
CASE

AeroAggregates, the First Vertically-Integrated Manufacturer of Ultra-Lightweight Aggregate Made From 100% Recycled Materials in the U.S.



AeroAggregates is revitalizing local manufacturing and developing a circular solution for post-consumer recycled glass in the Philadelphia region. Their product, an ultra-lightweight aggregate called foamed glass, has applications in transportation, infrastructure and construction. AeroAggregates is the first vertically-integrated company in the United States to produce this product, which has been in use for several decades in Europe.

BORROWER

AeroAggregates, LLC

CLF LOAN

\$3M

LOCATION

Eddystone, PA

TOTAL PROJECT

More than \$10M

PORTFOLIO AREA

End Market Manufacturing

BEFORE

Over the last 15 years, the volume of glass arriving at material recovery facilities (MRFs) has increased, which has strained aging sorting and cleaning equipment. As a result, the glass stream has become more contaminated, which has made it more difficult and less profitable for MRFs and glass processors to sell.

The greater Philadelphia area has 2.4 million households, and the typical household generates 100 pounds of glass recyclables a year, which translates to 120,000 tons of recyclable glass available each year for reuse.

At the same time, glass does have a robust potential post-consumer life, including as an ultra-lightweight material called foamed glass. Foamed glass has been manufactured and deployed in construction and infrastructure projects in Europe since the 1980s, but has never been produced or used domestically in the US.

AFTER

A team experienced in geotechnical engineering and recycling saw the product's potential, and after more than five years of planning, launched the country's first-ever vertically-integrated foamed glass manufacturer, located in Eddystone, PA. AeroAggregates is changing the game for glass processors in the Mid-Atlantic region. Now, MRFs are seeing significantly improved economics for sorting glass and are assured that the glass is recycled. As of the end of 2018, AeroAggregates has diverted 32,000 tons of glass-- or 146 million bottles --from landfill in the Philadelphia region. These bottles have found a second life in a variety of construction and infrastructure projects in the mid-Atlantic region, where soft coastal soils and other poor site conditions necessitate ground improvement as a precursor to building. As of July 2018, the company has employed 15 people at its headquarters and runs two production lines at their Eddystone facility, located on a former brownfield site.

KEY METRICS

PROGRESS TO DATE (EOY 2018)	PROJECTED IMPACT BY 2025
32,000 TONS DIVERTED	264,000 TONS DIVERTED
10,550 GHG AVOIDED (MTS)	73,000 GHG AVOIDED (MTS)
640,000 HOUSEHOLDS (EQUIVALENT)	800,000 HOUSEHOLDS (EQUIVALENT)
15 JOBS CREATED	20 JOBS CREATED

CONTEXT

Mixed glass accounts for up to 25 percent of the stream of recycled materials by weight in the United States. As a post-consumer material, recycled glass has many benefits and applications. It is infinitely recyclable, less energy-intensive to use than virgin glass or glass substitutes, and its potential uses go way beyond beer bottles.

Unfortunately, despite the increased volume of post-consumer glass arriving at single-stream sortation facilities, recovery and reuse remains stagnant due to significant challenges when it comes to finding efficient processing and cost-effective end-uses for the material. It is easily breakable and often contaminated, which taxes older sorting equipment at single-stream materials recycling facilities (MRFs). Even if a MRF can produce decent quality stock, they have to pay to transport the glass to the nearest processor for additional cleaning and sorting by color before it can be reused for container manufacturing.



Because of the weight of the material, transportation is a significant cost, and also results in additional greenhouse gas emissions. There is a significant shortage of nearby glass processing capacity for many communities across the US. If the glass is not sent to a processor, the MRF likely pays a discounted disposal fee at a landfill, where the glass will be used as alternative daily cover. This amounts to a missed opportunity to recover and recycle that material.

SOLUTION

Key to Closed Loop Fund's investment strategy is development of new end-markets for low- and no-value post-consumer recyclable commodities, including glass, while creating value throughout the supply chain. An investment in AeroAggregates is accomplishing both aims. AeroAggregates is the first company of its kind in the United States, using glass to produce an ultra-lightweight construction aggregate and in doing so, creating a valuable new revenue stream for local MRFs.

SOLUTION

Construction aggregates are particulate materials, like sand, limestone and gravel, that are typically extracted through capital-intensive mining and quarrying processes that generate negative environmental externalities. But, through a simple process involving just one other ingredient and a kiln, post-consumer glass can be turned into foamed glass, an ultra-lightweight aggregate that resembles volcanic pumice stone, but is strong enough to be used in a wide variety of road, building and infrastructure projects.

In addition to the environmental benefit of being made from 100 percent post-consumer recycled materials, foamed glass is less energy-intensive to produce than other lightweight aggregates. Also, it weighs 85 percent less than traditional aggregates, which makes it less expensive and polluting to transport. With 4 million miles of roads, the United States offers a considerable market opportunity for aggregate. Recognizing this, a group of people with decades of experience in the engineering and recycling industries began exploring how to bring foamed glass technology to the U.S.

The result of their collaboration is AeroAggregates LLC, the first vertically-integrated, U.S. -based manufacturer of ultra-lightweight aggregate made from 100 percent recycled materials. In 2016, the company bought a 10-acre site in Eddystone, Pennsylvania. Eddystone is located at the junction of I-95 and I-476, two major highways that give the site easy access to several major metropolitan areas in the Delaware Valley and mid-Atlantic regions. Aero's decision to locate on the East Coast was due, in part, to the market fit for the product: road construction projects in coastal areas with soft soils require significant ground improvement so that road materials do not settle too much.



Figure 1. Map showing AeroAggregate's headquarters (green pin) and 30-mile radius catchment area for sourcing glass. Blue pins indicate locations where AeroAggregate product is in use.

A mix of owner equity, equipment loans and mortgage debt from a local bank allowed the company to open the facility in late 2016, with one kiln and production starting in early 2017. A loan from Closed Loop Fund in early 2017 allowed the company to add a second kiln to the facility, which came online in summer 2018.

SOLUTION

Closed Loop Fund's loan aligns with several key components of the fund's investment strategy: increasing profitability for MRFs; strengthening and diversifying end-markets for recyclables; and developing infrastructure for circular supply chains.

BUSINESS CASE, KEYS TO SUCCESS

The decision to launch AeroAggregates was driven by its owners' experience in large-scale construction projects and geotechnical engineering, where they saw the increased demand for sustainable, lightweight fill materials due to increased design and construction requirements and challenges. In addition, many state departments of transportation have a mandate to preference recycled and American-made products. Aero's planning process included many meetings with the product's target customers, decision makers with whom the leadership team has deep relationships developed over decades: consulting engineers, transportation departments, the Federal Highway Administration (FHWA), concrete producers, and general contractors. All reported an increased use of lightweight materials.

Still, the decision to embark on this entrepreneurial journey was not taken lightly. The founding team members spent more than five years exploring the product's technical specifications. The start-up phase is capital-intensive, so the decision to launch the company required a leap of faith, albeit one informed by the company founders' strong understanding of, and belief in, the product's technical capabilities.

While AeroAggregates is producing a new, unique product, the most common competitor materials are expanded shale, which is three times heavier than foamed glass, and expanded polystyrene, which is flammable and degrades under certain conditions, thus limiting its uses in road construction.

The market for lightweight aggregate alone is estimated at 8 million tons per year. In 2015, state and local governments spent \$168 billion on highways and roads, which accounted for 6 percent of their direct spending.



Figure 2. Ultra-Lightweight Foamed Glass Aggregate (UL-FGA) is made from 100 percent post-consumer recycled glass.

BUSINESS CASE, KEYS TO SUCCESS

Relative to other lightweight aggregates, Aero's product is cost- and carbon-competitive, particularly because the source material can be procured close to where the product is produced. In addition, customers can realize further savings by adapting design and application, because the material is much lighter.

The company sees a broader range of end-markets for its product in the future, including in building, landscaping and coastal resiliency projects. The company has been working closely with engineering departments at many major universities to test new applications and continues to do outreach and education to potential customers to increase market awareness and acceptance of the product, which is unfamiliar in the United States market.

RESULTS TO DATE

Production began on one kiln in March 2017, and a second kiln came online in late 2018. The plant is currently processing about 90 tons of glass a day. At full capacity, the facility can process up to 64,000 tons of glass per year, which is roughly equivalent to 280 million beer bottles. Foamed glass is a proven technology in Europe, so technology risk is low. Still, AeroAggregates has contracted with two leading European companies to use their patented technology and receive technical support, and has also received technical assistance from the Pennsylvania Recycling Markets Center to ensure that the product had no traces of crystalline silica.

Aero is sourcing recycled glass cullet from MRFs and an independent processor in the Delaware Valley/Mid-Atlantic region. By the end of 2018, AeroAggregates had processed 32,000 tons of post-consumer glass. To date, the product has been shipped to projects from Massachusetts to Virginia, including road projects for PennDOT, Pennsylvania's transportation agency, and Amtrak. The company has also completed several smaller projects locally, including the Philadelphia Navy Yard and Subaru's corporate training headquarters in Camden, NJ. Projects like these demonstrate how Aero is catalyzing the development of a circular economy for glass in Pennsylvania and the greater Philadelphia region.

"Pennsylvania has developed a portfolio of uses for recycled glass; any state looking to increase the volume of glass that is recovered needs to do the same. Aero is an anchor part of our portfolio of uses because they have found an application that is both high-volume and high-value. Without a doubt, AeroAggregates will increase the volume of glass reused in the state of Pennsylvania."

**- Robert Bylone, Jr.,
Executive Director,
Pennsylvania Recycling
Markets Center**

RESULTS TO DATE

By closing the loop for glass, AeroAggregates is also changing the profitability of materials recovery facilities (MRFs). Aero's business model recognizes that MRFs need to receive value for their glass, which creates two streams of economic benefits: fees for the purchase of glass, and avoided landfill tip fees for glass that MRFs may have previously been unable to sell because of limited end-uses.

EARLY LESSONS LEARNED AND CHALLENGES

The extensive research, relationship-building and product testing that Aero's leadership team conducted before company launch generated a lot of interest in the product, but the company's leadership notes that having a product ready to ship was critical to converting interest into purchase orders. For this reason, they are quick to note that their capital-intensive, start-up business required an initial leap of faith to move ahead with facility build-out and production.

AeroAggregate's initial sales have been to a handful of public and private customers. On the public side, procurement of AeroAggregates' product was enabled by provisional code approvals, thus bypassing typical agency approval processes. In the future, public procurement processes that preference environmentally-friendly processes could further enhance AeroAggregate's competitiveness. This underscores the importance of incorporating ongoing education and advocacy of key customer segments, including government, into the company's work.

Still, anyone who has contracted with government knows that the sales cycle is long—often measured in years, not months. On top of that, construction projects are seasonal, so product shipments are not spread evenly throughout the year. Combined, these factors point to the critical need for flexible financing, including bridge and working capital, to manage uneven cash flow.

While the company is still young, it has generated a lot of excitement at the state level for its ability to solve a long-standing problem for the recycling industry: what to do with small pieces of mixed-color glass. The difficulty of sorting small pieces of glass by color has meant that a lot of this stock is disposed. In 2017, the company was awarded the William M. Heenan, Jr. Award from the Pennsylvania Recycling Markets Center, in recognition of the high-value, high-volume solution that their product brings to this long-standing challenge.

For more information about our portfolio, go to:
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