

In preparation for writing this article with Jeff Ziegenbein, I drove to Rancho Cucamonga, California — a primarily residential community of some 178,000 about 40 miles east of downtown Los Angeles — to visit the Inland Empire Regional Composting Facility. With a 10-acre footprint for processing, not including a 3-acre biofilter and another 3-acres for curing and staging finished compost, I figured it would be relatively easy to find by sight, sound or smell, even if the majority of the operation was housed indoors. Not so, and even when I arrived at one of its gates, I still wasn't sure if I was at the right place. I could have been at any given fence line surrounding any given warehouse, and despite the fact that this one's massive interior was full from floor to ceiling with biosolids compost, it wasn't until I actually entered the building that I could fully understand what a remarkable achievement in design and function the Inland Empire Regional Composting Facility really was. The facility's surprisingly mild demeanor — having not a single complaint since it opened its doors in April 2007 — defies the magnitude of its throughput, acreage and some million Inland Empire residents it serves.

— Rich Flammer



The Inland Empire composting facility, located adjacent to a wastewater treatment plant, features a 10-acre processing building (1), a 3-acre biofilter (2) and a 3-acre covered compost storage area (3).

HIGH VOLUME, LOW IMPACT

A MEGACOMPOSTING SUCCESS STORY

THE Inland Empire, colloquially known as the “IE,” is a metropolitan region in Southern California that includes Riverside and San Bernardino Counties. The area has a long, storied history of agriculture and a diverse range of topography and climate, from mountains to desert, elevations of over 10,000 feet to as low as 220 feet below sea level, and snow and freezing temperatures to dry triple digit heat. Mountain ranges or hills surround the IE and separate it from Los Angeles and Orange County to the west, the state of Arizona to the east, Inyo County to the north, and San Diego County to the south. More than four million people reside in the Inland Empire, making it the third most populous region in California. It is also the largest of three main regions of Southern California, covering some 27,000 square miles.

Similar to most other areas of Southern California suitable for farming, the IE's status as a major center of agriculture has diminished since the turn of the century, and continues to decline as development, particularly for housing that is considerably more affordable than coastal cities, con-

Processing 150,000 wet tons/year of biosolids and 60,000 tons/year of amendment inside a retrofitted warehouse produces soil amendments, sustainability and economic value for utility customers.

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sumes farmland. Yet dairies and farms persist, many with new residential neighbors, some in limbo after the economic downturn led to their land sale falling out of escrow, others trying to hang on until the economic landscape improves. San Bernardino agricultural production was valued at over \$500 million in the most recent data available, and Riverside County remains one of California's top producers of crop and livestock outputs with production values of over \$1 billion a year.

Dairies in particular were a major industry in the IE as recently as 10 years ago. Pushed out of Los Angeles and Orange counties in the early 1970s by development, hundreds of dairies were relocated eastward to the San Bernardino Agricultural District, and were safe from similar displacement by being in a “Dairy Preserve.” Or so they thought. The preserve was eventually decommissioned, and many operations moved once again... some as far as Idaho, New Mexico or Texas, some to other California counties.

In the region's heyday, approximately 400 dairies occupied the Chino Valley. While the dairies kept milk production in



Biosolids are tipped directly into designated hoppers (left). Bulking agents are blended and scooped into an amendment hopper with a front-end loader (below). The hoppers feed materials onto a conveyor that leads to pug mill mixers.



Southern California, cow manure challenged the integrity of the Chino Basin, one of the largest groundwater basins in the southern portion of the state. The basin's 235 square miles and some 5 million acre-feet of water began feeling the effects of one of the densest dairy cow populations in the country, as salts, nitrates and total dissolved solids leached into the underground aquifer. This challenge, in addition to other resource management and water-related issues in the region caused by rapid development of residential and nonagricultural commercial and industrial sectors, led the Inland Empire Utility Agency (IEUA) — a regional authority — to pursue composting.

The IEUA supplies imported and recycled water, wastewater management and other utility-related services — such as renewable electrical energy and composting — to residents in seven cities in the Inland Empire. Its five wastewater treatment plants produce 75,000 tons/year of biosolids. Prior to development of its enclosed facility, IEUA operated a 250,000 tons/year outdoor open windrow composting facility (processing biosolids, manure and amendments) in Chino, about 10 miles southwest of the current operation in Rancho Cucamonga. Due to progressively increasing urbanization of the Chino valley, dairies were rapidly replaced with housing developments. This change, coupled with tightening regulatory requirements, prompted the open windrow site to close in 2006. Throughout its 11-year history, the facility processed more than 1.3 million tons of manure and biosolids into compost. In addition to composting biosolids in Chino, the IEUA shipped material to Arizona for direct land application on nonfood crops such as cotton. This also served as an interim method of utilization between the time the Chino site closed and the new facility opened.

BIOSOLIDS PARTNERSHIP

In February 2002, a regional Joint Powers Authority (JPA) was formed between IEUA and the Los Angeles County Sanitation Districts (LACSD). LACSD serves 78 cities and unincorporated portions of Los Angeles County, an area compass-

ing 800 square miles and populated by about 5.7 million people who produce some 600,000 tons of biosolids annually. Its public health and environmental management programs include solid waste transfer and landfills, recycling, wastewater treatment, water reclamation and energy production.

The IEUA and LACSD jointly evaluated composting and concluded it was the most economically and environmentally sound method of beneficially recycling biosolids generated from the wastewater treatment facilities operated by each respective agency, as well as locally generated manure and yard trimmings. Their partnership, called the Inland Empire Regional Composting Authority (IERCA), offered a multitude of advantages for development of the facility, including a considerably larger budget than possible had either entity gone about building a comparable operation on their own.

The broader financial resources afforded by the JPA allowed consideration of many options, while increasing regulatory challenges to biosolids disposal or composting narrowed them, including some of the most stringent air emissions regulations in the U.S. (see sidebar: "Rule 1133") and direct land application bans requiring the material to be hauled over 150 miles away to Arizona. And despite an ample budget for development of the project, per ton biosolids processing costs needed to rival or come in lower than the \$40 to \$50/wet ton to land apply or \$70/wet ton or more to compost or pelletize in the region.

Today, the Inland Empire Regional Composting Facility (IERCF) processes approximately 150,000 tons of biosolids and 60,000 tons of wood and green waste per year. Annual processing costs are just under \$6 million, or about \$40/wet

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ton of biosolids. Costs are offset by revenues generated from compost sales, as well as tipping fees for green waste and other bulking agents received at the facility.

REPURPOSING AN IKEA WAREHOUSE

IERCF operates in a 452,320-square foot warehouse formerly occupied by IKEA, the international home products retailer. The site was one of 16 considered, and was chosen for close proximity to two major interstates, I-15 and I-10, which already handle commercial truck traffic, as well as consistency with neighboring land uses, compatibility with local zoning and public expectations for this type and scale of facility, and an architecture that allowed control of air emissions and odors. The entire property is 24.4 acres, and has a maximum security prison and a large retail warehouse facility as neighbors. The closest residence is a mile away. Another major advantage of the site is its location next to the IEUA's Regional Wastewater Treatment Plant No. 4. Sharing property with the treatment plant provided opportunities and efficiencies with resources, staffing, land and permits. The compost facility handles all of the solids produced at the treatment plant and uses recycled water produced there as well.

Construction to retrofit the building to house the largest indoor biosolids composting facility in the United States began in 2003, and was completed in April 2007. The general layout of the existing warehouse was utilized, but substantial internal modifications to allow for installation of mechanical material handling and ventilation equipment to support composting were required. Building modification costs of \$70 million brought the total project cost to \$85 million, which includes engineering and purchase of the property and original structure.

Environmental protection and being a good neighbor were deemed cornerstones of the IERCF design. Hence, the building was modified to accommodate the entire process, from biosolids/bulking agent receiving to finished product loading and all processing in between. Every activity within the facility is maintained under negative pressure, with exhaust air vented to a 3-acre biofilter constructed adjacent to the building, ensuring that all odors and dust are confined and treated. Air inside the structure is completely exchanged at least six times per hour, and exhausted to the biofilter to create a safe working environment. A health and safety team was established to conduct periodic tests to verify safety assumptions as well as dictate necessary personal protective equipment as needed. Assessments have been conducted at every throughput increase as well as on a scheduled annual basis and no major safety issues of concern have occurred at the IERCF to date.

Building features include tilt-up concrete walls, a wood truss frame roof, columns every 48 feet east to west and every 54 feet north to south, and loading docks along the entire north side. At 32 feet, the original ceilings were too high, allowing far too much volume of air to treat. So a drop ceiling made of galvanized steel was installed and lowered the height to 22 feet, reducing the facility's air volume by about one-third. To minimize temperature gradients and condensation, insulating foam was applied between the existing and new ceilings, and between existing and new poured and block concrete interior walls. To prevent corrosion of the building's interior, a polyester coating was applied a half-inch thick, covering fasteners and sealing joints, and removing all seams and any opening that caustic gases could penetrate and corrode.



The biofilter contains over 50,000 cubic yards of chipped wood piled onto a perforated floor (inset). Designed air flow rate is 813,200 cubic feet/minute.

Support columns were strengthened and coated, but didn't have to be moved because their existing spacing allowed adequate room for operation of the John Deere 644 and 744 loaders used at the facility. The columns have a protective concrete wrap in case they get struck by a loader. After one incident of a column being hit, staff fitted loaders with a Doppler radar system that warns the operators with both audio and visual signals when they are near any structures.

DESIGN CHALLENGES AND INNOVATIONS

Given the complexity of the biophysical manufacturing process involved with operating an indoor composting facility, the IERCF required extensive planning to work out a multitude of system design challenges. A start-up business plan defined five distinctive core business functions: product marketing and development, compost manufacturing, facility and equipment maintenance, administrative support and training. Within each of the business functions, two to five vital factors were identified as critical to the success of each business function's goal.

The interrelationship of these functions was also considered key to the venture working efficiently. For example, product marketing and development, often overlooked in composting facilities, was deemed critical to operations, as lack of sales and stagnant facility output could easily turn into overcapacity issues. To prepare for this, staff conducted a pilot project using feedstocks and a recipe similar to those expected during full-scale operations. The pilot confirmed some of the recipe assumptions as well as created samples of the finished product. The samples were analyzed at compost laboratories and distributed to potential customers. Coupled with test results, the compost samples created sales demand before operations got underway.

IERCF management also established a set of value activities to ensure operational standards were consistent with the high quality brand image of the facility they were seeking. These activities include: clean truck and facility grounds standards, odor control with automatic doors and negative aeration, product quality monitoring with analytical commitments to buyers, employee training, care and support standards, and on-time, within budget commitments to suppliers and customers. These service commitments were cre-

ated to ensure the same high standard exists from the production phase to delivery of exceptional quality compost.

FACILITY OPERATIONS

The IERCF receives biosolids from its own treatment facilities as well as LACSD's, in a 50/50 ratio that equates to 75,000 wet tons annually from each. Bulking agents such as yard trimmings, bedding and wood waste come from local equestrian centers including Disneyland and Hollywood Park, landscapers and tree trimmers. Bulking agents are also received from local material recovery facilities (MRF) that separate wood wastes and grind the material to meet IERCF specifications. The bulking materials are delivered to the IERCF and unloaded within the enclosure. Suppliers pay tipping fees based on the quality and volume of the materials, but are typically \$2/ton. More than 25 truckloads of material are received every day, 365 days of the year.

After weighing in, trucks delivering biosolids and bulking agents drive into the building's receiving area through high-speed roll up doors that close immediately after they enter and remain closed while they're unloading. Biosolids are tipped directly into designated hoppers and bulking agents are unloaded into a designated area where they are blended and scooped into an amendment hopper with a front-end loader. The hoppers feed the material onto belt conveyors that meter it in the appropriate ratio to two McLanahan pug mills for blending. The blended material is then conveyed to the active composting area where windrows, approximately 12 feet tall, 175 feet long and 20 feet wide, are constructed using front-end loaders.

The IERCF utilizes stationary material conveyance equipment (e.g. Spirac shaftless and shafted screw conveyors, belt conveyors, feed hoppers, etc.) to the greatest extent possible to facilitate materials movement through the facility. Although a significant amount of material is transported using front-end loaders, the mechanized conveyance equipment has contributed to the overall efficiency of the operation and reduced the number of workers needed.

The active composting process is designed for approximately 21 days, with a total daily input of 800 wet tons, or 1,700 cubic yards. The static pile windrows are constructed over an aeration system, which draws a maximum of 2.5 cubic feet per minute per cubic yard of air through the pile using an in-ground pipe and spigot system with hundreds of small air distribution grates in the floor. Each static pile has a dedicated aeration blower (located in the corridors of the building) that exhausts to the facility's biofilter. The blowers, controlled manually by facility operators, regulate pile temperatures for the most efficient composting. Over 75 Reotemp wireless temperature probes monitor temperatures in compost piles throughout the facility.

All air from inside the facility is also pulled by blowers through the biofilter. The negative flow of exhaust air is conveyed using a series of fans controlled by a SCADA (supervisory control and data acquisition) system. The SCADA system tracks all composting activity and records time and temperature conditions providing documentation required for meeting state and federal composting regulations. It also allows staff to operate facility equipment remotely, from front-end loaders or the floor. The entire facility is mapped out with wireless receivers that allow unrestricted access to SCADA controls within the facility. Recycled water is plumbed throughout the facility for use as



Trucks delivering biosolids and amendments drive into the building's receiving area through high-speed roll up doors that close immediately after they enter.

dust control as well as to adjust moisture content in active compost piles as needed.

Over 6,000 solar panels on the roof of the IERCF can produce up to one megawatt of electricity, enough to furnish up to 50 percent of the power required to operate the facility during normal operations. IERCA financed the installation through Morgan Stanley under the SunPower Access power purchase agreement (PPA) program. Under this agreement, electricity generated from the system is purchased from the financier, who owns and operates the system (which utilizes the T10 Solar Tile technology from SunPower Corporation). IERCA owns the renewable credits associated with the system, and benefits from immediate savings and a long-term hedge against rising peak power prices.

AIR PERMITS, BIOFILTER PERFORMANCE

By far the most onerous of the permitting required for the IERCF is the air permits. IERCF has two permits with the South Coast Air Quality Management District (SCAQMD). One regulates the overall facility, limiting annual feedstock throughput rates of all materials brought in to a maximum of 209,625 wet tons/year and 17,715 wet tons/month. It also stipulates that the design exhaust air capacity for the entire enclosed facility (maximum 813,200 cfm) is to be treated utilizing a biofilter. The second permit regulates the biofilter, setting design and operational constraints as well as performance standards. It establishes a minimum VOC and ammonia control efficiency of 80 percent (or greater) and specifies how and when compliance testing is to be conducted.



Over 6,000 solar panels on the roof of the IERCF can produce up to 1 MW of electricity, enough to furnish up to 50 percent of the power required to operate the facility.

IERCF's 3-acre biofilter (approximately 1,130 feet long and 131 wide (134,600 sf)) contains over 50,000 cubic yards of chipped wood piled onto a perforated floor supplied by BacTee. It occupies the entire length of the northern periphery of the parcel of land the composting building sits on. Designed airflow rate is 813,200 cfm; 12 cells that operate in parallel. Recycled water is used to keep the moisture content optimal at approximately 55 percent. Exhaust air slowly travels through the 8-foot deep bed of 6-inch minus fruit and nut tree chips, providing at least a full minute of exhaust air contact time. This residence time has been shown through numerous tests to remove greater than 90 percent of the VOCs and 100 percent of the ammonia as well as virtually all of the odors produced at the facility.

Meeting the SCAQMD permit requirements requires a rigorous operations plan and monitoring program. Routine inspection of the IERCF facility's complex air distribution and ventilation system ensures that the facility is operating as designed. Careful operation and maintenance of the biofilter is required with routine monitoring to ensure that key operational parameters such as the total air flow rate, air flow distribution and pressure differential (across the biofilter), media moisture content, and media quality are maintained. As required by SCAQMD, the facility completed a source test to verify the permit conditions. The source test results concluded that the biofilter's removal efficiency far exceeded the minimum required by SCAQMD under rule 1133.2.

PRODUCT BRANDING AND MARKETING

After composting, material is transported to the curing area, where it finishes off for a period of approximately 30 days. Curing windrows with the same dimensions as active composting piles are aerated to maintain optimum temperatures. The aeration system was designed to also be used for active composting if necessary.

After curing, material is conveyed to the screening area, which is equipped with a ventilation system and bag house to remove and capture dust generated from screening operations.

Overs are returned to the front of the building on belt conveyors for another cycle as a bulking agent. Screens are required to maintain a production level at least equal to the volume received each day or material will quickly back up and restrict throughput. Two 8-foot by 40-foot Wildcat trommel screens are used.

Since the main building was retro-

fitted, another covered, but open-sided facility was built for compost storage. The 3-plus acre facility can hold nearly three months' production of compost (about 50,000 cubic yards), often required during winter months, when sales are typically slow.

A factor deemed critical to the success of the IERCF was branding and market development of the finished product. Customer outreach and product and service branding— all done in-house — began two years before the start-up of the facility, including the pilot discussed earlier which enabled sales staff to get a jump on testing the product and providing potential customers with samples and lab sheets. The brand name is SoilPro Products. The product is described as “a wood based, nutrient rich compost made from recycled green waste, biosolids and horse stable bedding proven to save water and produce direct benefits to soils and crops in both horticulture (lawns and gardens) and agriculture (vegetables, fruits, nuts, and hay crops).”

The IERCF produces approximately 250,000 cubic yards (90,000 tons) of SoilPro compost annually. Its SoilPro Premium Compost is purchased by several companies that package it for retail sales, including Kellogg Garden Products, which bags the compost and sells it in big box stores such as Home Depot and Lowes. Other users, some 75 local customers in total, use the material to prepare soil for turf and other vegetation on both public and private properties. Demand for the product has ensured that everything made is sold, allowing the facility to maintain its throughput goals. SoilPro sales staff network with prospective customers through tradeshows and workshops, and has also worked closely with local cities that provide feedstock to the facility to encourage them to purchase and use the finished compost. More than 15 cities representing over one million residents participate in this “take back” program.

NEXT STEPS

The IERCA recently received the American Academy of Environmental Engineers (AAEE) “Excellence in Environmental Engineering® Honors Award in Operations/Management.” This award identifies, rewards and promotes projects that possess excellence in all aspects of environmental engineering, including demonstration of an integrated approach that considers all environmental media, quality measured by user satisfaction and performance, contribution to social and economic advancement, originality and innovation, and complexity of the problem addressed as well.

Future plans include, among others, generation of more sustainable power through installation of a wind turbine, which will provide up to a megawatt of clean energy as a test under a similar PPA as the solar project. The facility is located in an area with adequate wind to power a large turbine. If the pilot is successful, there is ample land to add additional turbines with enough output to remove the project entirely from the grid. (IEUA recently installed 2.5 megawatts of solar located at multiple agency facilities, as well as utilizes methane produced at its treatment plant digesters.)

The IERCF's location, design and rigorous operational and environmental controls have helped the partnership achieve its goal... to build and operate a biosolids composting facility that exists in harmony with its surrounding environment and produces a marketable, high quality end product from recycled materials. The IERCA Board of Directors has been



A fabric-covered building can hold nearly three months' production of compost (about 50,000 cubic yards). Storage space is often required during winter months, when sales are slower.





End uses of SoilPro Premium Compost include turf establishment, as illustrated in these before and after photos of an athletic field project.

diligent in ensuring that the IERCF's development and operation is economically, socially and ecologically sustainable. The fact that these materials are generated, processed and sold locally, reduce water consumption and protect ground and surface water resources, and represent a fair value to rate payers compared to other less economically and environmentally friendly options, such as disposal or long distance transport, combine to make the IERCA a great success. ■

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AIR QUALITY COMPLIANCE

THE South Coast Air Quality Management District (SCAQMD) is responsible for achieving federal ambient air quality standards and demonstrating compliance with the state and federal clean air acts. The South Coast Air Basin (Basin) is a serious nonattainment area for PM10 (particulate matter less than 10 microns) and is the only extreme ozone nonattainment area. The Basin includes all of Orange County and urban areas of Los Angeles, Riverside and San Bernardino counties, an airshed the agency deems "the smoggiest region of the U.S."

Ammonia is a precursor of PM10 and Volatile Organic Compounds (VOCs) are precursors to ozone. SCAQMD developed a technical assessment report in 2002 that identified emissions from cocomposting operations (composting with biosolids and/or manure) to produce significant VOC and ammonia emissions. In 2003, the SCAQMD adopted one of the most stringent air quality rules governing cocomposting projects in the country. Rule 1133.2, "Emission Reductions from Co-composting Facilities," requires that such operations located within the Basin utilize best management practices to reduce VOC and ammonia emissions emanating from the cocomposting facility by a minimum of 80 percent.

The IERCF was granted a permit to construct under Rule 1133.2, and was required to verify compliance with the rule. A source test was completed in 2009, verifying that the facility not only met, but far exceeded, the minimum standards of the rule, removing VOCs by 94.8 percent and ammonia by 100 percent.

EQUIPMENT INVENTORY

COMPOSTING over 200,000 tons annually requires a wide assortment of equipment and systems to keep operations running smoothly. The Inland Empire Regional Composting Facility (IERCF) utilizes the following:

- *Wildcat trommel screens:* Two 4-foot by 80-foot Wildcat stationary trommels. The company has worked closely with IERCF staff to keep the screens running and to upgrade them to operate in a reliable manner.
- *ReoTemp wireless temperature probes:* Over 75 wireless probes to monitor temperatures in compost piles throughout the facility.
- *Summit Structures compost storage building:* Covered but open-sided 3-plus acre structure to store about 3-months of compost production (50,000 cubic yards).
- *McLanahan mixers:* Two McLanahan pug-mill mixers that blend the compost recipe into a homogeneous feedstock.
- *John Deere front-end loaders:* Models 744 and 644 loaders have been fitted with high-capacity buckets.
- *AE Fan Equipment Company ventilation system:* 22 large capacity exhaust fans and 36 process fans that provide aeration for the compost and curing piles.
- *Spirac screw conveyors:* Both shaftless and shafted screw conveyors are employed, along with nearly 7,000 feet of 48-inch belt conveyors that move compost material through the facility.
- *SunPower Corporation solar panels:* Over 6,000 solar panels (T10 Solar Tile technology) installed on roof to provide 1 MW of electricity.