After 40 years of successfully composting biosolids, Merrimack plans for the future

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ABSTRACT | Since the 1970s the town of Merrimack, New Hampshire, has been successfully managing the biosolids generated at the wastewater treatment facility through composting. The original aerated static pile system was replaced in 1994 with an enclosed agitated bed facility. After extensive evaluation of alternatives, including both landfill disposal and privatization of the composting operation, the town recently completed a major upgrade to the composting facility. The town's investment in the continued operation of the composting facility was due in part to the compost marketing partnership with a third-party compost blender and marketer.

KEYWORDS | Biosolids, composting, compost, aerated static pile, agitated bed facility


The Merrimack Wastewater Treatment Facility

INTRODUCTION

Biosolids management is a significant cost for wastewater treatment plants in New England. Whereas many municipalities transport and dispose of biosolids in regional landfills or incinerators, the town of Merrimack, New Hampshire, has composted its wastewater residuals into biosolids for more than 40 years as a commitment to biosolids beneficial use. Merrimack has a population of about 26,000, occupies an area of 32.6 square miles (84.4 square kilometers), and is located along the Merrimack River in southern New Hampshire. The town was selected as one of the top 25 places to live in the United States in 2013 by *CNN/Money* Magazine. At nearly 800 people per square mile (310 people per square kilometer) it is predominantly an urban-suburban community with a median household income of about $70,000 per year.

This article describes the development of the composting program, changes to the composting technology, various studies and reviews over the years, and the commitment to continue with composting as the preferred option for managing biosolids. Over the years the town has developed a compost marketing program, which is also discussed below.

FACILITY DESCRIPTION

The Merrimack Wastewater Treatment Facility (WWTF) started operation in 1970 and underwent significant upgrades in 2007 and in 2013. The WWTF can treat 5.0 million gallons per day (mgd) (18.9 million liters per day [mL/d]) with an average flow of 1.8 mgd (6.8 mL/d). The Anheuser-Busch brewery generates about 35 percent of the flow and 70 percent of the total suspended solids (TSS) entering the plant.

The liquid treatment process train includes an activated sludge system with an anaerobic zone for enhanced biological phosphorus removal. A screw press produces a dewatered cake from a combination of primary and secondary solids, which are composted to meet Environmental Protection Agency Class A* standards. The facility has received a number of awards, including ones for operations and maintenance, biosolids, and industrial pretreatment.

SOLIDS MANAGEMENT

The WWTF started composting in the 1970s with an aerated static pile (ASP) operation and upgraded to the in-vessel agitated bed facility that began operations in 1994.

When the WWTF began operation, sludge was dewatered with vacuum filters and hauled to a lined lagoon next to the town's landfill off Lawrence Road in Merrimack. The New Hampshire Department of Environmental Services (NHDES) required the town to close the lagoon and remove the accumulated sludge. The town used the ASP composting approach to stabilize the lagoon sludge and operated the ASP at the lagoon site from 1979 to 1981. With the ASP operation being evaluated as successful, composting operations were permanently relocated to the grounds of the WWTF after 1981.

At present, the Merrimack compost facility handles about 9,600 wet tons per year (WTPY; 8,700 wet tonnes/year) of dewatered biosolids at approximately 20 percent dry solids. About 3,600 WTPY (3,300 wet tonnes/year; 37 percent) are received from other treatment facilities in southern New Hampshire and northeastern Massachusetts.

AERATED STATIC PILE COMPOSTING

A pilot was initiated in 1976 using the ASP method pioneered by the United States Department of Agriculture in Beltsville, Maryland (see Epstein et al. 1976). This approach consisted of mixing the dewatered sludge with wood chips (bulking agent) and placing the mixture of chips and sludge over perforated piping. Aeration blowers connected to the end of the pipe pulled air down through the mix. The odorous air was exhausted from the pile though a small scrubber pile of finished compost, which acted as a biofilter to remove odors.

The town encountered operational issues with the ASP system typical of many operations. The composting was performed outdoors and uncovered, and thus was exposed to both cold temperatures and precipitation. The original ASP facility was limited in controlling the composting process. As a result, the compost product was often wet and difficult to screen, and recovery and reuse of the wood chips was difficult. Since the compost from the ASP facility was wet and heavy, had an undesirable quantity of wood chips, and and as there was no marketing plan for it, the product had minimal value in the market. This meant that significant quantities of compost accumulated at the WWTF over many years. In addition, the air exhausted from the compost piles was odorous and the small scrubber piles did not control odor effectively.

*The U.S. Environmental Protection Agency Part 503 biosolids rule classifies wastewater residuals as "unclassified," "Class B," or "Class A." Unclassified material has undergone no processing for pathogen reduction. Class B material has undergone some processing to reduce pathogens and vector attraction but still has pathogens remaining. Class A material has undergone thermal processing to reduce pathogens to undetectable levels. Owing to the high level of treatment, Class A material can be used almost anywhere, including areas with much contact with the public.

UPGRADE TO ENCLOSED IN-VESSEL COMPOSTING

In the early 1990s the town began evaluating other composting approaches, including various in-vessel systems marketed and installed in the United States in the 1980s. The evaluation included assessing the overall compost process and making a consistent product.

After extensive review and visits to operational facilities, the town chose an agitated bed in-vessel compost technology. This technology was introduced into the United States in 1986 and a fully operational facility was installed at Earthgro, in Lebanon, Connecticut, where it processed manures. A facility similar in size to the facility planned for Merrimack was constructed at the Anheuser-Busch brewery in Baldwinsville, New York, to handle the solids generated from the treatment of brewery wastewater. When Merrimack began its design, several similar facilities were already located at municipal wastewater treatment facilities and processing biosolids, including in Fairfield, Connecticut, Plymouth, New Hampshire, and Lockport, New York.

The enclosed agitated bed facility offered a number of advantages over the town's ASP system:

- It captured and treated odors using biofiltration
- Agitated bed composting used automated temperature monitoring to control operation of the aeration blowers.
- Aeration was operated in a positive mode, controlling compost temperatures more precisely
- Dryer product was generated in a shorter time

Operational facilities demonstrated the system's ability to generate a consistent quality dry product that was marketable. Production of a consistent marketable product was of importance to the town, which had historically struggled to distribute compost.

FACILITY DESIGN AND LAYOUT

The agitated bed composting system is modular with parallel, elongated bays. The compost mix is loaded into the front end of each bay and moved

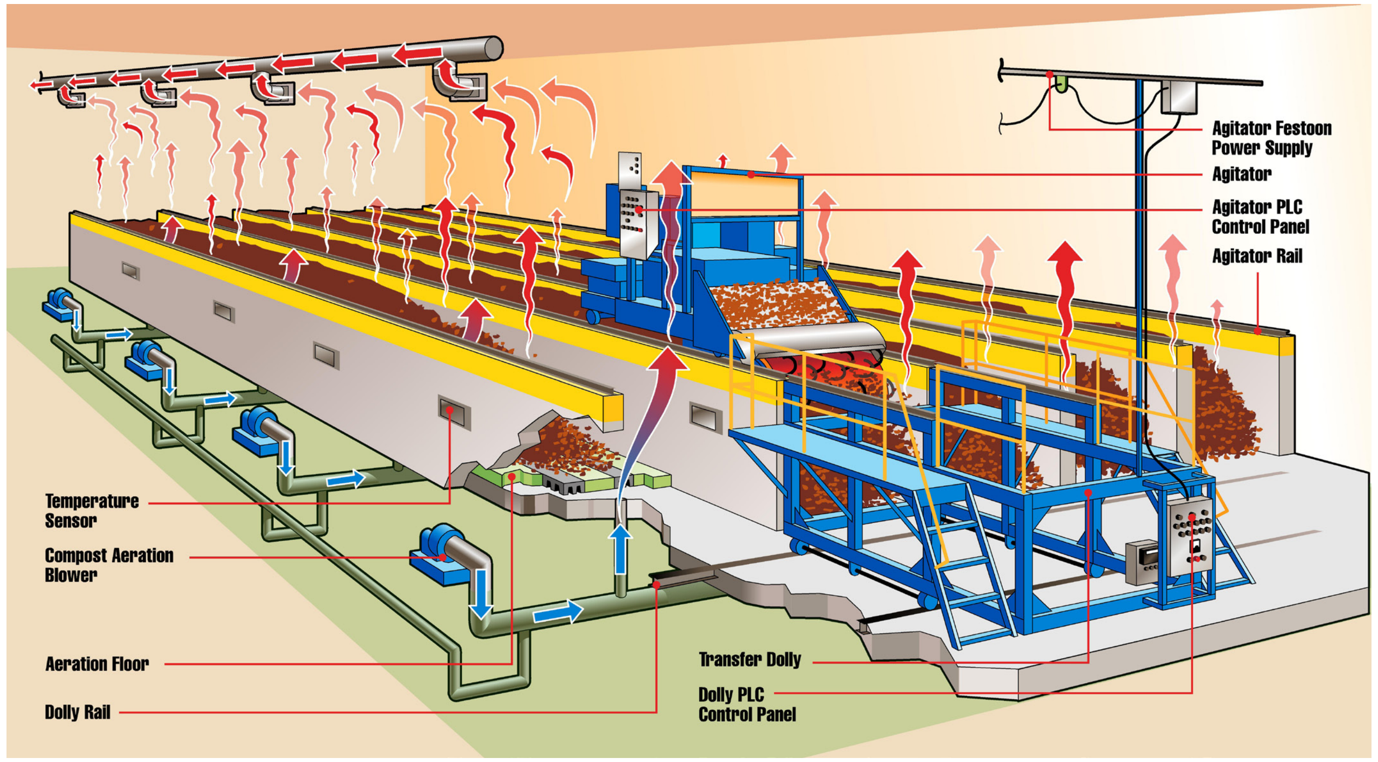

Figure 1. Schematic of agitated bed composting system

down the bay with an automated agitator traveling on rails mounted on the bay walls. Figure 1 shows the arrangement of the agitators and bays. The Merrimack facility was constructed with 15 bays and three agitators. Each bay can receive about 14 cubic yards (yd^3) [11 cubic meters (m^3)] or "charge" of new compost mix following the agitation process. A charge contains approximately 6 yd^3 (4.6 m^3) ~4 tons (3.6 tonnes) of biosolids and 8 yd^3 (6.1 m^3) ~2 tons (1.8 tonnes) of wood shavings. Each bay is designed to be agitated five times per week (once each working day). After about a 21-day retention, the compost is discharged from the bays and transferred using a front-end loader to uncovered outdoor curing. Approximately 7 yd^3 (5.3 m^3) of compost are discharged from each bay with each agitation. Compost removed from the enclosed facility is cured outdoors in open windrows for a minimum of 30 days. Paved areas previously used for the ASP operations now provide a location to cure, screen, and store compost. A wooden pole building, also constructed for the original ASP facility, stores the bulking agent.

Temperature sensors (thermocouples) in the bay walls automatically monitor compost temperatures. The temperature data controls the aeration blowers that provide oxygen and cooling. The aeration system follows design principles from various research studies, including Kuter et al. (1985) and MacGregor et al. (1981), that demonstrate the importance of adequate aeration to control temperatures and achieve drying.

The moist and odorous air driven off the compost is contained within an enclosed structure and exhausted from the building using fans located outside of the facility. Odorous air is passed through a biofilter to remove odors. The efficacy of simple biofilters to remove compost odors (largely mixtures of reduced sulfur compounds) has been demonstrated through testing at other agitated bed facilities (see Amirhor et al. 1995).

The enclosed compost facility began operation in October 1994, using proprietary agitated bed equipment including agitators and computer control system.

COMPOST MARKETING

The agitated bed system allowed the town to avoid the use of wood chips as a bulking agent and use finer-textured wood shavings as an alternative. This substitution resulted in a finer-textured product compost that was screened to a 3/8 inch (9.5 millimeter) size to produce a uniformly textured product, increasing the product's market value. Distribution and marketing of the compost was a concern for the town, so it entered into a compost marketing contract with a third-party compost blender and marketer. Except for some limited local sales, all compost is distributed through the third-party marketer in bulk. The local sales and give-away program for town residents account for about 1,400 yd^3 (1,100 m^3) of compost per year; that is less than 10 percent of the annual production. In 2015, the total volume sold will exceed 15,000 yd^3 (11,500 m^3). The third-party marketer has responsibility to find customers, set up trucking and delivery, and pay for all the delivery and marketing (e.g., promotional materials) expenses.

The town has maintained a commitment to operating the composting program to ensure the compost meets all regulatory standards and customer expectations. For example, although composting can be performed with a variety of amendments, the town has continued to procure sawdust and shavings even during periods of increased price, ensuring the product is consistent in texture and appearance. Through the partnership with the compost blender and marketer, the town shares responsibilities to obtain permits to distribute the compost across New England and New York.

Compost is widely used as a soil amendment. Despite negative perceptions associated with biosolids, strong markets for Merrimack's compost product have been developed and maintained over the years. An advantage of a third-party compost blender and marketer is that it can focus on establishing a diverse customer base that includes custom soil blenders who use the compost to prepare mixes for sports fields and golf course construction, garden centers, and landscape contractors. Third-party marketers also provide a professional sales staff that educates landscapers and landscape architects on the value and benefits of the product.

In recent years there has been a focus on sustainable landscaping using compost to improve soil quality. Because of its uniform and relatively fine particle size, Merrimack compost is used widely as top-dressing over established turf. Customers are adding organic matter to the soil and have reported that they can reduce use of irrigation water by reducing soil compaction and improving root growth. An example of a customer using compost for top-dressing is the Tournament Players Club (TPC) Boston in Norton, Massachusetts, which is the site of the PGA Tour FED EX® cup playoff. Compost is applied to the primary rough areas, resulting in denser turf and reduced irrigation.

The town receives a portion of the sales price in accordance with a revenue-sharing agreement with the third-party blender. Over the past 10 years, revenues to the town have increased through increases in both the share it receives and the value of the compost (Figure 2).

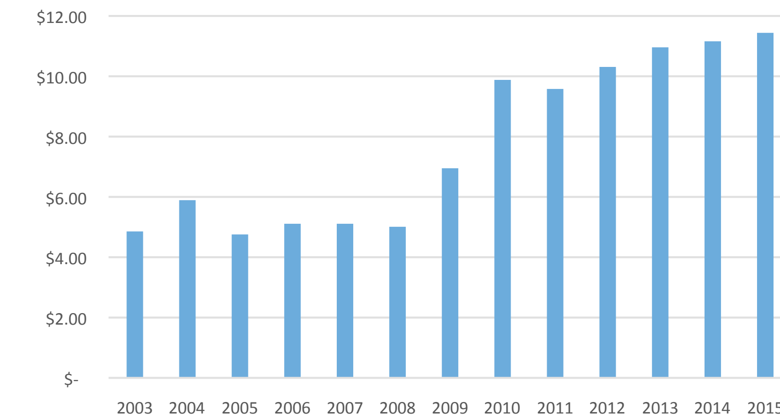

Figure 2. Town of Merrimack revenues ($/cy) from compost sales (2003 to 2015)

2008 STUDY

Since the startup of the enclosed agitated bed facility in 1994, the town has addressed a variety of challenges. Operating within an enclosed building allows for the odorous air exhausted from the compost vessels to be captured and treated. However, the air exhausted from the composts is saturated with water vapor and condenses readily on the interior surfaces, promoting an extremely corrosive environment. After 20 years of operation, structural damage to the building became evident. In addition, proper composting requires large supplies of consistent and dry bulking agent. For each wet ton of biosolids about 2 to 3 yd^3 (1.5 to 2.3 m^3/wet tonne) of wood shavings are used. With increased competition for wood used for fuel, the town found it increasingly difficult to obtain the needed quantities and faced escalating costs to secure the material.

Facing a significant investment to renovate the compost facility, in 2008 the town reviewed alternatives to dispose of biosolids. The following options were considered: One option was to close the compost facility and enter into an agreement with a third party for either landfill disposal or land application of the biosolids. Another option was to make the needed renovations and continue composting with either:

- A private contractors who would assume all responsibilities for the facility operations or
- Continued operation of the facility using treatment plant staff

The town solicited cost proposals for the options above and concluded it was best to renovate the facility and continue with operations. By using excess capacity, the town could generate additional revenues by processing additional biosolids from other treatment facilities outside town. The three most economical proposals were:

- Composting with town staff = $12.98 million net present value (NPV) or $84.30 per ton ($76.64/tonne);
- Composting using outside contractor = $13.12 million net present value (NPV) or $85.20 per ton ($77.45/tonne); and
- Landfill disposal = $15.68 million net present value (NPV) or $101.84 per ton ($92.58/tonne).

GREENHOUSE GAS EMISSIONS

At the same time the town was reviewing its options, the North East Biosolids and Residuals Association (NEBRA) reviewed the greenhouse gas (GHG) emissions from composting compared to those from landfill disposal. The NEBRA study (Beecher 2009) concluded that the composting option generates significantly fewer GHG emissions than landfill disposal. Although composting has higher energy requirements than landfilling, the latter method generates methane, a more potent GHG than carbon dioxide. Calculations indicated that future landfill disposal would emit 2.5 times more GHG equivalents than the current composting operation. With improved dewatering at the treatment plant factored in, the landfill option would generate 3.4 times more GHG than the composting option.

COMPOST FACILITY UPGRADES

Based on the 2008 review the town moved forward to renovate the compost facility at a cost of nearly $2.9 million. The project replaced the roof, computer control system, and compost agitators. The roof was a modified membrane roof with vapor barrier, with 1.5 inches (3.8 centimeters) of foam insulation under a a rubber membrane. One-third of the roof (the front area where most moisture was generated), consisted of stainless steel under a hot dipped galvanized roof panels. The facility also received all new purlins, and all bolts were replaced on the main supporting members.

The town also replaced the original three agitators with two new machines. The original agitators had lasted more than 20 years, and the three 25-horsepower (hp) [18 kilowatt (kW)] agitators were replaced with two 50-hp (37-kW) agitators to process the same 15 bays in an eight-hour workday. This change saved the town a lot of money and opened space in the mixing area for better loader movement.

The facility renovations and installation of the new agitators were completed in the fall of 2015. The composting operations continued on a reduced schedule as the work was performed.

FUTURE FOR MERRIMACK

The town supported the investment in the renovations to the enclosed agitated bed composting facility. Warrant articles require a two-thirds affirmative vote with all-day voting one month after the traditional town meeting. This hurdle was easily cleared, indicating broad acceptance of composting. The town had, since the early 1980s, provided a giveaway program for residents, and that popular program was likely a factor in the successful vote.

The investment in the renovation underscores Merrimack's long-term commitment to a composting program. This commitment has endured through changes in town staffing and successive public works directors and plant superintendents. Treatment plant staff have faced numerous operational challenges and embraced the attitude that they manufacture a valuable product and are not just treating wastes. Working with a private marketing company has enabled the town to maximize revenues from product sales and control its destiny. The town has also successfully taken on biosolids from other communities and runs the facility at near full capacity, and thus operates with greater economic efficiency.

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