San Luis Obispo County
Los Osos Wastewater Project Development

TECHNICAL MEMORANDUM

PROJECTS ALTERNATIVES GREENHOUSE GAS EMISSIONS INVENTORY

FINAL DRAFT
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2700 YGNACIO VALLEY ROAD • SUITE 300 • WALNUT CREEK, CALIFORNIA 94598 • (925) 932-1710 • FAX (925) 930-0208

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PROJECTS ALTERNATIVES
GREENHOUSE GAS EMISSIONS INVENTORY

1.0 PURPOSE

The purpose of this technical memorandum (TM) is to evaluate greenhouse gas (GHG) emissions for the proposed Los Osos wastewater treatment facility as discussed in the Viable Project Alternatives Fine Screening Analysis (Carollo, August 2007) and subsequent technical memoranda. The County of San Luis Obispo (County) seeks to estimate the annual greenhouse gas (GHG) emissions of two collection system alternatives, 1) Gravity Collection System and 2) STEP Collection System; and three treatment alternatives, 1) Oxidation Ditch Treatment, 2) BIOLAC Treatment, and 3) Air Diffusion System (ADS) Pond Treatment. This TM provides a comprehensive GHG inventory including both annual O&M and construction emissions that will aid in comparing alternatives.

The information in this TM will be used as 1) a basis for evaluating the impacts of project alternatives for the environmental review document, and 2) a basis for further developing the project alternatives.

2.0 BACKGROUND

The state of California adopted the Global Warming Solutions Act of 2006 (also known as Assembly Bill 32, AB 32) in September of 2006. This Act is the first regulatory program in the U.S. that will require public and private agencies statewide to reduce GHG emissions to 1990 levels by 2020. Currently, there is no mandate on publicly owned treatment works (POTWs); however, the California Air Resources Board (ARB) has stated that POTWs would be included in the near future and early voluntary reporting is recommended.

Pursuant to AB 32, this TM uses the California Climate Action Registry General Reporting Protocol (CCAR GRP), a set of measuring standards and protocols aligned with the international GHG Protocol Initiative and adapted to California. Assembly Bill 32 recommends using this protocol “where appropriate and to the maximum extent feasible.” Agencies that choose to participate in the CCAR process will not be required to significantly alter their reporting or verification program except as determined by ARB for compliance purposes.

Not all GHGs identified in AB 32 will be regulated for POTWs. This TM focuses on carbon dioxide, methane, and nitrous oxide GHG emissions as these gases are relevant to and comprise the majority of GHG emissions generated from the conveyance and treatment of wastewater. The estimated annual GHG emissions are a result of the construction and operations phases of the proposed alternatives. In general, annual GHG emissions generated are a function of the flow treated, the influent water quality, and the treatment

processes used. A description of the calculation methodology is provided in the following section.

3.0 METHODOLOGY

The development of GHG emissions estimates requires a set of “boundary” conditions to define the life cycle stages, the unit processes, and the time frame that is included in the analysis. For this inventory, the construction and operations phases of the collection system and treatment facilities are considered. This includes:

- Construction of the collection system and treatment facilities (includes operation of construction equipment),
- Operation of the collection system and treatment facilities,
- Production and hauling of materials consumed and excavated for the construction of the collection system and treatment facilities,
- Production and hauling of chemicals consumed for the treatment of wastewater and biosolids annual operations,
- Hauling of septage from STEP tanks to the treatment facility,
- Release of methane from collection systems and treatment facilities, and
- Hauling of biosolids to the final disposal site.

A summary sheet is created as a result of the inputs and the calculations performed in the spreadsheets that support the inventory. The summary sheet is included in the Appendix of this TM, in addition to a listing of all the assumptions applied to complete the analysis.

Figure 1 illustrates the system boundaries used for this analysis.

3.1 Categorize and Identify Sources of GHG Emissions

There are two categories of emissions, direct and indirect, that were identified and evaluated for both the construction phase and the on-going operations phase (annual emissions).

- *Direct emissions* are those resulting from sources owned or controlled by the agency, such as stationary combustion sources, mobile combustion sources, and treatment unit processes. For this inventory, this includes treatment unit process emissions (e.g. septic tank venting).

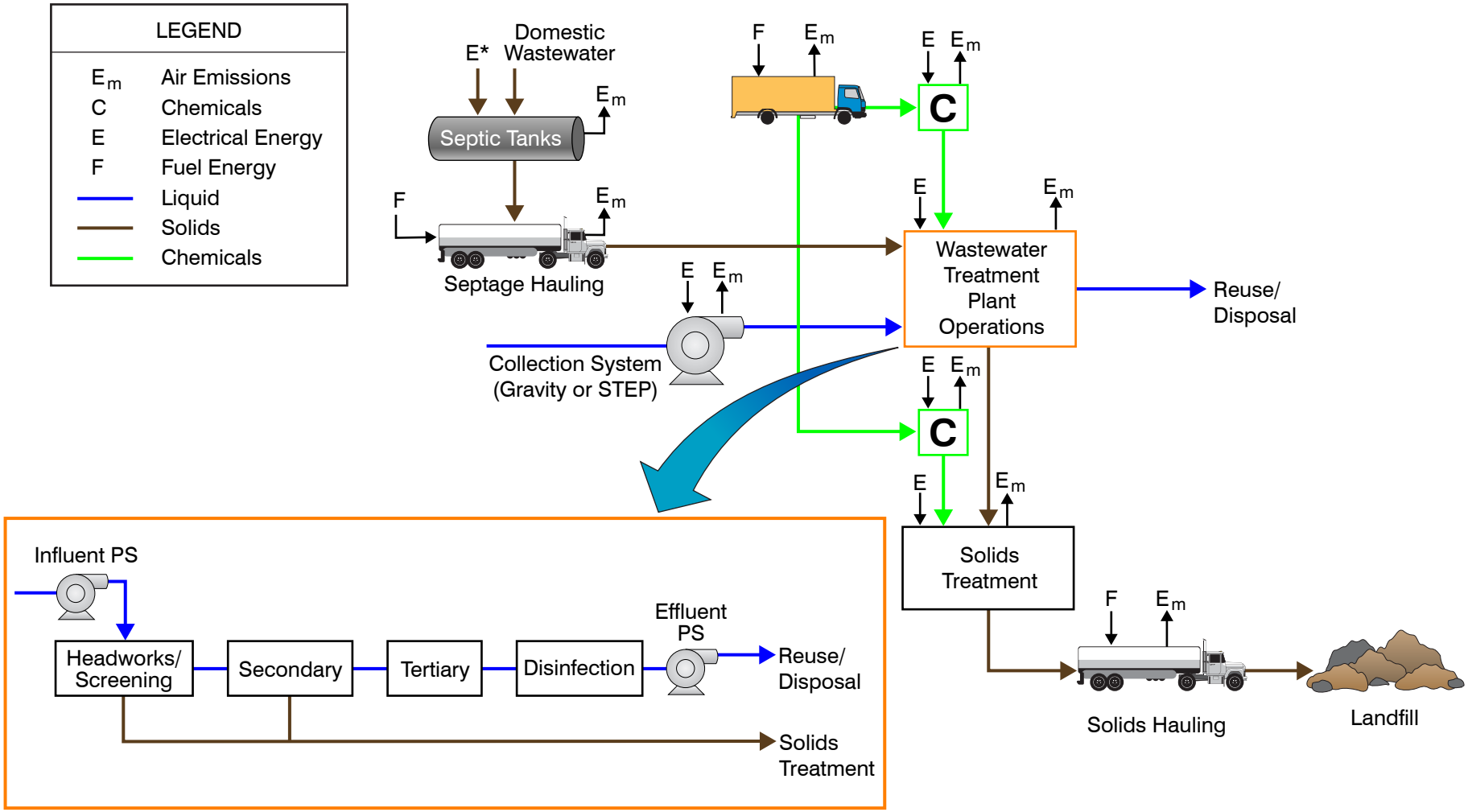

Figure 1
ALTERNATIVES SYSTEM BOUNDARY
LOS OSOS WASTEWATER PROJECT DEVELOPMENT
SAN LUIS OBISPO COUNTY

* Production of STEP Tanks

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- *Indirect emissions* are those originating from the actions of the agency, but are produced by sources owned or controlled by another entity. For this inventory, this includes: use of construction equipment, transport of septage, construction materials, and chemicals to the facilities, transport of biosolids to the disposal site, and purchased and consumed electricity for the operation of the facility, collection system, and the manufacturing of materials and chemicals used in the facility and collection system.

Indirect GHG emissions resulting from the construction phase are annualized over a 30-year time horizon to convert to annual emissions. These were added to the estimated annual GHG emissions resulting from operations to calculate the total annual GHG emissions.

3.2 Estimate GHG Emissions in Terms of "CO_2 Equivalents"

The major sources of GHG emissions were identified and categorized, and appropriate emission factors were determined. The data was then transferred into Carollo's GHG emissions inventory to calculate the quantities of carbon dioxide, methane, and nitrous oxide emissions generated from each source.

- *Electricity consumption (kilowatt-hours) x Emission Factor*
- *Vehicle fuel consumption (gallons or miles traveled) x Emission Factor*
- *Construction Material or Chemical Produced (unit weight) x Specific Energy (unit energy per unit weight of material or chemical) x Emission Factor*
- *Material Produced (unit weight) x Emission Factor*

Emissions were converted into carbon dioxide equivalent (CO_2e) emissions. The major GHG in the atmosphere is carbon dioxide. Other GHGs differ in their ability to absorb heat in the atmosphere. For example, methane (CH_4) has 21 times the capacity to absorb heat relative to carbon dioxide over a hundred-year time horizon, so it is considered to have a global warming potential (GWP) of 21. Nitrous Oxide (N_2O) has 310 times the capacity over a hundred-year time horizon having a GWP of 310. Therefore, a pound of emissions of carbon dioxide is not the same in terms of climatic impact as a pound of methane or nitrous oxide emitted. Carbon dioxide equivalent emissions are calculated by multiplying the amount of emissions of a particular GHG by its GWP (see Table 1).

Example: What is the CO_2e of one ton of methane emissions?

1 ton CH_4 x 21 (GWP, tons CO_2e/tons of CH_4 emitted) = 21 tons CO_2e

Table 1	Greenhouse Gases and Their Associated Global Warming Potentials (GWPs) Los Osos Wastewater Project Development San Luis Obispo County
Greenhouse Gas	**GWP*** **(unit mass CO_2e/unit mass of GHG emitted)**
Carbon Dioxide (CO_2)	1
Methane (CH_4)	21
Nitrous Oxide (N_2O)	310
* GWPs from the Intergovernmental Panel on Climate Change Second Assessment Report (1996) for a 100-year time horizon. These GWPs are still used today by international convention and the U.S. to maintain the value of the carbon dioxide "currency," and are used in this inventory to maintain consistency with international practice.	

4.0 DESCRIPTION OF GHG EMISSIONS ESTIMATES

This section provides a summary of the alternatives being evaluated and brief descriptions of the types of annual GHG emissions considered in this project and the sources of information.

Table 2 provides a summary of the alternative details used as a basis for the GHG inventory. The information provided in Table 2 is based on the alternatives developed in the Viable Project Alternatives Fine Screening Analysis (Fine Screening Analysis). Since the release of the Fine Screening Analysis in August 2007, updates have been made to the alternatives that are considered in this inventory and are presented in the Flows and Loads TM, Septage Receiving Station Option TM, Solids Handling Options TM, and the Partially Mixed Facultative Pond Options TM.

See the Appendix for a listing of assumptions and reference information used to complete the inventory and tables presenting the results of the direct and indirect GHG emissions described below.

4.1 Direct Emissions

4.1.1 Septic Tank Venting

Greenhouse gas (methane) emissions are generated from the anaerobic biodegradation of domestic wastewater within septic tanks in the community. The emissions generated are vented to the atmosphere contributing to the total carbon footprint calculated for the existing system and each project alternative.

Table 2 Summary of Project Alternative Details Used to Estimate Greenhouse Gas Emissions
Los Osos Wastewater Project Development
San Luis Obispo County

Alternative	Collection System	Treatment Technology	Tertiary Treatment Technology*	Solids Treatment & Disposal
Alternative 1	Gravity	**Oxidation Ditch** - Headworks, Oxidation Ditches, Secondary Clarifiers, UV Disinfection, Effluent PS**	Nitrification/ Denitrification & Filtration	Sub-Class B Biosolids
Alternative 2	STEP	**Oxidation Ditch** - Headworks, Oxidation Ditches, Secondary Clarifiers, UV Disinfection, Effluent PS	Nitrification/ Denitrification with methanol & Filtration	Sub-Class B Biosolids
Alternative 3	Gravity	**BIOLAC** - Headworks, Biolac Basins, Secondary Clarifiers, UV Disinfection, Effluent PS	Nitrification/ Denitrification & Filtration	Sub-Class B Biosolids
Alternative 4	STEP	**BIOLAC** - Headworks, Biolac Basins, Secondary Clarifiers, UV Disinfection, Effluent PS	Nitrification/ Denitrification with methanol & Filtration	Sub-Class B Biosolids
Alternative 5	Gravity	**ADS Ponds*** ** - Headworks, ADS Ponds, UV Disinfection, Effluent PS	Nitrification/ Denitrification with methanol & Filtration	Sub-Class B Biosolids
Alternative 6	STEP	**ADS Ponds*** ** - Headworks, ADS Ponds, UV Disinfection, Effluent PS	Nitrification/ Denitrification with methanol & Filtration	Sub-Class B Biosolids

* Tertiary treatment is not part of the base case project, however it will be considered in future projects since nitrification, denitrification, and/or filtration may be required to meet reuse/disposal water quality requirements.

** PS stands for Pump Station.

*** This inventory considered the Air Diffusion System (ADS) pond option, also known as the Nelson System since Nelson Environmental pioneered the pond system. In the ADS pond option, oxygen and mixing are provided by fine bubble diffusers that are laid out at the bottom of the ponds ensuring oxygen is vertically distributed throughout the pond. Based on the *2006 IPCC Guidelines for National GHG Inventories*, which is followed by the U.S. EPA, if a pond produces an aerobic environment it will produce little or no methane. This inventory assumes the ADS option does not generate any methane emissions. This is a conservative assumption as anaerobic pockets may occur in the accumulated solids, however it is consistent with the IPCC Guidelines.

Estimates of the annual methane emissions vented from septic tanks are included for the prohibition zone only at build-out. Alternatives considering a gravity collection system will not generate this type of emission since the septic tanks will be removed within the prohibition zone. The existing system and project alternatives considering a septic tank effluent pumping (STEP) collection system will have this type of emission within the prohibition zone.

Methane emissions are presented for the STEP collection system alternatives. Per Tables 10 and 11 of the Flows and Loads TM (February 2008), the BOD concentration of raw domestic sewage entering the septic tanks is 340 mg/L, a portion of the BOD remains with the settled solids and a portion leaves with the septic tank effluent, and the BOD concentration remaining in the septic tanks is 200 mg/L. The 200 mg/L BOD remaining in the tank is then converted to methane as the solids are digested. The estimate of annual pounds of BOD remaining in the septic tanks is based on a build-out population projected to be 18,428 and a daily flow per capita estimated to be 60 gallons per day with conservation (Flows and Loads TM, February 2008).

The approach used for calculating septic tank methane emissions are established in the *2006 IPCC Guidelines for National GHG Inventories* which is followed by the U.S. EPA. The approach assumes 16.25 percent of wastewater BOD_5 is anaerobically digested in a septic tank. This proportion of BOD is then multiplied by an emission factor of 0.6 kilograms of methane per kilogram BOD_5.

Odor control devices, such as those produced by Wolverine® for residential use, have been advertised as being capable of reducing methane and hydrogen sulfide emissions. An objective review of this device has shown that the vendor has no data to support the claim of reducing methane emissions.

4.2 Indirect Emissions

4.2.1 Operation of Collection System and Treatment Facilities

Greenhouse gas emissions estimates from the operation of the collection system pump stations and treatment facilities are based on the total annual energy demand (kilowatt-hours per year). The annual energy demands were estimated for the collection system options (gravity and STEP), the pump stations (PS) and treatment processes listed under the treatment technology options, the tertiary treatment options, and the solids treatment options. The total annual energy demand estimates were based on the operation and maintenance (O&M) estimates developed by Carollo Engineers.

Plant staff commuting and the periodic use of equipment for maintenance is not included in this GHG inventory since it is assumed to result in minimal impact relative to the operation of the collection system, pump stations, and treatment system and will not differ significantly among the alternatives.

4.2.2 Construction of the Collection System

Estimates of GHG emissions generated from the construction of the gravity and STEP collection systems were developed using previous estimates of pipeline lengths and Carollo's 3B Conceptual Pipeline Model to estimate material excavation. In order to install the pipeline, sections of roadway need to be removed and replaced. Estimates for roadway removal were also developed and presented in the Fine Screening Report and are considered in this inventory.

Construction crew commuting is not included in this GHG inventory since it is assumed to result in minimal impact relative to the construction and operation of the collection system and pump stations and will not differ significantly among the alternatives

4.2.3 Construction of Treatment Facilities

Estimates of GHG emissions generated from the construction of the treatment facilities were based on materials and processes required for each treatment process included in the project alternatives. The treatment trains for all alternatives consist of an headworks, filtration, ultraviolet (UV) disinfection, and an effluent pump station. The treatment processes that differ among the alternatives are the secondary and nitrification/denitrification processes.

Construction crew commuting is not included in this GHG inventory since it is assumed to result in minimal impact relative to the construction and operation of the treatment system and will not differ significantly among the alternatives

4.2.4 Chemical Production

The California Climate Action Registry General Reporting Protocol (CCAR GRP) considers energy required for the production of chemicals consumed in treatment processes to be outside the boundary of this type of inventory. However, in order to provide a more complete comparison of the impacts of the alternatives, and because of its relative contribution to the overall carbon footprint of the project, the energy consumed for chemical production was included in this inventory. The energy per unit chemical consumed is calculated using conversion factors from the text "Energy in Wastewater Treatment" by William F. Owen. Annual chemical consumption for each alternative is based on estimates developed by Carollo.

4.2.5 Construction Material Handling

Estimates of GHG emissions generated from the transport of construction materials are based on the type of truck used, the type of fuel consumed, and the distance from the materials' distribution center. Carollo applied assumptions for the truck type and fuel type consumed, and based the volume of material to be hauled and the source of materials on Carollo reference projects.

4.2.6 Solids Handling

Estimates of GHG emissions generated from the transport of Sub-Class B biosolids are based on the type of truck used, the type of fuel consumed, and the distance traveled to the disposal site. Per the Solids Handling Options TM, Sub-Class B biosolids are assumed to be hauled to a composting facility, McCarthy Family Farms in Kings County, CA, which is about a 130-mile trip. Carollo applied assumptions for the truck type and the fuel type used, and the disposal site was provided by the County.

4.2.7 Septage Handling

Estimates of GHG emissions for the transport of septage from the community of Los Osos the Los Osos WWTP for the project alternatives are based on several criteria. The criteria include the type of truck used, the type of fuel consumed, the annual number of truck trips required to transport domestic septage for the existing system and each project alternative, and the average distance traveled to the Los Osos WWTP. Carollo applied assumptions for the truck type, the fuel type used, and the average distance from the community's septic tanks to the Los Osos WWTP, while the number of truck trips was estimated per information provided in the Septage Receiving Station Option TM (Carollo, April 2008).

4.2.8 Chemical Handling

Estimates of GHG emissions generated from the transport of chemicals are based on the type of truck used, the type of fuel consumed, and the distance from the chemical's distribution center. Carollo applied assumptions for the truck type and fuel type consumed, and based the source of chemicals on Carollo reference projects.

5.0 EXISTING SYSTEM

The community of Los Osos, California is located on the coastline of Central California adjacent to the Morro Bay State and National Estuary. The existing system relies on privately owned septic tanks for its approximately 14,600 residents. The State Water Resources Control Board's On-Site Wastewater Treatment System Regulations (Assembly Bill 885, AB 885) will require that all septic tanks be pumped and inspected once every five years. For this inventory, GHG emissions related to the manufacturing, transport, and installation of the existing septic tanks are not included. It is assumed that the septic tanks will be pumped every five years and the septage will continue to be hauled to the Santa Maria WWTP. The BOD remaining in the septic tanks is converted into methane through anaerobic digestion and is vented to the atmosphere.

6.0 SUMMARY OF GHG EMISSIONS ESTIMATES FOR ALTERNATIVES

As part of the evaluation of the existing system and the project alternatives, GHG emissions estimates were developed. The resulting annual GHG emissions estimated for the construction and operation of each alternative are summarized in Figure 2 and Table 3. The differences in annual generation of GHG emissions among the alternatives are primarily drawn from energy consumption, chemical production, and methane generation. Greenhouse gas emissions resulting from construction processes and material handling are also presented as a “one-time” emission in Figure 3 and Table 4.

6.1 Annual GHG Emissions

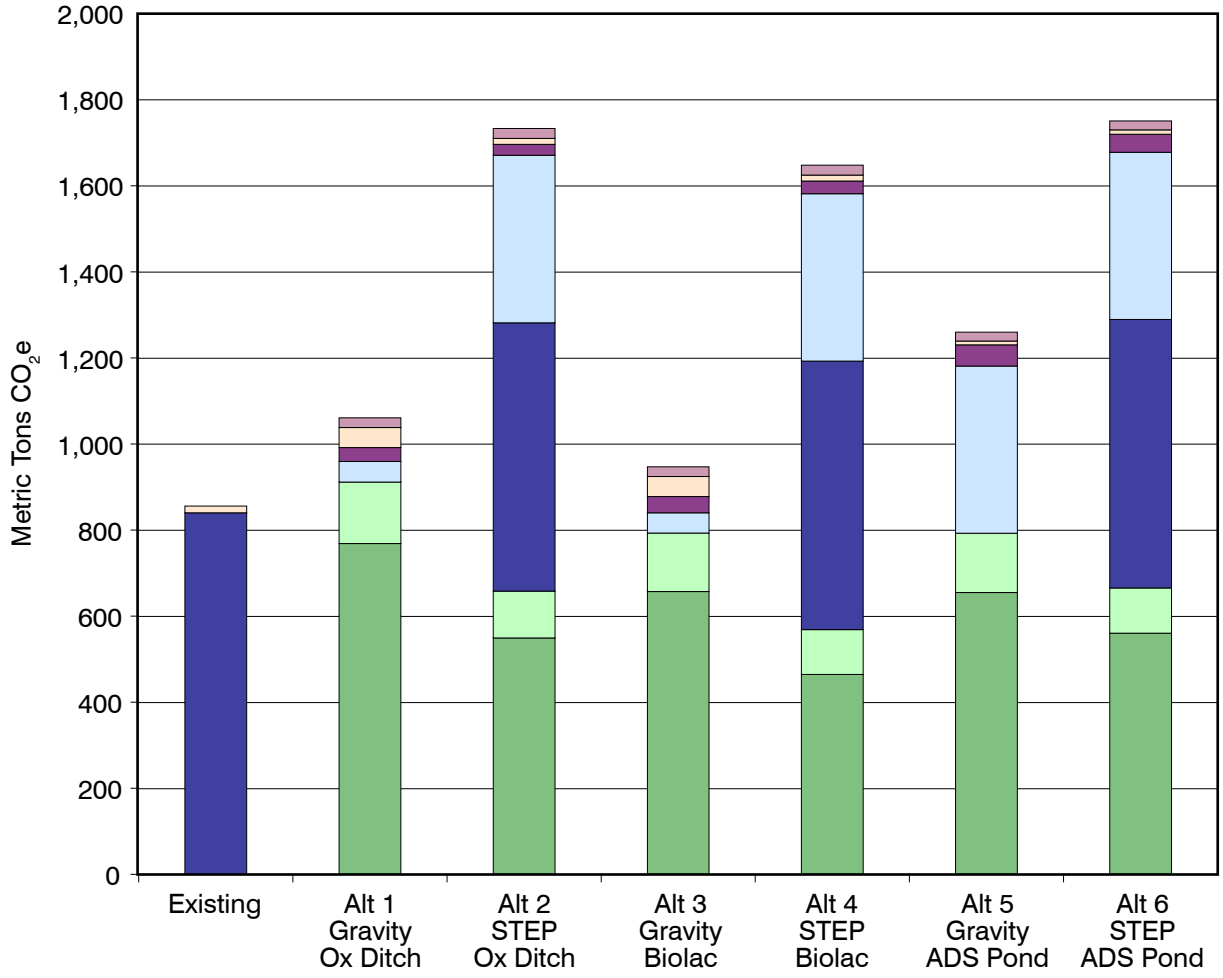
6.1.1 Energy Consumption

Energy consumed for the operations of both the collection system and treatment facility is considered. This category represents the annual electricity consumed for daily operations.

- The STEP collection system alternatives overall are the least energy intensive options. The STEP collection system alternatives can be considered nearly the same in energy consumption due to the uncertainty associated with these types of analyses.
- The Oxidation Ditch alternative in combination with the gravity collection system is the most energy intensive primarily due to the energy consumed for the oxidation ditch treatment process.
- The Biolac alternative in combination with the STEP collection system is the least energy intensive option.

6.1.2 Chemical Production

As mentioned in section 6.1.2, the alternatives served by gravity result in significantly less emissions than those served by STEP. This is also in part due to the STEP alternatives and the gravity ADS Pond alternative requiring more chemicals (i.e., methanol) for treatment purposes. Methanol serves as a carbon source in the denitrification process, and requires an energy intensive process for its production that leads to generation of indirect GHG emissions.



LEGEND

- Chemicals Handling
- Solids and Septage Handling
- Construction Material Handling
- Chemical Production
- STEP - Septic Tank Venting
- Construction Process and Material Production
- Collection System and Treatment Operations Energy

Figure 2
ANNUAL METRIC TONS OF
CARBON DIOXIDE EQUIVALENT (CO_2e) EMISSIONS
LOS OSOS WASTEWATER PROJECT DEVELOPMENT
SAN LUIS OBISPO COUNTY

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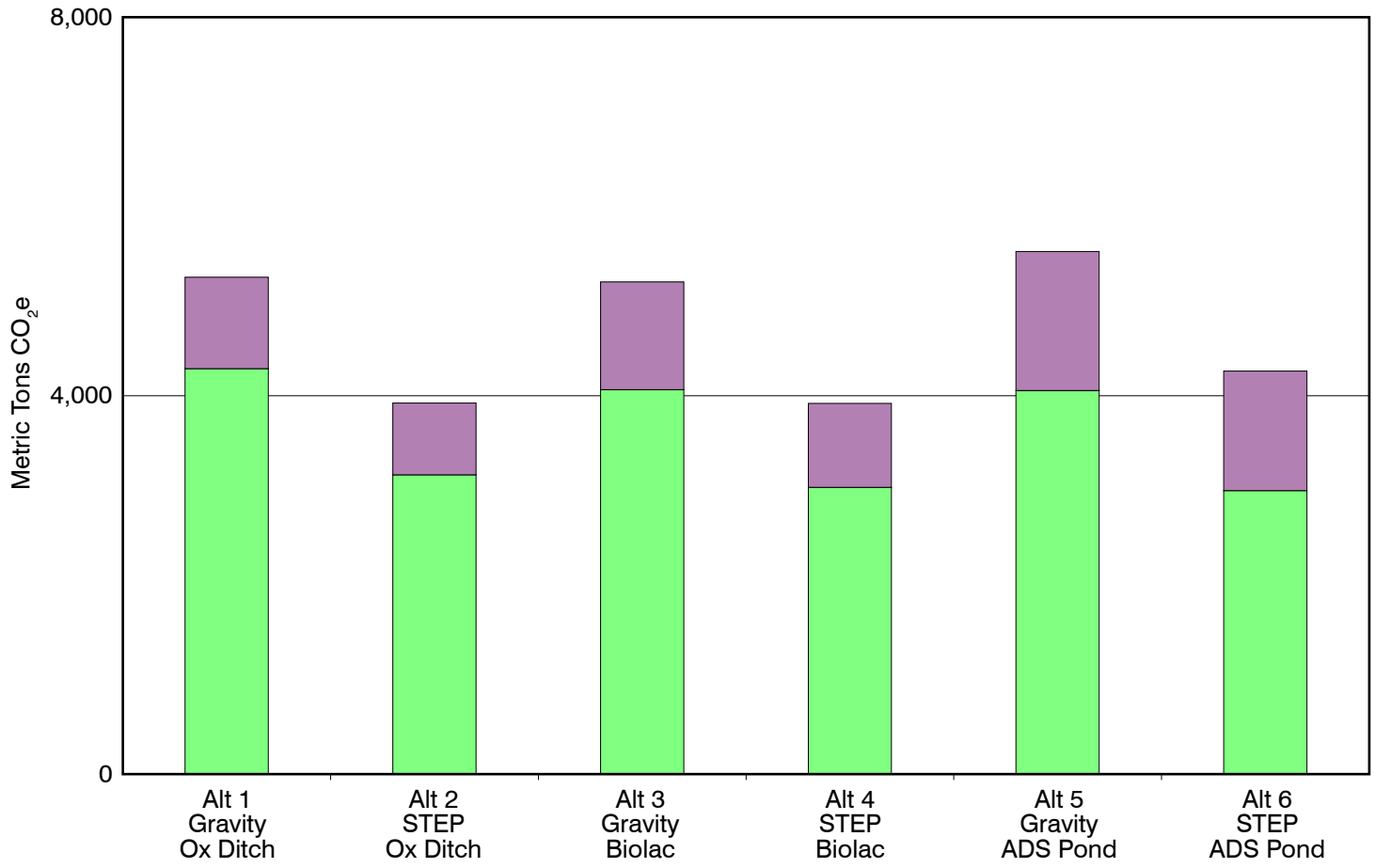
Table 3 Annual Total Metric Tons of Carbon Dioxide Equivalent (CO_2e) Emissions
Los Osos Wastewater Project Development
San Luis Obispo County

Alternative	INDIRECT						DIRECT	TOTAL Metric Tons CO_2e Emissions per year
	Collection System & Treatment Operations Energy	Construction Process & Material Production	Chemical Production	Construction Material Handling	Solids & Septage Handling	Chemicals Handling	STEP - Septic Tank Venting	
Existing	0	0	0	0	16	0	840	**856**
Alt 1 - Gravity Ox Ditch	769	143	48	32	47	22	0	**1,061**
Alt 2 - STEP Ox Ditch	549	103	389	22	14	23	624	**1,724**
Alt 3 - Gravity Biolac	657	136	47	38	47	22	0	**947**
Alt 4 - STEP Biolac	464	99	389	26	14	23	624	**1,639**
Alt 5 - Gravity ADS Pond	655	138	389	49	9	20	0	**1,260**
Alt 6 - STEP ADS Pond	560	100	389	39	10	21	624	**1,742**



LEGEND

- Construction Material Handling
- Construction Process and Material Production

Figure 3
TOTAL METRIC TONS OF
CARBON DIOXIDE EQUIVALENT (CO_2e) EMISSIONS
RESULTING FROM CONSTRUCTION ACTIVITIES
LOS OSOS WASTEWATER PROJECT DEVELOPMENT
SAN LUIS OBISPO COUNTY

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Table 4	Total Metric Tons of Carbon Dioxide Equivalent (CO_2e) Emissions Resulting from Construction Activities Los Osos Wastewater Project Development San Luis Obispo County		
	Indirect		
	Construction Process and Material Production	Construction Material Handling	Total Metric Tons CO_2e Emissions
Existing	0	0	**0**
Alt 1 - Gravity Ox Ditch	4,286	965	**5,251**
Alt 2 - STEP Ox Ditch	3,088	656	**3,744**
Alt 3 - Gravity Biolac	4,064	1,139	**5,203**
Alt 4 - STEP Biolac	2,955	786	**3,740**
Alt 5 - Gravity ADS Pond	4,055	1,469	**5,524**
Alt 6 - STEP ADS Pond	2,919	1,163	**4,082**

6.1.3 Methane Generation

The alternatives served by gravity result in significantly less emissions than those served by STEP. This is because septic tanks throughout the STEP collection system vent large amounts of methane annually due to the anaerobic digestion of settled solids within the tanks. Remember that methane has a GWP 21 times that of carbon dioxide.

6.2 Total Construction GHG Emissions

Total (or one-time) construction GHG emissions refer to the total emissions generated from construction processes and material handling without annualizing the emissions over the 30-year time horizon. These “one-time” emissions are presented in Figure 3 and Table 4.

These results show a different outcome due to the difference in materials (production and handling) and processes required for the construction of the collection systems and treatment processes for each alternative. Due to the uncertainty associated with these types of analyses, the material production and onsite construction processes are considered the same across alternatives served by the same type of collection system. However, the material handling (in other words, the transport of materials) varies across the alternatives due to the different sources or disposal locations of the materials.

6.3 Summary

In summary, for gravity collection system alternatives, the Biolac alternative generates the least GHG emissions compared to the Oxidation Ditch and ADS Pond alternatives. This is due to the alternative’s low chemical use and absence of septic tanks or other treatment process that would lead to methane generation and venting. However, for the STEP collection system alternatives, due to the uncertainty in these analyses, the levels of GHG emissions generated by each of the alternatives are considered nearly the same.

APPENDIX - ASSUMPTIONS AND GHG SUMMARY TABLES

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ELECTRICITY CONSUMPTION FOR OPERATIONS

- Treatment estimates include secondary treatment technology, nitrification/denitrification, tertiary treatment, and solids treatment.
- Pump station estimates include residential on-lot pumps (STEP system) or collection system pump stations (gravity system).
- Alternatives include community septage only at buildout for the prohibition zone.
- Existing system considers the existing septic tanks pumped every five years and the septage will continue to be hauled to the Santa Maria WWTP.
- Alternative 1 (Gravity Ox Ditch) system includes headworks/screening/septage receiving, oxidation ditch, secondary sedimentation, UV disinfection, and effluent pumping.
- Alternative 2 (STEP Ox Ditch) system includes headworks/screening/septage receiving, oxidation ditch, secondary sedimentation, UV disinfection, and effluent pumping.
- Alternative 3 (Gravity BIOLAC) system includes headworks/screening/septage receiving, BIOLAC process, secondary sedimentation, UV disinfection, and effluent pumping.
- Alternative 4 (STEP BIOLAC) system includes headworks/screening/septage receiving, BIOLAC process, secondary sedimentation, UV disinfection, and effluent pumping.
- Alternative 5 (Gravity ADS pond) system includes headworks/screening/septage receiving, ADS ponds, UV disinfection, and effluent pumping.
- Alternative 6 (STEP ADS pond) system includes headworks/screening/septage receiving, ADS ponds, UV disinfection, and effluent pumping.
- Solids treatment for all alternatives assumes thickening, dewatering, and hauling of subclass B solids to a landfill.
- Air Diffusion System ponds and Partially Mixed Facultative Ponds produce an aerobic environment, and therefore will produce little or no methane per *2006 IPCC Guidelines for National GHG Inventories*.

- Plant staff commuting and the periodic use of equipment for maintenance is not included in this GHG inventory since it is assumed to result in minimal impact relative to the operation of the collection system, pump stations, and treatment system and will not differ significantly among the alternatives.

CONSTRUCTION MATERIALS AND PROCESSES

- Gravity collection system construction includes installation of sewers and force mains, pump stations, laterals in right-of-way, on-lot laterals, removal of septic tanks, and roadway removal and materials.
- STEP collection system construction includes installation of sewers and force mains, laterals in right-of-way, on-lot laterals, removal and installation of septic tanks, and roadway removal and materials.
- STEP tank supplier is assumed to be Orenco System Inc. The local distributor is Bio-solutions in Agoura Hills, CA, and the tanks are assumed to be hauled 33 (unassembled, 11 high and 3 stacks) at a time on a step-deck truck to the Los Osos WWTP.
- STEP tanks are assumed to be placed with four (4) feet of cover, with 6" of aggregate base.
- For the installation of the STEP collection system, existing septic tanks will either be abandoned or removed (if the STEP tanks will be installed in the same location). The disposal of the removed septic tanks is not included in this inventory.
- Gravity and STEP collection system construction does not include manufacturing of pump or pump station equipment.
- The gravity collection system options will be installed using open trenching. Pipe lengths are based on the "Los Osos Wastewater Project Area A, B, C, & D - Bid Schedule" and the Fine Screening Report, assuming 4,769 connections and 12,000 feet of 18" diameter pipe from the central pump station to the out of town treatment facility (probable route).
- The STEP collection system options will be installed using horizontal directional drilling (HDD), pipe lengths are based on Ripley Pacific Team Los Osos Wastewater Management Plan Update (July 2006) and the Fine Screening Report, assuming 4,769 connections and 12,000 feet of 14" diameter pipe from a central location in town to the out of town treatment facility.
- Excavated material quantities for the collection system were calculated based on Carollo reference projects and the Carollo 3B pipeline model.

- Excavated material for the installation of the collection system pipeline will be reused onsite as backfill.
- Excavated material for construction of treatment facilities will be reused onsite as backfill. Excess excavated material will be off-hauled to the Cold Canyon landfill via 23-ton truck (assumed the same landfill as that used for solids disposal).
- Assuming the installation of laterals and the out of town conveyance will not require the removal or replacement of pavement or aggregate base.
- Biolac lining requirements are based on a Carollo reference project.
- Concrete, excavation, and backfill estimates for treatment construction are based on construction estimates prepared by Carollo.
- Assuming asphalt will be transported from Santa Maria, CA in 7.5 cubic yard capacity trucks.
- Aggregate base assumed to be supplied from Santa Maria, CA in 16 cubic yard capacity trucks.
- Assuming concrete will be transported from San Luis Obispo in trucks with 10 cubic yard capacity.
- Riprap will be hauled 18 tons per truckload to the Los Osos WWTP from Santa Maria, CA.
- The generation of construction material waste will not be significantly different across the alternatives and will result in minimal impact.
- Construction crew commuting is not included in this GHG inventory since it is assumed to result in minimal impact relative to the construction and operation of the collection system, pump stations, and treatment system and will not differ significantly among the alternatives.

CHEMICAL CONSUMPTION & HANDLING

- Assuming polymer for thickening and dewatering is 40% active.
- Information for polymer was provided by Nalco Chemicals Co. Polymer is assumed to be supplied in 250-gallon totes, delivered by carrier truck with an average capacity of 11 totes, and assumed shelf-life is 6 months. Minimum delivery frequency of 4 months is assumed.
- Quantities of polymer, alum, and methanol are based on the O&M estimates prepared by Carollo.

- Assuming that odor control chemicals will only be needed at the headworks and the thickening/dewatering building per Carollo reference projects.
- Typical building sizes were assumed for the headworks and thickening/dewatering buildings; air space to be treated is estimated at 90,000 cubic feet for the headworks and 25,000 cubic feet for the thickening/dewatering building. Sodium hydroxide concentration is 50% and sodium hypochlorite concentration at 12.5% based on Carollo reference project odor control system by RJ Environmental.
- Three-stage, packaged odor control scrubbers using sodium hydroxide and sodium hypochlorite were assumed.
- Sodium hypochlorite and sodium hydroxide suppliers are assumed to be located in Los Angeles, CA, and delivered via a 6,800-gallon tanker truck. Sodium hypochlorite shelf-life is 2 weeks per Carollo reference projects.
- Chemicals used for UV lamp cleaning are assumed to be negligible.
- Methanol is assumed to be supplied from Unibar (Fresno, CA) and delivered via a tanker truck with a capacity of 45,000 lbs (or 6,800 gallons).
- Assuming alum is 47% active, supplied in a 48,000 lb capacity tanker truck. Supplier is assumed to be located in Los Angeles per Carollo reference projects.

BIOSOLIDS & SEPTAGE HANDLING RESULTING FROM OPERATIONS

- Trucks hauling septage are assumed to be tankers with a 3000-gallon capacity per Septage Receiving Station Option TM, April 2008.
- Septage is assumed to travel 3 miles one-way to the Los Osos WWTP per Carollo estimate based on capacity of truck and average distance from community septic tanks to the WWTP.
- At build-out no septic tanks will exist within the prohibition zone for the gravity collection system project alternatives per Septage Receiving Station Option TM, April 2008.
- At build-out all septic tanks within the prohibition zone for the STEP collection system will contain 200 mg/L BOD in the septage. Per the Flows and Loads TM, the septic tank influent is 340 mg/L and a portion of the BOD is assumed to leave the septic tank.
- Population at build-out is estimated to be 18,428 and the daily flow per capita is estimated to be about 60 gallons per capita per day with conservation per the Flows and Loads TM, Table 6, February 2008.

- 16.25% of wastewater BOD_5 is anaerobically digested in septic tanks per "Improvements to the U.S. Wastewater Methane and Nitrous Oxide Emissions Estimates," U.S. EPA, Elizabeth A. Scheehle and Michiel R.J. Doorn.
- Trucks hauling solids are assumed to be enclosed long-bed trailers with a 40,000 lb capacity per the Biosolids Handling Options TM, April 2008.
- Hauling of sub-class B biosolids requires four trucks per week for the gravity collection system and one truck per week for the STEP collection system per the Biosolids Handling Options TM, April 2008.

The following tables summarize the GHG emissions generated by category for the existing system and the project alternatives. Brief explanations of the results of each table follow.

GHG EMISSIONS SUMMARY

Refer to CCAR:GRP 2007, Appendix C, for Emission Factors.	Subregion Electricity Emission Factors, gCO_2e/kWh	Petroleum Fuel Emission Factors, kg/MMBtu	Natural Gas Emission Factors, kg/MMBtu
Carbon Dioxide (CO_2)	364.9	62.30	53.05
Methane (CH_4)	0.0638	0.002	0.0059
Nitrous Oxide (N_2O)	0.5202	0.0006	0.0001

Legend
Inputs
Calculations
Carried Over
Not applicable

	Global Warming Potential
Carbon Dioxide (CO_2)	1
Methane (CH_4)	21
Nitrous Oxide (N_2O)	310

INDIRECT EMISSIONS

Table 1. CO_2-Equivalent Emissions Resulting from Electricity Consumption for Operation of the Treatment Facility & Pumping Stations

	Annual Electricity Consumption (kWh)	Multiply by Average Emission Factor, gCO_2e			Total CO_2e Emissions not including T&D Loss		Total CO_2e Emissions including T&D Loss
		Carbon Dioxide	Methane	Nitrous Oxide	gCO_2e	Metric Tons CO_2e	Metric Tons CO_2e
Existing	0	0	0	0	0	0	**0**
Alt 1 - Gravity Ox Ditch	1,934,998	706,144,446	123,492	1,006,500	707,274,438	707	**769**
Alt 2 - STEP Ox Ditch	1,382,920	504,673,017	88,258	719,333	505,480,608	505	**549**
Alt 3 - Gravity Biolac	1,654,383	603,738,799	105,583	860,536	604,704,918	605	**657**
Alt 4 - STEP Biolac	1,168,920	426,577,374	74,601	608,020	427,259,995	427	**464**
Alt 5 - Gravity ADS Pond	1,648,651	601,647,003	105,218	857,555	602,609,775	603	**655**
Alt 6 - STEP ADS Pond	1,410,123	514,600,287	89,995	733,483	515,423,764	515	**560**

Table 2. Annualized CO_2 Equivalent Emissions Resulting from the Processing and Production of Construction Materials over a 30-year Time Horizon

	CO_2e Generated per Process & Material Produced						
Material Name	**Existing**	**Alt 1 - Gravity Ox Ditch**	**Alt 2 - STEP Ox Ditch**	**Alt 3 - Gravity Biolac**	**Alt 4 - STEP Biolac**	**Alt 5 - Gravity ADS Pond**	**Alt 6 - STEP ADS Pond**
Treatment - Concrete	0	22,319,161	20,006,459	14,157,381	15,127,607	7,639,046	7,417,280
Treatment - Earthwork	0	203,466	220,599	860,886	597,393	5,454,224	5,461,539
Septic Tanks	0	0	12,690,162	0	12,690,162	0	12,690,162
Collection System	0	18,912,063	1,245,652	18,912,063	1,245,652	18,912,063	1,245,652
Lining - Polyethylene	0	0	0	298,124	203,291	1,860,131	1,860,131
Piping - PVC	0	101,425,680	68,770,191	101,425,680	68,770,191	101,425,680	68,770,191
LDPE (2% Black C) Tubing	0	0	0	0	0	2,212,939	2,212,939
Total Metric Tons CO_2e:	**0**	**143**	**103**	**136**	**99**	**138**	**100**

In grams...

In Metric Tons...

Table 3. Total CO_2 Equivalent Emissions Resulting from the Processing and Production of Construction Materials

	CO_2e Generated per Process & Material Produced							
Material Name	**Factor for 30-year Time Horizon**	**Existing**	**Alt 1 - Gravity Ox Ditch**	**Alt 2 - STEP Ox Ditch**	**Alt 3 - Gravity Biolac**	**Alt 4 - STEP Biolac**	**Alt 5 - Gravity ADS Pond**	**Alt 6 - STEP ADS Pond**
Treatment - Concrete	1.0	0	669,574,835	600,193,766	424,721,440	453,828,224	229,171,373	222,518,394
Treatment - Earthwork	1.0	0	6,103,983	6,617,964	25,826,565	17,921,775	163,626,709	163,846,183
Septic Tanks	1.0	0	0	380,704,864	0	380,704,864	0	380,704,864
Collection System	1.0	0	567,361,877	37,369,547	567,361,877	37,369,547	567,361,877	37,369,547
Lining - Polyethylene	3.0	0	0	0	2,981,241	2,032,912	18,601,311	18,601,311
Piping - PVC	1.0	0	3,042,770,396	2,063,105,724	3,042,770,396	2,063,105,724	3,042,770,396	2,063,105,724
LDPE (2% Black C) Tubing	2.0	0	0	0	0	0	33,194,090	33,194,090
Total Metric Tons CO_2e:		**0**	**4,286**	**3,088**	**4,064**	**2,955**	**4,055**	**2,919**

In grams...

In Metric Tons...

Table 4. CO_2 Equivalent Emissions Resulting from the Production of Chemicals

	CO_2e Generated per Chemical Produced						
Chemical Name	**Existing**	**Alt 1 - Gravity Ox Ditch**	**Alt 2 - STEP Ox Ditch**	**Alt 3 - Gravity Biolac**	**Alt 4 - STEP Biolac**	**Alt 5 - Gravity ADS Pond**	**Alt 6 - STEP ADS Pond**
Sodium Hypochlorite	0	12,062,971	12,062,971	12,062,971	12,062,971	12,062,971	12,062,971
Sodium Hydroxide	0	20,531,083	20,531,083	20,531,083	20,531,083	20,531,083	20,531,083
Polymer - Thickening	0	1,590,744	426,785	1,357,952	329,788	0	0
Polymer - Dewatering	0	4,772,231	1,280,355	4,073,856	989,365	975,515	819,432
Alum	0	5,401,095	5,431,954	5,401,095	5,431,954	5,401,095	5,431,954
Filter Polymer	0	3,597,111	3,617,307	3,597,111	3,617,307	3,597,111	3,617,307
Methanol	0	0	346,060,631	0	346,060,631	346,060,631	346,060,631
Total Metric Tons CO_2e:	**0**	**48**	**389**	**47**	**389**	**389**	**389**

Table 5. Annualized CO_2-Equivalent Emissions Resulting from Fuel Consumption for Construction Material Handling over a 30-year Time Horizon

	Annual VMT*	**Annual Gallons Diesel**	**Carbon Dioxide**	**Methane**	**Nitrous Oxide**	**Total CO2e Emissions**	
			(kg CO2/year)	**(g CO2e/year)**	**(g CO2e/year)**	**kilograms/year**	**Metric Tons/year**
Existing	0	0	0	0	0	0	**0**
Alt 1 - Gravity Ox Ditch	18,137	3,210	31,972	22,852	281,118	32,276	**32**
Alt 2 - STEP Ox Ditch	12,299	2,177	21,682	15,497	190,641	21,888	**22**
Alt 3 - Gravity Biolac	21,380	3,784	37,689	26,939	331,389	38,048	**38**
Alt 4 - STEP Biolac	14,713	2,604	25,936	18,538	228,046	26,183	**26**
Alt 5 - Gravity ADS Pond	27,569	4,879	48,599	34,737	427,319	49,062	**49**
Alt 6 - STEP ADS Pond	21,784	3,856	38,401	27,448	337,649	38,766	**39**

*Vehicle-miles traveled, VMT

Table 6. Total CO_2-Equivalent Emissions Resulting from Fuel Consumption for Construction Material Handling

	Total VMT*	**Total Gallons Diesel**	**Carbon Dioxide**	**Methane**	**Nitrous Oxide**	**Total CO2e Emissions**	
			(kg CO2e)	**(g CO2e)**	**(g CO2e)**	**kilograms**	**Metric Tons**
Existing	0	0	0	0	0	0	**0**
Alt 1 - Gravity Ox Ditch	364,965	96,301	959,156	459,857	5,656,965	965,273	**965**
Alt 2 - STEP Ox Ditch	338,477	65,307	650,455	426,482	5,246,400	656,128	**656**
Alt 3 - Gravity Biolac	495,054	113,522	1,130,678	623,769	7,673,344	1,138,975	**1,139**
Alt 4 - STEP Biolac	443,664	78,120	778,078	559,017	6,876,791	785,514	**786**
Alt 5 - Gravity ADS Pond	680,725	146,384	1,457,985	857,714	10,551,244	1,469,394	**1,469**
Alt 6 - STEP ADS Pond	655,798	115,666	1,152,036	826,306	10,164,874	1,163,027	**1,163**

*Vehicle-miles traveled, VMT

Table 7. CO_2-Equivalent Emissions Resulting from Fuel Consumption for Solids & Septage Handling

	Annual VMT*	**Annual Gallons Diesel**	**Carbon Dioxide**	**Methane**	**Nitrous Oxide**	**Total CO2e Emissions**	
			(kg CO2/year)	**(g CO2e/year)**	**(g CO2e/year)**	**kilograms/year**	**Metric Tons/year**
Existing	8,827	1,562	15,560	11,122	136,813	15,708	**16**
Alt 1 - Gravity Ox Ditch	26,180	4,634	46,151	32,987	405,787	46,589	**47**
Alt 2 - STEP Ox Ditch	7,824	1,385	13,793	9,859	121,277	13,924	**14**
Alt 3 - Gravity Biolac	26,180	4,634	46,151	32,987	405,787	46,589	**47**
Alt 4 - STEP Biolac	7,824	1,385	13,793	9,859	121,277	13,924	**14**
Alt 5 - Gravity ADS Pond	5,151	912	9,080	6,490	79,837	9,166	**9**
Alt 6 - STEP ADS Pond	5,500	973	9,695	6,930	85,249	9,788	**10**

*Vehicle-miles traveled, VMT

Table 8. CO_2-Equivalent Emissions Resulting from Fuel Consumption for Chemicals Handling

	Annual VMT*	Annual Gallons Diesel	Carbon Dioxide	Methane	Nitrous Oxide	Total CO2e Emissions	
			(kg CO2/year)	(g CO2e/year)	(g CO2e/year)	kilograms/year	Metric Tons/year
Existing	0	0	0	0	0	0	**0**
Alt 1 - Gravity Ox Ditch	15,552	2,222	22,128	19,596	241,056	22,389	**22**
Alt 2 - STEP Ox Ditch	15,842	2,273	22,639	19,961	245,551	22,905	**23**
Alt 3 - Gravity Biolac	15,552	2,222	22,128	19,596	241,056	22,389	**22**
Alt 4 - STEP Biolac	15,842	2,273	22,639	19,961	245,551	22,905	**23**
Alt 5 - Gravity ADS Pond	14,232	2,033	20,250	17,932	220,596	20,489	**20**
Alt 6 - STEP ADS Pond	14,522	2,084	20,761	18,298	225,091	21,005	**21**

*Vehicle-miles traveled, VMT

DIRECT EMISSIONS

Table 9. CO_2-Equivalent Emissions Venting directly from Septic Tanks

	Annual lbs of BOD Digested in Septic Tanks	Methane	Total CO2e Emissions	
		(kg CH4/year)	kilograms/year	Metric Tons/year
Existing	146,690	40,006	840,132	**840**
Alt 1 - Gravity Ox Ditch	0	0	0	**0**
Alt 2 - STEP Ox Ditch	108,912	29,703	623,769	**624**
Alt 3 - Gravity Biolac	0	0	0	**0**
Alt 4 - STEP Biolac	108,912	29,703	623,769	**624**
Alt 5 - Gravity ADS Pond	0	0	0	**0**
Alt 6 - STEP ADS Pond	108,912	29,703	623,769	**624**

TOTAL (Indirect + Direct) EMISSIONS

Table 10. Summary Table - Annual Total Metric Tons of Carbon Dioxide Equivalent Emissions

	INDIRECT						DIRECT	
	Collection System & Treatment Operations Energy	Construction Process & Material Production	Chemical Production	Construction Material Handling	Solids & Septage Handling	Chemicals Handling	STEP - Septic Tank Venting	TOTAL Metric Tons CO_2e Emissions
Existing	0	0	0	0	16	0	840	**856**
Alt 1 - Gravity Ox Ditch	769	143	48	32	47	22	0	**1,061**
Alt 2 - STEP Ox Ditch	549	103	389	22	14	23	624	**1,724**
Alt 3 - Gravity Biolac	657	136	47	38	47	22	0	**947**
Alt 4 - STEP Biolac	464	99	389	26	14	23	624	**1,639**
Alt 5 - Gravity ADS Pond	655	138	389	49	9	20	0	**1,260**
Alt 6 - STEP ADS Pond	560	100	389	39	10	21	624	**1,742**

Table 11. Summary Table - Total Metric Tons of Carbon Dioxide Equivalent Emissions due to Construction Activities

	INDIRECT		TOTAL Metric Tons CO_2e Emissions
	Construction Process & Material Production	Construction Material Handling	
Existing	0	0	**0**
Alt 1 - Gravity Ox Ditch	4,286	965	**5,251**
Alt 2 - STEP Ox Ditch	3,088	656	**3,744**
Alt 3 - Gravity Biolac	4,064	1,139	**5,203**
Alt 4 - STEP Biolac	2,955	786	**3,740**
Alt 5 - Gravity ADS Pond	4,055	1,469	**5,524**
Alt 6 - STEP ADS Pond	2,919	1,163	**4,082**

INDIRECT EMISSIONS

Recall *indirect emissions*, consistent with the CCAR protocol, are those originating from the actions of the agency, but are produced by sources owned or controlled by another entity. For this inventory, this includes: use of construction equipment, manufacturing and transport of the STEP tanks, transport of septage, construction materials, and chemicals to the facilities, transport of biosolids to the disposal site, and purchased and consumed electricity for the operation of the facility, collection system, and the manufacturing of materials and chemicals used in the facility and collection system.

Table 1. Carbon Dioxide Equivalent (CO_2e) Emissions Resulting from Electricity Consumption for Operation of the Treatment Facility & Pumping Stations

This table shows the carbon dioxide, methane, and nitrous oxide emissions generated from the production and delivery of electricity based on estimated demands at buildout, which is consumed for the operation of the treatment facility and pumps throughout the collection systems. The existing system does not require electricity and therefore does not generate CO_2e emissions in this category. In general, the alternatives considering a gravity collection system consume more electrical energy than the STEP alternatives due to variation in unit process sizing and the slight difference in collection system energy requirements. Alternative 1 (oxidation ditch alternative with a gravity collection system) is the most energy intensive primarily due to the oxidation ditch process energy consumption. Alternative 6 (air diffusing system pond alternative with a STEP collection system) is the least energy consuming alternative and is closely followed by Alternative 4 (Biolac alternative with a STEP collection system).

Table 2. Annualized Carbon Dioxide Equivalent (CO_2e) Emissions Resulting from the Processing and Production of Construction Materials over a 30-year Time Horizon

This table shows the carbon dioxide, methane, and nitrous oxide emissions generated from the processing and production of construction materials, which are consumed for the construction of the treatment facility and each collection system based on estimated demands at buildout, annualized over a 30-year period. The construction material processes considered are the excavation and backfill processes for the treatment facility (treatment), the septic tanks, and the collection system. The construction materials for which material production (energy consumed for production processes) is evaluated are concrete, fiberglass, polyethylene lining, PVC piping, and low-density polyethylene tubing.

The existing system does not require new construction and therefore does not generate CO_2e emissions in this category. In general, the alternatives considering a gravity collection system generate more CO_2e emissions than the STEP alternatives due to less demand for the construction of the STEP collection system and variation in unit process sizing. Alternative 1 (oxidation ditch alternative with a gravity collection system) generates the most CO_2e emissions primarily due to the PVC piping production required. Alternatives 2, 4,

and 6 (alternatives served by a STEP collection system) generate the least CO_2e emissions in this category.

Table 3. Total Carbon Dioxide Equivalent (CO_2e) Emissions Resulting from the Processing and Production of Construction Materials

This table shows the total carbon dioxide, methane, and nitrous oxide emissions generated from the processing and production of construction materials, which are consumed for the construction of the treatment facility and each collection system based on estimated demands at buildout. The construction material processes considered are the excavation and backfill processes for the treatment facility (treatment), the septic tanks, and the collection system. The construction materials for which material production (energy consumed for production processes) is evaluated are concrete, fiberglass, polyethylene lining, PVC piping, and low-density polyethylene tubing.

The existing system does not require new construction and therefore does not generate CO_2e emissions in this category. In general, the alternatives considering a gravity collection system generate slightly more CO_2e emissions than the STEP alternatives due to less demand for the construction of the STEP collection system and variation in unit process sizing. Alternative 1 (oxidation ditch alternative with a gravity collection system) generates the most CO_2e emissions primarily due to the PVC piping production required. Alternatives 2, 4, and 6 (alternatives served by a STEP collection system) generate the least CO_2e emissions in this category.

Table 4. Carbon Dioxide Equivalent (CO_2e) Emissions Resulting from the Production of Chemicals

This table shows the carbon dioxide, methane, and nitrous oxide emissions generated from the production (resulting from the energy consumed for production processes) of chemicals, which are required for odor control and treatment based on estimated demands of the alternatives at buildout. The chemicals include sodium hypochlorite, sodium hydroxide, thickening polymer, dewatering polymer, alum, filter polymer, and methanol.

The existing system does not require the use of chemicals and therefore does not generate CO_2e emissions in this category. In general, the alternatives considering a STEP collection system generate more CO_2e emissions than the gravity collection system alternatives (with the exception of Alternative 5) due to the methanol requirements of the denitrification process.

Table 5. Annualized Carbon Dioxide Equivalent (CO_2e) Emissions Resulting from Fuel Consumption for Construction Material Handling over a 30-year Time Horizon

This table shows the carbon dioxide, methane, and nitrous oxide emissions generated from the transport of construction materials, which are consumed for the construction of the treatment facility and each collection system based on estimated demands at buildout,

annualized over a 30-year period. The construction materials for which material handling (transport of materials from distributor and to disposal site) is considered are concrete, fiberglass, polyethylene lining, PVC piping, low-density polyethylene tubing, and remaining excavated material.

The existing system does not require new construction and therefore does not generate CO_2e emissions in this category. In general, the alternatives considering a STEP collection system generate less CO_2e emissions than the gravity collection system alternatives due to the handling of excavated material.

Table 6. Total Carbon Dioxide Equivalent (CO_2e) Emissions Resulting from Fuel Consumption for Construction Material Handling

This table shows the total carbon dioxide, methane, and nitrous oxide emissions generated from the transport of construction materials, which are consumed for the construction of the treatment facility and each collection system based on estimated demands at buildout. The construction materials for which material handling (transport from material distributor and/or to disposal site) is considered are concrete, fiberglass, polyethylene lining, PVC piping, low-density polyethylene tubing, and remaining excavated material.

The existing system does not require new construction and therefore does not generate CO_2e emissions in this category. In general, the alternatives considering a STEP collection system generate less CO_2e emissions than the gravity collection system alternatives due to the handling of the excavated material.

Table 7. Carbon Dioxide Equivalent (CO_2e) Emissions Resulting from Fuel Consumption for Solids & Septage Handling

This table shows the carbon dioxide, methane, and nitrous oxide emissions generated from the handling (transport) of solids and septage, which are generated at the treatment facility and in the septic tanks of the existing and STEP collection system alternatives based on estimated demands at buildout. The existing system's septage is hauled to the Santa Maria Wastewater Treatment Plant (WWTP), while the septage generated in STEP collection system is hauled to the Los Osos WWTP. Solids generated at the Los Osos WWTP are hauled to McCarthy Family Farms in Kings County, CA.

Alternatives 1 (oxidation ditch with gravity collection system) and 3 (Biolac with gravity collection system) generate more CO_2e emissions than the other alternatives due to the volume of septage and solids generated at the septic tanks and plant, respectively, which subsequently have to be transported to a disposal site.

Table 8. Carbon Dioxide Equivalent (CO_2e) Emissions Resulting from Fuel Consumption for Chemicals Handling

This table shows the carbon dioxide, methane, and nitrous oxide emissions generated from the handling (transport) of chemicals, which are required for odor control and treatment based on estimated demands of the alternatives at buildout. The chemicals include sodium hypochlorite, sodium hydroxide, thickening polymer, dewatering polymer, alum, filter polymer, and methanol.

The existing system does not require the use of chemicals and therefore does not generate CO_2e emissions in this category. In general, the alternatives are generating nearly the same amounts of CO_2e emissions.

DIRECT EMISSIONS

Recall *direct emissions*, consistent with the CCAR protocol, are those resulting from sources owned or controlled by the agency, such as stationary combustion sources, mobile combustion sources, and treatment unit processes. For this inventory, this includes treatment unit process emissions (e.g. septic tank venting).

Table 9. Carbon Dioxide Equivalent (CO_2e) Emissions Venting directly from Septic Tanks

This table shows the methane emissions generated (and vented) from the anaerobic digestion of settled solids within the septic tanks for the existing and STEP collection system alternatives. Remember that methane has a GWP 21 times that of carbon dioxide. The existing system generates the largest amount of methane annually due to the high concentration of BOD in the septic tanks.