirement	(MJ/day)	86,486.00	412,933.00
Digestate Characteristics	**Units**	**Small-to-Medium POTW (20 MGD)**	**Medium-to-Large POTW (100 MGD)**
Inert Solids Inputs	(m^3/day)	13,500.83	67,500.00
Solids in the Digestate	(kg/day)	23,942.38	119,707.72
Digestible Solid in Digestate	(kg/day)	10,441.54	52,207.72
Required Polymer for Dewatering	(kg/day)	119.71	598.54
Centrifuge Energy Demand	(MJ/day)	8,739.93	43,698.11
Total Dry Biosolids to be Disposed	(kg/day)	24,062.09	120,306.26
Total Volume of Generated Sludge	(m^3/day)	72.19	360.92
Digestate Fate		Landfill or Land Application	Landfill or Land Application
Amount of N in Digestate Disposed*	(kg/day)	-	-
Amount of P in Digestate Disposed*	(kg/day)	-	-
Amount of K in Digestate Disposed*	(kg/day)	-	-
Digestate Transportation Distance	(miles)	40.00	40.00
Supernatant Characteristics	**Units**	**Small-to-Medium POTW (20 MGD)**	**Medium-to-Large POTW (100 MGD)**
Solids Generation Rate	(m^3/day)	930.46	4,652.30
Supernatant Flow Rate	(m^3/day)	858.27	4,291.38

*Staff assumes that the digestate is only being land-filled or used as Alternative Daily Cover.

When operated under the conditions specified in this pathway, biogas yields from the mesophilic anaerobic digestion of municipal wastewater sludge should be fairly consistent across POTWs.

Other factors that can influence the biogas yield rates include, for example, co-digestion of food and FOG wastes, as well as digester operation under thermophillic operating conditions. This pathway however, does not consider the impacts of co-digestion or higher temperature digestion. Staff expects that co-digestion of food and FOG wastes with wastewater sludge would only have the impact of increasing the biogas yields and correspondingly lowering the proposed CI for the pathway. And while thermophillic digestion can dramatically increase biogas yield rates, the energy requirements to operate the digesters under thermophillic operating conditions can also be significantly higher.

Table IV-2 below presents some characteristics of the fugitive biogas and biomethane emissions from wastewater sludge digestion.

Table IV-2
Biogas and Biomethane Emissions Rates

Biomethane Emission Rates	Units	Small-to-Medium POTW (20 MGD)	Medium-to-Large POTW (100 MGD)
From Digester due to Leaks and Maintenance	(m^3 CH_4/m^3 Total Biogas Production)	0.0100	0.0100
From Digested Sludge Holding Tank:	-	-	-
- Holding Duration: 5 days	(m^3 CH_4/m^3 Net Biogas Production after Leakage)	0.0328	0.0328
- Holding Duration: 1 day	(m^3 CH_4/kg digestible solid in digestate)	0.0049	0.0049
From Operation of Centrifuges	(m^3 CH_4/m^3 Net Biogas Production after Leakage)	0.0082	0.0082
From Dewatered Biosolids Storage Tank	-	-	-
- Storage Duration: 10 days	(m^3 CH_4/m^3 Net Biogas Production after Leakage)	0.0164	0.0164
- Storage Duration: 1 day	(m^3 CH_4/kg digestible solid in digestate)	0.0014	0.0014
From Soil Applied Biosolids	(m^3 CH_4/m^3 digestate disposed)	0.0129	0.0129
From Landfilled Biosolids	(m^3 CH_4/m^3 digestate disposed)	0.0006	0.0006
From Supernatant	(m^3 CH_4/m^3 Supernatant)	0.0139	0.0139

V. Life Cycle Analysis of Energy Consumption and GHG Emissions Impacts

The wastewater sludge that is sent to the anaerobic digesters is generated from primary and secondary treatment processes at the wastewater treatment plant (WWTP). This sludge consists of volatile and other inert solids which must be decomposed before the plant can discharge the solid material and effluent. WWTPs provide heat energy to large anaerobic digestion vessels to break down the solids in the wastewater sludge.

Digestion of the wastewater sludge requires anaerobes or microbes that feed on the organic matter in the absence of oxygen, and thermal (heat) energy. The amount of heat supplied to the tanks dictates whether the digestion occurs under mesophilic (~ 35 deg C) or thermophillic (~ 55 deg C) conditions. Most POTWs in California[5] practice mesophilic anaerobic digestion. The anaerobic digestion process is also a function of the amount of time the wastewater sludge has spent in the digesters. The time spent in the digesters is called the "residence time," and it may last from 14-21 days. The by-product of the anaerobic digestion process is called biogas, a mixture of approximately 60 percent methane, and 40 percent carbon dioxide, along with some other impurities. In addition to the biogas, the wastewater sludge digestion process produces a digestate which is sent through centrifuges for dewatering. The dewatered biosolids are then typically sent off-site for land application, land-filling, or used as alternative daily cover (ADC). If the biosolids are completely free of pathogens and found to be rich in inorganic nutrients, they may be used as a soil amendment or crop fertilizer. Lastly, the biogas that accumulates in the digester header space is collected and processed to remove impurities, and then either used as fuel, or to provide process energy, or flared to reduce the GHG impacts the biogas may have on the environment. The biogas may also be further refined to remove the carbon dioxide, yielding near pure (99 percent) biomethane, which could be marketed as a transportation fuel.

In this section, staff will address the life cycle energy requirements for the production of biomethane from the mesophilic anaerobic digestion of wastewater sludge in a low solids (wet fermentation) process, as well as determine the life cycle GHG impacts for the proposed biomethane pathway. The GHG impacts are assessed based on the electrical and thermal energy demands of the individual operational processes which include anaerobic digestion, digestate management, supernatant management, first-stage biogas refining, and second-stage biogas refining along with biomethane compression, and on-site vehicle fueling. The wastewater sludge-to-biomethane pathway has been developed for two scenarios:

[5] See Appendix A, results of the California POTW Survey conducted by the California Association of Sanitation Agencies (CASA).

Small-to-Medium POTWs with wastewater inflows of 5-20 MGD and referred to as Alternative Case 1, and Medium-to-Large POTWs with wastewater inflows of 21-100 MGD and referred to as Alternative Case 2. Both scenarios assume that up to a two-stage mesophilic anaerobic digestion process will dictate the production of biogas in the digesters.

In the case of the small-to-medium POTW, it is assumed that a fraction of the biogas is expected to be consumed by the boilers for process thermal needs and to provide thermal energy for the digesters to operate under mesophilic operating conditions. The majority of the biogas produced would be allocated to the production of biomethane for transportation use purposes. Called the Alternative Scenario 1, this model also assumes that grid-based electrical power will be obtained for the electrical energy needs of the WWTP.

In the case of the Medium-to-Large POTWs, it is assumed that a majority of the biogas produced would be cleaned and conditioned for use in compliant combustion devices, such as gas-fired turbines with generators, to produce renewable power. Since such devices emit exhaust with high heat potential (in excess of 1,000 degrees F), a heat recovery steam generator (or heat exchanger with a steam boiler) would be used to recover the heat from the exhaust and produce steam to meet the thermal energy demands of the digesters. The remainder of the biomethane is then assumed to be allocated to transportation applications (such as on-site compressed natural gas or CNG vehicle fueling, or injection into the natural gas grid for off-site CNG vehicle fueling). Called the Alternative Scenario 2, this model does not depend upon external grid-based electrical power to operate the treatment processes at the WWTP since power is produced internally by the compliant combustion device and generator. Any electrical power produced and not consumed by the process units of the wastewater sludge digestion process is considered to be surplus electrical energy, which may be exported to the public grid, or may be considered to be displacing an equivalent amount of grid-based electrical generation.

An analysis of the process energy (electrical and thermal) requirements and life cycle GHG emissions impacts of each operational unit of the biomethane production cycle is presented below:

a. Mesophilic Anaerobic Digestion

Anaerobic digesters operating under mesophilic conditions require thermal energy and electrical energy inputs.

For Small-to-Medium POTWs with 5-20 MGD of wastewater inflows, Alternative Case 1 assumes that the digester thermal energy demand is met by a parasitic load on the biogas generated in the digesters. This biogas is consumed in a small industrial boiler that produces steam used

to bring the digesters into the mesophilic temperature range.
The GREET1 Model predicts that 86,486 MJ per day of thermal energy will be required for 2-stage mesophilic anaerobic digestion of wastewater sludge. Assuming a steam generation efficiency of 80 percent, the net thermal energy demand is estimated to be 108,108 MJ per day. The GHG emissions impacts from biogas combustion in a small, industrial boiler (10 – 100 mmBtu/hr) are presented in Table V-1 below:

Table V-1
GHG Emissions from Thermal Energy Demand for Anaerobic Digestion Small-to-Medium POTW (Alternative Case 1)

Pollutant	Emissions Factors for Small Industrial Boiler ** (g/mmBtu)	GHG Emissions Impacts for Alternative Case 1 (g/day)
VOC	2.42	247.66
CO	28.82	2,953.27
CH_4	1.10	112.71
N_2O	0.31	32.28
CO_2	58,176	5,961,000.00
CO_{2*}	41,848	4,288,014.00

* An adjustment to the CO_2 emissions is necessary since biogas (58 percent methane), rather than natural gas is assumed to be combusted in the boiler.
** See Spreadsheet "ca_greet1.8b_dec09.xls," Worksheet "EF," (10-100 mmBtu/hr Input).

Example Calculation for Estimating Methane Emissions

Thermal Demand for Anaerobic Digestion $= \frac{108{,}108\ MJ}{day}$

Methane Emissions Factor for Small Boiler $= \frac{1.10\ g\ CH_4}{mmBtu}$

Therefore, Methane Emissions $= \frac{108{,}108\ MJ}{day} \times \frac{1\ Btu}{1055.06\ J} \times \frac{1.10\ g\ CH_4}{mmBtu}$

Methane Emissions $= \frac{112.71\ g\ CH_4}{day}$

For medium-to-large POTWs with 21-100 MGD of wastewater inflows, Alternative Case 2 assumes that the digester thermal energy demand is met by the heat recovery operations from the exhaust of the gas-fired combustion device. The GREET1 Model predicts that 412,933 MJ per day of thermal energy will be required for 2-stage mesophilic anaerobic digestion of wastewater sludge. The recovered heat then producers more

steam for the purpose of providing heat energy to the digesters. Therefore, in Alternative Case 2, no additional natural gas or biogas is required to provide the thermal energy needed to bring the digesters into the mesophilic temperature range. Since no additional combustion is needed to heat the digesters, the GHG emissions from this operation are assumed to be zero.

Similarly, the GREET1 Model estimates that for Alternative Case 1, 8,709 MJ of electrical energy per day is required for the mesophilic anaerobic digestion process. This represents 27.5 percent of the total electrical demand for the wastewater sludge-to-biomethane pathway. As illustrated in the schematic for Alternative Case 1 (Figure IV-2), the electrical energy is assumed to be provided by the grid. Staff assumes that the applicable regional portfolio of electrical generating assets is the California-Marginal (CA-Marginal) mix. The GHG emissions impacts for fuel-cycle energy use and emissions of electric generation is presented in Table V-2 below:

Table V-2
GHG Emissions from Electrical Energy Demand for Anaerobic Digestion Small-to-Medium POTW (Alternative Case 1)

Pollutant	Feedstock* (g/mmBtu)	Fuel* (g/mmBtu)	Sum (g/mmBtu)	GHG Emissions Impacts of Electrical Energy Demand** (g/day)
VOC	10.19	5.67	15.86	130.94
CO	18.44	39.68	58.12	479.73
CH_4	212.37	7.04	219.42	1,811.18
N_2O	0.10	2.48	2.58	21.33
CO_2	8,276.83	96,249.68	104,526.51	862,814.77

*See Spreadsheet "ca_greet1.80b_dec09.xls," Worksheet "Electric," Feedstock and Fuel factors for stationary applications (Fuel-Cycle Energy Use and Emissions of Electric Generation: Btu or Grams per mmBtu of Electricity Available at User Sites (wall outlets)).

Example Calculation for Estimating VOC Emissions

Electrical Energy Demand for Anaerobic Digestion $= \frac{8{,}709\ MJ}{day}$

VOC Emissions Factor for Grid Power $= \frac{15.86\ g\ VOC}{mmBtu}$ *(Fuel Cycle Emissions)*

Therefore, VOC Emissions $= \frac{8{,}709\ MJ}{day} \times \frac{1\ Btu}{1055.06\ J} \times \frac{15.86\ g\ VOC}{mmBtu}$

VOC Emissions $= \frac{130.94\ g\ VOC}{day}$

For medium-to-large POTWs with inflows of 21-100 MGD, the GREET1 Model estimates that for Alternative Case 2, 43,546 MJ of electrical energy per day is required for the mesophilic anaerobic digestion process. This quantity represents approximately 30.7 percent of the total electrical demand for the wastewater sludge-to-biomethane pathway. The electrical energy demand is met by a high-efficiency on-site gas-fired turbine (simple or combined cycle) with generator. The GHG emissions impact of fuel combustion for stationary applications (grams per mmBtu of fuel burned) is presented in Table V-3 below:

Table V-3
GHG Emissions from Electrical Energy Demand for Anaerobic Digestion
Medium-to-Large POTW (Alternative Case 2)

Pollutant	Simple Cycle or Combined Cycle Gas Turbine (g/mmBtu of fuel input)*	GHG Emissions Impact of Electrical Energy Demand (g/day)
VOC	3.43	141.53
CO	24.00	990.56
CH_4	4.26	175.83
N_2O	1.50	61.91
CO_2	58,171	2,400,931.34

* See Spreadsheet "ca_greet1.80b_dec09.xls,", Worksheet "EF" (Emission Factors of Fuel Combustion for Stationary Applications (grams per mmBtu of fuel burned)).

Example Calculation for Estimating CO Emissions

Electrical Energy Demand for Anaerobic Digestion $= \frac{43{,}546\ MJ}{day}$

CO Emissions Factor for SC / CC Gas Turbine $= \frac{24.00\ g\ CO}{mmBtu}$ *(Fuel Combustion for Stationary Applications)*

Therefore, CO Emissions $= \frac{43{,}546\ MJ}{day} \times \frac{1\ Btu}{1055.06\ J} \times \frac{24.00\ g\ CO}{mmBtu}$

CO Emissions $= \frac{990.56\ g\ CO}{day}$

In addition to the GHG emissions impacts that arise from the thermal and electrical energy demand for the mesophilic anaerobic digestion process, the GREET1 Model additionally estimates fugitive methane losses from the digesters to be approximately one percent.

For Alternative Cases 1 and 2, a one percent fugitive methane loss equates to 69 and 347 m^3 per day, respectively. These losses are added to the overall GHG emissions impacts for determining the total well-to-tank (WTT) emissions.

b. Digestate Management

Once the minimum residence time for the batch of wastewater sludge in the digesters has been achieved and the biogas collected, the remaining residue (called digestate) is transported to the centrifuges for dewatering. Electrical energy is consumed by the pumps used to transport the digestate from the digesters to the centrifuges, as well as by the centrifuges themselves. This process produces dewatered biosolids. The transport of the dewatered biosolids to an off-site land application site or landfill consumes fossil fuel energy.

The GHG emissions impact of both electrical energy and fossil fuel consumption for digestate management activities is presented in Tables V-4 and V-5 below. The GREET1 Model estimates that, for Alternative Case 1, 8,740 MJ of electrical energy per day is required to transport and dewater the digestate. This quantity represents approximately 27.6 percent of the total electrical energy demand of the wastewater sludge–to-biomethane pathway. As illustrated in the schematic for Alternative Case 1 (Figure IV-2), the electrical energy is assumed to be provided by the grid. Staff assumes that the applicable regional portfolio of electrical generating assets is the CA-Marginal mix. The GHG emissions impacts for fuel-cycle energy use and emissions from electric generation is presented in Table V-4 below:

Table V-4
GHG Emissions from Electrical Energy Demand for Digestate Management (Small-to-Medium POTW)

Pollutant	Feedstock* (g/mmBtu)	Fuel* (g/mmBtu)	Sum (g/mmBtu)	GHG Emissions Impacts of Electrical Energy Demand (g/day)
VOC	10.19	5.67	15.86	131.41
CO	18.44	39.68	58.12	481.43
CH_4	212.37	7.04	219.42	1,817.61
N_2O	0.10	2.48	2.58	21.41
CO_2	8,276.83	96,249.68	104,526.51	865,878.60

*See Spreadsheet "ca_greet1.80b_dec09.xls," Worksheet "Electric," Feedstock and Fuel factors for stationary applications (Fuel-Cycle Energy Use and Emissions of Electric Generation: Btu or Grams per mmBtu of Electricity Available at User Sites (wall outlets)).

For medium-to-large POTWs with wastewater inflows of 21-100 MGD, the GREET1 Model estimates that for Alternative Case 2, 43,698 MJ of electrical energy per day is required for digestate transport and dewatering operations. This quantity represents approximately 30.8 percent of the total electrical energy demand for the wastewater sludge-to-biomethane

pathway. This electrical energy demand is met by a high-efficiency on-site gas-fired turbine (simple or combined cycle) with generator. The GHG emissions impact of fuel combustion for stationary applications (grams per mmBtu of fuel burned) is presented in Table V-5 below:

Table V-5
GHG Emissions from Electrical Energy Demand for Digestate Management (Medium-to-Large POTW)

Pollutant	Simple Cycle or Combined Cycle Gas Turbine (g/mmBtu of fuel input)*	GHG Emissions Impact (g/day)
VOC	3.43	142.02
CO	24.00	994.02
CH_4	4.26	176.44
N_2O	1.50	62.13
CO_2	58,171.00	2,409,317.79

* See Spreadsheet "ca_greet1.80b_dec09.xls," Worksheet "EF" (Emission Factors of Fuel Combustion for Stationary Applications (grams per mmBtu of fuel burned)).

The GREET1 Model predicts that the total amount of dry biosolids produced in the digestate dewatering stage will be 24,062 kilograms per day by the small-to-medium POTW (Alternative Case 1), and 120,306 kilogram per day by the medium-to-large POTW (Alternative Case 2). Staff assumes that the dewatered biosolids would be transported to a land application site or landfill 40 miles away from the small-to-medium POTW using a medium heavy-duty diesel truck (MHDDT) that travels 7.3 miles per gallon of fuel, and has a cargo payload of 8 short tons. For the medium-to-large POTW case, dewatered biosolids are assumed to be transported 40 miles using a heavy heavy-duty diesel truck (HHDDT) that travels 5 miles per gallon of fuel, and has a cargo payload of 23 short tons.

Staff estimates that 4.63 mmBtu per day and 12.02 mmBtu per day of ultra-low sulfur diesel will be consumed by the MHDDT and the HHDDT at the small-to-medium POTW and the medium-to-large POTW, respectively.

Example Calculation for Estimating ULSD Fuel Use for Biosolids (Dewatered Digestate) Transport

	Small-to-Medium POTW	***Medium-to-Large POTW***
Total Dry Biosolids to be Disposed (kg / day) (A1)	*24,062.09*	*120,306.26*
Total Dry Biosolids to be Disposed (tons / day) (A2)	*26.53*	*132.64*
Vehicle Cargo Carrying Capacity (tons) (B)	*8*	*22.5*
Number of Truck Trips Per Day (C = A1 or A2 / B)	*3.32*	*5.90*
Distance to Landfill or Land Application Site (miles) (D)	*40*	*40*
Total Distance Covered with Back-Haul (miles) (E = C x 2 x D)	*265.28*	*471.60*
Vehicle Fuel Economy (miles per gallon) (F)	*7.3*	*5*
Total ULSD Fuel Consumed (gallons) (G)	*36.34*	*94.32*
ULSD Lower Heat Value (LHV) (Btu / gallon) (H)	*127,464*	*127,464*
ULSD Energy Consumption (mmBtu / day) (I = G x H)	***4.63***	***12.02***

A summary of GHG emissions impacts from the production and use of ultra-low-sulfur diesel (ULSD) fuel in California is presented in Table V-6 below. These emissions represent the well-to-tank (WTT), or fuel-cycle GHG emissions associated with the production and transport of ULSD from petroleum crude for use in California. In addition to fuel cycle emissions, actual GHG emissions that ensue from transport of materials (dewatered digestate to landfill) must also be estimated. Together, the fuel cycle emissions and the GHG emissions from actual fuel use for transport operations represent the total GHG emissions impacts from diesel fuel use in California.

Table V-6
GHG Emissions from ULSD Fuel Use in California
(Fuel Cycle Emissions)*

	Feedstock	Fuel		Alternative Case 1	Alternative Case 2
	Crude for Use in CA Refineries (g/mmBtu)	Ultra Low Sulfur Diesel (g/mmBtu)	Total Well-to-Tank (WTT) Emissions** (g/mmBtu)	Small-to-Medium POTW WTT Emissions (g/day)	Medium-to-Large POTW WTT Emissions (g/day)
Loss Factor		1.0000441			
VOC	5.43	4.37	9.80	**45.38**	**117.79**
CO	19.71	7.16	26.88	**124.51**	**323.15**
CH_4	90.34	10.94	101.29	**469.16**	**1,217.70**
N_2O	0.11	0.11	0.23	**1.05**	**2.73**
CO_2	6,743.50	12,175.11	18,918.91	**87,634.00**	**227,451.00**

*Summary of Energy Consumption and Emissions: Btu or Grams per mmBtu of Fuel Throughput at Each Stage.

**Total Well-to-Tank Emissions = (Feedstock Factor) x (Loss Factor) + (Fuel Factor)

Example Calculation for Estimating ULSD Fuel Use Fuel Cycle CH_4 Emissions

Total Well-to-Tank (WTT) Emissions = *(Feedstock Factor) x (Loss Factor) + (Fuel Factor)*

Total Well-to-Tank (WTT) CH_4 Emissions = $\frac{90.34 \text{ g } CH_4}{\text{mmBtu}}$ x 1.0000441 (Loss Factor) + $\frac{10.94 \text{ g } CH_4}{\text{mmBtu}}$

Total Well-to-Tank (WTT) CH_4 Emissions = $\frac{101.29 \text{ g } CH_4}{\text{mmBtu}}$

ULSD Fuel Consumed - Medium HDDT = $\frac{4.63 \text{ mmBtu}}{\text{day}}$

Therefore, ULSD Fuel Use in California
(Fuel Cycle CH_4 Emissions)
(Small-to-Medium POTW) = $\frac{101.29 \text{ g } CH_4}{\text{mmBtu}}$ x $\frac{4.63 \text{ mmBtu}}{\text{day}}$

ULSD Fuel Use Fuel Cycle CH_4 Emissions
(Small-to-Medium POTW) = $\frac{469.16 \text{ g } CH_4}{\text{day}}$

Similarly,

ULSD Fuel Consumed - Heavy HDDT $= \frac{12.02\ mmBtu}{day}$

Therefore, ULSD Fuel Use in California
(Fuel Cycle CH_4 Emissions)
(Medium-to-Large POTW) $= \frac{101.29\ g\ CH_4}{mmBtu} \times \frac{12.02\ mmBtu}{day}$

ULSD Fuel Use Fuel Cycle CH_4 Emissions
(Medium-to-Large POTW) $= \frac{1{,}217.70\ g\ CH_4}{day}$

GHG emissions also arise from the actual combustion of ULSD in medium-heavy duty (small-to-medium POTWs), and heavy-heavy duty (medium-to-large POTWs) diesel-fueled vehicles when the dewatered biosolids are transported to a land application site or landfill. A transport distance of 40 miles is assumed (one-way). To simulate the GHG impacts of transporting the material, staff assumed that the physical properties of the dewatered digestate (dry biosolids) would be similar to transporting calcium carbonate ($CaCO_3$), a compound for which the energy consumption and emissions of feedstock and fuel transport is known in CA-GREET.

Table V-7
GHG Emissions from Distribution of Biosolids
(Dewatered Digestate)

	Material Transport	**Alternative Case 1**	**Alternative Case 2**
Pollutant	**Total Emissions (g/mmBtu)**	**Small-to-Medium POTW TTW Emissions (g/day)**	**Medium-to-Large POTW TTW Emissions (g/day)**
VOC	3.61	**16.71**	**43.36**
CO	16.33	**75.65**	**196.35**
CH_4	10.46	**48.43**	**125.70**
N_2O	0.21	**0.97**	**2.52**
CO_2	8,508.17	**39,410.56**	**102,288.74**

Example Calculation for Estimating ULSD Fuel N_2O Emissions from Biosolids Transport

	Small-to-Medium POTW	*Medium-to-Large POTW*
ULSD Energy Consumption (mmBtu / day) (A)	4.63	12.02
N_2O Emissions Factor (g / mmBtu) (B) (Staff assumes that dry Biosolids transport by truck can be simulated with $CaCO_3$ Transport)	0.21	0.21
Therefore, N_2O Emissions (g / day) (C = A x B)	**0.97**	**2.52**

The total impact of GHG emissions from dewatered digestate (biosolids) transport from the POTW to the land application site or landfill is the sum of the well-to-tank emissions (Table V-6) and the tank-to-wheels emissions (Table V-7). A summary of the total GHG emissions impact from transport and distribution of biosolids is presented in Table V-8 below:

Table V-8
Total GHG Emissions from ULSD Fuel Use

	Alternative Case 1	**Alternative Case 2**
Pollutant	**Small-to-Medium POTW WTW Emissions (g/day)**	**Medium-to-Large POTW WTW Emissions (g/day)**
VOC	62.09	161.15
CO	200.16	519.50
CH_4	517.60	1,343.40
N_2O	2.02	5.25
CO_2	127,044.56	329,739.73

In addition to the GHG emissions impacts that arise from digestate management, the GREET1 Model estimates fugitive methane losses from the digestate management system, which includes the sludge holding tanks, centrifuges, and the storage tanks. For Alternative Cases 1 and 2, fugitive methane losses are estimated to be 99 m^3 and 395 m^3 per day, respectively. These losses are added to the overall GHG emissions impacts for determining total well-to-tank (WTT) emissions for wastewater sludge-to-biomethane pathways.

c. Supernatant Management

Once the digestate has been dewatered, the biosolids that remain in the centrifuge are transported to a land application site or landfill. The fluid that is separated from the biosolids is called the supernatant. This fluid is returned to the wastewater treatment plant influent as a recycle stream. The electrical energy demand for returning the supernatant fluid to the influent channels is assumed to be insignificant.

The GHG emissions impacts of supernatant return to wastewater influent channels, however, are not zero. The GREET1 Model estimates that, supernatant storage tanks and return lines will emit an additional 12 m^3 and 60 m^3 CH_4 per day, for Small-to-Medium POTWs and Medium-to-Large POTWs (Alternative Cases 1 and 2), respectively. These losses are added to the overall GHG emissions impacts for determining total well-to-tank (WTT) emissions for the biomethane pathway.

d. Stage 1 Biogas Refining Process

Once the biogas is generated in the anaerobic digesters by the decomposition of the wastewater sludge under mesophilic operating conditions, it collects in the digester header space. The GREET1 Model suggests that the composition of the biogas is estimated to be approximately 58 percent methane (by volume), with the balance consisting of carbon dioxide and impurities. Blowers are employed to send the biogas in the digester header space to the stage-1 biogas refining unit, where impurities such as siloxanes, vinyl chloride, hydrogen sulfide, and moisture are removed so that efficient combustion of the biogas in an engine or turbine is possible. Removal of the impurities also minimizes buildup on engine parts and turbine blades.

Stage-1 biogas refining is assumed to consume only electrical energy. The GREET1 Model specifies that Small-to-Medium POTWS (Alternative Case 1) consume 7,297 MJ of electrical energy per day. This represents 23.1 percent of the total wastewater sludge-to-biomethane pathway electrical energy demand. The energy is assumed to be supplied by grid-based electrical power. The applicable regional portfolio of electrical generating assets is the California Marginal mix. The GHG emissions impacts for fuel-cycle energy use and emissions from electric generation are presented in Table V-9 below:

Table V-9
GHG Emissions from Electrical Energy Demand for Stage-1 Biogas Refining (Small-to-Medium POTW)

Pollutant	Feedstock* (g/mmBtu)	Fuel* (g/mmBtu)	Sum (g/mmBtu)	GHG Emissions Impacts of Electrical Demand (g/day)
VOC	10.19	5.67	15.86	**109.71**
CO	18.44	39.68	58.12	**401.93**
CH_4	212.37	7.04	219.42	**1,517.48**
N_2O	0.10	2.48	2.58	**17.87**
CO_2	8,276.83	96,249.68	104,526.51	**722,899.21**

*See Spreadsheet "ca_greet1.80b_dec09.xls," Worksheet "Electric," Feedstock and Fuel factors for stationary applications (Fuel-Cycle Energy Use and Emissions of Electric Generation: Btu or Grams per mmBtu of Electricity Available at User Sites (wall outlets)).

The GREET1 Model also indicates that approximately 69 m^3 CH_4 per day will be emitted from the stage-1 biogas refining process as fugitive methane losses. These losses are added to the overall GHG emissions impacts for determining total well-to-tank (WTT) emissions.

For Alternative Case 2 (Medium-to-Large POTW), the GREET1 Model estimates that 36,484 MJ per day of electrical energy will be required for stage-1 biogas refining. This represents 25.7 percent of the total wastewater sludge-to-biomethane pathway electrical energy demand. The electrical energy is assumed to be supplied by an on-site simple or combined cycle gas-fired turbine with generator running on biogas produced from the on-site digesters.

The GHG emissions impact of fuel combustion in the on-site gas-fired turbine (grams per mmBtu of fuel burned) is presented in Table V-10 below:

Table V-10
GHG Emissions from Electrical Energy Demand for Stage1-1 Biogas Refining (Medium-to-Large POTW)

Pollutant	Simple Cycle or Combined Cycle Gas Turbine (g/mmBtu of fuel input)*	GHG Emissions Impact (g/day)
VOC	3.43	118.57
CO	24.00	829.91
CH_4	4.26	147.31
N_2O	1.50	51.87
CO_2	58,171.00	2,011,545.92

* See Spreadsheet "ca_greet1.80b_dec09.xls," Worksheet "EF." (Emission Factors of Fuel Combustion for Stationary Applications (grams per mmBtu of fuel burned)).

In addition to the GHG emissions impacts that arise from the electrical energy demand for stage-1 biogas refining, the GREET1 Model estimates that this operation will produce approximately 343 m^3 per day in additional methane losses. These losses are added to the overall GHG emissions impacts for determining total well-to-tank (WTT) emissions.

e. Stage-2 Biogas Refining, Compression, and On-Site Vehicle Fueling

The stage-2 biogas refining process primarily includes removal of the carbon dioxide in the biogas to produce near pure biomethane. Several technologies may be employed to achieve this separation. These may include technologies such as pressure swing adsorption (PSA), water scrubbing, chemical scrubbing, or membrane separation. For PSA, methane recovery from the biogas can be near pure biomethane comprised in the product or sales gas (99 percent biomethane), with methane recovery efficiencies in the low to mid-90s.[6]

Electrical compressors are required to compress the biogas before it enters the stage-2 biogas refining process, as well as to compress the product gas (biomethane). Vehicle fueling options may include an on-site low-speed or high-speed biomethane fueling station, or the direct injection of the biomethane into the natural gas distribution grid. For on-site high speed vehicle fueling, compression pressures of up to 3,600 psi may

[6] Staff notes that this does not imply that the unrecovered methane from the biogas refining process is fugitive methane. The unrecovered methane usually exits in the tail gas of the refining process and could be flared, or recycled and mixed with the digester biogas, or could be spent to pre-heat the wastewater sludge.

be required. If injection of biomethane into the natural gas grid is desired, then biomethane compression pressures of 600-800 psi may be required[7]. For simplicity, this analysis assumes that vehicle fueling occurs on-site.

The GREET1 Model estimates that the primary energy input for the stage-2 biogas refining process is electrical energy. For small-to-medium POTWs (Alternative Case 1), the GREET1 Model estimates that 4,061 MJ of electrical energy per day is required for the stage-2 biogas refining process. This represents 12.8 percent of the total electrical demand for the total wastewater sludge-to-biomethane pathway. An additional 2,843 MJ per day of electrical energy is required for on-site biomethane compression and vehicle fueling. This represents nine percent of the total electrical demand for the pathway.

The energy is assumed to be supplied by grid-based electrical power. Staff assumes that the applicable regional portfolio of electrical generating assets is California Marginal. The fuel cycle GHG emissions from electric energy use are presented in Table V-11 below:

Table V-11
GHG Emissions from Electrical Energy Demand for Stage-2 Biogas Refining (Small-to-Medium POTW)

Pollutant	Feedstock* (g/mmBtu)	Fuel* (g/mmBtu)	Sum (g/mmBtu)	GHG Emissions from Electrical Energy Demand (g/day)
VOC	10.19	5.67	15.86	103.79
CO	18.44	39.68	58.12	380.27
CH_4	212.37	7.04	219.42	1,435.70
N_2O	0.10	2.48	2.58	16.91
CO_2	8,276.83	96,249.68	104,526.51	683,941.07

*See Spreadsheet "ca_greetv1.80b_dec09.xls," Worksheet "Electric," Feedstock and Fuel factors for stationary applications (Fuel-Cycle Energy Use and Emissions of Electric Generation: Btu or Grams per mmBtu of Electricity Available at User Sites (wall outlets)).

For Alternative Case 2 (Medium-to-Large POTW), the GREET1 Model estimates that 10,693 MJ of electrical energy per day will be required for the stage-2 biogas refining process. This amount of energy represents 7.5 percent of the total electrical energy demand. An additional 7,485 MJ of electrical energy per day, representing 5.3 percent of the total electrical energy demand, will be required for biomethane compression and on-site vehicle fueling. The electrical energy is assumed to be supplied by on-site simple or combined cycle gas-fired turbine with generator.

[7] Pursuant to staff conversation with Jack Dunlap, PG&E, on December 29, 2011.

The GHG emissions from of fuel combustion for stationary applications (grams per mmBtu of fuel burned) are presented in Table V-12 below:

Table V-12
GHG Emissions from Electrical Energy Demand for Stage-2 Biogas Refining (Medium-to-Large POTW)

Pollutant	Simple Cycle or Combined Cycle Gas Turbine (g/mmBtu of fuel input)*	GHG Emissions Impact (g/day)
VOC	3.43	59.08
CO	24.00	413.51
CH_4	4.26	73.40
N_2O	1.50	25.84
CO_2	58,171.00	1,002,275.51

* See Spreadsheet "ca_greet1.80b_dec09.xls," Worksheet "EF."

The GREET1 Model additionally estimates that the stage-2 biogas refining process will produce 38 m^3 and 99 m^3 of fugitive CH_4 emissions per day under Alternative Cases 1 and 2, respectively. These losses are added to the overall GHG emissions impacts for determining total well-to-tank (WTT) emissions.

VI. Applicable Credits, Well-to-Wheels GHG Emissions, and Proposed CI

In this section, staff will first present the LCFS credits that are applicable to the wastewater sludge-to-biomethane pathways presented under Alternative Cases 1 and 2. The credits are then combined with the life cycle GHG emissions of each alternative case to determine the net well-to-tank (WTT) GHG emissions for the fuel pathways presented. The final step for determining the overall carbon intensities of the Alternative 1 and 2 biomethane pathways consists of combining the total WTT with the tank-to-wheels (TTW) emissions from combustion of the biomethane fuel in the vehicle. The combined estimates for WTT and TTW GHG emissions produces the Well-to-Wheels (WTW) GHG emissions, which when divided by the fuel energy value yields the carbon intensity (CI) of the fuel.

a. Avoided Flare Emissions Credit

The reference case established in Section IV is driven by regulations requiring the organic content of the wastewater sludge to be reduced or destroyed before the treated effluent is discharged into the surface waters. Anaerobic digestion is the preferred method for destroying that organic content. Under the reference case, the biogas produced is flared to reduce the GHG content and other environmental impacts. In Alternative Cases 1 and 2, that biogas is used instead for transportation fuel and the generation of renewable electrical power using compliant combustion equipment. The avoidance of flaring generates a credit under both alternative cases. Table VI-1 presents the GHG emissions associated with flaring at small-to-medium, and medium-to-large POTWs. These impacts translate into the flaring emissions avoided credits under Alternative Cases 1 and 2, respectively.

Table VI-1 below presents the avoided GHG impacts from flaring the digester gas (Reference Case).

Table VI-1
Avoided Biogas Flaring Emissions Credit for Alternative Cases 1 and 2

Digester Biogas Yield (m^3 CH_4/day)	Alternative Case 1 6,931.35	Alternative Case 2 34,656.77
Pollutant	**GHG Emissions Impact (g/day)**	**GHG Emissions Impact (g/day)**
VOC	588.63	2,943.13
CO	6,121.71	30,608.56
CH_4	11,537.07	57,685.35
N_2O	259.00	1,294.98
CO_2	23,520,618.89	117,603,094.44

b. Cogenerated Electricity and Surplus Export Credit

Under Alternative Case 2 (medium-to-large POTWs), biogas or biomethane not allocated to transportation fuel would continue to be used in compliant power generating devices to produce renewable power. A portion of the renewable power produced on-site would be utilized to meet the electrical demands of the wastewater treatment process units (for example, for the anaerobic digestion process, digestate management, biogas refining, compression, and dispensing units, etc.). The power not utilized by the treatment process units would be available for export.

Staff notes that the surplus available energy may still be consumed by other process units with the wastewater treatment plant (for example, by the primary or secondary treatment processes), but if the on-site produced power is not consumed within the plant, it would be considered to be surplus cogenerated power available for export. Exported electricity would displace grid-based electricity. In California, surplus cogenerated electricity which is exported to the public grid, is assumed to displace the California Marginal portfolio mix of electrical power generating assets.

The GREET1 Model estimates that, for Alternative Case 2 (medium-to-large POTWs), 271,270 MJ of electricity per day would be generated. The electricity required for process operations is estimated to be 123,728 MJ of electricity per day. Therefore the net electricity available for export (surplus) to the public grid or process units is estimated to be 147,542 MJ per day.

Table VI-2 below shows the GHG emissions that are offset by displacing California-Marginal electricity. The displacement credit is calculated from both fuel-cycle and electrical generation energy use and emissions

(grams per mmBtu of electricity available at user sites (wall outlets)), net of transmission losses (8.1 percent).

Table VI-2
GHG Emissions Impact from the
Export of Surplus Cogenerated Electricity

Surplus Exported: 147,542 MJ/day	Feedstock	Fuel	Total	Alternative Case 2 Displacement Credit (g/day)
Pollutant	**(g/mmBtu)**	**(g/mmBtu)**	**(g/mmBtu)**	
VOC	10.19	5.67	15.86	2,038.62
CO	18.44	39.68	58.12	7,468.91
CH_4	212.37	7.04	219.42	28,198.47
N_2O	0.10	2.48	2.58	332.13
CO_2	8,276.83	96,249.68	104,526.51	13,433,237.31

c. Total Well-to-Tank (WTT) GHG Emissions Estimates

The WTT GHG emissions impacts assessed in Section V for material transport, thermal and electrical energy use, digestate management, supernatant management, biogas refining, biomethane compression, and on-site vehicle fueling when combined with the applicable credits for avoided flaring, and electricity exported, yield the total WTT GHG emissions for the wastewater sludge-to-biomethane pathway. A summary of the total WTT GHG emissions estimate for Alternative Case 1 (Small-to-Medium POTW) is presented in Table VI-3 below.

Table VI-3
Summary of Total Well-to-Tank GHG Emissions Impact for Small-to-Medium POTW (Alternative Case 1)

Anaerobic Digestion	Thermal Load (g/day)	Electrical Load (g/day)	Fugitive Emissions (g/day)	Total Emissions (g/day)
VOC	247.66	130.94	-	378.60
CO	2,953.27	479.73	-	3,432.99
CH_4	112.71	1,811.18	49,255.42	51,179.31
N_2O	32.28	21.33	-	53.61
CO_2	10,249,014.10	862,814.77	-	11,111,828.86
Total CO_2e				12,413,858.29
Digestate Management	**Transport (g/day)**	**Electrical Load (g/day)**	**Fugitive Emissions (g/day)**	**Total Emissions (g/day)**
VOC	62.09	131.41	-	193.49
CO	200.16	481.43	-	681.59
CH_4	517.60	1,817.61	70,691.81	73,027.02
N_2O	2.02	21.41	-	23.43
CO_2	127,044.56	865,878.60	-	992,923.16
Total CO_2e				2,827,254.80
Supernatant Management	**Transport (g/day)**	**Electrical Load (g/day)**	**Fugitive Emissions (g/day)**	**Total Emissions (g/day)**
VOC	-	-	-	-
CO	-	-	-	-
CH_4	-	-	8,544.99	8,544.99
N_2O	-	-	-	-
CO_2	-	-	-	-
Total CO_2e				213,624.76
Biogas Refining (1st Stage)	**Thermal Load (g/day)**	**Electrical Load (g/day)**	**Fugitive Emissions (g/day)**	**Total Emissions (g/day)**
VOC	-	109.71	-	109.71
CO	-	401.93	-	401.93
CH_4	-	1,517.48	48,984.44	50,501.92
N_2O	-	17.87	-	17.87
CO_2	-	722,899.21	-	722,899.21
Total CO_2e				1,991,746.85
Biogas Refining (2nd Stage)	**Thermal Load (g/day)**	**Electrical Load (g/day)**	**Fugitive Emissions (g/day)**	**Total Emissions (g/day)**
VOC	-	103.79	-	103.79
CO	-	380.27	-	380.27
CH_4	-	1,435.70	26,961.59	28,397.29
N_2O	-	16.91	-	16.91
CO_2	-	683,941.07	-	683,941.07
Total CO_2e				1,399,833.50

Table VI-3 (Continued)
Summary of Total Well-to-Tank GHG Emissions Impact for Small-to-Medium POTW (Alternative Case 1)

Avoided Biogas Flaring Emissions	Thermal Load (g/day)	Electrical Load (g/day)	Fugitive Emissions (g/day)	Total Emissions (g/day)
VOC	-	-	-	(588.63)
CO	-	-	-	(6,121.71)
CH_4	-	-	-	(11,537.07)
N_2O	-	-	-	(259.00)
CO_2	-	-	-	(23,520,618.89)
Total CO_2e				(23,897,673.91)
Surplus Electricity Export Credit	**Thermal Load (g/day)**	**Electrical Load (g/day)**	**Fugitive Emissions (g/day)**	**Total Emissions (g/day)**
VOC	-	-	-	-
CO	-	-	-	-
CH_4	-	-	-	-
N_2O	-	-	-	-
CO_2	-	-	-	-
Total CO_2e				-
Net WTT GHG Emissions	**Thermal Load (g/day)**	**Electrical Load (g/day)**	**Fugitive Emissions (g/day)**	**Total Emissions (g/day)**
VOC	-	-	-	614.54
CO	-	-	-	(1,923.13)
CH_4	-	-	-	5,002,836.81
N_2O	-	-	-	(43,857.35)
CO_2	-	-	-	(10,009,026.58)
NET WELL-TO-TANK (WTT) CO_2e EMISSIONS:				(5,051,355.72)

Similarly, a summary of the total WTT GHG emissions for Alternative Case 2 (Medium-to-Large POTWs) is presented in Table VI-4 below.

Table VI-4
Summary of Total Well-to-Tank GHG Emissions Impact for Medium-to-Large POTW (Alternative Case 2)

Anaerobic Digestion	Thermal Load (g/day)	Electrical Load (g/day)	Fugitive Emissions (g/day)	Total Emissions (g/day)
VOC	-	141.53	-	141.53
CO	-	990.56	-	990.56
CH_4	-	175.83	247,704.78	247,880.60
N_2O	-	61.91	-	61.91
CO_2	-	2,400,931.34	-	2,400,931.34
Total CO_2e				8,618,392.39
Digestate Management	**Transport (g/day)**	**Electrical Load (g/day)**	**Fugitive Emissions (g/day)**	**Total Emissions (g/day)**
VOC	161.15	142.02	-	303.17
CO	519.50	994.02	-	1,513.52
CH_4	1,343.40	176.44	353,459.06	354,978.91
N_2O	5.25	62.13	-	67.37
CO_2	329,739.73	2,409,317.79	-	2,739,057.53
Total CO_2e				11,636,929.86
Supernatant Management	**Transport (g/day)**	**Electrical Load (g/day)**	**Fugitive Emissions (g/day)**	**Total Emissions (g/day)**
VOC	-	-	-	-
CO	-	-	-	-
CH_4	-	-	42,725.08	42,725.08
N_2O	-	-	-	-
CO_2	-	-	-	-
Total CO_2e				1,068,126.91
Biogas Refining (1st Stage)	**Thermal Load (g/day)**	**Electrical Load (g/day)**	**Fugitive Emissions (g/day)**	**Total Emissions (g/day)**
VOC	-	118.57	-	118.57
CO	-	829.91	-	829.91
CH_4	-	147.31	244,922.22	245,069.53
N_2O	-	51.87	-	51.87
CO_2	-	2,011,545.92	-	2,011,545.92
Total CO_2e				8,155,414.21

Table VI-4 (Continued)
Summary of Total Well-to-Tank GHG Emissions Impact for Medium-to-Large POTW (Alternative Case 2)

Biogas Refining (2nd Stage)	Thermal Load (g/day)	Electrical Load (g/day)	Fugitive Emissions (g/day)	Total Emissions (g/day)
VOC	-	59.08	-	59.08
CO	-	413.51	-	413.51
CH_4	-	73.40	70,995.66	71,069.06
N_2O	-	25.84	-	25.84
CO_2	-	1,002,275.51	-	1,002,275.51
Total CO_2e				2,787,537.29
Avoided Biogas Flaring Emissions	**Thermal Load (g/day)**	**Electrical Load (g/day)**	**Fugitive Emissions (g/day)**	**Total Emissions (g/day)**
VOC	-	-	-	(2,943.13)
CO	-	-	-	(30,608.56)
CH_4	-	-	-	(57,685.35)
N_2O	-	-	-	(1,294.98)
CO_2	-	-	-	(117,603,094.44)
Total CO_2e				(119,488,369.55)
Surplus Electricity Export Credit	**Thermal Load (g/day)**	**Electrical Load (g/day)**	**Fugitive Emissions (g/day)**	**Total Emissions (g/day)**
VOC	-	-	-	(2,038.62)
CO	-	-	-	(7,468.91)
CH_4	-	-	-	(28,198.47)
N_2O	-	-	-	(332.13)
CO_2	-	-	-	(13,433,237.31)
Total CO_2e				(14,255,260.36)
Net Well-to-Tank GHG Emissions	**Thermal Load (g/day)**	**Electrical Load (g/day)**	**Fugitive Emissions (g/day)**	**Total Emissions (g/day)**
VOC	-	-	-	(13,601.33)
CO	-	-	-	(53,898.03)
CH_4	-	-	-	21,895,983.85
N_2O	-	-	-	(423,192.30)
CO_2	-	-	-	(122,882,521.45)
			NET WELL-TO-TANK (WTT) CO_2e EMISSIONS:	(101,477,229.25)

d. Tank-to-Wheel (TTW) GHG Emissions Estimates

Under both alternative scenarios, the biogas produced by the anaerobic digestion of wastewater sludge would be refined to near-pure or pipeline quality biomethane suitable for use as a fuel in a natural gas-fired heavy-duty vehicle. Such vehicles include transit buses and cargo delivery trucks. Staff assumes that all of the carbon in the biomethane

fuel would convert to carbon dioxide during combustion (ARB, 2009). The CH_4 and N_2O emissions from engines were estimated using combustion of biomethane in heavy-duty natural gas emission factors of 0.0375 gram per mile and global warming potentials of 25 and 298, respectively.

The resulting TTW GHG emissions for the Alternative Cases 1 and 2 are summarized in Table VI-5 below:

Table VI-5
Tank-to-Wheels GHG Emissions from
Combustion of Biomethane in a Heavy-Duty Natural Gas-Fired Vehicle

Parameter	Small-to-Medium POTW (Alternative Case 1)	Medium-to-Large POTW (Alternative Case 2)
Biomethane to Application (scf/day)	133,366.58	351,182.80
Biomethane Energy Value (mmBtu/day)	128.30	337.84
Biomethane Energy Value (MJ/day)	135,362.77	356,439.21
Available Product Gas (g/day)	2,720,678.14	7,164,129.16
Available C in Product Gas (g/day)*	2,020,103.52	5,319,365.90
Vehicle Miles Travelled**	28,200.58	74,258.17
CH_4 Emissions (g/day)	1,057.52	2,784.68
N_2O Emissions (g/day)	1,057.52	2,784.68
CO_2 from CH_4 Combustion in Vehicle	7,407,046.25	19,504,341.64
Net GHG Emissions (g CO_2e/day)	**7,748,625.74**	**20,403,793.71**
Net GHG Emissions (g CO_2e/MJ)	**57.24**	**57.24**

* Staff assumes that the available carbon in the fuel is 99 percent pure, and can be estimated from the molecular weight of the fuel. Therefore, Available C = 0.99 x 12 g C / 16 g CH_4 = 0.7425
** Staff assumes an NGV fuel economy of 4.8 MJ/mile is applicable.

e. Total Well-to-Wheels (WTW) GHG Emissions Estimates

The sum of the total WTT GHG emissions estimate, and the TTW estimate results in the lifecycle well-to-wheels (WTW) GHG emissions estimate for the transportation fuel (biomethane) being produced. The WTT estimates for Alternative Cases 1 and 2 were summarized in Tables VI-3 and VI-4, respectively. The TTW estimates for Alternative Cases 1 and 2 were presented in Table VI-5 above. The WTW estimates are then the sum of the WTT and TTW GHG emissions for the biomethane produced by the wastewater sludge anaerobic digestion process. When the WTW GHG emissions impacts are presented per unit

of fuel energy produced, the ratio represents the CI of the fuel. A summary of the WTW GHG emissions impacts for Alternative Cases 1 and 2, as well as the resultant CI of the fuel, is presented in Table VI-6 below.

Table VI-6
Total Well-to-Wheel (WTW) GHG Emissions and Proposed Carbon Intensities for Biomethane Derived from Wastewater Sludge

Parameter	Small-to-Medium POTW (Alternative Case 1)	Medium-to-Large POTW (Alternative Case 2)
Total WTT GHG Emissions Impacts ($g\ CO_2e$/day)	(5,051,355.72)	(101,477,229.25)
Total TTW GHG Emissions Impacts ($g\ CO_2e$/day)	7,748,625.74	20,403,793.71
Net WTW GHG Emissions Impacts ($g\ CO_2e$/day) **(A)**	2,697,270.02	(81,073,435.54)
Allocation of Biomethane to Application (m^3/day)	6,931.35	34,656.77
Allocation of Biomethane to Application (scf/day)	133,366.58	351,182.80
Biomethane LHV (Btu/scf)	962.00	962.00
Biomethane Energy Value (MJ/day) **(B)**	248,414.33	1,242,071.63
Biomethane CI ($g\ CO_2e$/MJ) (A / B)	**10.86**	**(65.27)**

VII. References

Argonne National Laboratory and Life Cycle Associates LLC, 2009. California-Modified Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation Model (CA-GREET), Version 1.8b, Systems Assessment Section, Center for Transportation Research, ANL, December 2009. http://www.arb.ca.gov/fuels/lcfs/ca_greet1.8b_dec09.xls

Argonne National Laboratory, 2012. Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation Model (GREET1), Systems Assessment Section, Center for Transportation Research Version 2, December 2012.

California Air Resources Board, 2009. "Detailed California Modified GREET Pathway for Compressed Natural Gas," Appendix A, Section 5.1, February 2009.

California Air Resources Board, 2012. "Proposed Low Carbon Fuel Standard (LCFS) Pathway for the Production of Biomethane from High Solids Anaerobic Digestion (HSAD) of Organic (Food and Green) Wastes," Section VI, Table VI-4, June 2012.

California Association of Sanitation Agencies (CASA), 2013. Survey of Publicly-Owned Treatment Work (POTW) Facilities in the State of California, February 2013.

Intergovernmental Panel on Climate Change, 2007. “Global Warming Potentials, Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 2007.

Appendix A

(CALIFORNIA ASSOCIATION OF SANITATION AGENCIES POTW SURVEY)

California Association of Sanitation Agencies (CASA)

Table A-1
February 2013 POTW Survey of Wastewater Sludge Digestion Practices

POTW Facility Name	Operating Authority	Average Daily Flow (MGD)	Design Flow Rate (MGD)	Anaerobic Digestion of Wastewater Sludge Practiced	Type of Anaerobic Digestion Practiced	Flare for Biogas	Waste Import
ARCATA WWTF	ARCATA, City of	1.3	2.3	YES	Mesophilic	YES	NO
ATWATER WWTF	ATWATER, CITY OF	6.0	6	YES	Mesophilic	YES	UNKNOWN
BAKERSFIELD WWTP 2	BAKERSFIELD, CITY OF	17.3	0	YES	Mesophilic	YES	YES
BAKERSFIELD WWTP 3	BAKERSFIELD, City of	16.9	0	YES	Mesophilic	YES	YES
BANNING WWTP	BANNING, CITY OF	2.2	3.6	YES	Mesophilic	YES	UNKNOWN
BEALE AIR FORCE BASE	BEALE AIR FORCE BASE 9CES/CEV	0.4	0	YES	Mesophilic	YES	UNKNOWN
BENICIA WWTP	BENICIA, City of	3.5	3.55	YES	Mesophilic	YES	UNKNOWN
BRAWLEY WWTP	BRAWLEY, CITY OF	3.9	5.9	YES	Mesophilic	YES	UNKNOWN
BURBANK WRP	BURBANK, CITY OF	10.0	0	YES	Thermophilic	YES	NO
BURBANK WRP	BURBANK, CITY OF	10.0	0	YES	Thermophilic	YES	NO
CALEXICO WPCP	CALEXICO, CITY OF	2.8	0	YES	Mesophilic	YES	UNKNOWN
Camarillo Water Reclamation Treatment Plant	Camarillo, City of	3.8	6.2	YES	Mesophilic	YES	NO
Camp Pendleton Plant # 1	US Marine Corps	0.0	1.5	YES	Mesophilic	YES	UNKNOWN
Camp Pendleton Plant # 2	US Marine Corps	0.0	0	YES	Mesophilic	YES	UNKNOWN
Carmel Area Wastewater District WWTF	Carmel Area Wastewater District	1.5	3	YES	Mesophilic	YES	YES
Central Marin Sanitation Agency	Central Marin Sanitation Agency	11.0	30	YES	Mesophilic	YES	YES
CHICO WWTP	CHICO, CITY OF	7.5	9	YES	Mesophilic	YES	UNKNOWN
Chowchilla WWTP	Chowchilla, City of	1.1	1.8	YES	Mesophilic	YES	UNKNOWN
City of Burlingame Wastewater Treatment Facility	Veolia West Operating Services, Inc.	3.4	5.5	YES	Mesophilic	YES	NO
City of Eureka Elk River WWTF	Eureka, City of	4.5	5.2	YES	Mesophilic	YES	NO
City of Millbrae WPCP	Millbrae, City of	1.5	3	YES	Mesophilic	YES	YES
City of Paso Robles WWTP	Paso Robles, City of	2.9	4.9	YES	Mesophilic	YES	NO
City of Riverside Water Quality Control Plant	Riverside, City of	29.4	40	YES	Mesophilic	YES	YES
City of San Mateo WWTP	San Mateo, City of	12.1	15.7	YES	Mesophilic	YES	NO
City of Santa Cruz Wastewater Treatment Facility	Santa Cruz, City of	9.0	17	YES	Mesophilic	YES	UNKNOWN
City of Simi Valley Water Quality Control Plant	Simi Valley, City of	9.1	12.5	YES	Mesophilic	YES	NO
City of Watsonville WWTP	Watsonville, City of	6.7	12	YES	Mesophilic	YES	YES
COLTON WRF	Colton, City of	5.0	8.4	YES	Mesophilic	YES	UNKNOWN
CORCORAN WWTP	CORCORAN, CITY OF	1.2	0	YES	Mesophilic	YES	UNKNOWN
CORNING WWTF	CORNING, City of	1.8	1.5	YES	Mesophilic	YES	UNKNOWN
CORONA WWTP 1	Corona, City of	9.0	0	YES	Mesophilic	YES	NO
CRESCENT CITY WWTP	CRESCENT CITY	1.9	1.86	YES	Mesophilic	YES	UNKNOWN
D.C. TILLMAN WRP	LOS ANGELES, BUREAU OF SANITATION, CITY OF	59.0	59	YES	Thermophilic	YES	NO

Table A-1
February 2013 POTW Survey of Wastewater Sludge Digestion Practices

POTW Facility Name	Operating Authority	Average Daily Flow (MGD)	Design Flow Rate (MGD)	Anaerobic Digestion of Wastewater Sludge Practiced	Type of Anaerobic Digestion Practiced	Flare for Biogas	Waste Import
D.C. TILLMAN WRP	LOS ANGELES, BUREAU OF SANITATION, CITY OF	59.0	0	YES	Thermophilic	YES	NO
DAVIS WWTP	DAVIS, CITY OF	5.5	7.5	YES	Mesophilic	YES	UNKNOWN
DELANO WWTP	DELANO, CITY OF	4.4	0	YES	Mesophilic	YES	UNKNOWN
Delta Diablo	Delta Diablo sanitation district	13.5	16.5	YES	Mesophilic	YES	NO
DINUBA WRF	DINUBA, City of	2.2	0	YES	Mesophilic	YES	UNKNOWN
Dublin San Ramon Services District REgional WWTP	Dublin San Ramon Services District	11.0	17	YES	Mesophilic	YES	NO
East Bay Municipal Utility District	East Bay Municipal Utility District	70.0	120	YES	Both	YES	YES
EL CENTRO WWTP	EL CENTRO, CITY OF	4.0	8	YES	Mesophilic	YES	UNKNOWN
El Dorado Hills Reclamation Plant	El Dorado Irrigation District	2.5	4	YES	Mesophilic	YES	NO
El Estero Wastewater Treatment Facility	Santa Barbara, City of	8.0	11	YES	Mesophilic	YES	YES
EL PORTAL WWTF	U.S. Dept of the Interior, National Park Service	0.5	0	YES	Mesophilic	YES	UNKNOWN
EMWD - MORENO VALLEY RWRF	EASTERN MUNICIPAL WATER DISTRICT	11.1	0	YES	Mesophilic	YES	YES
EMWD - PERRIS VALLEY RWRF	EASTERN MUNICIPAL WATER DISTRICT	11.6	0	YES	Mesophilic	YES	NO
EMWD - SAN JACINTO RWRF	EASTERN MUNICIPAL WATER DISTRICT	8.4	0	YES	Mesophilic	YES	NO
EMWD - TEMECULA VALLEY RWRF	Eastern Municipal Water District	13.7	0	YES	Mesophilic	YES	NO
Encina Wastewater Authority	Encina Wastewater Authority	23.9	40	YES	Mesophilic	YES	NO
EnerTech Rialto Biosolids Facility	Enertech	0.0	0	YES	Mesophilic	YES	NO
ESCONDIDO Hale Ave RRF	ESCONDIDO, CITY OF	15.4	18	YES	Mesophilic	YES	UNKNOWN
Fairfield-Suisun Sewer District	Fairfield-Suisun Sewer District	15.1	17	YES	Mesophilic	YES	YES
Fresno/Clovis Regional Wastewater Reclamation Facility	Fresno, City of	68.0	80	YES	Mesophilic	YES	YES
GOLETA WWTP	GOLETA SANITARY DISTRICT	4.8	10.5	YES	Mesophilic	YES	UNKNOWN
GRASS VALLEY WWTP	GRASS VALLEY, City of	1.9	2.78	YES	Mesophilic	YES	UNKNOWN
HANFORD WWTF	HANFORD, CITY OF	5.0	0	YES	Mesophilic	YES	UNKNOWN
Healdsburg WRF	HEALDSBURG, City of	1.2	2	YES	Mesophilic	YES	NO
Hill Canyon Wastewater Treatment Plant	Thousand Oaks, City of	9.5	14	YES	Mesophilic	YES	YES
Holtville WWTP	Holtville, City of	0.7	0	YES	Mesophilic	YES	UNKNOWN
Hyperion Treatment Plant, City of Los Angeles	Los Angeles, City of	300.0	450	YES	Thermophilic	YES	YES
Hyperion Treatment Plant, City of Los Angeles	Los Angeles, City of	300.0	450	YES	Thermophilic	YES	YES
IEUA CARBON CANYON WRF	INLAND EMPIRE UTILITIES AGENCY	8.7	0	YES	Both	YES	NO
IEUA Regional Plant No. 1	Inland Empire Utilities Agency	30.0	44	YES	Both	YES	YES
IEUA REGIONAL PLANT NO.5	INLAND EMPIRE UTILITIES AGENCY	10.5	0	YES	Both	YES	NO
INLAND EMPIRE UTILITIES PLT 2	INLAND EMPIRE UTILITIES AGENCY	15.0	0	YES	Mesophilic	YES	UNKNOWN
IRWD LOS ALISOS WRP	IRVINE RANCH WATER DISTRICT	4.3	0	YES	Mesophilic	YES	UNKNOWN

California Association of Sanitation Agencies (CASA)

Table A-1
February 2013 POTW Survey of Wastewater Sludge Digestion Practices

POTW Facility Name	Operating Authority	Average Daily Flow (MGD)	Design Flow Rate (MGD)	Anaerobic Digestion of Wastewater Sludge Practiced	Type of Anaerobic Digestion Practiced	Flare for Biogas	Waste Import
Joint Water Pollution Control Plant	County Sanitation Districts of Los Angeles County	300.0	400	YES	Mesophilic	YES	NO
KERN SA MT VERNON WWTP	KERN Sanitation Authority	3.5	0	YES	Mesophilic	YES	UNKNOWN
L.A.-GLENDALE WRP	LOS ANGELES, BUREAU OF SANITATION, CITY OF	15.0	0	YES	Thermophilic	YES	NO
L.A.-GLENDALE WRP	LOS ANGELES, BUREAU OF SANITATION, CITY OF	15.0	0	YES	Thermophilic	YES	NO
Laguna CSD WRF	LAGUNA COUNTY SANITATION DISTRICT	2.1	0	YES	Mesophilic	YES	UNKNOWN
Laguna Wastewater Reclamation Plant, City of Santa Rosa	Santa Rosa, City of	15.4	22	YES	Mesophilic	YES	NO
Lancaster Water Reclamation Plant	County Sanitation Districts of Los Angeles County	14.3	16	YES	Mesophilic	YES	NO
LAS GALLINAS VALLEY STP	LAS GALLINAS VALLEY S.D.	3.0	0	YES	Mesophilic	YES	NO
LAS VIRGENES TAPIA WRF/Compost	LAS VIRGENES MUNICIPAL WATER DIST	8.3	16.1	YES	Mesophilic	YES	NO
LINDA CNTY WATER D. WWTP	LINDA COUNTY WATER DISTRICT	1.0	1.8	YES	Mesophilic	YES	UNKNOWN
LIVERMORE WRP	LIVERMORE CITY OF	5.2	6.25	YES	Mesophilic	YES	UNKNOWN
LODI White Slough WPCF	LODI, CITY OF	6.4	8.5	YES	Mesophilic	YES	UNKNOWN
Lompoc RWRP	LOMPOC, CITY OF	3.1	5	YES	Mesophilic	YES	UNKNOWN
LONG BEACH WRP	COUNTY SANITATION DISTRICTS OF LOS ANGELES COUNTY	18.8	0	YES	Mesophilic	YES	NO
LOS COYOTES WRP	COUNTY SANITATION DISTRICTS OF LOS ANGELES COUNTY	22.4	0	YES	Mesophilic	YES	NO
MADERA WWTF	MADERA, City of	5.7	0	YES	Mesophilic	YES	UNKNOWN
MANTECA WQCF	Manteca, City lf	6.2	6.95	YES	Mesophilic	YES	UNKNOWN
MARIN CO. S.D. NO.5 WWTP	MARIN CO. S.D. NO.5	0.7	0.98	YES	Mesophilic	YES	UNKNOWN
MARYSVILLE WWTP	MARYSVILLE, City of	1.2	0	YES	Mesophilic	YES	UNKNOWN
MERCED WWTF	Merced, City of	7.3	11.5	YES	Mesophilic	YES	UNKNOWN
MICHELSON WRP	IRVINE RANCH WATER DISTRICT	13.5	0	YES	Mesophilic	YES	UNKNOWN
Modesto WQCF	MODESTO, CITY OF	25.0	70	YES	Mesophilic	YES	UNKNOWN
MONTEREY REG. WPCA	MONTEREY REG. WPCA	21.0	29	YES	Mesophilic	YES	YES
MORRO BAY / CAYUCOS WWTP	Morro Bay/Cayucos Sanitary District	1.2	0	YES	Mesophilic	YES	NO
MT. VIEW S.D. WWTP	MT. VIEW S.D.	1.6	3.2	YES	Mesophilic	YES	UNKNOWN
Napa Sanitation District	Napa Sanitation District	9.3	15	YES	Mesophilic	YES	YES
NORTH OF RIVER S. D. I WWTF	NORTH OF RIVER SANITARY DISTRICT I	5.8	0	YES	Mesophilic	YES	NO
North San Mateo County Sanitation District	North San Mateo County Sanitation District	6.3	10	YES	Mesophilic	YES	NO
Novato S.D. Novato WWTP	Novato Sanitary District	4.5	7.05	YES	Mesophilic	YES	NO
Oceanside San Luis Rey WWTP	OCEANSIDE, City of	9.3	15.4	YES	Mesophilic	YES	NO
Oceanside Water Pollution Control Plant	San Francisco Public Utilties Commission	15.0	21	YES	Mesophilic	YES	YES
Orange County Sanitation District No.1	Orange County Sanitation District	96.0	500	YES	Mesophilic	YES	NO
Oro Loma/Castro Valley Water Pollution Control Facility	Oro Loma Sanitary District	12.0	20	YES	Mesophilic	YES	YES

Table A-1
February 2013 POTW Survey of Wastewater Sludge Digestion Practices

POTW Facility Name	Operating Authority	Average Daily Flow (MGD)	Design Flow Rate (MGD)	Anaerobic Digestion of Wastewater Sludge Practiced	Type of Anaerobic Digestion Practiced	Flare for Biogas	Waste Import
OXNARD WWTP	OXNARD, City of	22.5	31.7	YES	Mesophilic	YES	YES
PALM SPRINGS WWTP	PALM SPRINGS, City of	5.7	0	YES	Mesophilic	YES	UNKNOWN
Palmdale Water Reclamation Plant	County Sanitation Districts of Los Angeles County	9.5	15	YES	Mesophilic	YES	NO
Petaluma Ellis Creek WRF	PETALUMA, CITY OF	5.6	5.2	YES	Mesophilic	YES	UNKNOWN
Pinole/Hercules WPCP	PINOLE, City of	2.0	4.06	YES	Mesophilic	YES	UNKNOWN
Placerville Hangtown Creek WRF	PLACERVILLE, City of	1.6	2.3	YES	Mesophilic	YES	UNKNOWN
POMONA WRP	COUNTY SANITATION DISTRICTS OF LOS ANGELES COUNTY	8.8	0	YES	Mesophilic	YES	NO
PORTERVILLE WWTF	Porterville, City of	4.6	0	YES	Mesophilic	YES	UNKNOWN
Redding Clear Creek WWTP	REDDING, City of	7.2	8.8	YES	Mesophilic	YES	UNKNOWN
REDLANDS WWTP	REDLANDS, CITY OF	12.0	0	YES	Mesophilic	YES	UNKNOWN
RIALTO WRF	RIALTO, CITY OF/Veolia Water	7.6	11.7	YES	Mesophilic	YES	UNKNOWN
RIDGECREST WWTP	RIDGECREST, CITY OF	2.5	0	YES	Mesophilic	YES	UNKNOWN
Roseville Dry Creek WWTP	ROSEVILLE, CITY OF	10.0	18	YES	Mesophilic	YES	UNKNOWN
Sacramento Regional County Sanidation District (SRCSD)	Mick Berklich	150.0	181	YES	Mesophilic	YES	YES
San Bernardino WRF	SAN BERNARDINO, City of	23.0	33	YES	Mesophilic	YES	UNKNOWN
SAN CLEMENTE WRP	SAN CLEMENTE, CITY OF	4.0	0	YES	Mesophilic	YES	UNKNOWN
San Diego Metro Biosolids Center (MBC)	SAN DIEGO, CITY OF	180.0	240	YES	Mesophilic	YES	NO
SAN ELIJO WRF	SAN ELIJO JOINT POWERS AUTH.	2.0	5.25	YES	Mesophilic	YES	UNKNOWN
San Francisco Airport WWTP	SAN FRANCISCO CITY & COUNTY	0.5	2.2	YES	Mesophilic	YES	UNKNOWN
SAN JOSE CREEK WRP	COUNTY SANITATION DISTRICTS OF LOS ANGELES COUNTY	83.6	0	YES	Mesophilic	YES	NO
San Jose/Santa Clara Water Pollution Control Plant	San Jose/Santa Clara Water Pollution Control Plant	110.0	167	YES	Mesophilic	YES	YES
SAN LEANDRO WPCP	SAN LEANDRO, City of	5.3	0	YES	Mesophilic	YES	UNKNOWN
SAN LUIS OBISPO WRF	SAN LUIS OBISPO, CITY OF	4.5	5	YES	Mesophilic	YES	UNKNOWN
SANGER WPCP	SANGER, City of	1.7	0	YES	Mesophilic	YES	UNKNOWN
SANTA MARGARITA CHIQUITA WRF	SOCWA/SANTA MARGARITA WATER DIST	6.6	0	YES	Mesophilic	YES	UNKNOWN
Santa Maria WWTP	Santa Maria, City of	7.8	0	YES	Mesophilic	YES	UNKNOWN
Saugus WRP	Sanitation Districts of Los Angeles County	4.1	0	YES	Mesophilic	YES	NO
Sausalito-Marin City Sanitation District WWTP	Sausalito-Marin City Sanitation District	1.4	1.8	YES	Mesophilic	YES	UNKNOWN
Sewer Authority - Mid Coastside	Sewer Authority - Mid Coastside	2.0	4	YES	Mesophilic	YES	NO
Sewerage Agency of Southern Marin	Sewerage Agency of Southern Marin/City of Mill Valle	2.7	3.6	YES	Mesophilic	YES	YES
Shasta Lake WWTP	Shasta Lake, City of	1.0	1.3	YES	Mesophilic	YES	UNKNOWN
SOCWA J.B. Latham Treatment Plant	South Orange County Wastewater Authority	11.5	0	YES	Mesophilic	YES	NO
SOCWA 3A WWTP	South Orange County Wastewater Authority	2.1	0	YES	Mesophilic	YES	NO

California Association of Sanitation Agencies (CASA)

Table A-1
February 2013 POTW Survey of Wastewater Sludge Digestion Practices

POTW Facility Name	Operating Authority	Average Daily Flow (MGD)	Design Flow Rate (MGD)	Anaerobic Digestion of Wastewater Sludge Practiced	Type of Anaerobic Digestion Practiced	Flare for Biogas	Waste Import
SOCWA Regional Treatment Plant	South Orange County Wastewater Authority	9.2	0	YES	Mesophilic	YES	NO
South Bayside System Authority	South Bayside System Authority	15.0	29	YES	Mesophilic	YES	YES
South San Francisco - San Bruno WQCP	South San Francisco, City of	8.9	13	YES	Mesophilic	YES	UNKNOWN
South San Luis Obispo WWTP	South San Luis Obispo County Sanitation District	2.6	3.3	YES	Mesophilic	YES	UNKNOWN
Southeast Water Pollution Control Plant	San Francisco Public Utilties Commission	56.0	85	YES	Mesophilic	YES	YES
stockton Regional WCF	Stockton, City of	30.0	55	YES	Mesophilic	YES	UNKNOWN
Sunnyvale WPCP	Sunnyvale, City of	11.3	29.5	YES	Mesophilic	YES	UNKNOWN
Tahoe-Truckee WWTP	Tahoe-Truckee Sanitation Agency	3.6	0	YES	Mesophilic	YES	UNKNOWN
Terminal Island Water Reclamation Plant	Los Angeles, City of	15.0	30	YES	Thermophilic	YES	NO
Terminal Island Water Reclamation Plant	Los Angeles, City of	15.0	30	YES	Thermophilic	YES	NO
Tracy WWTP	Tracy, City of	5.5	9	YES	Mesophilic	YES	UNKNOWN
Tulare WPCF	Tulare, City of	11.2	0	YES	Mesophilic	YES	UNKNOWN
Tuolomne Utilities District Regional WWTP	Tuolomne Utilities District	1.7	0	YES	Mesophilic	YES	UNKNOWN
Turlock WQCF	Turlock, City of	11.6	20	YES	Mesophilic	YES	UNKNOWN
Ukiah WWTP	Ukia, City of	2.5	2.8	YES	Mesophilic	YES	UNKNOWN
Union Sanitary District Alvarado Wastewater Treatment Facility	Union Sanitary District	27.0	33	YES	Mesophilic	YES	NO
Vacaville Easterly WWTP	Vacaville, City of	8.3	12	YES	Mesophilic	YES	UNKNOWN
Valencia Water Reclamation Plant	County Sanitation Districts of Los Angeles County	14.8	21	YES	Mesophilic	YES	NO
Ventura Water Reclamation Facility	Ventura, City of	9.0	14	YES	Mesophilic	YES	NO
Victor Valley Wastewater Reclamation Authority		13.5	18	YES	Mesophilic	YES	YES
Visalia WCP	Visalia, City of	12.4	22	YES	Mesophilic	YES	UNKNOWN
Wasco WWTP	Wasco, City of	1.7	3	YES	Mesophilic	YES	UNKNOWN
West County Wastewater District Facility	West County Wastewater District	8.0	12.5	YES	Mesophilic	YES	NO
Whittier Narrows WRP	County Sanitation Districts of Los Angeles County	7.8	0	YES	Mesophilic	YES	NO
Yuba City WTF	Yuba City	6.0	10.5	YES	Mesophilic	YES	UNKNOWN
Yucaipa Valley Henry N. Wochholtz WWTP	Yucaipa Valley Water District	4.0	4.5	YES	Mesophilic	YES	UNKNOWN

California Association of Sanitation Agencies (CASA)

Table A-2
February 2013 POTW Survey of Biogas Utilization Practices

POTW Facility Name	Operating Authority	Biogas for Digester Heating Purposes	Biogas for Building Heat & Air	Direct Pipeline Injection	Electric Power Export to Grid	ICE-Based Generation	Turbine-Based Generation	Microturbine-Based Generation	Fuel Cell-Based Generation
ARCATA WWTF	ARCATA, City of	YES	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
ATWATER WWTF	ATWATER, CITY OF	YES	UNKNOWN	UNKNOWN	NO	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
BAKERSFIELD WWTP 2	BAKERSFIELD, CITY OF	YES	YES	NO	NO	YES	NO	NO	NO
BAKERSFIELD WWTP 3	BAKERSFIELD, City of	YES	YES	NO	NO	YES	NO	NO	NO
BANNING WWTP	BANNING, CITY OF	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
BEALE AIR FORCE BASE	BEALE AIR FORCE BASE 9CES/CEV	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
BENICIA WWTP	BENICIA, City of	YES	NO	NO	NO	NO	NO	NO	NO
BRAWLEY WWTP	BRAWLEY, CITY OF	YES	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
BURBANK WRP	BURBANK, CITY OF	YES	NO	YES	YES	NO	NO	NO	NO
BURBANK WRP	BURBANK, CITY OF	YES	NO	YES	YES	NO	NO	NO	NO
CALEXICO WPCP	CALEXICO, CITY OF	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
Camarillo Water Reclaimation Treatment Plant	Camarillo, City of	YES	NO	NO	NO	NO	NO	NO	NO
Camp Pendleton Plant # 1	US Marine Corps	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
Camp Pendleton Plant # 2	US Marine Corps	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
Carmel Area Wastewater District WWTF	Carmel Area Wastewater District	YES	NO	NO	NO	NO	NO	YES	NO
Central Marin Sanitation Agency	Central Marin Sanitation Agency	YES	YES	NO	YES	YES	NO	NO	NO
CHICO WWTP	CHICO, CITY OF	YES	UNKNOWN	NO	NO	YES	NO	NO	NO
Chowchilla WWTP	Chowchilla, City of	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
City of Burlingame Wastewater Treatment Facility	Veolia West Operating Services, Inc.	YES	YES	NO	NO	YES	UNKNOWN	UNKNOWN	UNKNOWN
City of Eureka Elk River WWTF	Eureka, City of	YES	YES	NO	NO	YES	UNKNOWN	UNKNOWN	UNKNOWN
City of Millbrae WPCP	Millbrae, City of	YES	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	YES	UNKNOWN
City of Paso Robles WWTP	Paso Robles, City of	YES	NO	NO	NO	NO	NO	NO	NO
City of Riverside Water Quality Control Plant	Riverside, City of	YES	YES	NO	NO	YES	NO	NO	YES
City of San Mateo WWTP	San Mateo, City of	YES	NO	NO	NO	NO	NO	NO	N
City of Santa Cruz Wastewater Treatment Facility	Santa Cruz, City of	YES	NO	NO	NO	YES	NO	NO	NO
City of Simi Valley Water Quality Control Plant	Simi Valley, City of	NO	NO	NO	NO	NO	NO	NO	NO
City of Watsonville WWTP	Watsonville, City of	YES	UNKNOWN	UNKNOWN	YES	YES	UNKNOWN	UNKNOWN	UNKNOWN
COLTON WRF	Colton, City of	YES	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
CORCORAN WWTP	CORCORAN, CITY OF	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
CORNING WWTF	CORNING, City of	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
CORONA WWTP 1	Corona, City of	NO	NO	NO	NO	YES	NO	NO	N
CRESCENT CITY WWTP	CRESCENT CITY	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
D.C. TILLMAN WRP	LOS ANGELES, BUREAU OF SANITATION, CITY OF	YES	NO	YES	YES	NO	NO	NO	NO
D.C. TILLMAN WRP	LOS ANGELES, BUREAU OF SANITATION, CITY OF	YES	NO	YES	YES	NO	NO	NO	NO
DAVIS WWTP	DAVIS, CITY OF	YES	UNKNOWN	NO	NO	YES	UNKNOWN	UNKNOWN	UNKNOWN
DELANO WWTP	DELANO, CITY OF	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
Delta Diablo	Delta Diablo sanitation district	YES	UNKNOWN	NO	NO	YES	NO	NO	NO
DINUBA WRF	DINUBA, City of	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
Dublin San Ramon Services District REgional WWTP	Dublin San Ramon Services District	YES	YES	NO	YES	YES	UNKNOWN	UNKNOWN	YES
East Bay Municipal Utility District	East Bay Municipal Utility District	YES	YES	NO	YES	YES	YES	NO	NO

Table A-2
February 2013 POTW Survey of Biogas Utilization Practices

POTW Facility Name	Operating Authority	Biogas for Digester Heating Purposes	Biogas for Building Heat & Air	Direct Pipeline Injection	Electric Power Export to Grid	ICE-Based Generation	Turbine-Based Generation	Microturbine-Based Generation	Fuel Cell-Based Generation
EL CENTRO WWTP	EL CENTRO, CITY OF	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
El Dorado Hills Reclamation Plant	El Dorado Irrigation District	YES	NO	NO	NO	NO	NO	NO	NO
El Estero Wastewater Treatment Facility	Santa Barbara, City of	YES	NO	NO	NO	YES	NO	NO	YES
EL PORTAL WWTF	U.S. Dept of the Interior, National Park Service	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
EMWD - MORENO VALLEY RWRF	EASTERN MUNICIPAL WATER DISTRICT	YES	YES	NO	YES	NO	NO	NO	YES
EMWD - PERRIS VALLEY RWRF	EASTERN MUNICIPAL WATER DISTRICT	YES	YES	NO	NO	NO	NO	NO	YES
EMWD - SAN JACINTO RWRF	EASTERN MUNICIPAL WATER DISTRICT	YES	NO	NO	NO	YES	NO	NO	NO
EMWD - TEMECULA VALLEY RWRF	Eastern Municipal Water District	YES	NO	NO	NO	YES	NO	NO	NO
Encina Wastewater Authority	Encina Wastewater Authority	YES	YES	NO	NO	YES	NO	NO	NO
EnerTech Rialto Biosolids Facility	Enertech	YES	NO	NO	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
ESCONDIDO Hale Ave RRF	ESCONDIDO, CITY OF	YES	UNKNOWN	UNKNOWN	NO	YES	NO	NO	NO
Fairfield-Suisun Sewer District	Fairfield-Suisun Sewer District	YES	YES	NO	NO	YES	NO	NO	NO
Fresno/Clovis Regional Wastewater Reclamation Facility	Fresno, City of	YES	YES	NO	YES	NO	YES	NO	NO
GOLETA WWTP	GOLETA SANITARY DISTRICT	YES	NO	NO	NO	YES	NO	NO	NO
GRASS VALLEY WWTP	GRASS VALLEY, City of	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
HANFORD WWTF	HANFORD, CITY OF	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
Healdsburg WRF	HEALDSBURG, City of	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
Hill Canyon Wastewater Treatment Plant	Thousand Oaks, City of	YES	YES	NO	YES	YES	NO	NO	NO
Holtville WWTP	Holtville, City of	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
Hyperion Treatment Plant, City of Los Angeles	Los Angeles, City of	YES	NO	YES	YES	NO	NO	NO	NO
Hyperion Treatment Plant, City of Los Angeles	Los Angeles, City of	YES	NO	YES	YES	NO	NO	NO	NO
IEUA CARBON CANYON WRF	INLAND EMPIRE UTILITIES AGENCY	YES	NO	NO	NO	YES	NO	NO	UNKNOWN
IEUA Regional Plant No. 1	Inland Empire Utilities Agency	YES	NO	NO	NO	YES	NO	NO	YES
IEUA REGIONAL PLANT NO.5	INLAND EMPIRE UTILITIES AGENCY	YES	NO	NO	NO	YES	NO	NO	UNKNOWN
INLAND EMPIRE UTILITIES PLT 2	INLAND EMPIRE UTILITIES AGENCY	YES	NO	NO	NO	YES	NO	NO	NO
IRWD LOS ALISOS WRP	IRVINE RANCH WATER DISTRICT	YES	NO	NO	NO	YES	NO	NO	YES
Joint Water Pollution Control Plant	County Sanitation Districts of Los Angeles County	YES	NO	NO	YES	YES	YES	NO	NO
KERN SA MT VERNON WWTP	KERN Sanitation Authority	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
L.A.-GLENDALE WRP	LOS ANGELES, BUREAU OF SANITATION, CITY OF	YES	UNKNOWN	YES	YES	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
L.A.-GLENDALE WRP	LOS ANGELES, BUREAU OF SANITATION, CITY OF	YES	UNKNOWN	YES	YES	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
Laguna CSD WRF	LAGUNA COUNTY SANITATION DISTRICT	YES	UNKNOWN	NO	NO	NO	NO	YES	NO
Laguna Wastewater Reclamation Plant, City of Santa Rosa	Santa Rosa, City of	YES	NO	NO	YES	YES	NO	NO	NO
Lancaster Water Reclamation Plant	County Sanitation Districts of Los Angeles County	YES	NO	NO	NO	NO	NO	YES	NO
LAS GALLINAS VALLEY STP	LAS GALLINAS VALLEY S.D.	YES	NO	NO	NO	YES	NO	NO	NO
LAS VIRGENES TAPIA WRF/Compost	LAS VIRGENES MUNICIPAL WATER DIST	YES	UNKNOWN	NO	NO	YES	NO	NO	UNKNOWN
LINDA CNTY WATER D. WWTP	LINDA COUNTY WATER DISTRICT	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
LIVERMORE WRP	LIVERMORE CITY OF	YES	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
LODI White Slough WPCF	LODI, CITY OF	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
Lompoc RWRP	LOMPOC, CITY OF	YES	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
LONG BEACH WRP	DISTRICTS OF LOS ANGELES COUNTY	YES	NO	NO	NO	YES	YES	NO	NO

California Association of Sanitation Agencies (CASA)

Table A-2
February 2013 POTW Survey of Biogas Utilization Practices

POTW Facility Name	Operating Authority	Biogas for Digester Heating Purposes	Biogas for Building Heat & Air	Direct Pipeline Injection	Electric Power Export to Grid	ICE-Based Generation	Turbine-Based Generation	Microturbine-Based Generation	Fuel Cell-Based Generation
LOS COYOTES WRP	DISTRICTS OF LOS ANGELES COUNTY	YES	NO	NO	YES	YES	YES	NO	NO
MADERA WWTF	MADERA, City of	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
MANTECA WQCF	Manteca, City lf	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
MARIN CO. S.D. NO.5 WWTP	MARIN CO. S.D. NO.5	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
MARYSVILLE WWTP	MARYSVILLE, City of	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
MERCED WWTF	Merced, City of	YES	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
MICHELSON WRP	IRVINE RANCH WATER DISTRICT	YES	UNKNOWN	UNKNOWN	NO	YES	UNKNOWN	UNKNOWN	UNKNOWN
Modesto WQCF	MODESTO, CITY OF	YES	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
MONTEREY REG. WPCA	MONTEREY REG. WPCA	YES	YES	NO	YES	YES	UNKNOWN	UNKNOWN	UNKNOWN
MORRO BAY / CAYUCOS WWTP	Morro Bay/Cayucos Sanitary District	YES	NO	UNKNOWN	NO	NO	NO	NO	NO
MT. VIEW S.D. WWTP	MT. VIEW S.D.	YES	NO	NO	NO	YES	NO	NO	NO
Napa Sanitation District	Napa Sanitation District	YES	NO	NO	NO	YES	NO	NO	NO
NORTH OF RIVER S. D. I WWTF	NORTH OF RIVER SANITARY DISTRICT I	YES	NO	NO	NO	YES	NO	NO	NO
North San Mateo County Sanitation District	North San Mateo County Sanitation District	YES	NO	NO	YES	YES	NO	YES	NO
Novato S.D. Novato WWTP	Novato Sanitary District	YES	YES	NO	NO	NO	NO	YES	NO
Oceanside San Luis Rey WWTP	OCEANSIDE, City of	YES	YES	NO	NO	YES	NO	NO	NO
Oceanside Water Pollution Control Plant	San Francisco Public Utilties Commission	YES	YES	NO	NO	YES	NO	NO	NO
Orange County Sanitation District No. 1	Orange County Sanitation District	NO	YES	NO	YES	YES	NO	NO	YES
Oro Loma/Castro Valley Water Pollution Control Facility	Oro Loma Sanitary District	YES	NO	NO	YES	YES	NO	NO	NO
OXNARD WWTP	OXNARD, City of	YES	NO	NO	NO	YES	NO	NO	NO
PALM SPRINGS WWTP	PALM SPRINGS, City of	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
Palmdale Water Reclamation Plant	County Sanitation Districts of Los Angeles County	YES	NO	NO	NO	NO	NO	NO	NO
Petaluma Ellis Creek WRF	PETALUMA, CITY OF	YES	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
Pinole/Hercules WPCP	PINOLE, City of	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
Placerville Hangtown Creek WRF	PLACERVILLE, City of	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
POMONA WRP	DISTRICTS OF LOS ANGELES COUNTY	YES	NO	NO	YES	YES	YES	NO	NO
PORTERVILLE WWTF	Porterville, City of	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
Redding Clear Creek WWTP	REDDING, City of	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
REDLANDS WWTP	REDLANDS, CITY OF	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
RIALTO WRF	RIALTO, CITY OF/Veolia Water	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
RIDGECREST WWTP	RIDGECREST, CITY OF	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
Roseville Dry Creek WWTP	ROSEVILLE, CITY OF	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
Sacramento Regional County Sanidation District (SRCSD)	Mick Berklich	NO	NO	YES	YES	NO	YES	NO	NO
San Bernardino WRF	SAN BERNARDINO, City of	YES	YES	UNKNOWN	NO	YES	UNKNOWN	UNKNOWN	UNKNOWN
SAN CLEMENTE WRP	SAN CLEMENTE, CITY OF	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
San Diego Metro Biosolids Center (MBC)	SAN DIEGO, CITY OF	YES	YES	NO	YES	YES	NO	NO	NO
SAN ELIJO WRF	SAN ELIJO JOINT POWERS AUTH.	YES	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
San Francisco Airport WWTP	SAN FRANCISCO CITY & COUNTY	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
SAN JOSE CREEK WRP	DISTRICTS OF LOS ANGELES COUNTY	YES	NO	NO	YES	YES	YES	NO	NO
San Jose/Santa Clara Water Pollution Control Plant	San Jose/Santa Clara Water Pollution Control Plant	YES	YES	UNKNOWN	NO	YES	NO	NO	YES

Table A-2
February 2013 POTW Survey of Biogas Utilization Practices

POTW Facility Name	Operating Authority	Biogas for Digester Heating Purposes	Biogas for Building Heat & Air	Direct Pipeline Injection	Electric Power Export to Grid	ICE-Based Generation	Turbine-Based Generation	Microturbine-Based Generation	Fuel Cell-Based Generation
SAN LEANDRO WPCP	SAN LEANDRO, City of	YES	NO	NO	NO	YES	NO	NO	NO
SAN LUIS OBISPO WRF	SAN LUIS OBISPO, CITY OF	YES	UNKNOWN	NO	NO	NO	NO	YES	NO
SANGER WPCP	SANGER, City of	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
SANTA MARGARITA CHIQUITA WRF	SOCWA/SANTA MARGARITA WATER DIST	YES	UNKNOWN	UNKNOWN	NO	YES	NO	NO	NO
SANTA MARIA WWTP	SANTA MARIA, City of	YES	UNKNOWN	UNKNOWN	UNKNOWN	YES	UNKNOWN	UNKNOWN	UNKNOWN
SAUGUS WRP	DISTRICTS OF LOS ANGELES COUNTY	YES	NO	NO	NO	NO	NO	YES	NO
SAUSALITO-MARIN CITY SD WWTP	SAUSALITO-MARIN CITY S.D.	YES	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
SEWER AUTHORITY_MID COASTSIDE	SEWER AUTHORITY_MID COASTSIDE	YES	NO	NO	NO	YES	NO	NO	NO
Sewerage Agency of Southern Marin	Sewerage Agency of Southern Marin/City of Mill Valle	YES	NO	NO	NO	NO	NO	NO	NO
Shasta Lake WWTP	Shasta Lake, City of	YES	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
SOCWA 3A WWTP	SOUTH ORANGE COUNTY WW AUTH	YES	NO	NO	NO	YES	NO	NO	NO
SOCWA J. B. LATHAM TP	SOUTH ORANGE COUNTY WW AUTH	YES	UNKNOWN	NO	NO	YES	N	NO	NO
SOCWA REGIONAL TP	SOUTH ORANGE COUNTY WW AUTH	YES	NO	NO	NO	YES	NO	NO	NO
South Bayside System Authority	South Bayside System Authority	YES	YES	NO	NO	YES	NO	NO	NO
South San Francisco - San Bruno WQCP	South San Francisco, City of	YES	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
South San Luis Obispo WWTP	SOUTH SAN LUIS OBISPO CSD	YES	NO	NO	NO	YES	NO	NO	NO
Southeast Water Pollution Control Plant	San Francisco Public Utilties Commission	YES	YES	NO	NO	YES	NO	NO	NO
STOCKTON REGIONAL WCF	Stockton, City of	YES	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
SUNNYVALE WPCP	SUNNYVALE, City of	YES	UNKNOWN	UNKNOWN	UNKNOWN	YES	UNKNOWN	UNKNOWN	UNKNOWN
TAHOE-TRUCKEE WWTP	TAHOE-TRUCKEE SANITATION AGENCY	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
Terminal Island Water Reclamation Plant	Los Angeles, City of	YES	NO	NO	NO	NO	NO	NO	NO
Terminal Island Water Reclamation Plant	Los Angeles, City of	YES	NO	NO	NO	NO	NO	NO	NO
TRACY WWTP	TRACY, CITY OF	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
TULARE WPCF	TULARE, CITY OF	YES	NO	NO	NO	YES	NO	NO	NO
Tuolomne U.D. Regional WWTP	TUOLUMNE UTILITIES DISTRICT	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
Turlock WQCF	TURLOCK, City of	YES	UNKNOWN	UNKNOWN	NO	YES	NO	NO	NO
Ukiah WWTP	UKIAH, CITY OF	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
Union Sanitary District Alvarado Wastewater Treatment Facil	Union Sanitary District	YES	NO	NO	NO	YES	NO	NO	NO
VACAVILLE EASTERLY WWTP	VACAVILLE, CITY OF	YES	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
Valencia Water Reclamation Plant	County Sanitation Districts of Los Angeles County	YES	NO	NO	NO	NO	NO	NO	NO
Ventura Water Reclamation Facility	Ventura, City of	YES	UNKNOWN	UNKNOWN	UNKNOWN	YES	UNKNOWN	UNKNOWN	UNKNOWN
Victor Valley Wastewater Reclamation Authority		YES	NO	NO	NO	NO	NO	NO	NO
VISALIA WCP	VISALIA, City of	YES	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
WASCO WWTP	WASCO, City of	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
WEST COUNTY WASTEWATER DST FAC	WEST COUNTY WASTEWATER DISTRICT	YES	NO	NO	NO	YES	NO	NO	NO
WHITTIER NARROWS WRP	DISTRICTS OF LOS ANGELES COUNTY	YES	NO	NO	YES	YES	YES	NO	NO
YUBA CITY WTF	YUBA CITY	YES	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	YES	UNKNOWN
Yucaipa Valley Henry N. Wochholtz WWTP	Yucaipa Valley Water District	YES	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN

California Association of Sanitation Agencies (CASA)

Table A-3
February 2013 POTW Survey of WWTP Not Digesting Wastewater Sludge

POTW Facility Name	Operating Authority	Average Daily Flow (MGD)	Design Flow Rate (MGD)	Digestion of Wastewater Sludge Practiced	Type of Anaerobic Digestion Practiced	Flare for Biogas	Waste Import
Adelanto WWTF	Adelanto, City of	2.16	0.00	NO	UNKNOWN	UNKNOWN	NO
American Canyon WWTF	American Canyon, City of	1.66	2.50	NO	UNKNOWN	UNKNOWN	NO
ANDERSON WPCP	ANDERSON, CITY OF	1.20	2.00	NO	UNKNOWN	UNKNOWN	NO
ARVIN WWTP	ARVIN, CITY OF	1.25	0.00	NO	UNKNOWN	UNKNOWN	NO
AUBURN WWTP	AUBURN, CITY OF	1.40	1.67	NO	UNKNOWN	UNKNOWN	NO
AVENAL WWTP	AVENAL, CITY OF	1.63	0.00	NO	UNKNOWN	UNKNOWN	NO
BARSTOW WWTF	BARSTOW, City of	2.30	4.50	NO	UNKNOWN	UNKNOWN	NO
Beaumont WWTP #1	BEAUMONT, City of	2.52	4.00	NO	UNKNOWN	UNKNOWN	NO
BIG BEAR AREA WWA WTP	BIG BEAR AREA REGIONAL WWA	3.20	0.00	NO	UNKNOWN	UNKNOWN	NO
BLYTHE RWRF	BLYTHE, City of	1.20	0.00	NO	UNKNOWN	UNKNOWN	NO
BRENTWOOD WWTF	BRENTWOOD, CITY OF	3.20	5.00	NO	UNKNOWN	UNKNOWN	NO
CALEXICO WWTP - Delete	Calexico, City of	0.00	0.00	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
California Men	California Dept. of Corrections and Rehabilitation	1.20	0.00	NO	UNKNOWN	UNKNOWN	NO
Calistoga WWTP	Calistoga, City of	0.50	0.00	NO	UNKNOWN	UNKNOWN	NO
Camp Pendleton Plant #11	US Marine Corps	0.00	3.15	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
Camp Pendleton SRTTP	US Marine Corps	2.50	3.50	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
Camrosa WRF	Camrosa Water District	1.45	0.00	NO	UNKNOWN	UNKNOWN	NO
CARPINTERIA S.D. WWTP	CARPINTERIA S.D.	1.38	1.70	NO	UNKNOWN	UNKNOWN	NO
Central Contra Costa Sanitary District	Central Contra Costa Sanitary District	50.00	0.00	NO	UNKNOWN	UNKNOWN	NO
CERES WRF	CERES, CITY OF	3.10	0.00	NO	UNKNOWN	UNKNOWN	NO
Chuckawalla WWTF	CA Dept. of Corrections	1.25	0.00	NO	UNKNOWN	UNKNOWN	NO
CITY OF ANGELS WWTP	City of Angles	0.00	0.00	NO	UNKNOWN	UNKNOWN	NO
CLOVERDALE WWTP	CLOVERDALE, CITY OF	2.00	0.66	NO	UNKNOWN	UNKNOWN	NO
Coachella Avenue 54 WWTP	COACHELLA, CITY OF	2.80	4.50	NO	UNKNOWN	UNKNOWN	NO
COACHELLA VWD - WRP 10 Palm Desert	COACHELLA VALLEY WATER DISTRICT	10.00	0.00	NO	UNKNOWN	UNKNOWN	UNKNOWN
COACHELLA VWD - WRP 4 Mid Valley	COACHELLA VALLEY WATER DIST.	5.00	7.00	NO	UNKNOWN	UNKNOWN	NO
COACHELLA VWD - WRP 7 Imp. Dist. 58	COACHELLA VALLEY WATER DISTRICT	2.47	0.00	NO	UNKNOWN	UNKNOWN	NO
Corcoran State Prison	CA Dept. of Corrections	4.00	0.00	NO	UNKNOWN	UNKNOWN	NO
CORONA WWTP NO. 3	Carona, City of	1.00	0.00	NO	UNKNOWN	UNKNOWN	NO
CUTLER-OROSI JPWA	CUTLER-OROSI JOINT POWERS WASTEWATER AUTHORITY	1.20	1.47	NO	UNKNOWN	UNKNOWN	NO
DISCOVERY BAY WWTP	Discovery Bay, Town of	1.73	2.10	NO	UNKNOWN	UNKNOWN	NO
DIXON WWTF	DIXON, City of	1.27	0.00	NO	UNKNOWN	UNKNOWN	UNKNOWN
EL DORADO DEER CREEK WWTP	EL DORADO IRRIGATION DISTRICT	3.00	2.50	NO	UNKNOWN	UNKNOWN	NO

Table A-3
February 2013 POTW Survey of WWTP Not Digesting Wastewater Sludge

POTW Facility Name	Operating Authority	Average Daily Flow (MGD)	Design Flow Rate (MGD)	Digestion of Wastewater Sludge Practiced	Type of Anaerobic Digestion Practiced	Flare for Biogas	Waste Import
Elsinore Valley Horse Thief Canyon Facility	Elsinore Valley MWD	1.00	0.00	NO	UNKNOWN	UNKNOWN	NO
ELSINORE VALLEY Regional Facility	ELSINORE VALLEY MWD	3.30	0.00	NO	UNKNOWN	UNKNOWN	NO
EXETER WWTF	EXETER, CITY OF	1.07	0.00	NO	UNKNOWN	UNKNOWN	NO
FALLBROOK WWTP 1	FALLBROOK PUBLIC UTILITY DISTRICT	1.76	2.70	NO	UNKNOWN	UNKNOWN	NO
FILLMORE WRP	FILLMORE, CITY OF	0.90	0.00	NO	UNKNOWN	UNKNOWN	NO
FORTUNA WWTP	FORTUNA, CITY OF	1.00	1.50	NO	UNKNOWN	UNKNOWN	UNKNOWN
GALT WWTP	Galt, City of	2.40	3.00	NO	UNKNOWN	UNKNOWN	NO
GUSTINE WWTF	GUSTINE, City of	0.70	0.00	NO	UNKNOWN	UNKNOWN	NO
Hughson WWTP	Hughson, City of	0.80	0.00	NO	UNKNOWN	UNKNOWN	NO
Ironhouse Sanitary District	Ironhouse Sanitary District	0.00	2.50	NO	UNKNOWN	UNKNOWN	NO
KING CITY WWF	KING, City of	0.76	0.00	NO	UNKNOWN	UNKNOWN	NO
LAKE COUNTY NW REGIONAL PLANT	LAKE COUNTY SAN DISTRICT	0.99	6.00	NO	UNKNOWN	UNKNOWN	NO
LAKE COUNTY SE REGIONAL PLANT	LAKE COUNTY SAN DISTRICT	6.00	6.00	NO	UNKNOWN	UNKNOWN	NO
Lamont WWTP	LAMONT, CITY OF	2.20	2.50	NO	UNKNOWN	UNKNOWN	NO
LEE LAKE REGIONAL STP		0.00	0.00	NO	UNKNOWN	UNKNOWN	UNKNOWN
LEMOORE WWTP	LEMOORE, City of	2.20	0.00	NO	UNKNOWN	UNKNOWN	NO
Lincoln WTRF	Lincoln, City of	3.00	4.20	NO	UNKNOWN	UNKNOWN	NO
LINDSAY WWF	LINDSAY, City of	1.20	0.00	NO	UNKNOWN	UNKNOWN	NO
LIVE OAK WWTP	Live Oak Sanitary District	0.00	0.00	NO	UNKNOWN	UNKNOWN	NO
Livingston DWTF	Livingston, City of	1.10	0.00	NO	UNKNOWN	UNKNOWN	NO
Los Banos WWTP	LOS BANOS, CITY OF	3.00	4.00	NO	UNKNOWN	UNKNOWN	NO
MISSION SPRINGS ALAN L. HORTON WWTP	MISSION SPRINGS WATER DISTRICT	1.46	0.00	NO	UNKNOWN	UNKNOWN	NO
MONTECITO S.D. WWTP	MONTECITO S.D.	0.79	1.50	NO	UNKNOWN	UNKNOWN	NO
MOORPARK	VENTURA COUNTY Waterworks Districts	3.00	3.00	NO	UNKNOWN	UNKNOWN	NO
Mountain House WWTP	Mountain House CSD	2.00	3.00	NO	UNKNOWN	UNKNOWN	UNKNOWN
NEEDLES WWTP	NEEDLES, CITY OF	0.55	0.00	NO	UNKNOWN	UNKNOWN	UNKNOWN
NEWHALL RANCH SD WRP	NEWHALL RANCH SD	0.00	0.00	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
NEWMAN WWTP	NEWMAN, CITY OF	1.11	2.18	NO	UNKNOWN	UNKNOWN	UNKNOWN
OAKDALE WQCP	OAKDALE, CITY OF	1.60	0.00	NO	UNKNOWN	UNKNOWN	UNKNOWN
Oceanside La Salina WWTP	OCEANSIDE, City of	2.90	5.50	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
Ojai Valley Wastewater Treatment Plant	Ojai Sanitation District	0.00	0.00	NO	UNKNOWN	UNKNOWN	NO
OLIVEHURST WWTP	OLIVEHURST PUD	1.30	1.80	NO	UNKNOWN	UNKNOWN	UNKNOWN
Oroville WWTP	Sewerage Commission - Oroville Region	3.00	6.50	NO	UNKNOWN	UNKNOWN	UNKNOWN

Table A-3
February 2013 POTW Survey of WWTP Not Digesting Wastewater Sludge

POTW Facility Name	Operating Authority	Average Daily Flow (MGD)	Design Flow Rate (MGD)	Digestion of Wastewater Sludge Practiced	Type of Anaerobic Digestion Practiced	Flare for Biogas	Waste Import
Pacifica Calera Creek WRF	Pacifica, City of	2.90	4.00	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
PALO ALTO RWQCP	PALO ALTO, CITY OF	21.30	39.00	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
PATTERSON WQCF	PATTERSON, CITY OF	1.50	0.00	NO	UNKNOWN	UNKNOWN	UNKNOWN
Pismo Beach WWTF	PISMO BEACH, CITY OF	1.75	1.75	NO	UNKNOWN	UNKNOWN	UNKNOWN
Rancho California Santa Rosa WRF	Rancho California Water District	2.74	0.00	NO	UNKNOWN	UNKNOWN	NO
RED BLUFF, CITY OF	RED BLUFF, CITY OF	1.60	2.50	NO	UNKNOWN	UNKNOWN	NO
Redding Stillwater WWTP	REDDING, City of	2.70	4.00	NO	UNKNOWN	UNKNOWN	NO
REEDLEY WWTP	REEDLEY, CITY OF	2.04	5.00	NO	UNKNOWN	UNKNOWN	NO
RIO DELL WWTP	RIO DELL, CITY OF	1.00	0.00	NO	UNKNOWN	UNKNOWN	NO
Riverbank WWTP	Riverbank, City of	1.70	7.90	NO	UNKNOWN	UNKNOWN	NO
Roseville Pleasant Grove WWTP	Roseville, City of	6.50	12.00	NO	UNKNOWN	UNKNOWN	NO
Russian River County Sanitation District	Russian River County Sanitation District	0.00	0.00	NO	UNKNOWN	UNKNOWN	UNKNOWN
SALIDA SD WWTP	SALIDA SANITARY DISTRICT	1.03	2.40	NO	UNKNOWN	UNKNOWN	NO
Santa Paula WRF	SANTA PAULA, CITY OF	1.71	2.50	NO	UNKNOWN	UNKNOWN	NO
SELMA-KINGSBURG-FOWLER WWTP	SELMA-KINGSBURG-FOWLER CSD	3.00	0.00	NO	UNKNOWN	UNKNOWN	NO
Sonoma Valley County Sanitation District	Sonoma Valley County Sanitation District	0.00	0.00	NO	UNKNOWN	UNKNOWN	UNKNOWN
SOUTH COUNTY REGIONAL WWTP	SOUTH COUNTY REGIONAL WASTEWATER AU	7.50	0.00	NO	UNKNOWN	UNKNOWN	NO
SOUTH TAHOE PUD WWTP	SOUTH TAHOE PUBLIC UTILITY DISTRICT	3.90	0.00	NO	UNKNOWN	UNKNOWN	NO
SUSANVILLE WWTP	SUSANVILLE SD	0.95	2.00	NO	UNKNOWN	UNKNOWN	NO
Taft Federal Prison WWTF	Taft Federal Prison	0.29	0.47	NO	UNKNOWN	UNKNOWN	NO
TAFT WWTF	TAFT, CITY OF	0.29	0.47	NO	UNKNOWN	UNKNOWN	NO
TEHACHAPI WWTP	TEHACHAPI, City of	0.85	0.00	NO	UNKNOWN	UNKNOWN	NO
Twentynine Palms USMC Mainside WWTP	US Marine Corps	1.30	2.50	NO	UNKNOWN	UNKNOWN	NO
UC DAVIS MAIN WWTP	UNIVERSITY OF CALIFORNIA, DAVIS	1.49	0.00	NO	UNKNOWN	UNKNOWN	NO
Vallejo Sanitation and Flood Control District	Vallejo Sanitation and Flood Control District	13.10	0.00	NO	UNKNOWN	UNKNOWN	NO
Valley Sanitary District WWTF	VALLEY SANITARY DISTRICT	6.10	11.00	NO	UNKNOWN	UNKNOWN	NO
Western Riverside County Regional WWTP	Western Riverside County Regional Wastewater Authority	4.41	0.00	NO	UNKNOWN	UNKNOWN	NO
Willits WWTP	WILLITS, City of	1.15	1.30	NO	UNKNOWN	UNKNOWN	NO
WILLOWS WWTP	Willows, City of	0.00	0.00	NO	UNKNOWN	UNKNOWN	NO
Windsor WWTF	Windsor, Town of	1.80	2.25	NO	UNKNOWN	UNKNOWN	NO
WOODLAND WWTP	WOODLAND, CITY OF	6.00	7.80	NO	UNKNOWN	UNKNOWN	NO
YREKA WWTP	YREKA, CITY OF	1.00	0.00	NO	UNKNOWN	UNKNOWN	NO