

Land Application

Land application of Class B and most Class A/EQ biosolids in California are generally regulated under Water Quality Order No. 2004-12-DWQ, which is known as the General Order (GO). The GO establishes a permit process intended to mirror the 40 CFR Part 503 regulations, with special considerations for groundwater quality and soils specific to California. The GO mirrors the PR and VAR requirements of EPA 40 CFR 503 regulations. The pollutant limits generally mirror the EPA Table 1 Ceiling Concentrations.

Composting

Biosolids composting is regulated as a solid waste under the California Integrated Waste Management Regulations and is governed by California's Department of Resources Recycling and Recovery (CalRecycle). Additionally, because compost facilities generate air emissions (unless they are fully enclosed), compost processing is also regulated by the CARB. Permit requirements for composting operations are dependent on the feedstock used and the facility location. Compost facilities located in a new greenfield will have substantial permitting requirements, whereas composting biosolids within the property of a wastewater treatment plant requires fewer permit requirements (i.e. odor management plan and best practices). For GSD, initiating a compost facility within the treatment plant will be much easier to permit than a new compost facility located elsewhere.

Landfill Disposal

Landfill disposal and alternative daily cover (ADC) is a significant outlet for biosolids in California, accounting for one-third of biosolids management in the state in 2017. However, in recent years, California has passed multiple waste diversion bills that will significantly impact biosolids management, including AB341 (75% landfill diversion), AB1594 (removal of diversion credit for ADC), and SB1383 (reduction in short-lived climate pollutants (SLCP)).

With these regulations in planning, up to 600,000 wet tons of biosolids will need to be diverted from landfill and integrated into the existing beneficial use marketplace within the next five to ten years. While it is anticipated that additional compost facilities and land application sites will eventually be developed, local jurisdictions and regulatory/permitting barriers have historically delayed the start-up of new beneficial use programs. Therefore, there will likely be an increase in demand for existing facilities, such as the merchant compost facility currently utilized by the GSD.

Local Regulatory Review

While regulations have been established at both the national and state levels, local jurisdictions in California can set regulations that are more restrictive than the State or Federal Regulations. As seen in Figure 1, counties near Santa Barbara County have enacted bans of Class B biosolids

products or have developed requirements for conditional use permits. While Santa Barbara and Los Angeles Counties have not officially enacted local ordinances, these counties have minimal agricultural land not used to produce food crops, so these counties are “practically” unavailable for Class B biosolids. In recent years, local ordinances have limited beneficial use opportunities for Class B biosolids, causing utilities to rely on alternative daily cover and/or merchant processing facilities for the ultimate disposition of biosolids products. Should GSD elect to land apply biosolids, land application of Class B biosolids is virtually impossible.

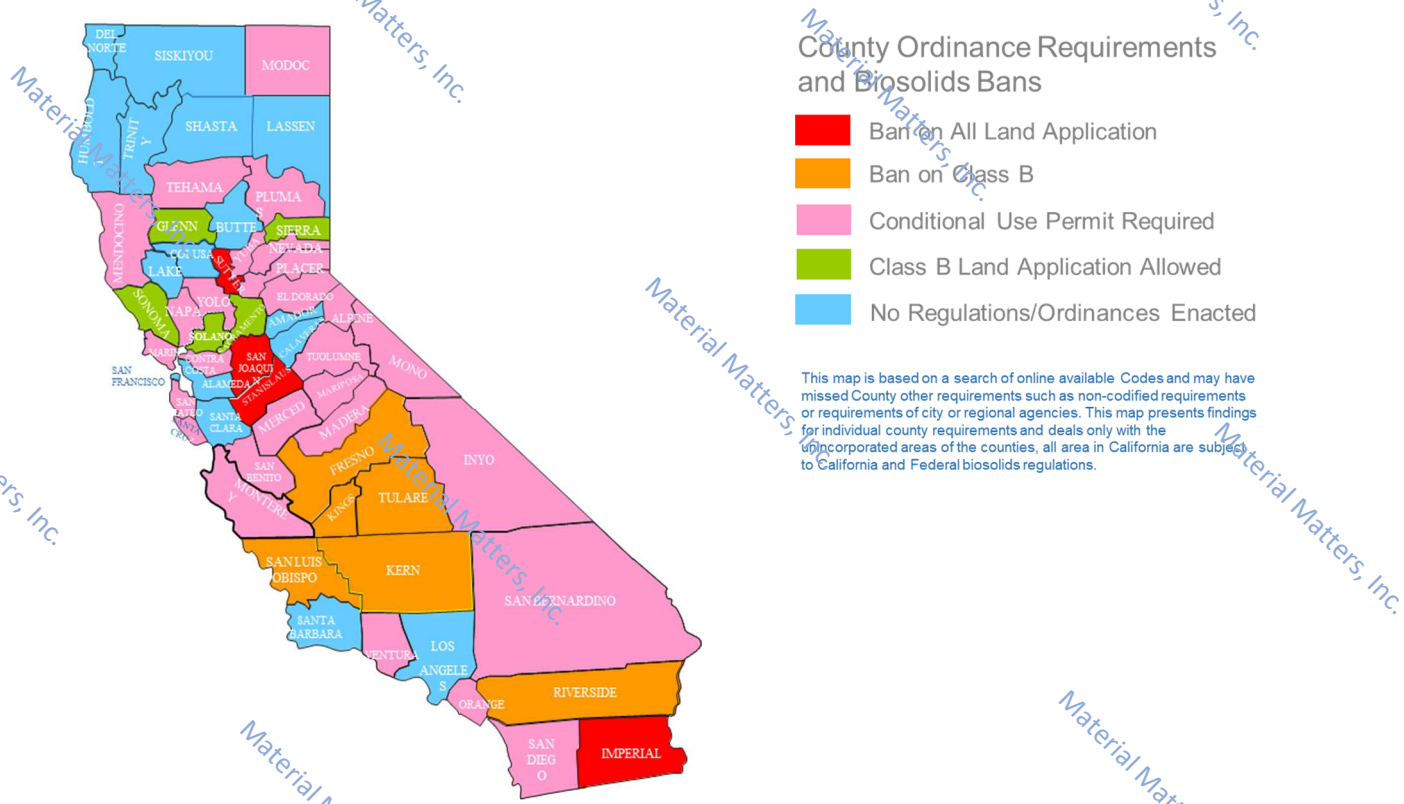


Figure 1. County Ordinance Requirements and Biosolids Bans¹

Biosolids Characteristics

Products produced by each of the five (5) technologies considered, including mesophilic anaerobic digestion, TPAD, composting, thermal drying, and thermo-chemical hydrolysis (Lystek) were characterized.

Mesophilic anaerobic digestion (MAD) involves the decomposition of organic solids in the absence of oxygen in heated (30 to 38 °C), well-mixed tanks, resulting in the reduction of total solids by 45 to 50 percent. Biosolids produced with appropriately sized, mixed, and heated conventional MAD facilities can readily satisfy required US Environmental Protection Agency

¹ California Association of Sanitation Agencies (CASA), 2018.

federal standards (USEPA 40 CFR Part 503 regulations) Class B PR (Alternative 2) and process VAR (Option 1) requirements necessary for land application.

In general, these products have low to moderate nuisance odor potential; however, research shows that anaerobically digested products dewatered using centrifuge facilities may experience bacterial regrowth accompanied by intense malodors (Higgins, et. al, 2007). Mesophilic AD stabilized biosolids are limited to use in areas with low public access: bulk agriculture, land reclamation, and disposal (i.e. landfill or monofill). An example of a Class B, anaerobically digested cake is seen in Figure 2.



Figure 2. An example of a Class B anaerobically digested product.

Temperature phased anaerobic digestion (TPAD) consists of three to five days of thermophilic digestion (50 to 57 °C) followed by at least 10 days of mesophilic digestion (30 to 38 °C). The TPAD process takes advantage of a much greater digestion rate (4 times faster than mesophilic digestion), which allows for decreased detention time. Temperature-Phased AD absorbs shock loads better than MAD, exhibits reduced potential for digester foaming, and is much more efficient at volatile solids destruction compared to MAD (15 to 25% greater than MAD) (Metcalf & Eddy, 2003).

Biosolids produced with appropriately sized, mixed, and heated TPAD digesters will readily satisfy Class A PR (Alternative 1) and process VAR (Option 1) requirements. Relative to MAD biosolids, TPAD digestion has been shown to improve solids dewaterability, producing greater %TS in the cake (Metcalf & Eddy, 2003). Unlike MAD cake, TPAD cake meets Class A requirements, which allow for beneficial use in markets with low *and* high public access. In general, because non-agriculture markets are not typically outfitted with equipment to handle bulk cake products, TPAD biosolids are typically limited to use in the bulk agriculture and land reclamation markets. An example of a TPAD cake is seen in in Figure 3.



Figure 3. An example of a Class A/EQ biosolids cake product.

Composting is a process in which the organic fraction of biosolids undergoes biological degradation in the presence of air (oxygen) to create a stable, humus-like product. Biosolids are blended with a high-carbon feedstock (typically woody material) and aerated, resulting in accelerated material decomposition to produce the temperature rise required for pathogen destruction. A successful composting operation will have control over the many inputs to the composting process including the carbon to nitrogen ratio, air supply, moisture content, pH control, temperature, and mixing/turning.

Compost produced with anaerobically digested biosolids will meet Class A biosolids requirements through PR Alternative 5, and VAR Option 5. By utilizing a processed biosolids feedstock (through MAD), the composting process will have a lower potential for site malodors, and, if composted correctly, the finished product will have a rich, earthy (musty) aroma that most people do not find offensive. Class A/EQ biosolids compost is a direct substitute for other compost products, allowing for beneficial use in a wide variety of markets including topsoil manufacturing, landscaping, sod production, and others. An example of a Class A/EQ compost is shown in Figure 4.



Figure 4. An example of a Class A/EQ biosolids compost product.

Thermal drying is the process of adding heat to evaporate water in the biosolids that cannot be mechanically removed with a mechanical dewatering device. In the thermal drying process,

dewatered biosolids are fed into a dryer, subjected to temperatures greater than 200 °F, and dried to greater than or equal to 90% TS. Thermal drying following anaerobic digestion greatly reduces product volume for drying and transforms a Class B product into an EQ product.

Dried, anaerobically digested biosolids products will meet Class A/EQ biosolids requirements through PR Alternative 5, and VAR Option. While well-digested thermally dried products tend to have low odor intensity when dry, when the product is rewetted for the first time, it can produce an intense odor that can be considered offensive to the public. The final product will be granular, typically ranging in size from two to eight mm and will contain dust that can be controlled through screening and the addition of dedusting oils (Figure 5). Depending on the size, uniformity, and density of the dried biosolids product, dried biosolids can be marketable to a variety of low and high public access markets including bulk agriculture, soil blending, sod production, landscaping, and others.



Figure 5. An example of a thermally dried Class A/EQ biosolids product.

Lystek is a thermal hydrolysis process that exposes dewatered biosolids to heat, alkalinity (elevation of pH to between 10 and 10.5), and high-speed sheering to create a high-solids (~12 to 15% TS) flowable Class A product called LysteGro®. The LysteGro® product can be subsequently re-fed to the anaerobic digester to obtain additional volatile solids destruction, and, in turn, create additional biogas, and a product called LysteMize®.

LysteGro® will meet EQ biosolids requirements through PR Alternative 1 (time and temperature), and VAR Option 2 (bench-scale anaerobic digestion, because PR must happen before or at the same time as VAR Option 1, therefore 38% VSR may not be used). However, if the LysteMize® process is used, in which MAD also occurs *after* the Lystek process, the product may meet EQ requirements through PR Alternative 1, and VAR Option 1. The Lystek products are reported to have a low odor profile when injected into the soil. The final product will be high-solids liquid, typically with the consistency of warm honey (Figure 6). To date, the Lystek products have only been distributed into the bulk agriculture market.

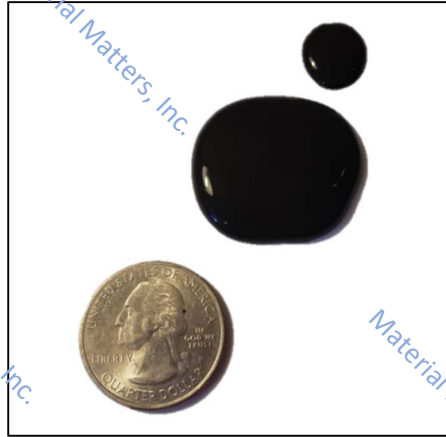


Figure 6. An example of LysteGro.

Market Assessment Results

Biosolids distribution occurs via two (2) major pathways in southern CA: Full-Service Providers (FSP) and Direct Marketing. Material Matters conducted interviews with potential customers from each distribution pathway to understand the advantages and disadvantages of each product, as well as outside-the-gate expenses and revenues.

Full Service Providers

FSP are biosolids management companies (or similar) that are responsible for processing biosolids (e.g. dewatering, composting, etc.) and/or marketing and distribution of the final biosolids product. The FSP typically assumes responsibilities associated with beneficial use and storage of the biosolids. In southern California, FSPs principally manage biosolids via composting, with a portion (mainly in southeastern California) going to bulk agriculture. Table 2 summarizes FSP in southern California, and the facilities currently available.

Table 2. Merchant Facilities for Southern California Biosolids

Company Name	Bulk Agriculture	Composting	Current Facility Location(s) to process S. CA biosolids
Synagro		X	Hinkley, CA Taft, CA
WeCare	X		Yuma, AZ
Lystek	X		None
Engel & Gray		X	Santa Maria, CA
Liberty Composting		X	Lost Hills, CA

During the market assessment, it was identified that FSPs are not directly land applying Class B biosolids in Southern California because of local ordinances banning Class B land application and due to the lack of available non-food crop land. As a result, the majority of biosolids in Southern California that are managed by FSP are composted at a merchant compost facility. While capacity currently exists at merchant compost facilities, new regulations encouraging diversion of organics from landfill will likely lead to an excess of raw feedstocks for the existing facilities, which will lead to higher tipping fees. Permitting new merchant composting facilities typically takes many years due to approvals required by multiple layers of government.

One alternative management solution is with the Lystek process. Lystek operates a successful facility in northern CA and coordinates the land application on behalf of the utility; farm sites are located within ~30 miles of the WRF. If the Lystek process is selected, the product will be marketed into the bulk agriculture market. However, as previously noted, land available for land

application locally is limited, so transportation distance for GSD will likely two to three times longer than the transportation distance required for the northern California facility.

Direct Marketing

The GSD also has the option to market biosolids products (Class A/EQ or Class B) directly to the customer (Direct Marketing). Direct marketing involves beneficial use program management supervised by GSD or a marketing agent (or combination). This approach provides more control and flexibility for GSD relative to final program implementation. Here, GSD contracts directly with the customers and the customers pay the GSD for the product.

Material Matters identified and contacted beneficial users in southern CA, as shown in Figure 7.

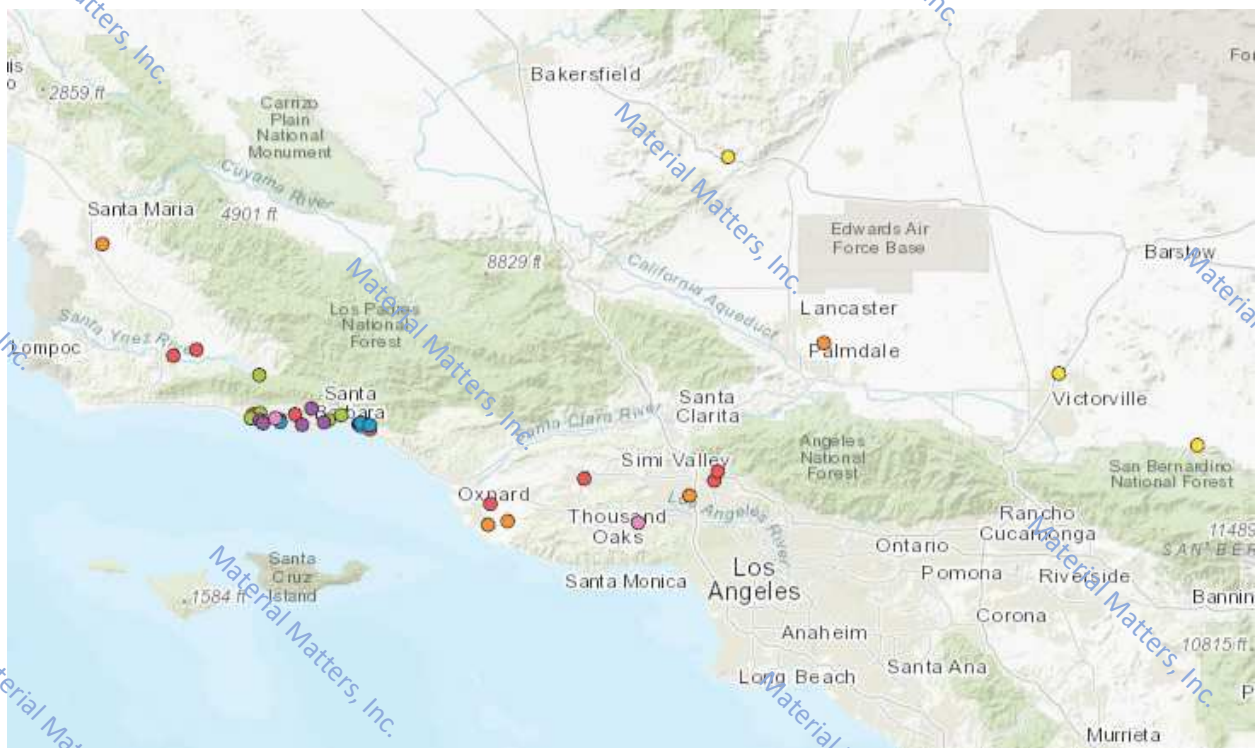


Figure 7. All markets contacted during the market assessment.

Notably, the agriculture market, which is typically the foundation of most biosolids beneficial use markets, was identified as a non-viable market due to the substantial transportation distance to access feed and fiber crops (i.e. crops not consumed directly by humans). Material Matters interviewed each market to better appreciate and understand their critical market factors, including capacity; seasonality; storage needs and availability, and; product characteristic preferences.

In total, eight (8) biosolids beneficial use markets were identified; listed in order from most promising to least promising:

- Soil Manufacturers

- Nurseries
- Sod
- Local Parks/Organizations
- Golf Course
- Land Reclamation
- Landscaping
- Alternative Fuel

a) *Soil Manufacturers*

Soil manufacturers mix soil (i.e. subsoil, topsoil), mineral components (i.e. sand), and materials with high organic matter content (i.e. bark, peat, compost, and biosolids) for a variety of industries including horticulture, landscaping, land development (construction), and site restoration. In the soil blending market, biosolids are blended with other materials such as subsoil, topsoil, and sand, to enhance the macro- and micro-nutrient content and organic matter content, improve soil drainage and water holding capacity, and reduce the bulk density.

The soil manufacturers showed a *strong interest* in using an EQ biosolids compost product. Many of the soil manufacturers already utilize a compost product (in many cases, a biosolids-based compost), and have existing transportation routes in the Goleta/Santa Barbara area. Soil manufacturers also showed some interest in using a thermally dried product.

b) *Nurseries*

Nurseries, as defined for this document, include the production of non-food crops, such as flowers and cannabis. Non-hydroponic, large-scale production of cannabis or flowers requires specially made soils and/or fertilizers. The organic matter in soil blends used for growing cannabis and flowers is often comprised of peat, at least in part. Due to the high organic matter content and the renewable nature of biosolids compost and granular products, biosolids appear to be a good substitute / supplement for fertilizer products used in these markets.

Most nurseries showed *little interest* in utilizing an EQ biosolids product directly from GSD, because they use specialty soil blends, produced off-site, that meet the specific nutrient needs for their products. However, multiple entities noted that if a biosolids-based product was included in a soil blend, and proven effective (demonstrated), they would be interested in trying the product.

c) *Sod*

Sod production, also known as turfgrass production, is a specialized agricultural market that involves growing a stand of high quality turfgrass and harvesting the grass with the roots and a thin layer of topsoil. In the sod production market, biosolids can be incorporated into the soil prior to planting to provide soil amending and fertilizer benefits for turfgrass establishment.

Biosolids can also be top-dressed on the turfgrass as a slow-release nitrogen fertilizer. In either case, biosolids compost and granules provide organic matter, organic N, P, and iron.

Most sod producers showed *low to moderate* interest in utilizing an EQ biosolids product, because of rotation with vegetable crops (in some cases organic) and apprehension about the crop available nitrogen not being available quickly enough for the short (3-4 mo.) sod growing season.

d) Local Parks/Organizations

Parks often maintain very robust, aesthetically pleasing landscaping programs, as the parks typically have very high public access. Local parks utilize fertilizer for maintenance of planting beds, lawns, shrubs, trees, and walkways. Parks also utilize compost and mulch for landscaping areas. Due to the high organic matter content and spreadability of biosolids compost and granular products, biosolids has been successfully used as a low-cost organic matter supplement to meet the fertilizer and/or compost needs of local parks.

Most parks showed *low interest* in using a Class A/EQ biosolids product produced by GSD. Many parks only use a small amount of compost and/or mulch each year and contract their lawn care services out to a third party. Local parks either already used reclamation water, so they already had access to enough nutrients, or their landscaping and maintenance was completed by a third party that were unresponsive to interview requests.

e) Golf Course

Golf courses take extreme care to manage the quality of the greens, fairways, and overall landscaping to achieve the professional look demanded by the industry's customers. Most golf courses hire a Superintendent whose primary responsibility is to attend to the golf course landscaping. Due to the organic matter content and macro- and micro- nutrients found in biosolids, thermally dried biosolids have been successfully distributed into the golf course market. Locally, the Encina Wastewater Treatment plant, located just a few hours from GSD, has successfully marketed its thermally dried pellets to more than a dozen golf courses. Notably, biosolids products must be uniform in size and texture, and must have a low odor profile and be low in dust.

None of the golf courses identified and contacted returned requests for interviews after multiple attempts. Due to the lack of response and because each golf course will only be a minor user of biosolids products (a single golf course can only use a few tons of biosolids each year), the golf course market was identified as a *low priority* market for a biosolids product.

f) Land Reclamation

Disturbed land reclamation is the process of stabilizing the soil and reestablishing vegetation on land previously utilized for mining or on industrial sites / Brownfields (drastically disturbed lands). In many cases, especially in the case of abandoned mines, the topsoil has been stripped

and removed, and the remaining soil is highly erodible with little capacity to sustain vegetative growth over time. In order to stabilize the soil, an organic matter source, such as compost or biosolids cake may be utilized with success. Biosolids provide organic matter and nutrients, which generates beneficial topsoil properties.

Biosolids have been successfully used for a variety of land reclamation projects in other states, but despite strong efforts by the California Association of Sanitary Agencies (CASA), land reclamation using biosolids is a novel market in California. Therefore, while land reclamation shows some promise in the future, the market is in its infancy at this time, and cannot be relied upon as a primary beneficial use outlet until these pilot/demonstration projects are completed.

g) *Landscaping,*

Landscapers improve the look of a property through design and maintenance of planting beds, lawns, shrubs, trees, and walkways, and will often have long-term contracts with universities, businesses, and public parks. Landscapers typically use expensive products, such as leaf compost or peat moss, to fulfill the organic matter specification on many of their revegetation projects. Due to the high organic matter content found in biosolids compost, it has been successfully used as a low-cost organic matter supplement in the construction market. Biosolids cake contains organic matter like that of compost; however, due to the high moisture content and stickiness, the landscaping market is a novel immature market for biosolids cake products.

The landscapers identified and contacted during the assessment did not return requests for interviews after multiple attempts. It is anticipated this market may be a secondary beneficial use market, so the client is suggested to reconnect with this market when a Class A/EQ compost or granular product is produced.

h) *Alternative Fuel*

Cement kilns require a significant amount of energy to convert limestone and other inputs into the final product called “clinker”. Coal, a non-renewable fossil fuel, is conventionally used to heat these raw inputs to very high temperatures required for this process.

The local alternative fuel market was identified as a non-viable market due to stringent local air emission standards, which limit feedstocks allowed to be processed at these facilities.

Conclusion

The Team led a regulatory review and preliminary biosolids market assessment for locally available markets for each of the products under consideration as part of the Goleta Sanitary District’s *Biosolids and Energy Strategic Plan*. Major findings include:

- California regulations guiding the use of biosolids are generally more complex than in other states due to the authoritative power of regional and local governments.

Specifically, local ordinances have limited beneficial use opportunities for Class B biosolids, causing utilities to rely on alternative daily cover and/or merchant processing facilities for the ultimate disposition of biosolids products.

- Landfill diversion legislation will put additional pressures on beneficial use infrastructure as utilities currently landfilling biosolids and utilizing ADC move to alternative management options.
- Regardless of potential regulations on the horizon, developing infrastructure on-site to create a Class A/EQ product will provide the least economic vulnerability for the final management of the product.
- The soil blending market (in conjunction with the nursery and sod market) in California is promising for the **Class A/EQ Compost** from both a regulatory and a market demand standpoint.
- **Class A/EQ cake, Class B cake, and Class A/EQ liquid** are chiefly limited to distribution through a third-party vendor (Notably, vendors would most likely further process these products to create a Class A/EQ compost product).
- Direct beneficial use of Class B biosolids cake for agriculture and/or reclamation is **not a viable outlet** because suitable areas and/or crops for Class B land application (i.e. crops grown for animal feed) are not locally available, or within an economically viable transportation distance from GSD.
- From the market assessment standpoint, processing Class B MAD cake into compost or drying at GSD appears to be a viable option with suitable market partners and local outlets.

The findings for this study are summarized in Table 3. The absence of a checkmark indicates the market has a poor outlook because it meets at least two of the following criteria: it is a novel market, can only accept a small percentage of the City's biosolids, and has a very narrow range of acceptable biosolids characteristics due to market preferences or regulatory pressures. One checkmark indicates the market could be viable and meets one of the following criteria: it is a novel market/pilot scale; it can only accept a small percentage of the City's biosolids, and/or has a very narrow range of acceptable biosolids characteristics. Two checkmarks indicate the market is an established market, at least one entity showed interest in using a large percentage of the City's biosolids (>50%), and the market can tolerate some variation in product quality. Three checkmarks indicate the market is an established market, and multiple entities showed a strong interest in using most or all the product.

Table 3. Market Summary

	MAD Cake	TPAD Cake	Compost	Thermal Drying	Lystek
Full-Service Providers	✓✓	✓✓	✓	✓	✓✓
Soil Manufacturers			✓✓✓	✓✓	
Nurseries			✓		
Sod					
Local Parks/ Organizations			✓	✓	
Land Reclamation	✓	✓	✓	✓	✓
Golf Course					
Alternative Fuel					

References

Higgins et. al. 2007. Reactivation and growth of non-culturable indicator bacteria in anaerobically digested biosolids after centrifuge dewatering. *Water Research*;41(3):665-73.

Metcalf & Eddy, Inc. 2003. *Wastewater Engineering: Treatment and Reuse*. Boston: McGraw-Hill, Print.