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May 9, 2018

Scott McClelland
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Subject: Encina Biosolids, Energy and Emissions

Dear Scott,

Brown and Caldwell is pleased to deliver the Biosolids, Energy and Emissions (BEE) Plan Executive Summary and updated Technical Memoranda 7 and 8 for your review. The Executive Summary provides an overview of our process and recommendations. TMs 7 and 8 have been updated to incorporate EWA's comments. TM 7 serves as the comprehensive summary of our overall recommendations. We will sign and seal these TMs and deliver an overall package – final TMs 1 through 8 – next week as a compiled final deliverable.

Very truly yours,

Brown and Caldwell

Scott Lacy
Project Manager

Attachments (3)

1. Attachment A: Biosolids, Energy and Emissions Plan Executive Summary
2. Attachment B: Technical Memorandum 7 – Alternatives Development, Evaluation and Selection
3. Attachment C: Technical Memorandum 8 – Grant and Incentive Programs Summary

BEE Executive Summary

The Encina Wastewater Authority (EWA) has undertaken a Biosolids Energy and Emissions (BEE) Plan that will be used to update the previous Energy and Emissions Strategic Plan and integrate pertinent recommendations arising from the recently completed Process Master Plan. The BEE Plan has several goals:

- Provide a comprehensive analysis of all project elements including biosolids treatment, biogas use, energy generation, and waste heat
- Address capacity limitations in the solids handling process at the Encina Water Pollution Control Facility (EWPCF)
- Assess which alternative is likely to be the most cost-effective and sustainable solution for EWA
- Move EWPCF toward lower energy costs, rate stability, and greater overall sustainability
- Reduce greenhouse gas emissions

As part of the BEE Plan, the Brown and Caldwell (BC) team performed an extensive technology and alternatives analysis which is documented in a series of eight technical memoranda. Major decisions were made, including technology selection and narrowing of alternatives, in a series of workshops with EWA staff. Table 1 includes a list of these eight technical memoranda.

Table 1. Summary of BEE Technical Memoranda	
TM 1	Baseline Energy Profiles and Projections
TM 2	Technology Evaluations for Biosolids Handling
TM 3	Technology Evaluations for Alternative Power Production
TM 4	Technology Evaluations for Biogas Production
TM 5	Technology Evaluations for Waste Heat
TM 6	Air Emissions
TM 7	Alternatives Development, Evaluation, and Selection
TM 8	Grant Incentive Programs Summary

BEE Process

The process began with an evaluation and selection of technologies for solids processing and energy generation. The technologies selected are presented in Table 2. These technologies were subjected to a fatal flaw screening process and evaluated for the following fatal flaw criteria:

- There must be at least one full-scale installation of the technology at a wastewater treatment plant (WWTP) in North America
- There must be at least one successful installation of the technology at a facility of similar size to EWPCF to ensure compatibility
- The technology must be accommodated within EWPCF's limited available footprint
- The technology must be capable of being integrated into the existing treatment infra-structure

If a given technology failed any of the fatal flaw criteria, it did not proceed to the next round of evaluation.

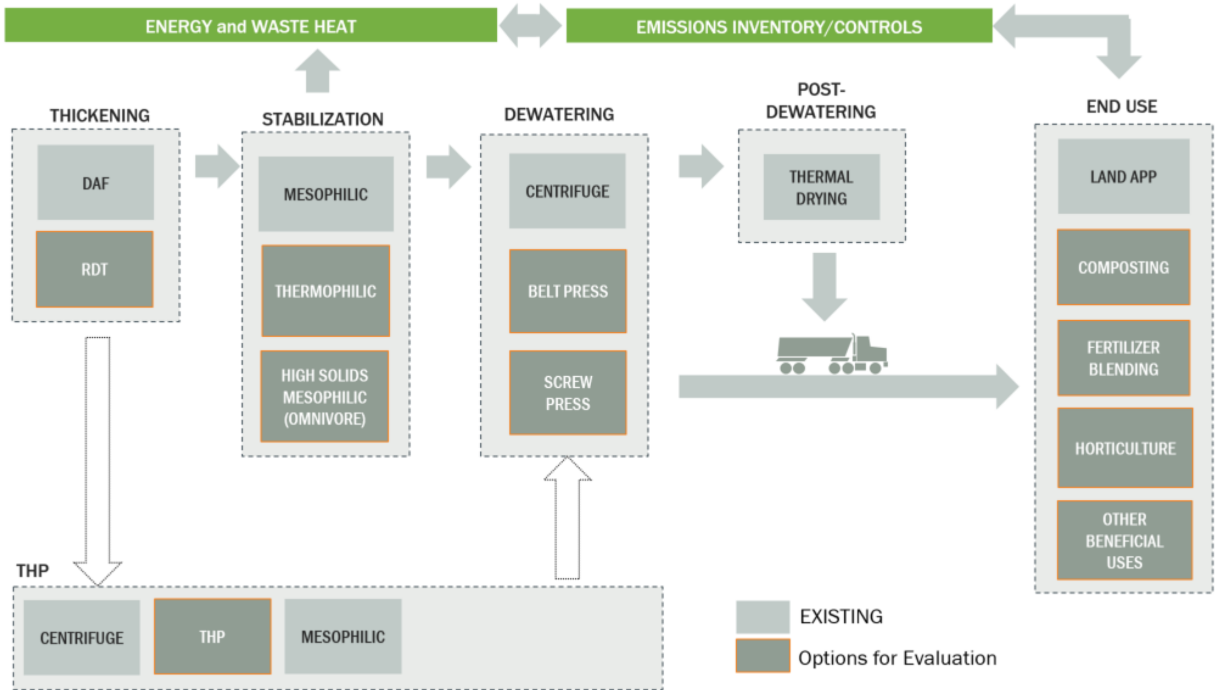
Table 2. Evaluation and Selection of Technologies for Solids Processing and Energy and Heath Utilization						
Solids Processing Technologies				Energy and Heat Utilization		
Thickening	Stabilization	Dewatering	Post Digestion	Biogas Treatment	Energy Generation	Waste Heat Utilization
Primary clarifier	**Mesophilic anaerobic digestion**	**Centrifuge**	**Direct drum drying**	**Biogas upgrading**	**Internal combustion engines**	Small-scale steam turbines
Dissolved air floatation	**Mesophilic high-solids digestion**	**Belt filter press**	Indirect drying	**Gas conditioning**	**Microturbines**	**Thermophilic digestion or thermal hydrolysis process**
Rotary drum	Staged mesophilic anaerobic digestion	**Screw press**	Solar drying	**Exhaust treatment**	**Direct use of biogas in drying**	Adsorption and absorption chillers
	Acid-gas phase digestion	Rotary press	Gasification	WAS pretreatment	Fuel cells	Organic Rankine cycle
	Thermophilic anaerobic digestion	Volute press	Pyrolysis	**Increased co-digestion**	Energy storage (batteries)	Gasification of biosolids
	Temperature-phased anaerobic digestion	Bucher press	Incineration		**Large-scale photovoltaics**	
	Thermal hydrolysis process		Deep-well injection		**Small-scale photovoltaics**	
	Enzymatic hydrolysis		Dehydration		Wind turbines	
	Thermo-chemical hydrolysis				Direct sale to adjacent power plant	
	Lystek				**Net energy metering**	

Technologies in bold were considered in the end to end alternatives.

Following the fatal flaw evaluation, technologies were scored and ranked for a series of criteria developed with EWA. While some criteria overlap, unique criteria were developed for the solids and energy related technologies. Technologies were ranked on a scale of 1 to 5, with scoring performed in a workshop setting. Those with an aggregate score of under 3 were eliminated from further analysis. Those technologies that were used in the formation of end-to-end alternatives are presented in bold in Table 3; alternatives that are not presented in bold were eliminated from further consideration.

Table 3. BC Report Grid Style			
Criterion	Description	Scoring Description	Weight
Proven Technology Performance	Proven and reliable technology with same configuration intended at Encina. Long successful operating track record.	Low score indicates no successful large-scale operating installations in North America or Europe, no successful demonstration scale installations in North America or Europe, and unknown safety or reliability record. High score indicates more than one successful operating installation in North America or Europe, more than one operating installation at a WWTP of at least 40 mgd in North America or Europe, track record duration > 5 years, and vendors in western USA.	20%
Minimize Life-Cycle Costs	Qualitative metric of program cost. Capital and O&M costs based on existing EWA data or similar experience at other WWTPs. Potential revenues from sales.	Low score indicates high capital cost to build onsite facilities, high O&M costs, and low energy recovery efficiency. High score indicates low capital cost to build onsite facilities, low O&M costs, and potential revenue.	10%
Energy/Resource Recovery	Recovery of renewable energy.	Low score indicates high energy requirement for onsite technology, technology does not recover, and low efficiency recovery of renewable energy. High score indicates a higher electrical efficiency.	25%
O&M Impacts	Impacts to existing plant O&M staff levels. Complexity of new technology O&M and control systems. Reliability of new technology (potential downtime). Minimal impacts to plant safety.	Low score indicates more O&M time required, complex mechanical and control systems required compared with existing plant facilities, potential equipment downtime, and newer hazards. High score indicates reduction in O&M staff time required, new technology is simple to operate and maintain, reliable with minimal downtime, and no new hazards.	10%
Environmental Impacts	Impacts to carbon footprint and air permitting.	Low score indicates high carbon footprint for technology, and new permitting for environmental regulatory requirements. High score indicates low carbon footprint for technology, reduced pollutant emissions, no additional permitting for environmental regulatory requirements.	15%
Community & Stakeholder Impacts	Minimize nuisance impacts such as dust, odors, vectors, aesthetics, noise and traffic. Assess impacts to partner agency issues/values as well as local planning codes and requirements.	Low score indicates nuisance factors for on-site technology are difficult to mitigate. High score indicates nuisance factors can be mitigated at plant site.	10%
Project Site Compatibility	Assess compatibility of technology with available plant footprint. Incorporation into existing treatment process.	Low score indicates lack of site space for new facilities, requires abandonment of existing facilities, and difficult integration with existing plant. High score indicates available footprint for new facilities and maintains space for future facilities, ease of integration with existing processes and facilities.	10%

The BC team then worked with EWA to create over 48 end-to-end alternatives, which evaluated the solids process from thickening to final disposition, as well as assessing biogas treatment and beneficial use. Figure 1 shows how the technologies that passed the evaluation scoring criteria were combined to create end to-end-alternatives.



Alternatives were developed for beneficial use of digester gas alongside solids handling improvements. The digester gas utilization alternatives included engine-based cogeneration systems, microturbine-based cogeneration systems, and gas separation to produce renewable natural gas (RNG) for pipeline injection. All technologies were evaluated across a range of DG production rates and various solids stabilization methods, which assumed various levels of co-digestion of organic high-strength waste (HSW). Alternatives were compared to a status quo alternative that assumed DG would be used to operate the existing cogeneration engines and solids dryer, with the remainder of gas flared when the dryer is down for maintenance. Solids handling alternatives included options to upgrade or enhance digestion capacity and final biosolids quality, including thermophilic digestion (Class B and Class A), thermal hydrolysis process (THP), and Omnivore, as well as mesophilic digestion, EWA's existing stabilization technologies. Nearly all solids processing alternatives were evaluated with both one or two dryer trains in service.

The top 5 end-to-end options evaluated are summarized in Figure 2. These alternatives were evaluated over two rounds of modeling and are represented on a net present value (NPV) basis.

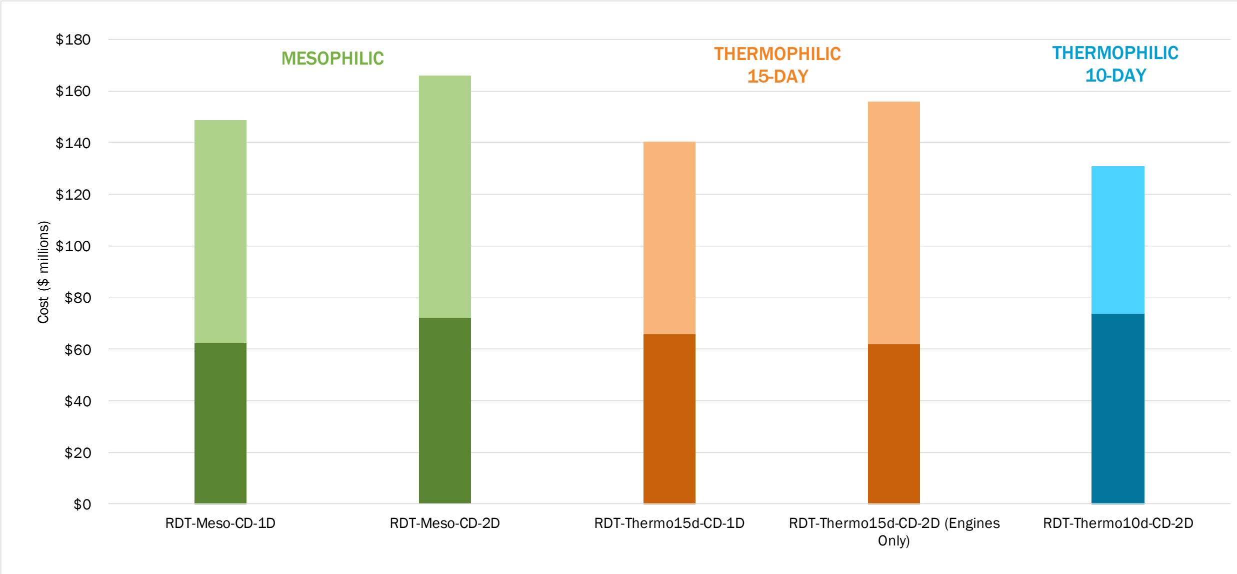


Figure 2. Overall NPV for top 5 alternatives

The top 5 end-to-end alternatives all have similar capital and NPV costs; therefore, cannot be screened based on economics alone. In addition, these alternatives have similar near-term project components such as digester improvements and RDTs for co-thickening. For all alternatives, long term projects should be selected based on meeting capacity, resiliency against changes, reducing odor, and reducing truck traffic at the plant.

Key Findings

Alternatives were ranked based on the 20-year NPV model results. The key findings of the analysis are listed below:

- All alternatives benefited from increased DG production from co-digestion of organic HSW.
- Improved thickening with rotary drum thickeners (RDT) provides multiple benefits and has reduced lifecycle costs compared to the existing thickening scheme.
- Thermophilic digestion allows for a higher loading potential of HSW for co-digestion; however, all solids alternatives are compatible with the existing engines or pipeline injection alternatives for DG utilization. There is currently no direct driver to upgrade to thermophilic.
- While the second dryer train does not perform as well on an NPV basis in nearly all alternatives, there are non-cost and practical reasons to implement a second train. The timing of bringing this second train on line to realize the most cost savings will be a very important decision for EWA.
- Upgraded DG for use as vehicle fuel, via pipeline injection, provides the greatest apparent NPV compared to cogeneration systems or in the solids dryer.
- Continued use and operation of the cogeneration system is recommended. Any measures that increase permitted cogeneration energy production or reduce the cost of electricity should be pursued. A net electric metering (NEM) tariff would reduce electric utility costs by eliminating the standby charge—it would also allow for power export and simplify (or eliminate) the EWPCF's current grid isolation practice. Any air permit revisions to allow for greater DG utilization and energy output are recommended. The addition of upstream DG conditioning and exhaust treatment using a carbon monoxide (CO) catalyst appears to be the best pathway. Any changes that trigger more stringent exhaust treatment measures, such as selective catalytic reduction (SCR) or continuous emissions monitoring systems, should be avoided.

Implementation

Among the top performing alternatives, a series of near term (defined as 0 to 5 years) projects were common. These included digester improvements to address capacity issues, co-thickening improvements (RDTs), high strength waste receiving upgrades, and pipeline injection of biomethane. The BC team recommends that EWA address these near-term projects in its capital planning efforts. The majority of the mid-term (5-10 years from now) also had common elements, including dryer modifications, Class B biosolids truck loadout improvements, an Omnivore project, and centrifuge upgrades. The main differences between these options are that the mid-term projects address a mixture of aging equipment as well as desirable improvements to support high strength waste receiving and biosolids beneficial reuse while the near-term projects address immediate constraints and opportunities associated with the solids and energy processes at the EWPCF. Ultimately, the long-term (10 to 20 years) decisions are what distinguish the top performing alternatives and allow for full implementation of the recommended alternative, which includes a second dryer, an additional Omnivore project, and truck traffic improvements. These long-term projects will address the future increase in solids loadings to the EWPCF.

BC worked with EWA to develop a preferred alternative and discuss issues with associated phasing. Ultimately, addressing digester capacity early on in the program allows EWA to expand its co-digestion program and boost digester gas production. Timing on construction of the second dryer can be evaluated in further detail depending on the expansion of the co-digestion program and performance of thickening and digestion improvements with respect to solids reduction. Figure 3 shows an implementation schedule for the recommended alternative based on cost, resiliency, ability to meet plant capacity, and reducing truck traffic and odors.

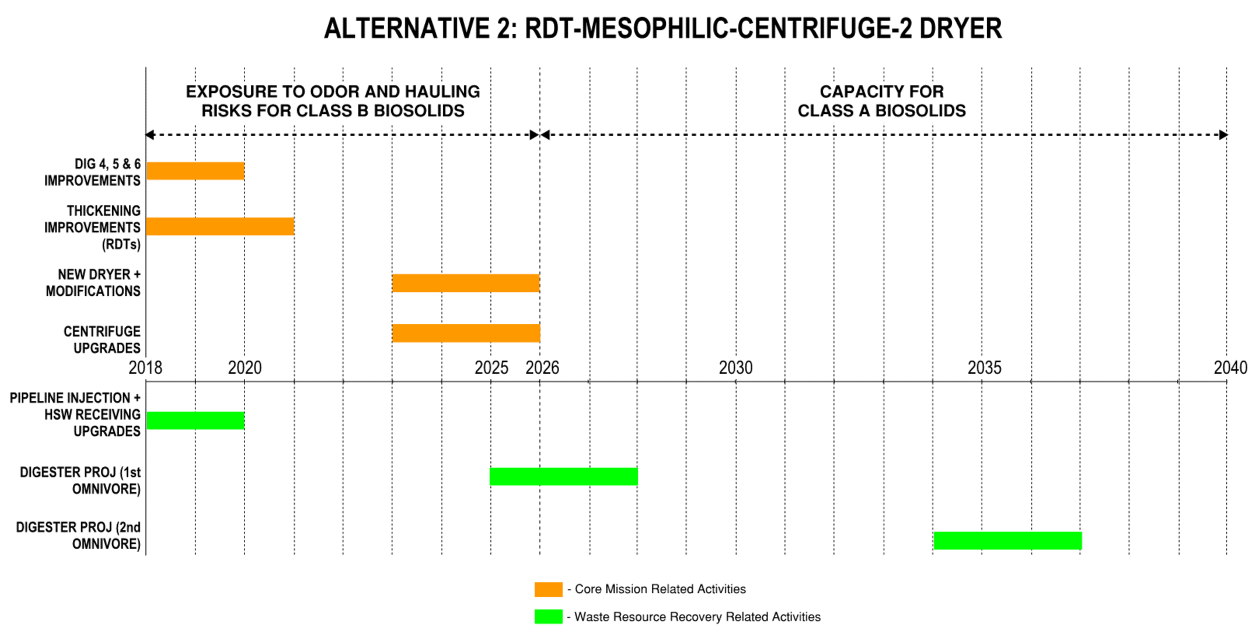


Figure 2. Implementation schedule for Alternative 3 (recommended alternative)

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Technical Memorandum

FINAL

Prepared for: Encina Wastewater Authority

Project Title: Biosolids, Energy and Emissions

Project No.: 150871.003.001

Technical Memorandum No. 1

Subject: Baseline Energy Profiles and Projections

Date: February 13, 2018

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