Proposal for:

City of New Bedford

Request for Expression of Interest to Permit, Design, Build, Finance, Own, Operate & Maintain and Market Products from an Organics-to-Energy Sludge Processing Facility

Solicitation Number—19192009

Prepared by
Waldron Engineering & Construction, Inc.

July 12, 2018
July 12, 2018

Susan Bruce
Director of Purchasing
City of New Bedford
133 William Street
New Bedford, MA 02746

RE: City of New Bedford
    Organic to Energy Sludge Process Facility
    RFEI Solicitation #19192009

Dear Ms. Bruce:

Waldron Engineering & Construction, Inc. (Waldron) along with Power Island Energy Anaergia and Wright-Pierce Engineering, collectively referred to as the "Team," is pleased to submit the attached Request for Express of Interest (RFEI) in response to Permit, Design, Build, Finance, Own, Operate & Maintain and Market Products from an Organics-to-Energy Sludge Processing Facility issued by the City of New Bedford.

Our Team’s proposed approach is best matched the project goals with additional value-added benefits that will further enhance the project. Our Team consists of industry leading experts in their area of practice and strong knowledge in advance waste treatment technology. We have proven track record executing and financing complex waste to energy and power generation projects.

Our Team look forward to the opportunity to participate the RFP technical and financial proposal in the coming months

We thank you for providing our Team the opportunity to respond to the RFEI for this project. We trust the foregoing will be of interest to you and if you have any question with respect to the information contained herein please do not hesitate to contact us.

Sincerely,

Waldron Engineering & Construction, Inc.

Cedric Chan, P.E.
Director
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WALDRON
1. Executive Summary
Executive Summary

The Waldron Team is the right organization and presents the right approach to provide the services to the City of New Bedford. Our Team provides a Turnkey approach to develop, permit, finance, design, build, own and operate a waste to energy facility at City of New Bedford’s current property. Our approach greatly benefits the City of New Bedford and nearby community financially and environmentally as state of the art facility for the next twenty years or longer.

We assembled some of the industry leading organizations with a wealth of experience working in waste to energy processing plants, environmental permitting, heat and power generation, utility interconnection approval, innovative project financing, complex project execution and local construction project experience. Our combined experience of over 500 project completions similar to this RFEI proves that our success is no fluke.

Waldron specializes in engineering, construction, commissioning and testing of power generation, combined heat and power and renewable energy facilities. Waldron has successfully executed over 1000 projects for over 300 clients. Waldron has designed and/or constructed 25 plants that are in operation and 7 that are in design and/or construction. Waldron ventured into the renewable energy world by executing projects utilizing Organic Rankine, Wave Hydrokinetics, Biomass, Biogas and Compressed Air Energy System Technologies. Waldron’s multi-disciplinary team provides expertise through all phases of energy generation and distribution projects, from conceptual phase studies through to final commissioning and testing and to commercial operation.

Our Team’s anaerobic expert, Anaergia, is a global technology leader in the recovery of resources and valuable products from waste streams with a focus on organic wastes. Their technologies and integrated solutions are used to achieve municipal waste diversion and sustainability targets, and reduce greenhouse gas emissions. At the core of Anaergia’s solutions is the unique and patented Organic Extrusion Press (OREX™), for the separation of organic material from solid waste for beneficial reuse and diversion from the landfill, and its Omnivore™ High Solids Anaerobic Digestion technologies for processing a wide range of organic waste, including sewage sludge, municipal solid waste and high strength liquid organic waste.

Our Team has addressed the goals of this RFEI and is committed to develop and execute a successful project that provides many benefits to City of New Bedford and surrounding communities.
2. Introduction to the Waldron Team

a. Waldron Engineering & Construction, Inc. - Lead Engineer & Project Manager
b. Power Island Energy
c. Anaergia - Digester Equipment & Operator
d. Wright-Fierece - Civil & Environmental Engineering
2. Introduction to Waldron Team

The team of Waldron Engineering & Construction, Inc., Power Island Energy, Aneargia and Wright-Pierce, collectively referred to as the “Team”, is pleased to submit the attached Request for Expression of Interest (RFEI) Solicitation Number 19192009 Organics to Energy Sludge Process Facility.

The collaboration of the Waldron Team will deliver best-in-class services to the City of New Bedford. Our assembled team of professionals has experience working with wastewater treatment, municipality and other state clients, including the Cities of Nashua, Braintree, Camden, NJ, Toronto, ON, Fall River and many more on similar waste to energy infrastructure projects. We have the experience, resources, availability and financial background to execute your project from development to completion.

<table>
<thead>
<tr>
<th>Project Team</th>
<th>Role</th>
<th>Lead Person</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waldron Engineering and Construction, Inc.</td>
<td>Project Manager</td>
<td>Cedric Chan&lt;br&gt;Director&lt;br&gt;37 Industrial Drive&lt;br&gt;Exeter, NH 03833&lt;br&gt;(603) 772-7153 (Main)&lt;br&gt;(603) 772-7693 (Fax)&lt;br&gt;<a href="mailto:chan@waldron.com">chan@waldron.com</a></td>
</tr>
<tr>
<td></td>
<td>Engineer of Record</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power Island Energy</td>
<td>Project Finance</td>
<td>Steve Wilson&lt;br&gt;President&lt;br&gt;(904) 327-5718&lt;br&gt;<a href="mailto:s.wilson@powerislandenergy.com">s.wilson@powerislandenergy.com</a></td>
</tr>
<tr>
<td>Aneargia</td>
<td>Anaerobic Digester Supplier and Operation</td>
<td>Ashwani Kumar&lt;br&gt;Managing Director&lt;br&gt;(905) 766-3333 x230&lt;br&gt;<a href="mailto:ashwani.kumar@anaergia.com">ashwani.kumar@anaergia.com</a></td>
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<tr>
<td>Wright-Pierce</td>
<td>Civil Engineer and Environmental Permitting</td>
<td>Jeffrey Pinnette, PE&lt;br&gt;Project Manager&lt;br&gt;(207) 798-3756&lt;br&gt;<a href="mailto:jeffrey.pinnette@wright-pierce.com">jeffrey.pinnette@wright-pierce.com</a></td>
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A more detailed description of Waldron Engineering, Aneargia, and Wright-Pierce can be found in Attachment 1 in this Section.
A. Waldron Engineering and Construction, Inc.

Waldron Engineering & Construction, Inc. specializes in engineering, construction, commissioning and testing of power generation, combined heat and power, renewable energy, central heating and chilling facilities. As a premier power engineering and construction management firm in the US, Waldron prides itself in being a leader in advancing new and emerging energy production technologies and developing ways to bring them to commercial application. Whether you need engineering design, construction management, commissioning, or a full-service EPC firm that can take a project from initial concept to final operation, we can partner with you to deliver the best solutions on time & on budget.

Our reputation and exemplary skill set is well respected within the energy-focused community and we would be delighted to share our references with you.

Company History

In 1992, along with the other members of the founding team who are still at the company today, Terence Waldron formed Waldron Engineering, Inc. which quickly built a reputation by providing top-notch engineering services to the fast-growing merchant and private power industry. This laid the foundation for a broader array of services to eventually include the design of energy generation and distribution infrastructure tailored to the specific needs of a diverse client base. In response to a growing need for the delivery of a complete array of services including construction and commissioning, Waldron Engineering, Inc. expanded into Waldron Engineering & Construction, Inc.

Under the leadership of Mr. Waldron, John Sweet, Cedric Chan and David Forbes, the Waldron team has successfully executed over 1000 projects for over 300 clients. Waldron has designed and/or constructed 25 plants that are in operation and 7 that are in design and/or construction. Waldron has ventured into the renewable energy world by executing projects utilizing Organic Rankine, Wave Hydrokinetics, Biomass, and Compressed Air Energy System Technologies. Waldron's multi-disciplinary team provides expertise through all phases of energy generation and distribution projects, from conceptual phase studies through to final commissioning and testing.

Our Market

- Combined Heat and Power feasibility studies having completed 35 to date.
- Combined Heat and Power Facilities with 25 in operation and 5 in design and construction.
- Peaking Plants with 6 in operation and one in construction.
- Alternative Energy Projects
- Utility Engineering design having completed over 1000 projects
Power Island Energy, LLC (PIE) is based in Jacksonville FL with an office in Boston MA. Power Island Energy, LLC. Develops, invests and arrange financing for onsite power projects including Microgrids. Power Island utilizes Senior Debt, Junior Debt, Grants, and Equity to finance developments and projects. Additionally, we work with partners to provide tax equity financing.

PIE's recently completed a microgrid project financing for City of Bridgeport, CT. The micro grid is part of a municipal pilot program through the Department of Energy and Environmental Protection (DEEP); natural gas micro grids are designed to provide continuous power to critical public facilities in the event of a major power failure. The Bridgeport microgrid will provide a central, independent and local generating facility to supply and distribute power in “island” (when the grid goes down) and parallel modes to City Hall, Police Headquarters and the Golden Hill Senior Center. The Microgrid in general will serve approximately 144,000 citizens of Bridgeport. In addition, the generators' excess heat will be utilized to provide both heating and cooling by way of an absorption chiller to City Hall, Police headquarters and the Cabaret Buildings. The Microgrid will use Virtual Net Metering to apply any excess electricity to other City Facilities.

The project owner is Bridgeport MicroGrid LLC, in turn owned by OR&L Construction, Controlled Air and the principals of Power Island Energy. A project-specific Energy Services Agreement between Bridgeport Micro-Grid LLC and the city was negotiated which delineates all terms and conditions governing the operations of the micro grid including how charges for energy, operations and maintenance and capacity are to be calculated and escalated over the twenty-year term.

Senior Lender: First Niagara Bank, NA (subsidiary of KeyCorp (NYSE: KEY), 20-year term, self-amortizing

Junior Lender: Connecticut Green Bank, 20-year term, self-amortizing

Other financing: $2.9mm grant from DEEP

Equity: $1mm

City's Prospectus containing additional information on Bridgeport: [http://roosevelt-cross.com/pos/CTBridgeport01a-POS1154789488.pdf](http://roosevelt-cross.com/pos/CTBridgeport01a-POS1154789488.pdf)
Anaergia is a global leader in organics recovery and the production of clean energy, fertilizer and recycled water from waste streams, and offers the widest range of waste to resource solutions for municipal, industrial, commercial and agricultural markets. Anaergia delivers integrated solutions globally through offices established across North America, Europe, Africa and Asia. With approximately 175 employees globally, and over 25 years of experience, Anaergia's technology has been utilized in over 1,600 anaerobic digestion and renewable energy projects worldwide.

![World map with locations marked](image)

**Figure 1: Anaergia Global Offices and Regional Headquarters.**

Anaergia has both extensive process expertise and a large in-house waste diversion technology portfolio which allows it to provide its customers with process solutions optimized to achieve their specific goals in the most economic manner possible. Our solutions enable the recovery of resources and valuable products from waste streams that can be used to offset local fossil fuel consumption, reach municipal greenhouse gas reduction and sustainability targets, and improve the quality of life for partnering communities.
Corporate Structure, Year & Jurisdiction of Incorporation

Anaergia Inc. is a privately held corporation composed of several subsidiaries and affiliates with its corporate head office in Burlington, Ontario. Anaergia’s legacy in resource recovery from waste and high solids anaerobic digestion technology started in 1992 when UTS Biogastechnik GmbH was formed in Germany (now a wholly owned subsidiary of Anaergia). In 2010, Anaergia Inc. was formed to bring the best European resource recovery and high solids anaerobic digestion technologies to North America by building on the successes of UTS Biogastechnik and its other subsidiaries. In 2014, Anaergia acquired db Technologies BV, a company based in the Netherlands, and VM Press SRL, a company based in Italy. These two companies design and manufacture equipment for the processing of source separated organics and municipal solid wastes, including technology for the extraction and cleaning of organics from municipal and commercial solid waste streams to produce a clean organic feedstock for anaerobic digestion or composting.

Examples of Major Clients

- City of Toronto – Toronto, ON, Canada
- Toyo Energy Solutions Co. – Yabu City, Japan
- Camden County Municipal Utilities Authority – Camden, NJ, USA
- Region of Limassol – Pentakomo Village, Limassol, Cyprus
- Goa Waste Management Corporation – Saligao Bardez, Goa, India
- New Horizons Energy – Cape Town, South Africa
- Kelda Organics Energy Ltd. – Tremorfa, Cardiff, UK
- Recology LLC – San Francisco, CA, USA
- TEG Environmental Group (now owned by East London Biogas) – London, UK
- Victor Valley Water Reclamation Authority – Victorville, CA, USA
- Zweckverband Abfallwirtschaft Kaiserslautern (ZAK) – Kaiserslautern, Germany
- BayWa r.e. renewable energy GmbH – Szarvas, Hungary
Company Overview

Established in 1947, Wright-Pierce is organized as a closely-held private corporation since 1954. We maintain ownership and management by current employees invested in the success of our clients, and therefore our company. We believe this differentiates us from our publicly-owned competitors whose main corporate mission is to maximize shareholder value. We have an ownership transition plan in place that ensures continuity of ownership and business operations beyond the death, disability or retirement of key stockholders and officers.

We successfully complete many infrastructure projects each year, ranging in size from less than $100,000 to more than $100-million. We provide complete engineering services from initial planning, through design, bidding, construction administration, and operational assistance. Wright-Pierce helps municipalities and municipal utilities build and maintain their infrastructure systems to support the community’s vision for the future and to enhance quality of life.

We continue to grow and expand our office space to provide responsive service to our clients.

Wastewater Engineering Services

The effective management and treatment of wastewater is critical to maintaining public health, supporting the character of our communities and economic development, and protecting the environment.

Civil / Infrastructural Services

From our beginning more than a half-century ago, Wright-Pierce has been known for its civil engineering services. Today we apply state-of-the-art technology and know-how to resolve our state, municipal, institutional, commercial and industrial clients’ civil infrastructure needs.
Waldron Engineering & Construction, Inc. specializes in the design, construction, commissioning and testing of power generation, combined heat and power, renewable energy, central heating and chilling facilities.
WHAT WE DO

- We provide professional engineering consulting and design services to the power industry

- Experience in:
  - CHP
  - Peaking Plants
  - Biomass
  - Emerging Technologies
  - Feasibility Studies

- NYSERDA Flex Tech Consultant

- North America, Central and South America, Indonesia and the Caribbean

- Fuels ranging from biogas to natural gas
Waldron covers all disciplines required to completely engineer and construct and commission a facility.

<table>
<thead>
<tr>
<th>Discipline</th>
<th>Licensed</th>
<th>Engineer</th>
<th>Designer</th>
<th>Coordinator</th>
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CHP EXPERIENCE

25 CHP Plants in Operation
= 186,850 kw

5 CHP Plants in Design
= 50,100 kw

Technology:
- Reciprocating Engine
- Gas Turbine
- Steam Turbine

Performed 35 CHP studies to date
<table>
<thead>
<tr>
<th>Project</th>
<th>Technology</th>
<th>kw</th>
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<th>Industry/Sector</th>
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<th>Construction</th>
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<td>Beth Israel Hospital, New York</td>
<td>Reciprocating Engine</td>
<td>250</td>
<td>CHP</td>
<td>Hospital</td>
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<td>Fraser Paper, Edinboro PA</td>
<td>Steam Turbine, Boiler</td>
<td>40,000</td>
<td>Biomass, CHP</td>
<td>Papermill</td>
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<td>One Bryant Park, New York NY</td>
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<td>CHP</td>
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<td>Gillette, Boston MA</td>
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<td>Pfizer (Wyeth BioPharma), North Andover MA</td>
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<td>UMass Medical Phase 1, Worcester MA</td>
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<td>Simmons College, Boston, MA</td>
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## CHP Plants in Progress

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<th>Project</th>
<th>Technology</th>
<th>kw</th>
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<tbody>
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<td>Hanscom Air Force Base, Bedford, MA</td>
<td>Gas Turbine</td>
<td>4,500</td>
</tr>
<tr>
<td>Ocean Spray, Middleboro, MA</td>
<td>Reciprocating Engine</td>
<td>2,000</td>
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<tr>
<td>Nashua Wastewater Treatment Facility, Nashua, NH</td>
<td>Biogas Reciprocating Engine</td>
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<tr>
<td>UCONN Storrs Campus, Storrs, CT</td>
<td>Gas Turbine Trigeneration</td>
<td>8000</td>
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<tr>
<td>UMass Amherst, Amherst, MA</td>
<td>Gas Turbine &amp; Renewable</td>
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<td>TWA Flight Center Hotel, New York, NY</td>
<td>Recip Engine/Energy Storage</td>
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<td>Norfolk Naval Shipyard, Portsmouth, VA</td>
<td>Gas Turbine</td>
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<td>Portsmouth Naval Shipyard, Kittery, ME</td>
<td>Gas Turbine</td>
<td>11,000</td>
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<tr>
<td>Natick Soldier System, Natick, MA</td>
<td>Gas Engine</td>
<td>1,750</td>
</tr>
<tr>
<td>Institution</td>
<td>Location</td>
<td></td>
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<tr>
<td>-------------------------------------------------</td>
<td>---------------</td>
<td></td>
</tr>
<tr>
<td>*Lahey Clinic</td>
<td>Burlington, MA</td>
<td></td>
</tr>
<tr>
<td>*Brigham &amp; Women's Hospital</td>
<td>Boston, MA</td>
<td></td>
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<tr>
<td>Children's Hospital</td>
<td>Boston, MA</td>
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<tr>
<td>Eastern Maine Medical Center</td>
<td>Bangor, ME</td>
<td></td>
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<tr>
<td>*UMass Medical</td>
<td>Worcester, MA</td>
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<tr>
<td>Newton Hospital</td>
<td>Newton NJ</td>
<td></td>
</tr>
<tr>
<td>*Yale University</td>
<td>New Haven, CT</td>
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</tr>
<tr>
<td>*Columbia University</td>
<td>New York, NY</td>
<td></td>
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<tr>
<td>*Harvard University</td>
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<td></td>
</tr>
<tr>
<td>*Pfizer</td>
<td>Groton, CT</td>
<td></td>
</tr>
<tr>
<td>*Biogen</td>
<td>Cambridge, MA</td>
<td></td>
</tr>
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<td>Glatfelter Paper</td>
<td>Spring Grove, PA</td>
<td></td>
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<tr>
<td>Town of Brattleboro</td>
<td>Brattleboro, VT</td>
<td></td>
</tr>
<tr>
<td>*Frito-Lay</td>
<td>Kirkwood, NY</td>
<td></td>
</tr>
<tr>
<td>*Onyx Specialty Papers</td>
<td>South Lee, MA</td>
<td></td>
</tr>
<tr>
<td>Rhode Island Hospital</td>
<td>Providence, RI</td>
<td></td>
</tr>
<tr>
<td>*Lincoln Paper &amp; Tissue</td>
<td>Lincoln, ME</td>
<td></td>
</tr>
<tr>
<td>*Phillips Exeter Academy</td>
<td>Exeter, NH</td>
<td></td>
</tr>
<tr>
<td>*Hudson Yards</td>
<td>New York, NY</td>
<td></td>
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<tr>
<td>*Gillette</td>
<td>Boston, MA</td>
<td></td>
</tr>
<tr>
<td>City of Newark</td>
<td>Newark, NJ</td>
<td></td>
</tr>
<tr>
<td>*Acushnet Ball Plant 3 (Titleist)</td>
<td>Acushnet, MA</td>
<td></td>
</tr>
<tr>
<td>Solutia</td>
<td>Indian Orchard, MA</td>
<td></td>
</tr>
<tr>
<td>Callaway</td>
<td>Chicopee, MA</td>
<td></td>
</tr>
<tr>
<td>Marcel Paper</td>
<td>Elmwood Park, NJ</td>
<td></td>
</tr>
<tr>
<td>Finch Paper</td>
<td>Glen Falls, NY</td>
<td></td>
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<tr>
<td>NYCEDC</td>
<td>New York, NY</td>
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<tr>
<td>Dartmouth College</td>
<td>Hanover, NH</td>
<td></td>
</tr>
<tr>
<td>CAS Feasibility Project</td>
<td>Hartford, CT</td>
<td></td>
</tr>
<tr>
<td>Longwood Medical Energy</td>
<td>Boston, MA</td>
<td></td>
</tr>
<tr>
<td>NIH Facility</td>
<td>Bethesda, MD</td>
<td></td>
</tr>
<tr>
<td>*Ocean Spray</td>
<td>Middleboro, MA</td>
<td></td>
</tr>
</tbody>
</table>

*Studies that turned into CHP projects.
HOSPITAL CLIENTS

Lahey Hospital & Medical Center
Beth Israel Medical Center
Eastern Maine Medical Center
Monmouth Medical Center
St. Luke's - Roosevelt Hospital
Newton Medical Center
Boston Children's Hospital
Brigham and Women's Hospital
Harvard Medical School
Dana Farber Cancer Institute
UMass Medical
Baystate Medical Center
Brookdale Medical
CAMPUS CLIENTS

Harvard University
Montclair State University
UMass Medical
UMass Amherst
UCONN Storrs
Columbia University
Simmons College
Yale University
University of New Hampshire
Cornell University
Dartmouth College
<table>
<thead>
<tr>
<th>Manufacturing Clients</th>
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</thead>
<tbody>
<tr>
<td>Fraser Paper</td>
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<td>Frito-Lay</td>
</tr>
<tr>
<td>Ocean Spray</td>
</tr>
<tr>
<td>Lincoln Paper &amp; Tissue</td>
</tr>
<tr>
<td>Lyondell Basell</td>
</tr>
<tr>
<td>Munksjö-Décor</td>
</tr>
<tr>
<td>Gillette</td>
</tr>
<tr>
<td>Biogen Idec</td>
</tr>
<tr>
<td>Pfizer</td>
</tr>
<tr>
<td>Glatfelter Paper</td>
</tr>
<tr>
<td>Wyeth</td>
</tr>
<tr>
<td>Necco</td>
</tr>
</tbody>
</table>
FEDERAL CLIENTS

Natick Soldier System
Portsmouth Naval Shipyard
NASA Langley
Hanscom Air Force Base
Norfolk Naval Shipyard
## TYPICAL PROJECTS

<table>
<thead>
<tr>
<th>Project Name / Location</th>
<th>Process/Plant Elements</th>
<th>Project Elements</th>
<th>Project Highlights</th>
</tr>
</thead>
<tbody>
<tr>
<td>D3O Energy, LLC Monclair, NJ</td>
<td>• 6.4 MW Electrical Power</td>
<td>• Waltron was the Engineer of Record</td>
<td>• Island Operation</td>
</tr>
<tr>
<td>Milford Regional Medical Center</td>
<td>• 400 kW Steam, Engine</td>
<td>• Waldron was the Engineer of Record</td>
<td>• New Jersey Project</td>
</tr>
<tr>
<td>Beth Israel Medical Center Brooklyn, NY</td>
<td>• 16 mpg Steam, 100 kW Boiler Steam</td>
<td>• Waltron was the Engineer of Record</td>
<td>• Hospital Setting</td>
</tr>
<tr>
<td>Ewing Industries Ewing, MA</td>
<td>• 4,200 Tons Chilling</td>
<td>• Waldron was the Engineer of Record</td>
<td>• Hot Water System</td>
</tr>
<tr>
<td>Brigham and Women's Hospital Boston, MA</td>
<td>• 500 kW Waste Water Recovery Engine</td>
<td>• Waldron was the Engineer of Record</td>
<td>• Island Operation</td>
</tr>
<tr>
<td>Pfizer Global Manufacturing Groton, CT</td>
<td>• 100 kW Waste Water Recovery Engine</td>
<td>• Waltron was the Engineer of Record</td>
<td>• Microgrid</td>
</tr>
<tr>
<td></td>
<td>• 15,000 Tons Chiller</td>
<td>• Waltron was the Engineer of Record</td>
<td>• Island Operation</td>
</tr>
<tr>
<td></td>
<td>• 500 kW Waste Water Recovery Engine</td>
<td>• Waldron performed a feasibility study and then Schematic Design, Design</td>
<td>• Restructure Integration</td>
</tr>
<tr>
<td></td>
<td>• 500 kW Waste Water Recovery Engine</td>
<td>Development and Detailed Design</td>
<td>• Stayed Online During Super Storm</td>
</tr>
<tr>
<td></td>
<td>• 500 kW Waste Water Recovery Engine</td>
<td>• Waltron was the RPD Consultant</td>
<td>• Dual Fuel</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Status</th>
<th>Delivery Method &amp; Role</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operational</td>
<td>Engineering</td>
<td>Confidential</td>
</tr>
<tr>
<td>Operational</td>
<td>Engineer, Perform, Construct</td>
<td>$1.4M</td>
</tr>
<tr>
<td>Operational</td>
<td>Engineer, Perform, Construct</td>
<td>Confidential</td>
</tr>
<tr>
<td>Operational</td>
<td>Engineering</td>
<td>Confidential</td>
</tr>
<tr>
<td>Operational</td>
<td>Engineer, Perform, Construct</td>
<td>Confidential</td>
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</table>
# Typical Projects

<table>
<thead>
<tr>
<th>Project Name / Location</th>
<th>Project Owners</th>
<th>Process/Plant Elements</th>
<th>Project Elements</th>
<th>Project Highlights</th>
<th>Status</th>
<th>Delivery Method &amp; Role Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Falls Lay, Dayville, CT</td>
<td>Falls Lay, Inc.</td>
<td>4.6 MW Solar® Centaur 20 Gas Turbine Generator</td>
<td>Wartsila designed, procured, permitted, constructed and commissioned plant</td>
<td>High Pressure Steam</td>
<td>Operational</td>
<td>Engineer, Procure, Construct, Ox</td>
</tr>
<tr>
<td>LyondellBasell, Lake Charles, LA</td>
<td>LyondellBasell, Inc.</td>
<td>15 MW Solar® Centaur 20 Gas Turbine Generator</td>
<td>Wartsila designed, procured, permitted, constructed and commissioned plant</td>
<td>High Pressure Steam</td>
<td>Operational</td>
<td>Engineer, Procure, Construct, Ox</td>
</tr>
<tr>
<td>Harvard University, Cambridge, MA</td>
<td>Harvard University</td>
<td>160,000 lb/hr boiler</td>
<td>Wartsila designed, procured, permitted, constructed and commissioned plant</td>
<td>High Pressure Steam</td>
<td>Operational</td>
<td>Engineer, Procure, Construct, Ox</td>
</tr>
<tr>
<td>P&amp;G Gillette World HQ, Boston, MA</td>
<td>P&amp;G Gillette, Inc.</td>
<td>5 MW back-pressure steam power</td>
<td>Wartsila designed, procured, permitted, constructed and commissioned plant</td>
<td>High Pressure Steam</td>
<td>Operational</td>
<td>Engineer, Procure, Construct, Ox</td>
</tr>
<tr>
<td>Wyeth Biopharma, Andover, MA</td>
<td>Wyeth Biopharma, Inc.</td>
<td>2.6 MW Diesel backup generator</td>
<td>Wartsila designed, procured, permitted, constructed and commissioned plant</td>
<td>High Pressure Steam</td>
<td>Operational</td>
<td>Engineer, Procure, Construct, Ox</td>
</tr>
<tr>
<td>Ullman Medical School, Woodlands, TX</td>
<td>Ullman Medical School</td>
<td>7.2 MW Solar® Centaur 20 Gas Turbine Generator</td>
<td>Wartsila designed, procured, permitted, constructed and commissioned plant</td>
<td>High Pressure Steam</td>
<td>Operational</td>
<td>Engineer, Procure, Construct, Ox</td>
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</tbody>
</table>

**WALDRON ENGINEERING & CONSTRUCTION, INC.**
# Typical Projects

<table>
<thead>
<tr>
<th>Project Name / Location</th>
<th>Biogen</th>
<th>Dan Bryant Park</th>
<th>ConEdison Energy</th>
<th>Twin Rivers Technologies</th>
<th>Southbridge Cogeneration</th>
<th>MCI - Bridgewater</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project Owner</strong></td>
<td>Biogen</td>
<td>Dan Bryant</td>
<td>ConEdison Energy</td>
<td>Twin Rivers Technologies</td>
<td>Southbridge</td>
<td>MCI</td>
</tr>
<tr>
<td><strong>Process/Plant Elements</strong></td>
<td>50 MW Solar Turbine 50 Combination Turbine w/ HRSG &amp; SCR</td>
<td>4.5 MW Solar Turbine 50 Solar 50,000 lb/hr Steam Gas Turbines w/ HRSG</td>
<td>2 Natural Gas 16,000 lb/hr Steam Turbine</td>
<td>6.5 MW Electric Generation</td>
<td>1.3 MW Biomass Cogeneration</td>
<td></td>
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<tr>
<td></td>
<td>6,000 lb/hr Steam Gas Turbine HRSG</td>
<td>2,000 lb/hr Steam Gas Turbine</td>
<td>1.8 MW OPEX Gas Turbine</td>
<td>6,000 lb/hr Steam</td>
<td>1.3 MW Biomass Cogeneration</td>
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</tr>
<tr>
<td></td>
<td>400 lb/hr Steam gas</td>
<td>1200 lb/hr Steam Gas</td>
<td>4000 lb/hr Steam Gas</td>
<td>2,500 lb/hr Steam</td>
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<tr>
<td></td>
<td>200 lb/hr Steam</td>
<td>1200 lb/hr Steam Gas</td>
<td>1200 lb/hr Steam Gas</td>
<td>2,500 lb/hr Steam</td>
<td>2,500 lb/hr Steam Gas</td>
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<tr>
<td><strong>Project Elements</strong></td>
<td>Valmet designed, permitted, construction management and technical support</td>
<td>Valmet designed, permitted, construction management and technical support</td>
<td>Valmet designed, permitted, construction management and technical support</td>
<td>Valmet designed, permitted, construction management and technical support</td>
<td>Valmet designed, permitted, construction management and technical support</td>
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</tr>
<tr>
<td></td>
<td>In service 2009</td>
<td>In service 2009</td>
<td>In service 2009</td>
<td>In service 2009</td>
<td>In service 2009</td>
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<tr>
<td><strong>Project Highlights</strong></td>
<td>HRSG with SCR &amp; CESM</td>
<td>HRSG with SCR &amp; CESM</td>
<td>Natural Gas Compression</td>
<td>Natural Gas Compression</td>
<td>Natural Gas Compression</td>
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<tr>
<td></td>
<td>Blending / Backfeed</td>
<td>Blending / Backfeed</td>
<td>Blending / Backfeed</td>
<td>Blending / Backfeed</td>
<td>Blending / Backfeed</td>
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<tr>
<td></td>
<td>High Pressure Steam</td>
<td>High Pressure Steam</td>
<td>High Pressure Steam</td>
<td>High Pressure Steam</td>
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<tr>
<td></td>
<td>Typically 3 to 5 times per year</td>
<td>Typically 3 to 5 times per year</td>
<td>Typically 3 to 5 times per year</td>
<td>Typically 3 to 5 times per year</td>
<td>Typically 3 to 5 times per year</td>
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<tr>
<td><strong>Status</strong></td>
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<td>Operational</td>
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<tr>
<td><strong>Delivery Method &amp; Role</strong></td>
<td>Engineer, Contractor, Owner</td>
<td>Engineer, Contractor, Technical Support</td>
<td>Engineer, Owner, Contractor</td>
<td>Engineer, Owner, Contractor</td>
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<tr>
<td><strong>Cost</strong></td>
<td>$16M</td>
<td>$15M</td>
<td>$15M</td>
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WALDRON ENGINEERING & CONSTRUCTION, INC.
STATEMENT OF QUALIFICATIONS
Submitted to: Waldron Engineering & Construction, Inc.

PROFESSIONAL ENGINEERING SERVICES
June 27, 2018 | Anaerobic Digestion

Wright-Pierce
Engineering a Better Environment
A Brief History

Established in 1947, Wright-Pierce is organized as a closely-held private corporation since 1954. We maintain ownership and management by current employees invested in the success of our clients, and therefore our company. We believe this differentiates us from our publicly-owned competitors whose main corporate mission is to maximize shareholder value. We have an ownership transition plan in place that ensures continuity of ownership and business operations beyond the death, disability or retirement of key stockholders and officers.

Wright-Pierce is an award-winning, multi-discipline engineering firm that has been providing wastewater, water and civil infrastructure services for over 70 years.

We successfully complete many infrastructure projects each year, ranging in size from less than $100,000 to more than $100-million. We provide complete engineering services from initial planning, through design, bidding, construction administration, and operational assistance. Wright-Pierce helps municipalities and municipal utilities build and maintain their infrastructure systems to support the community's vision for the future and to enhance quality of life.

We continue to grow and expand our office space to provide responsive service to our clients.

Number of Employees by Discipline

<table>
<thead>
<tr>
<th>Discipline</th>
<th>Total Staff (All 8 Offices)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administration</td>
<td>34</td>
</tr>
<tr>
<td>Architects</td>
<td>4</td>
</tr>
<tr>
<td>Environmental/Civil Engineers</td>
<td>112</td>
</tr>
<tr>
<td>Structural Engineers</td>
<td>6</td>
</tr>
<tr>
<td>Electrical Engineer</td>
<td>6</td>
</tr>
<tr>
<td>Instrumentation and Controls Engineers</td>
<td>7</td>
</tr>
<tr>
<td>Geologists/Hydrogeologists</td>
<td>2</td>
</tr>
<tr>
<td>Landscape Arch.</td>
<td>1</td>
</tr>
<tr>
<td>GIS Specialist</td>
<td>3</td>
</tr>
<tr>
<td>Mechanical Engineer</td>
<td>3</td>
</tr>
<tr>
<td>CADD Tech</td>
<td>24</td>
</tr>
<tr>
<td>Interns</td>
<td>12</td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
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<tr>
<td>RPR/Inspectors</td>
<td>17</td>
</tr>
<tr>
<td>TOTAL</td>
<td>234</td>
</tr>
</tbody>
</table>
Section 1
COMPANY PROFILE

New Hampshire
Portsmouth
230 Commerce Way, Suite 302
Portsmouth, NH 03801

Manchester
250 Commercial St, Suite 4014
Manchester, NH 03101

As shown, we have specialized technical and engineering staff in-house as needed to support the project including structural, architectural, mechanical, electrical, and instrumentation engineers. We also have CAD design and GIS technicians. They are all very familiar with the technical issues and code requirements for municipal projects.

An Award-Winning Firm

Wright-Pierce has been recognized by several industry organizations for business performance and engineering excellence. We rank in Engineering-News-Record (ENR) "Top" lists including Top 500 Design Firms, Top 200 Environmental Design Firms in the country. Many of our projects receive regional ACEC Engineering Excellence Awards. One of our wastewater treatment projects recently received an ENR Best Regional Project Award and a National ACEC Engineering Excellence Award. In addition, PSMJ, a firm dedicated to business practices of architectural and engineering (A/E) firms worldwide, awarded us their "Circle of Excellence Award" for several years after assessing benchmarks for operations, management and sustainability. For several consecutive years, we have received the Platinum Award—one of only six firms in North America to do so.

These awards speak to our focus on client service, successful business practices and technical excellence.

Responsive Service Focused on Your Success

Project success is our focus and the only measure of our success. We utilize our extensive expertise in practical, innovative, and efficient water, wastewater and civil infrastructure solutions to develop tailored solutions to meet your current and future needs.

- We listen to our clients to understand the project issues and goals
- We stress practical, operator-friendly solutions
- We understand fiscal constraints and emphasize value-based solutions
- We involve and collaborate with our clients throughout the projects

We are about building long-standing relationships and delivering on our promise to help our clients succeed to improve their communities and protect public health and the environment for the future.

Wright-Pierce — innovative, reliable, sustainable solutions for your project success today and tomorrow!
WASTEWATER ENGINEERING SERVICES

The effective management and treatment of wastewater is critical to maintaining public health, supporting the character of our communities and economic development, and protecting the environment.

Wastewater Treatment
- Facility planning
- Capacity evaluations
- Pilot/Treatability studies
- Nutrient removal
- Toxicity reduction
- Industrial pretreatment/local limits analysis
- Septage treatment
- Fats, oils and grease (FOG) management
- Alternative disinfection
- Natural treatment systems
- Water reclamation/reuse
- Receiving water modeling/TMDL analysis
- Decentralized treatment systems

Wastewater Collection
- Sewer system evaluations
- Sewer systems and pumping stations
- Collection system modeling and master planning
- Infiltration/inflow monitoring and removal
- Sewer system evaluation surveys (SSES)
- Combined sewer overflow (CSO) removal/treatment
- Sewer separation
- CMOM/SSO
- Decentralized collection
- Treatment and disposal systems

Sludge Management
- Thickening and sludge storage
- Dewatering
- Hauling
- Stabilization
- Anaerobic Digestion
- Aerobic Digestion
- Alkalinity
- Composting
- Drying
- Incineration
- Beneficial Use
  - agriculture
  - land application
  - horticultural applications

Odor Control / Air Quality Control
- Direct chemical addition
  - oxidants
  - pH adjustments
  - binding agents
- Exhaust Treatment
  - Activated carbon and other adsorbents
  - Wet Scrubbers
    - Packed bed scrubbers
    - Tray Scrubbers
    - Venturi scrubbers
    - Mist scrubbers
- Biological
  - biofilters
  - biotrickling filters
  - activated sludge diffusion
- Thermal destruction
  - Regenerative thermal oxidizer
Section 1  
COMPANY PROFILE

ADDITIONAL AND SUPPORT SERVICES

Support Services
- Process instrumentation and control/SCADA
- Process optimization/operation assistance
- Energy audits/management
- Funding/financial assistance/rate studies
- Value engineering/peer review/OPM
- Regulatory consultation
- Infrastructure asset management systems/GIS/
- GASB 34 compliance
- Bidding Assistance
- Construction Administration and Resident Project Representation

Water Treatment Services
- Pre-design and pilot studies
- Filtration
- Iron and manganese removal
- Softening
- Disinfection
- Corrosion control
- Taste and odor control
- Arsenic removal
- Radon removal
- SCADA systems
- Process optimization/operation assistance
- Membranes
- Disinfection by-product reduction

Stormwater Management
- Best Management Practices
- Culverts
- Hydraulic Modeling/Design
- Low Impact Development
- Permitting
- Retention Basins
- Bio Retention Systems
- Vegetative Buffers
- Rain Gardens/Bio Retention Cells

Building Design Services
- Architectural & Structural
- Mechanical/ HVAC
- Electrical
- SCADA/Instrumentation & Controls

Water System Pumping, Storage and Distribution
- Distribution systems
- Hydraulic analysis
- Pumping and booster stations
- Transmission/distribution
- Systems design
- Storage facilities

Geographic Info. Systems (GIS)
- Horizontal infrastructure mapping
Civil / Infrastructure Services

From our beginning more than a half-century ago, Wright-Pierce has been known for its civil engineering services. Today we apply state-of-the-art technology and know-how to resolve our state, municipal, institutional, commercial and industrial clients’ civil infrastructure needs.

- Dams and levees
- Streets and highways
- Sidewalks
- Bicycle and pedestrian trails
- Downtown revitalization
- Recreational and athletic facilities
- General utilities
- Sewer systems/CSO studies
- Sewers/pump stations
- Business/industrial parks
- Bridges and culverts
- Docks and piers
- Retaining walls
- Natural gas pipelines
- Stormwater management
- Site development
- Environmental assessments and permitting
- Geographic information systems (GIS) and mapping
- Asset management/infrastructure inventory, management and maintenance databases/GASB 34 compliance
- Municipal planning board project review services
- Residential
Section 1
COMPANY PROFILE

BUILDING DESIGN SERVICES

Wright-Pierce takes the term “full-service” seriously. We maintain professional in-house capabilities in civil, architectural, structural, mechanical, electrical, instrumentation services. This enables us to effectively and efficiently coordinate all the disciplines required to design a project. These disciplines are experts in our core markets, and they stress sustainable design practices. We employ several professionals who are leadership in energy and environmental design (LEED) accredited.

- Structural/architectural
- Industrial, commercial & public buildings/structures
- Building planning & design
- Reinforced concrete,
- Masonry, steel, aluminum, fiberglass & wood structures
- Foundations & retaining walls
- Bridges & dams
- Building evaluations and renovations
- Roof analysis & replacement
- Code & ADA compliance and building evaluations
- Sustainable design practices
- Marine structures
- Mechanical / HVAC systems
- Plumbing systems
- Fire protection systems
- Electrical
- Power distribution systems
- Motor control centers
  Interior & exterior lighting and power systems
- Emergency & standby power
- Security & fire alarm systems
- Grounding & lighting protection
- Energy audits/conservation
- Information & telecommunications technology infrastructure
- Instrumentation process control & information technology plan
- Supervisory control and data
- Acquisition (SCADA)
- Programmable logic controllers
- Distributed control systems
- Networks & telemetry systems
- Alarm systems
- Design/build services
- General services
- Forensic investigations & expert testimony
- Design-Build advisory services
- Value engineering/project peer review services
- Cost estimating
- Construction administration
- Training / O&M manuals
Facilities Redevelopment Services

As one of northern New England's oldest and most respected consulting firms, Wright-Pierce has often been called upon to assist with planning, engineering and permitting for reuse and enhancement of previously developed sites. The nature of these sites often means that the redevelopment proposal will need to identify, characterize and address a variety of challenges above and beyond those associated with "greenfield" sites. Wright-Pierce offers a wide range of expertise to implement redevelopment efforts after the environmental challenges are identified. Wright-Pierce provides an integrated team of in-house experts, offering skills in the following areas:

- Planning
- Mapping / GIS
- Regulatory assessment
- Environmental laboratory
- Civil engineering
- Landscape architecture
- Water and wastewater engineering
- Electrical and mechanical engineering
- Structural engineering
- Architecture

Our recent experience includes redevelopment efforts associated with a number of such sites. Services provided include the following:

- Site planning
- Economic development
- Community revitalization
- Demolition and debris disposal
- VRAP compliance
- Funding options
- Military facilities
- Regulatory approvals
- Public process
- Renewable energy options
- Riverfront Parks
Section 1
COMPANY PROFILE

VISUAL REPRESENTATION

Wright-Pierce uses a variety of techniques and tools to develop graphic representation materials for public utilities projects. Uses for infrastructure visualization materials include the following:

Design development
Client review
Public meetings
Planning board review
Regulatory agency review

Successful visual communication of project designs is important throughout all phases of project development. Clear, accurate, visual representation of the project is a key component in design development. Visuals are developed using the following methods: hand sketches; diagrams; computer-aided plans, sections and elevations; 3-D models; photo-simulations and virtual tours (i.e. flyovers, drive-bys, and walk-throughs).
OUR FULL-SERVICE WASTEWATER ENGINEERING

Wright-Pierce provides a full-range of engineering services and has extensive experience in all significant elements of wastewater and sludge management projects. Our engineers have the in-house support staff to "cover all the bases". Our wastewater engineers draw on the support of other disciplines, as needed, from our multi-discipline staff and consultants. We have in-house mechanical (HVAC), electrical, instrumentation/SCADA, structural, and civil/site engineers, as well as architects and landscape architects, GIS and CAD technicians, hydrogeologists, licensed wastewater operators, and construction inspectors; all of which focus exclusively on our infrastructure projects. These support staff know the code issues relevant to wastewater projects and have extensive experience planning, evaluating, designing, and constructing wastewater infrastructure projects. We believe having these in-house resources allows us to deliver higher quality services more cost-effectively and more expeditiously.

One of the most significant elements of all wastewater treatment facilities are is the provisions for solids handling. This can be as simple as sludge storage, thickening, and/or dewatering for off-site disposal; but often includes stabilization via anaerobic or aerobic digestion, alkaline stabilization, composting or drying. For large facilities, thermal destruction via incineration is a common volume reduction measure. The following table summarizes our extensive sludge management experience:

### Sludge Management Experience

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<th>Design</th>
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<th>Wastewater Receiving</th>
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Wright-Pierce has designed and upgraded more than 100 wastewater treatment plants.
## Section 2
### RELEVANT EXPERIENCE / QUALIFICATIONS

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*Private clients (non-marketed)*
ANAEROBIC DIGESTION AND CLASS A STABILIZATION

We have extensive experience with anaerobic digestion, and the process alternatives for generating a Class A product either as part of the anaerobic digestion process or through supplemental processing of the digested solids via drying, alkaline stabilization, or composting. In addition, our experience includes both liquid and dewatered sludge pumping and conveying, receiving facilities (including extensive septage and FOG receiving experience), and evaluation of return flow impacts from sludge digestion, thickening and dewatering systems.

Wright-Pierce has been involved with anaerobic digestion projects involving biosolids, food waste and agricultural manure including biogas utilization, as well as nutrient recovery from return flows. Our experience goes back 40 years to when we designed an EPA demonstration project at the Wilton, Maine Wastewater Facility (digesters, methane production, generator, solar heat, heat pumps, etc.). This project was commissioned by EPA to allow a determination as to the cost-effectiveness of the various energy conservation strategies available to wastewater treatment facilities. Our more recent experience ranges from single facility digesters to merchant/community-based digesters and various digester upgrades. Many of these systems also included evaluation of biogas use options. We are familiar with all of the technology alternatives for both conventional Class B anaerobic digestion and various options for Class A anaerobic digestion. Our recent experience includes:

**Danbury Connecticut:** Wright-Pierce has been involved in both short-term and long-term improvements to the anaerobic digesters at the Danbury Wastewater Treatment Facility. The short-term improvements included replacement of a failed cover with a new membrane cover and installation of a new linear-motion mixing system. We are currently designing comprehensive long-term improvements as discussed in the case study at the end of this section.

** Lewiston-Auburn Water Pollution Control Authority, Lewiston, Maine:** Wright-Pierce assisted the Lewiston-Auburn Water Pollution Control Authority with a siloxane removal upgrade to the digester gas cleaning system prior to their combined heat and power generators. This system utilizes activated carbon for siloxane removal, as well as enhanced removal of hydrogen sulfide.
Section 2
RELEVANT EXPERIENCE / QUALIFICATIONS

Nashua, New Hampshire: Wright-Pierce has been assisting the City of Nashua with a variety of improvements at its WWTF including:

- Replacement of the draft-tube mixer for the primary egg-shaped digester.
- Installation of a pumped mixing system for the secondary digester. This Rotamix mixing system is intended to improve overall volatile solids destruction and reduce grit accumulation in the anaerobic digestion system.

In addition, Wright-Pierce has designed new dewatering facilities, new mixing facilities for sludge storage, a grit removal upgrade, and is currently overseeing a screening upgrade.

Winnipesaukee River Basin Program, Franklin, New Hampshire: Wright-Pierce has recently completed an assessment of the factors causing difficulties maintaining temperature in the anaerobic digesters at the Franklin WWTF. The study focused on the operation of the tube in water bath heat exchangers serving the digesters as well as the various temperature measurement devices.

Village Green, LLC, Brunswick, Maine: Wright-Pierce is assisting Village Green Partners in the development of a merchant anaerobic digestion facility that will utilize Quasar anaerobic digestion technology for biosolids, food waste and FOG. This facility will be located on the former Naval Air Station and will utilize combined heat and power for digester heating and electrical generation. Wright-Pierce’s responsibilities include site design and all aspects of permitting.

Private Facility, Massachusetts: Wright-Pierce has recently completed a conceptual design and economic model for a private biosolids/food waste/FOG anaerobic digester at a Massachusetts landfill location. This facility would utilize combined heat and power for digester heating and electrical generation. The biogas from the digester would supplement the existing landfill gas system.

Manchester, Connecticut: Wright-Pierce carried out a thorough evaluation of the options for upgrading the anaerobic digesters as part of a major nutrient removal upgrade of this facility. The City ultimately decided against the investment due in great part to the impact of the return flows.

Greater Lawrence Sanitary District, North Andover, Massachusetts: Wright-Pierce designed the biosolids drying facility to utilize biogas as the primary fuel source for both the dryer system and the regenerative thermal oxidizer. Hot condensate from a three-stage tray scrubber is used...
for heating the anaerobic digesters. The facility is energy self-sufficient during all but the coldest periods when operating on biogas.

*Twin Birch Farms, Cayuga County Soil and Water Conservation District, Auburn, New York:* Wright-Pierce completed an investigation of the feasibility of struvite recovery from the filtrate from an anaerobic digester handling manure solids. This investigation evaluated the economic feasibility of struvite recovery, particularly for farms facing phosphorus loading limitations.

*Eastern Connecticut Resource Conservation and Development, Inc.:* The Eastern Connecticut RC&D is working with farmers in different regions of Connecticut to develop manure management options to better manage manure nutrients. Wright-Pierce worked with the RC&D and the Woodstock, CT area farmers to evaluate the feasibility anaerobic digestion of dairy manure and other feedstocks (including food waste and FOG) in several different digester configurations and biogas use scenarios for individual farms and at a regional facility. As part of this work, Wright-Pierce developed conceptual designs and costs for a number of digester configurations options, investigated funding options and performed a market analysis to determine the revenue generating capacity of the facility.

*Essex Junction, Vermont:* Wright-Pierce completed an evaluation of options to upgrade their existing anaerobic digesters to a Class A (Type I) process including thermophilic aerobic digestion.

*Stavanger, Norway:* Wright-Pierce assisted the City of Stavanger, Norway in technology selection for a biowaste processing facility. This included assessment of a range of solid waste anaerobic digestion and composting technology alternatives. At that time, composting of the biowaste was selected as the preferred technology using an agitated bin composting system provided by Sutco of Germany.

*Dinwiddie County, Virginia:* Wright-Pierce completed a technical assessment of a failed solid waste digester.

**Sludge Drying**

Wright-Pierce has been involved in 11 sludge dryer projects across the United States. Our premier dryer project is the design, construction administration and start-up for the New England Fertilizer Biosolids Drying Facility at the Greater Lawrence Sanitary District located in North Andover, MA. This facility produces a dried, pelletized product from anaerobically-digested sludge for widespread distribution. We have also conducted a
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number of other assignments pertaining to sludge drying for New England Fertilizer and have assisted Veolia North America in evaluating the feasibility of dryers for facilities in New York and Delaware.

ALKALINE STABILIZATION

Wright-Pierce has been a leader in beneficial use through agricultural land application of lime-stabilized biosolids. Use of lime stabilization following digestion would be unusual, but might be considered. We have been involved with over 20 lime stabilization projects in New England including Spencer, MA, South Portland, ME, Waterville, ME and Lewiston-Auburn, ME. Class A (Type I) stabilization can be achieved using higher lime dosage rates or systems that reduce the lime dosage rates and add supplement heat. The latter includes RDF Technologies system used by the City of Concord, NH, that we recently assisted in upgrades.

COMPOSTING

Composting is a common finishing step for anaerobically-digested solids for achieving Class A standards. Wright-Pierce’s list of composting experience in New England is lengthy. We recently oversaw the upgrade of the agitated bin-style composting facility in Merrimack, NH, and construction of a new aerated static pile composting facility for the Sanford Sanitary District in Maine. Our over 32 composting projects overall include experience with all major technology alternatives including windrow, aerated static pile, agitated bin, and tunnel/container. We have also been involved with a wide variety of feedstocks including raw and digested sludge, mixed solid waste, separated organic waste, leaf and yard waste, bark mulch and manures.

ODOR CONTROL EXPERIENCE

Effective control of odors is perhaps the greatest public relations challenge facing wastewater facilities. Wright-Pierce is thoroughly versed with and has extensive experience with all types of odor control systems. We are nationally recognized for our odor control expertise, and have performed evaluations, and completed designs for dozens of clients throughout the United States and abroad. Wright-Pierce has a proven track record in the design of effective odor control systems, including activated carbon, wet scrubbing and biofiltration. We have designed odor control systems ranging in sizes from 120 cfm up to 150,000 cfm.
Wright-Pierce has a thorough understanding of the four interrelated factors that can lead to objectionable odor impacts:

- process control
- facility siting
- containment of odor sources
- treatment of exhaust air

The availability of sites with large land buffers for new facilities is limited in many parts of the country. Further, most existing wastewater facilities are facing encroaching development and must find ways to avoid objectionable impacts to neighboring properties. The capture and treatment of emissions is required to avoid objectionable odor impacts. Wright-Pierce has a thorough understanding of the characteristics of emissions from the various wastewater treatment and organic waste processing operations with a particular expertise in composting emissions, and the technology options that are available for treatment.

Wright-Pierce has broad experience in the evaluation of odor control requirements for wastewater treatment and biosolids processing facilities. Wright-Pierce has been responsible for numerous projects focusing exclusively on odor control. In addition, virtually all new facilities and upgrade projects require an assessment of the potential for adverse odor impacts. Wright-Pierce recommends the following comprehensive approach to determine the level of enclosure and exhaust air treatment that is required:

- Define site buffers and community impact levels to avoid objectionable impacts
- Undertake the preliminary design of odor control facilities
- Air volumes
- Odor control
- Conduct air dispersion modeling
- Reevaluate preliminary design
- Establish final odor control design criteria to avoid objectionable off-site impacts.

Our odor control experience is summarized in the table that follows:
DIGESTER COMPLEX IMPROVEMENTS

Danbury, Connecticut

Wright-Pierce, as part of a design team with Veolia Water and Black & Veatch, is designing and developing contract documents for the comprehensive upgrade of the Danbury Wastewater Treatment Facility. The comprehensive upgrade will consist of upgrades to two existing two-stage high-rate anaerobic digester complexes, modifications to an existing gas waste flare assembly, and the construction of a new fats, oils, and grease (FOG) receiving facility.

The WPCP has two, two-stage, high-rate anaerobic digester complexes that each consist of a primary and secondary digester, and a control building. The proposed improvements to each digester complex include the installation of a new digester covers, new digester mixing system, new heat exchanger equipment, and the replacement of multiple sludge pumps. The purpose of the FOG facility is to provide a location to offload, store and feed FOG to the digesters to boost biogas production and increase the production of renewable energy. The new FOG facility will include truck unloading, two 25,000-gallon FOG storage tanks, and the process equipment needed to process and transport the stored FOG. A pilot test was successfully conducted in May 2018 to test the capabilities of a Huber strain press to receive and process FOG deliveries.

Excess biogas generated by the digester complexes that is not consumed by the treatment plant cogeneration system, will be burned off at two new waste-flare assemblies. Design will be completed by the end of 2018.
3. Waldron Team
Strength
Advantages

The Waldron Team recognizes that by combining the strengths of our organizations, we create a formidable team that can leverage the expertise and depth of talent of this Team in project financing, project development, environmental and utility supply permitting, engineering and design, local presence in construction, waste to energy generation and operation. Our strengths complement each other, which, from our collective experiences garnered over the years—from design/development to construction through long-term operations—will be combined for the benefit of your project.

Experienced with Anaerobic Digester Design, Construction and Operation

Our Team has the extensive expertise in anaerobic digester and treatment equipment design, process engineering, equipment manufacturing, project integration, project permitting, project financing, project construction and project execution to efficiently deliver an effective solution to its customers.

Anaergia has designed, manufactured and optimized waste processing solutions worldwide to maximize the effectiveness and reliability of core processes, including: mixed solid waste pre-processing, organic substrate cleaning and feeding systems, high solids anaerobic digestion, nutrient recovery and wastewater treatment. With a proven portfolio of more than 1,600 facilities that span over 20 years, Anaergia is globally recognized for providing proven solutions that are highly versatile, efficient and reliable.

Anaergia and its affiliate companies are global leaders in offering sustainable solutions for the conversion of waste to resources and energy. Through a proven portfolio of proprietary technological solutions, expertise and an experienced design, manufacturing and operations team, Anaergia can improve your plant by upgrading its design as well as improving its operational parameters.

Experienced with Combined Heat and Power (CHP)

This team has implemented many projects of similar technology for our clients. Waldron is the engineer of record for over 25 CHP projects and 200 MW of generation capacity currently in operation. Waldron has strong experience with major equipment types including reciprocating engines, steam turbines, combustion turbines, steam and electric driven centrifugal chillers; steam and hot water absorption chillers; watertube and firetube boilers; and various types of heat recovery equipment and balance of plant hydronic systems. On the distribution side Waldron has completed hundreds of projects associated
with electrical and thermal utility distribution. Waldron’s core staff includes licensed mechanical, electrical, structural and controls engineers, as well as construction managers.

To maximize the project feasibility, we are completely focused on the life cycle performance not just from a cost basis but on a net operating capacity basis. Our goal is always to deliver “95%+” availability. This team will transfer their expert knowledge base to this project.

Permits and Interconnection Approvals

Waldron, along with Wright-Pierce, completed many projects located in the New England states with stringent environmental and electrical interconnection approvals. Waldron successfully completed over 12 power generation projects in Massachusetts while Wright-Pierce completed over 20 wastewater treatment and digester facility permitting and odor control projects. We work regularly to gain approvals for projects in densely populated areas where noise, air and odor emissions are key neighborhood concerns and we are able to work with neighborhood-based groups and local communities to gain their acceptance of our projects.

Project Financing

Waldron, along with Power Island Energy, LLC (PIE) will work to put together the most efficient financial structure for all phases of the New Bedford Organics to Energy Facility Project. PIE has experience with financing structures using equity, preferred equity, bank debt, bonds, grants, tax equity, institutional investors and private investors. We can work with Startups thru AAA Credit. The City of Bridgeport CT Microgrid was an A- credit project.

In the waste to energy space PIE is currently working with Anaergia on a $145m Bioenergy Project in Southern California that is scheduled to start construction in September 2018 and be in operation in early 2020. We are also working with Anaergia on several other waste to energy projects in CA. Power Island Energy is familiar with the many contractual requirements and hurdles for Feedstock and Off Taker Agreements in the waste to energy space.
4. Proposed Treatment Technology & Processes
Proposed Treatment Technology & Processes

Background

Currently, the City of New Bedford wastewater treatment facility sludge is thickened and pumped into tanker trucks before being sent for final disposal at a privately-operated (Synagro) incinerator facility in Rhode Island. Costs for sludge management in 2017 were approximately $2,600,000 or $444.38 per dry ton, including transportation from the plant. Electricity use at the wastewater treatment plant was approximately 11 million kWh in calendar year 2017 at a cost of $3,240,000. Without the actual electric bills, we estimated the average electricity consumption at the New Bedford wastewater treatment facility is about 1,200 kW at an average of 29¢ per kWh. We would like to verify the electricity cost, it seems higher than expected. The City also has an existing vehicle fleet that utilized 28,918 gallons of diesel and 96,443 gallons of gasoline in calendar year 2017.

The Cities of Brockton and Fall River intend to provide dewatered sludge cake produced at their respective WWTPs. In addition, The City is also considering to accept green waste, organic waste, and fats oils and grease (FOG) at the Organics-to-Energy Facility.

Process Technology

Due to the high energy cost at the wastewater treatment facility and the high cost of sludge transportation, our team would like to propose a combined heat and power (CHP) application that utilize the sludge to generate biogas and sends the biogas to reciprocating engines to generate electricity. The waste heat from the engine lube oil system and jacket water will be captured by a circulating hot water system to keep the digester at constant temperature. The benefit of the CHP system is to effectively extract the hydrocarbon in the sludge and transform to other forms of energy, i.e. electricity to be used by the wastewater treatment facility to lower the overall energy cost and sludge transportation cost.

When combining the sludge of New Bedford, Brockton, and Fall River, we estimated the combined sludge feed to the digester can sufficiently produce about 433 scfm at 60% methane concentration of biogas gas which will be fed to a reciprocating engine designed to burn biogas to generate about 1,700 kW of electricity and 2,000 kW of thermal energy.

The new Organics to Energy Sludge Process Facility will be located at the existing incinerator building and control building area.

Please see Attachment 2 for the Waste to Energy Process Application Description and Appendix A - Block Flow Diagram and Appendix B - Conceptual Site Layout.
6. Schedule
We estimated the overall schedule for facility development, permitting, design, financing, design, construction, startup, testing and operation to be about 21 months.
7. Description of Use/Not Use of Existing Building/Equipment
Description of use/not use of existing incinerator building, transfer station and/or any equipment

The conceptual Organic to Energy Sludge Process facility is planned to be at the same location as the existing incinerator at this time. Final location, layout and equipment size will be determined at later development phase.

From our site visit, the condition of the incinerator building is poor but the building foundation may be reused, assuming the new facility footprint is similar to the existing building size, to reduce civil and structural cost.

In the later phase of the project development, our Team will conduct a thorough assessment on the existing Incinerator building, transfer station or other existing equipment that can be reused.
8. Constraints
8 Constraints

The success of a project is dependent on a clear definition of project goals with inputs from various stakeholders, how well the Team works together and understands the potential roadblocks, constraints, and risks and develops prevention, remedies and solutions to the risks.

Our Team is assembled with highly accomplished professionals who have successfully completed many of these types of projects. As the Team leader, Waldron, utilizes a variety of methods to ensure as much seamlessness amongst all the partners as possible.

In other projects, we experienced many similar constraints and risks from the development phase to project execution to operation. It is important that the Team understands the risks and has the knowhow to solve them.

During the development phase, some important factors would need to be clarified:

a. expected sludge quantity, quality and costs
b. utility cost
c. expected energy production
d. PPA, energy sales agreement, O&M agreement and residual value
e. expected waste discharge quantity and quality
f. cost of debt service
g. determine site soil conditions
h. project cost and schedule
i. list of permit and schedule
j. neighborhood approval

During the design and construction phase, some important factors would need to be clarified:

a. develop performance guarantee and availability guarantee
b. equipment and system size to match performance guarantee and within project budget
c. permit approvals
d. operability
e. constructability and quality control
f. equipment delivery and construction coordination
g. cost and schedule recovery plan
h. proper startup and testing to ensure stable operation and meets guarantee
i. operator training
9. Reference Facilities
Waldron performed a detailed evaluation of the existing cogeneration building at the Nashua Wastewater Treatment Facility (NWTF). The evaluation included the existing piping, gas production, the two boilers, heat exchangers, gas cleaning room, the exhaust gas flare, gas hold tank feed system. Waldron provided a preliminary design report on findings and recommended solutions.

Waldron was the Engineer of Record, environmental and electricity utility permitting agent for the replacement of an existing 300 kW engine generator and associated auxiliary equipment with two 225 kW engine generators, gas blending system for easy startup and maintain consistency fuel gas quality at the engines, associated heat exchangers, new control system and new electrical switchgear enable Net Metering at the facility. The new design benefited the wastewater facility with significant energy saving, increased the overall operating efficiency, flexibility and redundancy.
Waldron has been contracted as the Engineer of Record for the energy center serving the historic TWA Flight Center Hotel at JFK Airport. MCR Development is the investment firm redeveloping the iconic landmark into a new state-of-the-art hotel. Waldron's role is to design a grid independent combined cooling, heating and power facility for the project. The equipment will include three nominal 335kW CHP engines, a single 335 standby engine, with a 500kW ESS system. The design scope is a comprehensive engineering scope that will provide a fully coordinated design. The BIM model will be coordinated with and turned over to the building contractor as well as technical documents that are ready to be issued for bidding and construction.

QUICK FACTS

Location: New York, NY

Design Start: Sept. 2018

Size & Technology: 3x335kW GE-Jenbacher, 500/1000 kWe/kWh Energy Storage System

Firm Role: Engineer, Permitting Support

Contact: Jason Garone
Director of Construction
MCR Development LLC
646.870.7718
jgarone@mcrdevelopmentllc.com

Rendering of the TWA Flight Center Hotel at JFK Airport: Courtesy MCR Development

WALDRON ENGINEERING & CONSTRUCTION, INC.
37 INDUSTRIAL DRIVE SUITE G-1 EXETER, NH 03833 603.772.7153
WALDRON.COM
### Section 2
RELEVANT EXPERIENCE / QUALIFICATIONS

#### Air Quality and Odor Control Experience Table

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<td><strong>Activated Carbon Systems</strong></td>
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<td>Primary Clarifiers</td>
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<td>340</td>
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<td>Abu Dhabi Sewerage Services Company</td>
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<td>STEP Tunnel Project</td>
<td>30,000</td>
<td>50,400</td>
<td>Deep Tunnel Sewer at Work Shaft 4</td>
<td>Process design review engineer for design-build project currently in construction phase. AmerAir activated carbon system</td>
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<tr>
<td>Design-Build-Operate Contractor: Karafi National</td>
<td>30,000</td>
<td>50,400</td>
<td>Deep tunnel sewer at Work Shaft 7</td>
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<td>Nashua Wastewater Treatment Facility, Nashua, NH</td>
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<td>11,700</td>
<td>Headworks Screening, Wetwell, Main Interceptor</td>
<td>Renovation of existing unit—operational in 2017.</td>
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<td>1,000</td>
<td>Sludge Truck Bay</td>
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<td>Mattabassett District</td>
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<td>Cromwell, CT</td>
<td>4,800</td>
<td>8,000</td>
<td>Influent Interceptor, Screening and Wetwell</td>
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<td></td>
<td>4,500</td>
<td>7,500</td>
<td>Destractors</td>
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<td>14,000</td>
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<td>Primary Clarifiers and Sludge Receiving Tanks</td>
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<td>30,000</td>
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<td>Sludge Disposal Building</td>
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<td>Bypass of RTO Treating Biosolids Dryer Exhaust</td>
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<td>Long Creek Pump Station</td>
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<td>South Portland, ME</td>
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<td>Sludge Cake Receiving Area</td>
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<td>CSO Storage Tunnel - NBC, Providence, RI</td>
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<td>Mechanic Street Pump Station, Portsmouth, NH</td>
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<td>Modifications to allow winter operation at 3,000 cfm. Operational since 2004.</td>
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<td>Durham Wastewater Treatment Facility, Durham, NH</td>
<td>350</td>
<td>600</td>
<td>Headworks</td>
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</table>
# Relevant Experience / Qualifications

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<th>Project Status/Comments</th>
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<td>1,700 / 750</td>
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<td>Wells, Maine</td>
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<td>Old Town Wastewater Treatment Facility</td>
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<td>Spencer Wastewater Treatment Plant</td>
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<td>Septage Receiving Facility</td>
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</tr>
</tbody>
</table>
## Section 2
### RELEVANT EXPERIENCE / QUALIFICATIONS

<table>
<thead>
<tr>
<th>Project/Client</th>
<th>CFM</th>
<th>M3/HR</th>
<th>Application</th>
<th>Project Status/Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Naugatuck Wastewater Treatment Facility</td>
<td>17,000</td>
<td>28,300</td>
<td>Dewatering/Sludge Handling/Headworks</td>
<td>Detailed evaluation in 2016.</td>
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<tr>
<td>Glastonbury, Connecticut</td>
<td>2,000</td>
<td>3,300</td>
<td>Primary Clarifiers</td>
<td>Upgrades currently under construction.</td>
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<tr>
<td>Mattabassett District</td>
<td>5,300</td>
<td>9,000</td>
<td>Sludge Storage Tank</td>
<td>2-stage scrubber: Operational since 2015.</td>
</tr>
<tr>
<td>Cromwell, Connecticut</td>
<td>3,000</td>
<td>5,100</td>
<td>Dewatering</td>
<td>2-stage scrubber: Operational since 2015.</td>
</tr>
<tr>
<td>Serentzas District</td>
<td>17,000</td>
<td>28,800</td>
<td>Incinerator</td>
<td>Multi venturi, followed by wet ESP, &amp; activated carbon for mercury. Operational since 2018.</td>
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<tr>
<td>Poughkeepsie Wastewater Treatment Facility</td>
<td>2,500</td>
<td>4,200</td>
<td>Dewatering and Sludge Truck Bay</td>
<td>Operational in 2017.</td>
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<tr>
<td>Poughkeepsie, New York</td>
<td>1,200</td>
<td>2,000</td>
<td>Dewatering and Sludge Truck Bay</td>
<td>Operational in 2017.</td>
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<tr>
<td>Keene Wastewater Treatment Facility</td>
<td>39,000</td>
<td>65,000</td>
<td>Gravity Thickeners, Dewatering</td>
<td>Replacement of mist scrubber vessels. Operational since 2015.</td>
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<tr>
<td>Keene, New Hampshire</td>
<td>31,000</td>
<td>52,000</td>
<td>Headworks, Dewatering, Sludge Storage Tanks</td>
<td>Evaluation completed 2013.</td>
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<tr>
<td>Manchester Wastewater Treatment Facility</td>
<td>2,000</td>
<td>3,300</td>
<td>Sludge Storage Tank</td>
<td>Renovation of existing packed-bed scrubber systems. Operational since 2013.</td>
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<tr>
<td>Manchester, New Hampshire</td>
<td>14,500</td>
<td>24,200</td>
<td>Dewatering</td>
<td>Renovation of existing system. Operational since 2019.</td>
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<td>Greater Augusta Utility District</td>
<td>2,750</td>
<td>4,600</td>
<td>Headworks</td>
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<tr>
<td>Wastewater Treatment Facility</td>
<td>14,000</td>
<td>23,200</td>
<td>Primary Clarifiers &amp; Gravity Thickeners</td>
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<tr>
<td>Augusta, Maine</td>
<td>25,000</td>
<td>42,700</td>
<td>Sludge dewatering and WAS thickening</td>
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<tr>
<td>Nashua Wastewater Treatment Facility</td>
<td>25,000</td>
<td>42,700</td>
<td>Biosolids Drying, Facility – General Ventilation</td>
<td></td>
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<tr>
<td>Nashua, New Hampshire</td>
<td>17,000</td>
<td>28,300</td>
<td>Dewatering</td>
<td>Evaluation completed in 2009.</td>
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<tr>
<td>Naugatuck Wastewater Treatment Facility</td>
<td>2,000</td>
<td>3,300</td>
<td>Primary Clarifiers</td>
<td></td>
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<tr>
<td>New England Organics</td>
<td>6,000</td>
<td>10,200</td>
<td>Headworks, Septage, Sludge Tanks</td>
<td>Operational since 2009.</td>
</tr>
<tr>
<td>Hawk Ridge Composting Facility</td>
<td>150,000</td>
<td>255,000</td>
<td>Ammonia Removal for Biosolids and Food Waste Composting</td>
<td>Three (3) packed-bed scrubbers. Operational since 2008.</td>
</tr>
</tbody>
</table>
# Relevant Experience / Qualifications

<table>
<thead>
<tr>
<th>Project/Client</th>
<th>CFM</th>
<th>M³/HR</th>
<th>Application</th>
<th>Project Status/Comments</th>
</tr>
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<tbody>
<tr>
<td>Unity Fertilizer Plant</td>
<td>127,000</td>
<td>220,000</td>
<td>Fertilizer Process Exhaust</td>
<td>Preliminary design in 2004 2 packed-bed scrubbers, regenerative thermal oxidizer, venturi scrubber.</td>
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<tr>
<td>Polk County, Florida</td>
<td>28,000</td>
<td>48,000</td>
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<tr>
<td>Cypress Chemical Company</td>
<td>70,000</td>
<td>119,000</td>
<td>Fertilizer Facility, Scrubbers, Particulate Removal, Thermal Destruction</td>
<td>Odor control performance study in 2003.</td>
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<tr>
<td>Helena, Arkansas</td>
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<tr>
<td>East End Wastewater Treatment Plant</td>
<td>55,000</td>
<td>92,000</td>
<td>Headworks, Grit Chamber, Primary Clarifiers, Channels, Gravity Thickeners, Sludge Tanks</td>
<td>Packed-bed scrubber operational in 2003.</td>
</tr>
<tr>
<td>Portland Water District</td>
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<tr>
<td>Greater Lawrence Sanitary District</td>
<td>28,000</td>
<td>47,000</td>
<td>Drying Building Odor Control</td>
<td>Packed-bed scrubber operational since 2002.</td>
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<tr>
<td>North Andover, Massachusetts</td>
<td>14,000</td>
<td>23,800</td>
<td>Drying System Process Gas</td>
<td>Impingement tray scrubber Venturi scrubber.</td>
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<tr>
<td>Stonington, Connecticut</td>
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<tr>
<td>Rockland County Co-Composting Facility</td>
<td>82,000</td>
<td>139,000</td>
<td>Ammonia Removal for Biosolids Composting</td>
<td>Packed bed scrubber. Operational since 1999.</td>
</tr>
<tr>
<td>Hibburn, New York</td>
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<tr>
<td>Regional Biosolids Processing Facility</td>
<td>22,000</td>
<td>37,000</td>
<td>Drying Building Biosolids Handling Building</td>
<td>Preliminary design. Completed in 1999.</td>
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<tr>
<td>Fairhaven Wastewater Treatment Facility</td>
<td>6,000</td>
<td>10,200</td>
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<tr>
<td>Fairhaven, Massachusetts</td>
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<tr>
<td>Tri-Town Septage Treatment Facility</td>
<td>3,100</td>
<td>5,300</td>
<td>Sludge Storage and Thickening</td>
<td>Packed-bed scrubber. Operational since 1997.</td>
</tr>
<tr>
<td>Orleans, Massachusetts</td>
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<tr>
<td>Biosolids Composting Facility</td>
<td>170,000</td>
<td>290,000</td>
<td>Composting</td>
<td>Preliminary design of mist chamber system completed in 1993.</td>
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<tr>
<td>Southern New England Metropolitan Area</td>
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<tr>
<td>Gardiner Wastewater Treatment Plant</td>
<td>10,000</td>
<td>17,000</td>
<td>Headworks and Sludge Storage</td>
<td>Packed-bed scrubber. Operational since 1987.</td>
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<tr>
<td>Gardiner, Maine</td>
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<tr>
<td><strong>Biofiltration Systems</strong></td>
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<tr>
<td>Lift Station # 45</td>
<td>4,300</td>
<td>7,300</td>
<td>Wetwell</td>
<td>Under design. Modify RioRem Biofiltering/Biofilter for New Station</td>
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<tr>
<td>Orlando, Florida</td>
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<tr>
<td>Manchester Wastewater Treatment Facility</td>
<td>29,000</td>
<td>48,070</td>
<td>Gravity Thickener and Sludge Storage Tanks</td>
<td>Anaer biofilter. Operational since 2013.</td>
</tr>
<tr>
<td>Manchester, Connecticut</td>
<td>1,000</td>
<td>1,500</td>
<td>Dewatering, Septage Wetwell and Gravity Thickener</td>
<td>BioRem biotrickling/biofilter. Operational since 2012.</td>
</tr>
<tr>
<td>Plymouth Wastewater Treatment Facility</td>
<td>1,000</td>
<td>1,500</td>
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<td></td>
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<tr>
<td>Plymouth, New Hampshire</td>
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<td></td>
</tr>
<tr>
<td>Coff's Harbour Council Resource Recovery Facility</td>
<td>350,000</td>
<td>250,000</td>
<td>Biosolids and Food Waste Composting</td>
<td>Operational since 2006.</td>
</tr>
<tr>
<td>Coff's Harbour, Australia</td>
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<tr>
<td>Hawk Ridge Composting Facility</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unity, Maine</td>
<td></td>
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</tbody>
</table>

WRIGHT-PIERCE
Engineering a Better Environment
## Section 2
### RELEVANT EXPERIENCE / QUALIFICATIONS

<table>
<thead>
<tr>
<th>Project/Client</th>
<th>CFM</th>
<th>MV/HR</th>
<th>Application</th>
<th>Project Status/Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unity Fertilizer Plant Polk County, Florida</td>
<td>19,000</td>
<td>36,000</td>
<td>Biosolids Receiving Building</td>
<td>Open biofilter. Preliminary design completed in 2003.</td>
</tr>
<tr>
<td>Van Buren Wastewater Treatment Plant Van Buren, Maine</td>
<td>2,000</td>
<td>3,000</td>
<td>Sludge Holding Tanks</td>
<td>Final design completed in 2002.</td>
</tr>
<tr>
<td>Killingly Wastewater Treatment Plant Danielson, Connecticut</td>
<td>14,000</td>
<td>23,800</td>
<td>Headworks Sludge Holding Tanks Trickling Filter</td>
<td>Open biofilter. Operational since 2002.</td>
</tr>
<tr>
<td>Merrimack Wastewater Treatment Plant Merrimack, New Hampshire</td>
<td>1,800</td>
<td>3,000</td>
<td>Sludge Holding Tanks</td>
<td>Open biofilter. Operational since 2001.</td>
</tr>
<tr>
<td>Athlone Transfer Station Cape Town, South Africa</td>
<td>60,000</td>
<td>102,000</td>
<td>MSW Handling</td>
<td>Final design. Completed in 1998.</td>
</tr>
<tr>
<td>Composting Facility Hagstad Stavanger, Norway</td>
<td>71,000</td>
<td>120,000</td>
<td>Biovaste Composting</td>
<td>B&amp;K bio sludge. Operational since 2000.</td>
</tr>
<tr>
<td>Wastewater Pump Station Hampton, New Hampshire</td>
<td>120</td>
<td>180</td>
<td>Pump Station Wetwell</td>
<td>Open biofilter. Operational since 2000.</td>
</tr>
<tr>
<td>Rockland County Co-Composting Facility Hilburn, New York</td>
<td>82,000</td>
<td>139,000</td>
<td>Composting</td>
<td>CVT America system. Operational since 1999.</td>
</tr>
<tr>
<td>Biosolids and Biovaste Composting Facility Kristiansand, Norway</td>
<td>73,000</td>
<td>124,000</td>
<td>Composting</td>
<td>B&amp;K bio sludge. Operational since 1998.</td>
</tr>
<tr>
<td>City of Keene Keene, New Hampshire</td>
<td>12,000</td>
<td>20,400</td>
<td>Biosolids Composting</td>
<td>Final design. Completed in 1998.</td>
</tr>
<tr>
<td>Manchester Wastewater Treatment Plant Manchester-By-the-Sea, Massachusetts</td>
<td>4,500</td>
<td>7,500</td>
<td>Headworks Sludge Storage</td>
<td>Open biofilter. Operational since 1998.</td>
</tr>
<tr>
<td>Bar Harbor Wastewater Treatment Plant Bar Harbor, Maine</td>
<td>5,500</td>
<td>8,500</td>
<td>Septage Treatment and Composting</td>
<td>Open biofilter. Operational since 1994.</td>
</tr>
<tr>
<td>Interstate Septic Systems, Inc. Rockland, Maine</td>
<td>72,000</td>
<td>122,000</td>
<td>Composting</td>
<td>Open biofilter. Operational since 1998.</td>
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<tr>
<td>Septage Treatment and Composting Facility Yarmouth, Massachusetts</td>
<td>116,000</td>
<td>197,000</td>
<td>Septage Treatment and Composting</td>
<td>Open biofilter. Operational since 1999.</td>
</tr>
<tr>
<td>Scarborough Wastewater Treatment Plant Narragansett, Rhode Island</td>
<td>400</td>
<td>700</td>
<td>Sludge Storage</td>
<td>Open biofilter. Operational since 1991.</td>
</tr>
<tr>
<td>Abu Dhabi Sewerage Services Company STEP Tunnel Project Design-Build-Operate Contractor: Karafi National</td>
<td>30,000</td>
<td>50,400</td>
<td>Deep Tunnel Sewer at Work Shaft 4</td>
<td>Process design review engineer for design-build project currently in construction submission phase. AmeriAir bio-trickling filter system.</td>
</tr>
<tr>
<td>Fitchburg Wastewater Treatment Facility Fitchburg, Massachusetts</td>
<td>12,000</td>
<td>20,400</td>
<td>Primary Treatment and Sludge Storage</td>
<td>Bioscrubbing upgrade under construction.</td>
</tr>
<tr>
<td>Mattabasset District Cromwell, Connecticut</td>
<td>5,400</td>
<td>9,000</td>
<td>Sludge Storage Tank</td>
<td>Relocated Blowup Purpsring. Operational since 2015.</td>
</tr>
</tbody>
</table>
### Section 2
#### RELEVANT EXPERIENCE / QUALIFICATIONS

<table>
<thead>
<tr>
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<th>Project Status/Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mattabassett District Cromwell, Connecticut</td>
<td>3,000</td>
<td>5,000</td>
<td>Primary Effluent Channels</td>
<td>Bioscrubbing. Operational since 2014.</td>
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<tr>
<td>Bar Harbor Wastewater Treatment Facility Bar Harbor, Maine</td>
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<td></td>
<td>Sludge Dewatering Room</td>
<td>Operational since 1997.</td>
</tr>
<tr>
<td><strong>Thermal Oxidation</strong></td>
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<tr>
<td>Greater Lawrence Sanitary District North Andover, Massachusetts</td>
<td>3,000</td>
<td>5,100</td>
<td>Biosolids/Dryer Exhaust</td>
<td>Regenerative thermal oxidizer. Operational since 2002.</td>
</tr>
<tr>
<td>Unity Fertilizer Plant Polk County, Florida</td>
<td>127,000</td>
<td>220,000</td>
<td>Fertilizer Process Exhaust</td>
<td>Preliminary design. 2 packed-bed scrubbers, regenerative thermal oxidizer, venturi scrubber.</td>
</tr>
<tr>
<td>Regional Biosolids Processing Facility Fairhaven, Massachusetts</td>
<td>7,000</td>
<td>12,000</td>
<td>Biosolids/Dryer Exhaust</td>
<td>Preliminary design completed in 1999.</td>
</tr>
</tbody>
</table>
Section 2
RELEVANT EXPERIENCE / QUALIFICATIONS

INCINERATION

Wright-Pierce also has extensive experience with sludge incineration. This includes the design of the new sewage sludge incinerator for the Mattabassett District in Cromwell, Connecticut. The 1.5 dry ton/hour unit was supplied by Suez (formerly Infilco Degremont). This EPA Region 1 installation was the first incinerator in the country to proceed with compliance documentation under the new SSI emission rules. The facility has combination tray/venturi scrubber with caustic addition for SO2 control, a wet electrostatic precipitator, and utilizes a CPPE activated carbon system for mercury removal.

Incineration Experience Table

<table>
<thead>
<tr>
<th>Client / Project</th>
<th>Incinerator Type</th>
<th>Incinerator Size</th>
<th>No. of Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mattabassett District, Cromwell, CT</td>
<td>FBI</td>
<td>1.5 dry T/hr</td>
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<tr>
<td>New Sewage Sludge Fluidized Bed Incinerator Design / Permitting</td>
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<tr>
<td>Veolia Water North America, Lynn, MA</td>
<td>FBI</td>
<td>1 dry T/hr</td>
<td>1</td>
</tr>
<tr>
<td>Fluidized Bed Incinerator Consulting, Lynn, MA</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Veolia Water North America, Naugatuck, CT - Multiple Projects</td>
<td>FBI</td>
<td>3.5 dry T/hr</td>
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<tr>
<td>Upgrade to Meet New SSI Rule / FBI consulting / System Capacity Review</td>
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<tr>
<td>Veolia Water North America, Fall River, MA</td>
<td>FBI</td>
<td>1.5 dry T/day</td>
<td>1</td>
</tr>
<tr>
<td>Fluidized Bed Incinerator Consulting</td>
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<tr>
<td>Veolia Water North America, Cranston, RI</td>
<td>MHI</td>
<td>1.6 dry T/hr</td>
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<tr>
<td>Upgrade to Meet New SSI Rule / Permit / Regulatory Support</td>
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<tr>
<td>Manchester, NH</td>
<td>FBI</td>
<td>1.8 dry T/hr</td>
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<tr>
<td>Dewatering System Impact on FBI Capacity Fuel Use</td>
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<tr>
<td>and Operating Costs</td>
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<tr>
<td>Manchester, NH</td>
<td>FBI</td>
<td>1.8 dry T/hr</td>
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<td>Use of FBI for Odor Control - Performance Study</td>
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<tr>
<td>Fraser Paper, Madawaska, ME</td>
<td>Waste Boiler</td>
<td>2.3 dry T/hr</td>
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<tr>
<td>Sludge Disposal Options Evaluation</td>
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</tbody>
</table>
DEWATERING AND THICKENING EXPERTISE

Optimizing of sludge handling including thickening, and dewatering can significantly reduce such operations and maintenance. Our thickening projects have included gravity belt thickeners, rotary drum thickeners, flotation thickeners, gravity thickeners as well as application of co-thickening secondary sludge with primary sludge in primary clarifiers or gravity thickeners. When cost constraints allow, we generally favor separate thickening for waste activated secondary sludge. For small to medium size installations, rotary drums deserve thorough evaluation, while for larger installations gravity belt thickeners are usually favored for separate secondary sludge thickening.

Wright-Pierce has extensive experience with all conventional dewatering technologies including belt filter presses, centrifuges, plate and frame filter presses, and various forms of drying beds. We have been a leader in evaluating new alternatives for dewatering including the Huber inclined rotary screw press, the FKC screw press, and the Fournier rotary press. The alternate dewatering technologies have proven to offer consistency in performance in terms of solids concentration, throughput and exceptional odor control.

Some of the highlights of our unparalleled experience with slow rotational speed dewatering technologies include:

- Huber Screw Presses: Old Town, ME (1st U.S. installation of the inclined screw press); Gardiner, ME (2nd US installation); and most recently Kennebunk, ME (1st in the U.S. installation of Huber’s latest design), Lincoln, ME, Nahua, NH, and Durham, NH.
- Fournier Rotary Presses: Hampton, NH (2nd U.S. installation), Portland, Maine, and Plymouth, New Hampshire
- FKC Screw Press: Merrimack, NH (1st true municipal installation of an FKC screw press for dewatering in the northeast), Lewiston-Auburn Water Pollution Control Authority, Lewiston, ME, and Keene, NH

Our application of centrifuge dewatering both for larger applications includes the City of Manchester, New Hampshire; the Mattabasset District in Cromwell, Connecticut; and Haverhill, Massachusetts. Smaller facilities including Sunapee and Farmington, NH; Wells, Sanford, and Falmouth, Maine. The Haverhill, MA centrifugals are the first units of its size (29-inch) in the US.

We have designed numerous belt filter press installations including most recently in Danbury, Connecticut; Claremont, New Hampshire; Hudson, Massachusetts; and Skowhegan, Maine.
Section 2
RELEVANT EXPERIENCE / QUALIFICATIONS

REGULATORY AND PERMITTING EXPERIENCE

Wright-Pierce has considerable experience preparing the necessary local, state, and federal permit applications that are required for municipal projects. In Massachusetts, we are routinely working with local planning and zoning boards (P&Z), zoning boards of appeals (ZBA), and inland wetland commissions, along with special local groups. We also have considerable experience dealing with the various state permitting agencies such as the MassDEP, the United States Environmental Protection Agency (EPA), and the United States Army Corps of Engineers. We have established a good working relationship with many personnel at the MassDEP. Most of the civil and environmental projects undertaken by Wright-Pierce involve some level of permitting by local, state and federal agencies.
DIGESTER COMPLEX IMPROVEMENTS

Donbury, Connecticut

Wright-Pierce, as part of a design team with Veolia Water and Black & Veatch, is designing and developing contract documents for the comprehensive upgrade of the Danbury Wastewater Treatment Facility. The comprehensive upgrade will consist of upgrades to two existing two-stage high-rate anaerobic digester complexes, modifications to an existing gas waste flare assembly, and the construction of a new fats, oils, and grease (FOG) receiving facility.

The WPCP has two, two-stage, high-rate anaerobic digester complexes that each consist of a primary and secondary digester, and a control building. The proposed improvements to each digester complex include the installation of a new digester covers, new digester mixing system, new heat exchanger equipment, and the replacement of multiple sludge pumps. The purpose of the FOG facility is to provide a location to offload, store, and feed FOG to the digesters to boost biogas production and increase the production of renewable energy. The new FOG facility will include truck offloading, two 25,000-gallon FOG storage tanks, and the process equipment needed to process and transport the stored FOG. A pilot test was successfully conducted in May 2018 to test the capabilities of a Huber strain press to receive and process FOG deliveries.

Excess biogas generated by the digester complexes that is not consumed by the treatment plant cogeneration system, will be burned off at two new waste-flare assemblies. Design will be completed by the end of 2018.
Expression of Interest to

Permit, Design, Build, Finance, Own
Operate & Maintain and Market Products from
An Organics-to-Energy Sludge Processing Facility

Submitted to:
City of New Bedford
July 12, 2018

Ms. Susan Bruce
Director of Purchasing
City of New Bedford
133 William Street
New Bedford, Massachusetts 02746

Re: Request for Expression of Interest
City of New Bedford
To Permit, Design, Build, Finance, Own
Operate & Maintain and Market Products from
An Organics-to-Energy Sludge Processing Facility

Dear Ms. Bruce,

New England Fertilizer Company (NEFCO) is pleased to submit our Expression of Interest (EOI) in response to the above-referenced Request for Expression of Interest (Solicitation Number 19192009).

NEFCO, a New England company, is widely recognized as an industry leader in designing, building and operating biosolids management facilities. We typically perform using a Design-Build-Operate-Maintain (DBOM) contract, which provides the ideal risk transfer approach for our clients. Our strong financial status allows us to arrange private financing if the City so desires. Public-Private-Partnerships (P3) are gaining momentum in the biosolids industry as municipalities see private financing and third-party operating responsibility as a positive for their non-core management focus, such as, biosolids management.

NEFCO has more than 50 collective operating years of experience and prides itself on being a steward of our clients’ assets. As an example, our DBOM contract with the Massachusetts Water Resources Authority has been in place since 1991 and is a model for the benefits of a DBOM contract. Further evidencing our being the leading biosolids firm, we were awarded a contract to DBOM the largest biosolids drying facility in North America (in Detroit, Michigan). The selection was based on our overall...
cost, our reputation and the confidence that the Great Lakes Water Authority had in NEFCO to achieve their goals. This 420 dry ton per day facility will play a critical role in the future of Detroit’s biosolids program.

Developing a partnership with NEFCO will bring the following benefits to the City:

- **NEFCO will focus on exactly what the City needs, biosolids management.** If feasible, energy recovery methods will be implemented in a future phase. NEFCO will leverage its experience with a similar facility that we operate and maintain. The Greater Lawrence Sanitary District has recently installed a co-digestion and combined heat and power facility to supplement a biosolids drying facility that NEFCO operates and maintains. This energy neutral arrangement is a potential model for this project.

- **NEFCO has developed a regional biosolids management facility which requires significant coordination.** Regional systems are very difficult to develop and coordinate. NEFCO’s facility in West Palm Beach, Florida that was developed for the Solid Waste Authority (SWA) of Palm Beach County receives cake biosolids from six different plants. NEFCO has the expertise to blend and process different material which has been proven over the last ten years at the SWA facility.

- **Use of energy recovery approaches supports the City’s commitment to Utility of the Future Initiative.** NEFCO will explore the option of enhancing the biosolids management facility with co-digestion of source separated organics at the project site to generate additional gas, which will offset the use of natural gas to fuel the biosolids drying facility. NEFCO uses alternative fuels such as digester or landfill gas at three of its six facilities.

- **Turnkey design, permitting, construction and operation/maintenance capability reduces the risk for the City.** NEFCO recommends the use of a DBOM procurement for this project. It provides the best value and right amount of risk transfer for the City, allowing it to focus on its core businesses. NEFCO is part of The O’Connell Companies, Inc. and our affiliate company, Daniel O’Connell’s Sons, a 135-year-old Massachusetts construction company, constructs the facilities that NEFCO designs and operates. This turnkey capability reduces risk and provides our clients with a single point of responsibility and significant cost savings over teams formed with separate entities.

- **Complete product use and distribution responsibility.** NEFCO is responsible for the beneficial use and distribution of the product from all of our facilities, amounting to more than 700 tons per day. Our product distribution experience over the last 27 years in New England will be invaluable for this project. NEFCO will take responsibility for the product, removing the risk from city, and will beneficially use our network of fuel/energy and agricultural outlets.
NEFCO has the project development, engineering, construction, and operating skill-set and experience to ensure the successful implementation of a biosolids management solution. All of our operating facilities have been constructed using a DBOM approach and after 25 years we continue to operate all of the facilities that we have constructed. We have been selected for every operations and maintenance contract renewal as well.

NEFCO is ideally suited to deliver a biosolids management solution for the City of New Bedford. As highlighted throughout our EOI, NEFCO has the project development, design, finance, construction, and operating skill-set and experience to ensure the successful execution of the City’s biosolids project. NEFCO is a reputable, financially-strong, industry-leading biosolids management company that will be the right partner for the City of New Bedford and we look forward to further discussions with your team.

Sincerely,

[Signature]
Larry W. Bishop, PE
General Manager

Attachment
EXECUTIVE SUMMARY

NEFCO is a prominent New England developer and operator of biosolids management facilities. NEFCO is a subsidiary of The O'Connell Companies, a privately held Massachusetts firm founded in 1879 which provides construction, biosolids management, commercial real estate development, commercial property and asset management, and energy services. The O'Connell Companies employs more than 350 people. This skilled workforce includes project managers, superintendents, civil, chemical, electrical, environmental, and mechanical engineers, estimators, operators, accountants, finance, legal, and office/administrative staff.

NEFCO has the project development, engineering, construction, financing, and operating skill-set and experience to ensure the successful execution of the biosolids management operations and maintenance along with any capital improvements that the City of New Bedford (the City) may want to undertake as part of the project. All of our operating facilities have been implemented using the design-build-operate-maintain (DBOM) procurement approach and after more than two decades we continue to operate all of the facilities that we have constructed. We have been selected for every operations and maintenance contract renewal as well.

In May 2019, NEFCO was selected to design, construct and operate the largest biosolids dryer facility in North America for the City of Detroit. Since May 2019, NEFCO has completed and started up the biosolids dryer in Detroit and has been operating one of the world’s premier dewatering, drying, and pelletizing facilities since 1991. For more than 25 years, we have operated this 240-dry ton per day (DTPD) facility, which is located in Quincy, Massachusetts. NEFCO provides services to the City of Boston and 43 surrounding communities via a long-term operations contract with the Massachusetts Water Resources Authority (MWRA). NEFCO receives all of MWRA’s liquid sludge (over
1,000,000 gallons per day) via a seven mile long, deep rock pipeline, then dewatered and dries the sludge into a pelletized product for beneficial use.

Our 420- DTPD facility in Detroit, Michigan will play a critical role in the future of Detroit’s biosolids program. The Detroit Project involved the permitting, design, construction, operation and maintenance of a new facility adjacent to the existing wastewater treatment plant. The design firm capacity of the biosolids drying facility is 316 DTPD with a maximum capacity of 420 DTPD. The facility includes eight centrifuges for dewatering operations and four direct-fired rotary drum dryer trains. This is the largest biosolids drying facility in North America.

NEFCO permitted, designed, constructed and operates the biosolids drying facility (52 DTPD) in Shakopee, Minnesota for the Metropolitan Council Environmental Services (MCES), and the Biosolids Drying Facility (38 DTPD) in North Andover, Massachusetts, for the Greater Lawrence Sanitary District (GLSD). Each of these was a DBOM project that we have operated for over 10 years. NEFCO designed and constructed a 100 DTPD facility for the Solid Waste Authority (SWA) of Palm Beach County, Florida and has been operating this regional facility since August 2009. NEFCO designed, constructed and operates a dewatering and drying facility for the City of Cumberland, Maryland. This facility has a capacity of 11 DTPD and began operations in August 2010 with a 15-year operating contract.

NEFCO is a privately held company with strong financial resources, which allows rapid business decisions and accountability to our most important asset, our clients. NEFCO has its corporate headquarters in Holyoke, Massachusetts and maintains offices in North Quincy, MA, Detroit, MI, North Andover, MA, West Palm Beach, FL, Sarasota, FL, Shakopee, MN, and Cumberland, MD.
NEFCO is uniquely qualified to provide biosolids management services to the City as we have designed, constructed and operated facilities throughout North America for more than two decades. NEFCO has been in continuous, successful and profitable operation since 1991, during which time we have constantly expanded our base of client contracts.

NEFCO is committed to the North American market and is extremely interested in working with the City to develop a biosolids management approach that is the most financially, environmentally, and socially feasible.
SECTION 1

NEFCO has more than 50 collective operating years of experience and prides itself on being a steward of our clients’ assets. NEFCO has the project development, engineering, construction, and operating skill-set and experience to ensure the successful implementation of a biosolids management solution. All of our operating facilities have been constructed using a DBOM approach and after 27 years we continue to operate all of the facilities that we have constructed. We have been selected for every operations and maintenance contract renewal as well.

NEFCO is ideally suited to deliver a biosolids management solution for the City of New Bedford. As highlighted throughout our Expression of Interest, NEFCO has the project development, design, finance, construction, and operating skill-set and experience to ensure the successful execution of the City’s biosolids project.

NEFCO was formed in 1986 to respond to a DBOM procurement for a biosolids dryer facility for the MWRA. NEFCO is a subsidiary of The O’Connell Companies and is a general partnership comprised of O’Connell Development Group, Inc. (ODG), its Managing General Partner, and Dunn Associates of Boston, MA. In addition to NEFCO, Dunn Associates is also involved in commercial real estate development. ODG is a subsidiary of The O’Connell Companies, Inc. NEFCO has its corporate headquarters in Holyoke, Massachusetts and maintains offices in North Quincy, MA, Detroit, MI, North Andover, MA, West Palm Beach, FL, Sarasota, FL, Shakopee, MN, and Cumberland, MD.

The City will have a single point of contractual responsibility for the design, construction, operation, and maintenance of the Project. NEFCO’s General Manager, Larry Bishop, PE will be the Project Manager. The contact information for Mr. Bishop is as follows:
NEFCO has assembled a team with specific expertise designing, constructing, and operating municipal biosolids drying facilities exactly like the proposed biosolids processing solution for the City. The NEFCO team provides that experience and has worked together before on new dryer facilities or upgrade/modification projects at existing dryer facilities. Therefore, the City will receive the benefit of a team that has worked together over the last 27 years.

DOC, the lead contractor, is a general contractor and affiliate company to NEFCO. Jeff Bardell will be the contractor’s lead member. DOC works over the full range of construction, from serving as General Contractor to working as Design-Build. The contact information for Mr. Bardell is as follows:

Jeffrey Bardell
President
Daniel O’Connell’s Sons
100 Franklin Village Drive, Suite 106
Franklin, Massachusetts 02038
508.520.8900 (p)
508.520.8925 (f)
jbardell@dconells.com

Tighe & Bond will provide structural, mechanical, process, electrical, utilities, and site engineering, and lead all permitting efforts. In addition, Tighe & Bond will provide construction administration and O&M support services. Christopher Bone, PE will be Tighe & Bond’s Project Manager and lead engineer. The contact information for Mr. Bone is as follows:
Based on the experience of NEFCO’s team members on O&M projects, we understand the importance of integrating design, construction, operation and maintenance in order to build a successful project. To ensure that clear responsibility is provided for in our team structure, various sub-teams and contractual agreements will be used to ensure the performance of all obligations. The basis of NEFCO’s approach is to ensure that the design-build and O&M teams are effectively integrated so that potential solutions within each discipline are evaluated alongside considerations of the impact on, or relationship with, the other disciplines. The goal is for our proposal to reflect a best-value approach to the Project’s development.

NEFCO has designed, built, and is currently operating biosolids processing facilities throughout the United States. All facilities are currently in production with a processing capacity of approximately 3,500 wet tons per day. Current average annual output is almost 150,000 tons per year of Class A EQ dried biosolids. Table 1 references the facilities that NEFCO has operated within the past ten years.
NEFCO, a New England company, is widely recognized as an industry leader in designing, constructing and operating biosolids management facilities.

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Turnkey design, permitting, construction and operation/maintenance capability reduces the risk for the City. NEFCO recommends the use of a DBOM procurement for this project. It provides the best value and right amount of risk transfer for the City, allowing it to focus on its core businesses. NEFCO is part of The O’Connell Companies, Inc. and our affiliate company, Daniel O’Connell’s Sons (DOC), a 136-year-old Massachusetts construction company, constructs the facilities that NEFCO designs and operates. This turnkey capability reduces risk and provides our clients with a single point of responsibility and significant cost savings over teams formed with separate entities.

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NEFCO is proposing a combined sludge dewatering and drying facility located at the New Bedford Transfer Station Site location to serve the biosolids management needs of the City and to process biosolids hauled in from the Cities of Brockton and Fall River.

This biosolids processing facility will include liquid sludge receiving tanks to receive thickened sludge from New Bedford, dewatering centrifuges to dewater liquid sludge from New Bedford Wastewater Treatment Plant (WWTP), dewatered cake receiving bunkers to receive dewatered cake from the centrifuges and trucked in dewatered solids from Brockton and Fall River. The dewatered solids will be heat dried in rotary drum dryers, sized to process the combined solids from all three facilities. The new facility will also include associated storage, conveying, loading, and emissions control equipment to provide a complete, functional plant. Figure 1 shows a schematic of the proposed treatment scheme.

Figure 1. Proposed Wastewater Residuals Processing Facility
**Solids Generation**

The City of New Bedford owns a secondary WWTP that is permitted to treat an average flow of 21 million gallons per day. The sludge generated at the WWTP is currently thickened and hauled to a privately-operated incinerator facility for disposal. The City generated approximately 7,132 dry tons of sludge in Year 2017. The City has been in discussion with the Cities of Brockton and Fall River, who have committed 100% of their sludge to this regional biosolids processing facility. The annual average solids quantities to be processed at the Regional facility from the three Cities are listed in Table 2.

**Table 2. Annual Average Solids Quantities for Processing**

<table>
<thead>
<tr>
<th>YEAR</th>
<th>NEW BEDFORD</th>
<th>BROCKTON</th>
<th>FALL RIVER</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%TS</td>
<td>TDPY</td>
<td>%TS</td>
</tr>
<tr>
<td>2015</td>
<td>6.5%</td>
<td>5,852</td>
<td>28.5%</td>
</tr>
<tr>
<td>2016</td>
<td>7.3%</td>
<td>6,749</td>
<td>28.1%</td>
</tr>
<tr>
<td>2017</td>
<td>7.0%</td>
<td>7,132</td>
<td>28.8%</td>
</tr>
<tr>
<td>Average</td>
<td>6.9%</td>
<td>6,628</td>
<td>28.7%</td>
</tr>
<tr>
<td>Maximum</td>
<td>7.3%</td>
<td>7,132</td>
<td>28.8%</td>
</tr>
<tr>
<td>Minimum</td>
<td>5.5%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

¹ Liquid sludge @ 3.0%TS
² From monthly data

**Drying Technology**

This section provides a brief description of the proposed heat drying technology to be used for the regional biosolids processing facility at New Bedford.

The rotary drum drying process contains two sub-systems that operate simultaneously: the solids handling system and the air handling system. The solids handling system consists of live bottom dual screw feeders at the base of the cake storage bin that withdraw biosolids at a controlled rate. These screws will be adjusted to deliver the required solids feed rates to the dryers. The dual feeder screws feed a weigh belt conveyor that weighs and transports the cake to a pug mill mixer. The dried recycle product is coated with dewatered cake in the mixer to generate a dryer feedstock of approximately 60
to 65% solids. The damp mix is introduced into a triple-pass rotary drum dryer with direct gas heating. The hot mix of combustion products from the furnace, tempered with recycled dehumidified exhaust gas, dries the biosolids in the drum and provides the motive force to propel the solids through the dryer. The dried biosolids exit the dryer and are pneumatically conveyed, together with process air, to the cyclone separator. The separated product drops through a rotary air lock into the screen, which separates the product into four fractions: trash; oversize; product; and fines. Trash, consisting of coarse plastic and other undesirable solids is collected in a small container for disposal. Oversized material drops into the crusher to be reduced in size and is recycled along with the fines. The properly sized material, which is the finished product, is cooled by a water-based plate cooler and transported to storage silos using either a drag conveyor or a dense-phase pneumatic conveyor system. The product is loaded from the silo into trucks using a mixing screw. A small amount of dust suppression agent is added to the product during truck loading. Figure 2 shows the solids handling components of the dryer system.

Figure 2. Rotary Drum Dryer System: Solids Handling Components

Under normal circumstances, natural gas will provide the heat necessary to evaporate moisture in the dryers. The furnace burner, which provides the heat necessary to evaporate moisture from the biosolids mix, creates a very hot mix of combustion products, which is tempered or cooled by recycling
dehumidified exhaust gas. The tempered, hot gas dries the sludge in the drum and provides the motive force to propel the solids through the dryer. The dried solids, gas, and evaporated water exit the drum through a duct to the separator cyclone, where solids are separated from the gas.

The exhaust gas is next treated in a series of steps to control emissions. The exhaust is first passed through a scrubber/condenser to remove water vapor, particulate and ammonia. The heat absorbed in the scrubber/condenser will be transferred to WWTP effluent used as cooling water. This countercurrent condenser produces hot water (120-140°F) which may be used by the City. The greater part of the dehumidified gas is returned to the inlet of the dryer where it is used as tempering air within the dryer as described above. The remaining gas, i.e., the gas that cannot be reused in the dryer may (at the discretion of state regulators) be scrubbed again with a "polishing" venturi scrubber. Finally, a regenerative thermal oxidizer (RTO) destroys odor causing compounds and organic vapors. The volatile organic compounds are oxidized to odorless carbon dioxide, and are discharged to the atmosphere. Thermal oxidizers control about 98% of organic vapors, and are generally regarded as Best Available Control Technology ("BACT") for odors and volatile organic compounds (VOC). Figure 3 shows the air emissions control equipment of the dryer system.

Figure 3. Rotary Drum Dryer System: Air Emissions Control Equipment
An approximate solids balance for the proposed biosolids processing facility and sizing of the main components of the facility was prepared. The solids processes were sized to handle the maximum solids production reported during the three-year period from 2015 through 2017 based on a 5-day week operation. Liquid sludge receiving and equalization facility for thickened sludge from New Bedford WWTP was sized based on the lowest solids concentration reported from the monthly hauling data. Some excess capacity is provided in the liquid sludge receiving tank to receive liquid sludge from Fall River in the need arises.

Building layouts and cross-sectional views for the rotary drum drying facility are included on the following pages.
Approximate return wastewater flows from the biosolids processing facility are shown in Table 3.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Quantities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dewatering Centrate</td>
<td>gal/yr</td>
<td>28,080,000</td>
</tr>
<tr>
<td>Scrubber Condensate</td>
<td>gal/yr</td>
<td>215,280,000</td>
</tr>
<tr>
<td>Total Annual WW Return</td>
<td>gal/yr</td>
<td>243,360,000</td>
</tr>
<tr>
<td>WW Return Rate</td>
<td>cf/ft</td>
<td>2,020</td>
</tr>
</tbody>
</table>

The centrate from the solids dewatering will contain uncaptured solids from the dewatering process. Assuming 95% capture in the centrifuges, the dewatering centrate will have a solids concentration of 3,100 mg/L. The scrubber condensate from the dryers will contain particulates removed from the exhaust air stream in the dryer. The TSS concentration in the recycle stream from the dryer is expected to range from 300 to 350 mg/L.

**Product Management**

The dried material from the proposed biosolids processing facility will be beneficially used as a fertilizer product and/or as a renewable fuel. NEFCO will be responsible for moving all product generated from the proposed biosolids facility in a timely manner based on our extensive experience and the existing market opportunities.

NEFCO has been marketing dried biosolids product from their operating facilities for over twenty-five years. NEFCO moves more than 100,000 tons of dry product annually from six different facilities, and 100% of the dry product goes to beneficial use. Table 4 lists the approximate quantities of biosolids distributed by NEFCO from their operating facilities in Year 2017.
NEFCO's biosolids processing facility design offers many added value components to the City of New Bedford. Some of the added value components include:

- Safety Program
- Asset Reliability Program
- Lowest process equipment costs.
- Ability to operate facility in an urban residential location.
- High degree of automation; low labor costs.
- Exceptional value for sludge dewatering and improved process control.
- Product Marketing expertise within Massachusetts.

NEFCO has a very thorough Safety Program that is used at all levels of the company to maintain the highest standards in safety performance and behaviors. The Safety Program is centered around the following five Key Safety and Health Principles.

1. Committed and Accountable Leadership
2. Education and Training
3. Managing and Planning for Safety
4. Measurement and Reporting
5. Continuous Improvement

One of the cornerstones of the Safety Program is the Safety Management System (SMS). The SMS is made up of a number of policies and procedures and incorporates all of the OSHA-required programs such as Fire Protection, Lockout / Tagout, Fall Protection, Personal Protective Equipment, Hazard Communications, Confined Space, Respiratory Protection, Hearing Conservation, and many others.

NEFCO has implemented an Asset Reliability Program. We maintain our client's assets as if they were our own. The Asset Reliability Program was developed using the Water Environment Research
Foundation Sustainable Infrastructure Management Program Learning Environment (WERF SIMPLE) prescriptions for asset management, and the Uptime® Elements™ body of knowledge principles as espoused by The Reliability Leadership Institute for the reliability framework. Together, the two components of the Asset Reliability Program will maximize facility uptime and maintain assets in the best practical condition cost-effectively.

The overall process is designed in a manner that allows many different equipment manufacturers the ability to fit their equipment into our process. Major process equipment is specified carefully and then procured via a bid process. This results in the lowest possible process equipment cost. Contrast this with requesting bids from different companies for the entire set of process equipment together.

As described in Section 3, the process and building design results in an odor-free, dust-free environment surrounding the drying facility. This allows for siting the facility in an urban residential location. As shown in the picture below, NEFCO’s MWRA facility in Quincy, MA is located within close proximity to residential apartments, condominiums, and homes. In a regional facility, like NEFCO’s SWA facility in West Palm Beach, FL, the indoor cake receiving area and the fast-acting design of the roll-up doors keeps incoming sludge cake odors to a minimum after the cover of the cake hauling truck is removed.
Each dryer train in the biosolids processing facility is highly automated. The steps in the startup and shutdown sequences are linked closely to allow for complex operations with a minimum of operational staffing required. During routine operations, field operators provide some monitoring of equipment and processes, however they are available to complete other safety, maintenance, project, and housekeeping activities.

NEFCO integrates dewatering activities into the routine operation of a biosolids drying facility. Maintenance and operating staff are responsible for both drying and dewatering equipment; there are no separate staff positions solely for dewatering. This results in lower labor costs and improved coordination between dewatering and drying. It also results in closer coordination of liquid and cake sludge inventory management.

NEFCO has over 32 combined years of dried biosolids Product Marketing experience from the MWRA and GLSD biosolids drying facilities in Quincy and North Andover, MA respectively.

**Additional Value-Add Process Options**

A variation of the base drying option is to add anaerobic digesters upstream from drying. Anaerobic digestion of sludge upstream from drying reduces the mass of solids for drying and provides a fuel source for the dryers. The option is described below.

**Anaerobic Digestion Upstream from Drying**

Anaerobic digestion of sludge is synergistic with drying, providing several advantages. The mass of solids to be dried is reduced by 30 to 50% through conventional digestion. Using thermal drying in conjunction with mesophilic digestion will also provide an opportunity to maximize the overall energy equation. Digester gas can offset the energy requirements for drying and, in return, waste heat recovered from dryer condensate can provide process heating for the digesters. Digester gas needs minimal treatment prior to use in direct-fired rotary dryers. Dryers can utilize the low-pressure gas and require no contaminant removal. The customary emission controls of NEFCO dryer systems will also
remove much of the sulfur dioxide produced from burning digester gas, thereby minimizing air emissions from flares.

Under this option, thickened solids from the New Bedford WWTP will be received in a liquid receiving tank. Dewatered solids from Cities of Brockton and Fall River will be received in a cake bunker, resuspended into solution, and blended with the solids from New Bedford in the liquid receiving tank. The combined solids will be anaerobically digested, dewatered, and dried to produce a marketable product. If there is an option to receive solids from Fall River in the liquid form, that would be preferred with anaerobic digestion since resuspending dewatered solids could require a significant energy input.

By providing excess capacity in the digesters, it might be possible to receive supplemental feedstocks for digestion to generate additional digester gas. Digester gas in excess of what is required by the dryers can be used in a combined heat and power (CHP) system to generate electricity for onsite use.

Figure 5 shows the solids processing scheme with anaerobic digestion.
The amount of dryer energy needs that can be provided by digester gas typically depends on the efficiency of the mechanical dewatering step upstream from drying, the volatile solids concentration of the incoming feed, digester performance, and the dryer operations. A conventional system should be able to achieve 45 to 50% reduction in volatiles, assuming a volatile solids concentration of 70 to 80% in the incoming feed sludge. Assuming a dewatered cake TS of 23 to 25% (with centrifuges), digester gas should be able to provide 100% of the energy requirements for drying.

Despite its advantages, anaerobic digestion is not universally practiced at wastewater plants. With volatile solids reductions in the digesters comes conversion of particulate organic nitrogen to soluble ammonia and lysing of cell mass leading to higher concentrations of soluble phosphorus. These are unavoidable side-effects of anaerobic digestion. The additional nutrient loads imposed on the WWTP by the recycle streams from the dewatering process have to be taken into consideration if digestion is implemented upstream from drying.

**Use of Landfill Gas for Drying**

The Shawmut Avenue Landfill facility, which is adjacent to the proposed site for the biosolids processing facility, may still be generating some landfill gas that could be used to partially offset the fuel requirements for drying. Another potential process enhancement that could improve long-term energy efficiency of the biosolids processing facility is a landfill gas-natural gas blend system that could maximize the use of landfill gas for drying. Typically, dryer burners are designed to operate solely on either natural gas or landfill gas. Blending of the two fuel streams is typically not possible. The gas blend system will help minimize the use of natural gas by using landfill gas to supply the dryer requirements up to the maximum availability of landfill gas. Energy demand in excess of the available landfill gas will be met by blending natural gas. The gas blend system typically includes a burner combination firing system for both landfill gas and natural gas. A fuel caloric value (BTU value) measurement device will be installed downstream of a gas mixing device to send the BTU value of the fuel back to the PLC. The total BTU required for evaporating moisture from the feed will be maintained by natural gas, while using landfill gas for the base load, if the landfill gas flow, pressure, and/or quality decrease, natural gas flow will increase to maintain the target BTU value.
NEFCO has implemented a similar gas blend system at their West Palm Beach (WPB), FL drying facility. The dryer system at WPB uses LFG as the primary fuel, but is designed to blend in natural gas as required to maintain the required energy input to the dryer. Figure 6 shows a typical gas blending system that could be implemented at the proposed drying facility.

![Diagram of dryer fuel blending system design](image)

Figure 6. Dryer Fuel Blending System Design

A gas blend system could also be used with the anaerobic digestion option to maximize the use of digester gas in the dryers. The gas blend system in this case will include a burner combination firing system for digester gas and natural gas, with energy demand in excess of the available digester gas met by blending natural gas.
The schedule on the following page shows the major milestones and main schedule categories for the proposed biosolids processing facility. NEFCO’s general contractor affiliate company, DOC, would put together the detailed schedule and maintain schedule compliance. A period of just over two years from Award of Contract to Substantial Completion is challenging for this project scope, however NEFCO has experience with tight schedules. Together, NEFCO and DOC designed, built, and commissioned the Great Lakes Water Authority biosolids drying facility in Detroit seven months ahead of schedule.
At this point NEFCO would demolish the abandoned incinerator and maintenance facilities at the New Bedford Transfer Station site for locating the new biosolids processing facility. The remediation work required to make the site usable would be undertaken by NEFCO depending on the funding for that type of work.

A site plan showing the proposed biosolids processing facilities at the Transfer Station site is shown on the following page.
At this stage of the procurement NEFCO does not foresee any issues other than the remediation of any hazardous materials. NEFCO’s approach would be to minimize impact to the existing building envelopes. If that is not possible the City would need to provide a mechanism to pay for the cleanup. For example, an allowance could be included in the contract for the environmental remediation.
Table 5 on the following page demonstrates a list of reference facilities successfully undertaken by NEFCO that most closely match what is being considered for New Bedford. The table summarizes the location, facility size, type of sludge processed, initial date of operation, and beneficial use. Additional information can also be found on the project profile sheets on the following pages.
<table>
<thead>
<tr>
<th>Location / Facility Square footage</th>
<th>Type of Sludge Processed</th>
<th>Type of Fuel</th>
<th>Dry tons per year</th>
<th>History of operations, including start-up date and years of service</th>
<th>Beneficial Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Icewind Probizell Processing Facility&lt;br&gt;Quincy, MA&lt;br&gt;314,000 square feet&lt;br&gt;200 dry tons per day capacity</td>
<td>Anaerobically Digested</td>
<td>Natural Gas</td>
<td>46,279</td>
<td>Initial contract was executed in 1963. Operations commenced December 1991. BIP issued June 2009—new 15-year operation contract executed in 2021.</td>
<td>Fertilizer/Alternative Fuel</td>
</tr>
<tr>
<td>Icewind Probizell Processing Facility&lt;br&gt;Shippenee, Indi&lt;br&gt;14,892 square feet&lt;br&gt;55 dry tons per day capacity</td>
<td>Undigested and digested&lt;br&gt;2012; Anaerobically Digested as of 2013</td>
<td>Anaerobic Digester Gas</td>
<td>10,095</td>
<td>Operations commenced December 2000. Facility has been in operation for 13 years (design and built by NIECFO).</td>
<td>Fertilizer</td>
</tr>
<tr>
<td>Icewind Probizell &amp; Peddick Processing Facility&lt;br&gt;North Andover, MA&lt;br&gt;35,767 square feet&lt;br&gt;45 dry tons per day capacity</td>
<td>Anaerobically Digested</td>
<td>Anaerobic Digester Gas</td>
<td>6,306</td>
<td>Design, construction and operations agreement was executed with Divco in February 2013. Facility has been in operation for 8 years (designed and built by NIECFO).</td>
<td>Fertilizer</td>
</tr>
<tr>
<td>Icewind Probizell Processing Facility&lt;br&gt;West Palm Beach, FL&lt;br&gt;37,513 square feet&lt;br&gt;105 dry tons per day capacity</td>
<td>Liquefied combined with anaerobically digested</td>
<td>Landfill Gas</td>
<td>28,500</td>
<td>Operations commenced Summer 2009. NIECFO will operate the facility initially under a 10-year contract renewable for an additional 10 years. (Designed and built by NIECFO.)</td>
<td>Fertilizer</td>
</tr>
<tr>
<td>Heaven Probizell Facility&lt;br&gt;Beaverton, OR&lt;br&gt;45,010 square feet&lt;br&gt;450 dry tons per day capacity</td>
<td>Undigested combined sewer sludge</td>
<td>Natural Gas</td>
<td>66,845</td>
<td>The initial contract was executed in May 2013. Construction was completed in 2014, with a twenty-year Operation &amp; Maintenance Contract through 2017.</td>
<td>Fertilizer</td>
</tr>
</tbody>
</table>

1. All NIECFO facilities produce municipal sludge from wastewater treatment plants. The solids are received as liquid (2% to 6% solids) or dewatered (13% to 20% solids).
2. NIECFO produces a liquid product that is used as an agricultural fertilizer.
3. All facilities use state of the art environmental controls for air, odor and wastewater. These controls are better explained in section 3.
4. NIECFO’s contractual costs with our clients are confidential. A general range for capital cost is $200,000 to $1,000,000 per year ton per day and annual O&M costs range from $200 to $400 per annual dry tons processed. These costs are dependent on fuel type, size, dewatering, staffing, etc.
BIOSOLIDS PROCESSING FACILITY

97 East Howard Street
Quincy, MA

KEY PARTICIPANTS
NEFCO: design/build/operate biosolids drying system
Daniel O’Connell Sons: contract administration

CLIENT
Massachusetts Water Resources Authority (MWRA)

HISTORY OF OPERATIONS
Ref. issued June 2000 – new 15-year operations contract awarded to NEFCO.

DESCRIPTION OF SYSTEMS & PROCESSES
This process utilizes direct-fired, rotary drum drying systems fueled by natural gas. Drier exhaust is treated by scrubbing, condensing, recirculation, and thermal oxidizer. The facility design capacity in excess of 500 wet tons per day (based on 256 solids). Each drying train can process in excess of approximately 160 wet tons per day (based on 256 solids). The facility has twelve centrifuges and six dryer process trains.

CAPITAL & OPERATING COSTS
Total initial capital for this facility (excluding site preparation, large-facilities, and liquid biosolids storage) was approximately $80 million. An additional $45 million was invested in an expansion to accommodate full secondary buildout at Deer Island. Total annual O&M revenue is approximately $1.5 million.

NEFCO TEAM
Michael Thayer > Process Design; James Sullivan > General Contractor; Larry Billups > Engineering; Manuel Inigo > Operations; Steve Macdonald with Daniel O’Connell Sons > Project Executive; and Mark Hoey with Tighe & Bond > Engineering

CLIENT CONTACT
David Dunne, Director of the Deer Island Treatment Plant
MWRA, 100 First Avenue, Charlestown, MA 02129
p (617) 560-7870  f (617) 560-7850  Dave.Dunne@mwra.com

NEFCO
Environmental Services
KEY PARTICIPANTS
NEFCO: design/audit/operate biosolids drying system
Daniel O'Connell's Sons: contract administration

CLIENT
Metropolitan Council Environmental Services (MCES)

HISTORY OF OPERATIONS

DESCRIPTION OF SYSTEMS & PROCESSES
This process utilizes a direct-fired, rotary drum drying system fueled by anaerobic digester gas, natural gas and fuel oil. Drier exhaust is treated by scrubbing, condensing, re-circulation, and thermal exchangers. The facility design capacity is approximately 300 wet tons per day (based on 26% solids). This facility has a single dryer process train.

CAPITAL & OPERATING COSTS
Construction contract value: approximately $16 million
Total annual O&M revenue: approximately $4.6 million

NEFCO TEAM
Michael Thayer: Process Design; James Sullivan: General Partner; Manuel Inigo: Operations and Steve Malovivo with Daniel O'Connell's Sons: Project Executive

CLIENT CONTACT
Lea Thompson: General Manager
MCES 150 Robert St. North St. Paul, MN 55101
p (651) 692-8101  f (651) 692-1110  Lea.Tompson@metc.state.mn.us

Public private partnership with MCES
Alternative fuel — biogas (digester gas)
100% processing using single dryer
Processes digested sludge cake to Class AA biosolids
Unique staffing — NEFCO manages MCES union staff
D-B-O Contract

NEFCO
BIOSOLIDS
DRYING &
PELLETIZING
FACILITY

GLSD Wastewater
Treatment Plant
240A Charles Street
North Andover, MA

KEY PARTICIPANTS
NPFCO: Design/build/operate biosolids drying system
Daniel O'Connell's Sons contract administration.

CLIENT
Greater Lawrence Sanitary District (GLSD)

HISTORY OF OPERATIONS
Design, construction and operations agreement was executed in February 1999.
Facility commenced operations in December 2002. Ten-year operations contract
extension executed in October 2008.

DESCRIPTION OF SYSTEMS & PROCESSES
This process utilizes direct-fired, rotary drum drying systems fueled by digester
gas with natural gas as standby fuel. Dryer exhaust is treated by scrubbing, condensing,
condensate, and thermal oxidation. The facility design capacity is in excess of 150 wet
tons per day (based on 25% solids). Each drying train can process in excess of 75 wet
tons per day (based on 25% solids). This facility has two independent dryer process trains.

CAPITAL & OPERATING COSTS
Construction contract value: approximately $13 million
Total annual O&M revenue is approximately $2.1 million

NEFCO TEAM
Michael Gugerty > Process Design; James Sullivan > General Partner; Manuel
Irijo > Operations; and Steve Maltese with Daniel O'Connell's Sons > Project
Executive

CLIENT CONTACT
Cheri Coutts Executive Director
GLSD 240 Charles Street North Andover, MA 01845
p (978) 685-3622 f (978) 685-7780 ccoutts@glsd.org

Public private partnership
with GLSD
First facility of its kind in the
US to run on
biogas (digester gas)
Processes digested sludge
cake to Class AA biosolids
Virtually eliminates
the need for fossil fuel
in the drying process
10 year contract renewal
due to client satisfaction
D-B-O Contract

NEFCO
Recycle. Reuse. Restore
KEY PARTICIPANTS
NEFCO: design/perm/operate biosolids drying system.
Daniel O'Connell Sears - contract administration

CLIENT
Solid Waste Authority of Palm Beach County Florida (SWA)

HISTORY OF OPERATIONS
Operations commenced Summer 2009. NEFCO will operate the facility initially under a 10-year contract renewable for an additional 10 years.

DESCRIPTION OF SYSTEMS & PROCESSES
This process utilizes direct-fired, rotary drum drying systems fueled by landfill gas and natural gas. Dryer exhaust is treated by scrubbing, condensing, recirculation, and thermal oxidation. Each drying train can process in excess of 330 wet tons per day. This facility has two independent dryer process trains.

CAPITAL & OPERATING COSTS
Construction contract value approximately $27 million
Total annual O&M revenue is approximately $4.4 million

NEFCO TEAM
Michael Thayer - Process Design; James Sullivan - General Partner; Larry Bishop - Engineering; Manuel Irujo - Operations; Steve Malanaro with Daniel O'Connell Sears - Project Executive; and Frank Tymowski with Wade Trim - Engineering

CLIENT CONTACT
Raymond Schauer - Director, Engineering & Public Works
SWA of Palm Beach County 7901 North Jog Road West Palm Beach, FL 33411
p (561) 610-4000 f (561) 615-4578 rschauer@swa.org

Public private partnership with SWA
Processes digested sludge cake to Class AA biosolids

Alternative fuel - biogas (landfill gas)

Regional facility serving six municipalities

Architecturally designed to complement aesthetics of the resource recovery campus

D-B-O Contract
KEY PARTICIPANTS
NEFCO: design/build/operate biosolids drying system
Daniel O’Connell Sons: contract administration

CLIENT
City of Cumberland, Department of Public Works

HISTORY OF OPERATIONS

DESCRIPTION OF SYSTEMS & PROCESSES
This process utilizes a direct-fired, rotary drum drying system fueled by natural gas. Dryer exhaust is treated by scrubbing, condensing, recirculation, and thermal oxidation. Facility is equipped with a new high solids centrifuge. The facility design capacity is approximately 11 dry tons per day (based on 27% solids). The facility includes a biosolids dryer which is capable of evaporating in excess of 3,000 pounds per hour of water from the incoming sludge cake.

CAPITAL & OPERATING COSTS
Approximately $16 million
Total annual O&M revenue is approximately $850,000

NEFCO TEAM
Michael Thayer: Process Design; James Sullivan: General Partner; Larry Bishop: Engineering; Manuel Irigo: Operations; Steve Malotano with Daniel O’Connell Sons: Project Executive; and Mark Ivey with Tige & Bond: Engineering

CLIENT CONTACT
John Dilieto: Director, Engineering Division
City of Cumberland DEP 215 Bowen Street, Cumberland, MD 21502
p (301) 729-6021 f (301) 729-6038 jdilieto@allcormet.org

Public private partnership with City of Cumberland
Centrifuge dewatering & thermal drying
Processes digested sludge to Class AA biosolids
All product is distributed by NEFCO
Environmental benefits enabled the City of Cumberland to secure grant funding
D-B-O Contract

NEFCO
NEFCO
NEFCO
NEFCO
NEFCO
NEFCO
KEY PARTICIPANTS
NEFCO design/ build/ operate biosolids drying system
Daniel O’Connell & Sons, contractor

CLIENT
Great Lakes Water Authority (GLWA)

PROJECT DESCRIPTION
NEFCO was selected to design, build, and operate a 420 dry ton per day (peak capacity) facility. The facility features technologically advanced air pollution, noise, and odor control systems ensuring NEFCO is a good neighbor to the community. Benefits from this contract include significant annual cost savings over the current management practice. The project is expected to result in increased capacity and reduced cost versus a DWSA-digested capital project that was planned, more efficient staffing, and a facility that greatly reduces impacts to the local community. The initial contract was executed in May 2013. Construction was completed in 2015, with a 10-year Operation & Maintenance Contract through 2027.

The process utilizes four direct-fired, rotary drum dryer trains fueled by natural gas. The process exhaust is treated by scrubbing, condensation, desiccation, and thermal catalysis. The facility has a design capacity of 516 dry tons per day (based on 20% solids). Dewatering is achieved using eight centrifuges (two per train) prior to drying.

CAPITAL & OPERATING COSTS
Construction contract value approximately $13 million
Total annual O&M revenue approximately $13 million

NEFCO TEAM
Michael Slagle > Process Design; James Smith > General Technician; Larry Bishop > Project Manager; Manuel Argáez > Operations, Heat Soak; Process Specialist; Steve Maizans with Daniel O’Connell & Sons > Construction Leader; Chris Renne with Tyler & Bond > Engineering; Dennis Peca with Wade Trim > Engineering

CLIENT CONTACT
Philip Korn > Head Engineer of Water Systems
Great Lakes Water Authority
5500 West Jefferson • Detroit, MI 48221
p: (313) 297-5906  f: (313) 297-6811  Philip.Korn@water.org

Largest biosolids drying facility in North America
Reduced the City’s costs by nearly $17 million annually
Project completion ahead of schedule by nearly six months
All product beneficially used regionally for agricultural and fuel purposes
NEFCO's design and operation of the biosolids processing facility will minimize impacts on the sensitive surrounding community.

The proposed facility will be totally enclosed with an odor scrubber serving the building ventilation system. The building ventilation system will be designed as a cascade system that serves two purposes. First, air will be drawn through the processing room to cool and ventilate that section of the plant. This air will then be ducted into the cake storage room, providing ventilation of that area. Finally, the exhaust from the cake storage room will be ducted to a scrubber to remove odor-causing substances. The exhausted building air will be scrubbed in an alkaline hypochlorite scrubber. This scrubber will remove acidic and oxidizable odor-causing substances, especially odorous sulfur compounds such as hydrogen sulfide. All exhaust from potentially odorous areas of the plant will be treated. This system will assure the City of an odor free, dust free environment surrounding the drying facility.

Noise from the biosolids processing facility will be controlled. NEFCO typically includes fans, motors, and equipment that do not emit more than 85 dB(A) measured at 3 feet. Ambient noise can also be an issue with the community. In addition to providing quiet equipment, most equipment will be located indoors where the building envelope will provide additional sound attenuation. Process fans can also generate a pure tone that can propagate great distances. NEFCO's design for scrubbers and RTOs are "forced draft", placing sound-attenuating equipment downstream of the fans thus eliminating such noise.

Since thermal drying reduces the total mass of the final product by approximately 80%, truck traffic on local streets will improve as a result of the project. Dried biosolids also have far fewer potential community impacts such as odors, dripping tailgates or insect pests.
In addition, developing a partnership with NEFCO will bring the following benefits to the City:

- **NEFCO will focus on exactly what the City needs, biosolids management.** If feasible, energy recovery methods will be implemented in a future phase. NEFCO will utilize its experience with a similar facility that we operate and maintain, The Greater Lawrence Sanitary District has recently installed a co-digestion and combined heat and power facility to supplement a biosolids drying facility that NEFCO operates and maintains. This energy neutral arrangement is a potential model for this project.

Implementing a drying facility will provide what is needed, biosolids management. The technology is robust and can process a variety of blended sludges as evidenced by the SWA facility. Also, it has the fewest “moving parts”, meaning it will be up and running prior to other approaches. After implementation NEFCO can explore other complimentary technologies to produce energy or recover other constituents that have value.

- **NEFCO has developed a regional biosolids management facility which requires significant coordination.** Regional systems are very difficult to develop and coordinate. NEFCO’s facility in West Palm Beach Florida that was developed for the Solid Waste Authority (SWA) of Palm Beach County receives cake biosolids from six different plants. NEFCO has the expertise to blend and process different material which has been proven over the last ten years at the SWA facility.

- **Use of energy recovery approaches.** NEFCO will explore the option of enhancing the biosolids management facility with co-digestion of source separated organics at the project site. Also, NEFCO uses alternative fuels such as digester or landfill gas at three of its six facilities, which offsets the use of natural gas to fuel the biosolids drying facility.

- **Turnkey design, permitting, construction and operation/maintenance capability reduces the risk for the City.** NEFCO recommends the use of a DBOM procurement for this project. It provides the best value and right amount of risk transfer for the City, allowing it to focus on its core businesses. NEFCO is part of The O’Connell Companies, Inc. and our affiliate company, Daniel O’Connell’s Sons
(DOC), a 136-year-old Massachusetts construction company, constructs the facilities that NEFCO designs and operates. This turnkey capability reduces risk and provides our clients with a single point of responsibility and significant cost savings over teams formed with separate entities.

**Complete product use and distribution responsibility.** NEFCO is responsible for the beneficial use and distribution of the product from all of our facilities, amounting to more than 700 tons per day. Our product distribution experience over the last 27 years in New England will be invaluable for this project. NEFCO will take responsibility for the product, removing the risk from O&Y, and will beneficially use our network of fuel/energy and agricultural outlets.
Parallel Products Expression of Interest, Organics-to-Energy Facility, New Bedford, MA
(Bid Number 19192009)

July 12, 2018
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Executive Summary

Parallel Products (Parallel) is excited for the opportunity to provide a response to the Request for Expression of Interest (RFEI) to the Cities of New Bedford, Fall River and Brockton. Parallel is an innovative recycling company with a strong and growing presence in New Bedford in addition to processing and recycling operations across the US.

Parallel has partnered with Aries Clean Energy, LLC to bring an innovative, environmentally friendly biosolids processing solution to New Bedford that includes dewatering, drying, fluidized bed gasification and energy recovery that is superior to current solutions and is designed to be reliable, safe, minimize environmental liability, and be cost effective compared to current solutions. Parallel has acquired a 69-acre site in the New Bedford Business Park that is centrally located to the three cities. The company plans to design, build and operate the biosolids processing plant at this location.

Parallel's proposal offers a number of advantages and benefits including an industrial site with scope for meeting all of the cities' needs and additional expansion, easy logistical access to the site by road and rail, operations optimization due to being part of a larger site, a proven environmentally friendly technology, energy recovery initially to replace natural gas, and in the long term to generate electricity that can be easily distributed with existing utility infrastructure due to site solar energy generation, minimized environmental liability since the only byproducts are Class A biosolids and non-leachable ash, plant reliability due to redundancy of key equipment, expedited site permitting, and cost savings to each of the three cities.

Parallel Products would like to thank the Cities of New Bedford, Fall River and Brockton for providing the company with the opportunity to be of service to them in meeting their biosolids processing needs.
Section 1. Contractor Description

Parallel Products (Parallel) is a 35-year-old recycling and waste to energy company headquartered in Louisville, KY, and has been operating in southern Massachusetts since 2004. It has active processing and recycling operations in New Bedford, New York (NY), Louisville (KY), Greeley (CO), and Rancho Cucamonga (CA). The company has partnered with Artes Clean Energy, LLC (Artes) on a proprietary environmentally friendly process related to biosolids gasification followed by the beneficial use of energy. All correspondence should be directed to the contact below:

Name: Tim Cusson
Title: Vice President – Business Development
Address: 969 Shawmut Ave, New Bedford, MA 02746
Email: TimC@parallelproducts.com
Phone: 617-908-0828

Examples of successful past projects:

Over the past 10 years, Parallel has deployed approximately $30 million in capital to successfully develop multiple operating sites across the country. All of the projects described below were developed and continue to operate internally, so there are no external references. All sites exceeded their economic and operational goals, and collectively process ~250,000 tons of material annually (6-800 tons per day).

1. Massachusetts commodity recovery and product destruction: Design, procurement, site development, construction, and operation of multi-faceted recycling operations throughout Massachusetts. Operations include high volume product destruction, glass/metal/plastics separation, liquids management, plastics size reduction and purification, inbound and outbound logistics and transportation for over 40,000 tons of material annually.

2. Massachusetts Solar Electricity Generation: Over the past 2 years, Parallel has successfully designed and built solar installations on and near its 100 Duvalhine Boulevard site that is expected to generate over 15 GWh of electricity over the next 20 years.

3. Colorado commodity recovery and product destruction: Design, procurement, site development, construction, and operation of multi-faceted recycling facility. Operations include high volume product destruction, glass/metal/plastics separation, liquids management, inbound and outbound logistics and transportation for over 10,000 tons of material annually.
4. **Kentucky commodity recovery and product destruction**: Upgrade and repurposing of decades old Louisville facility to support operations including high volume product destruction, glass/metal/plastics separation, liquids management, fermentation and distillation of fuel grade ethanol, inbound and outbound logistics and transportation for 100,000 tons of material annually, including management of an active rail spur.

5. **Southern California commodity recovery and product destruction**: Upgrade and repurposing of decades old facility to support operations including high volume product destruction, glass/metal/plastics separation, liquids management, fermentation and distillation of fuel grade ethanol, inbound and outbound logistics and transportation for over 60,000 tons of material annually, including management of an active rail spur.

6. **New York commodity recovery and product destruction**: Upgrade, redesign, and operation of multi-faceted recycling facility. Operations include high volume product destruction, glass/metal/plastics separation, liquids management, plastics size reduction, inbound and outbound logistics and transportation for over 30,000 tons of material annually.

Figure 1. Parallel Products Louisville and Rancho Cucamonga Plants
Arlos Clean Energy, I.C., based in Franklin, Tennessee, designs and builds innovative bio-based downdraft and fluidized bed gasification systems using its eight patents granted to date. Its projects provide for the sustainable disposal of waste, biosolids, reduction of carbon emissions, and the production of clean thermal and electrical energy. Arlos has commercialized gasification and energy recovery units in the US in Sanford (FL), Lebanon (TN), and Covington (TN).

1. Sanford Biosolids Gasification: A plant was designed, built and operated to take in 30 wet tons per day, dewater, dry, gasify, and recover the energy in a thermal oxidizer. This energy was used in the drying process in lieu of natural gas. The plant met the regulatory requirements for air emissions for the Florida Department of Environmental Protection.

2. Covington Wood Chips and Biosolids Gasification: A plant was designed, built and operated to process 12 tons per day of wood chips and sewage sludge. The incoming materials are dried, gasified, and the energy is recovered in a thermal oxidizer for use in the process. In July 2015, Arlos assumed operation and fiscal responsibility for the plant, which is currently being used for advanced energy R&D purposes.

3. Lebanon Wood Chips and Biosolids Gasification: The world’s largest downdraft gasifier with a capacity of 60 tons per day of wood chips and sewage sludge was commissioned in October 2016. The system generates electricity from syngas (syn gas) combustion using an Organic Rankine Cylinder generator and is expected to divert more than 16 million pounds from landfills and generate more than 36 MW-hrs over the life of the project.
Section 2. Contractor Capabilities & Experience

Parallel Products has a long history of employing innovative methods to derive economically and environmentally beneficial uses from materials that most would consider waste. The company has operated for over 35 years, and locally in the southern Massachusetts area for 15 years. The current management team has worked together for over a decade, and has a proven ability to identify, develop, and execute on complex waste-to-energy opportunities.

Parallel currently owns and operates facilities in California, Kentucky, Colorado, New York, and Massachusetts, and manages sub-contractor relationships that cover nearly every other heavily populated area of the country. During its history, the company has invested tens of millions of dollars to develop real estate and customized, proprietary processes that yield optimal value for waste feed stocks. Focusing primarily on the destruction of unsalable beverage and health and beauty products, the company has recovered several million tons of material that otherwise would have gone to waste. The company achieves all of this while strongly protecting the reputations of its clients, which include many of the most recognizable beverage, alcohol, and pharmaceutical brands in the world.

The company maintains core competencies directly related to managing biosolids waste, including:

- Large scale handling of solid and liquid materials (receiving, storage, processing, sorting, post-processing)
- Chemical engineering process operations, such as distillation, evaporation, natural gas fired boiler operations, fermentation, drying, conveyance of solids and liquids, storage, and truck and rail transportation, and the management of two active rail spurs in Louisville and Rancho Cucamonga
- Providing highly reliable, mission critical management services for waste material generators, including issuing certificates of destruction for incoming materials, and certificates of analysis guaranteeing quality of outgoing products.
- Sales and marketing of recovered commodity products
- Strong employee health and safety program and record
- Compliance with federal, state, and local environmental regulations administered by a wide variety of parties, including Federal Environmental Protection Agency (EPA), Alcohol and Tobacco Tax & Trade Bureau (TTB), California Air Resources Board (CARB), Occupational Safety and Health Administration (OSHA), Massachusetts Department of Environmental Protection (DEP), Massachusetts Environmental Policy Act (MEPA).
South Coast Air Quality Management District (SCAQMD – Los Angeles area), multiple state and local air permitting, site permitting, and liquids treatment agencies/facilities, and regional utility grid operators.

In addition to these core competencies, Parallel has demonstrated repeatedly that it can deploy innovative solutions that richly benefit all stakeholders. Some examples of this include:

- Unique processing of waste beverages into Renewable Fuel Standard (RFS) designated renewable fuel ethanol approved by the EPA
- Proprietary process for stripping methanol and other contaminants from ethanol waste streams
- Specialized process for safely destroying high proof alcohol-based consumer products, while recovering 90%+ of material as usable commodity
- Secured a CARB (California Air Resources Board) carbon intensity index score lower than traditional corn ethanol producers due to reduced carbon emission profile
- Specialized PET flake color sorting process using optical sorting, improving value and recyclability of underlying product
- Deep expertise in the processing and sale of commodities such as paper, cardboard, PET, polyethylene, polypropylene, and fuel grade ethanol in multiple states
- Investment in and use of renewable energy inputs (such as solar) to enhance processes that already deliver extraordinary environmental benefits

For more detail on Parallel’s capabilities, please visit its website (http://parallelproducts.com) to view process descriptions and videos (http://parallelproducts.com/Video). Parallel is partnering with Aries Clean Energy, LLC (Aries), a leader in the deployment of fluidized bed gasification and energy recovery from biosolids and wood waste. Aries, based in Franklin, Tennessee, designs and builds innovative bio-based downdraft and fluidized bed gasification systems using its eight patents granted to date. Its projects provide for the sustainable disposal of waste, biosolids, reduction of carbon emissions, and the production of clean thermal and electrical energy.
Section 3. Technology & Facility Description

Introduction

Parallel Products (Parallel) is located at 969 Shonea Avenue, New Bedford. Parallel Products owns the property located at 100 Duchaine Boulevard, New Bedford, MA. The site includes 69 acres of land and is zoned IC. Parallel proposes to construct and operate a solid waste processing and handling facility at the Duchaine Boulevard site, including a biosolids processing facility. A new rail siding track will be constructed to provide rail service to the site. A project loca plan is included in Attachment A. A site plan of the existing and proposed site conditions is included in Attachment B.

The state of Massachusetts has witnessed the closure of several landfills and incinerators in recent years, with more projected to be closed in the future. This has led to a severe shortage of processing capacity for biosolids which are being incinerated in neighboring states like Rhode Island. This has resulted in higher costs and fewer options for cities like New Bedford, Brockton, and Fall River. Parallel is proposing an environmentally friendly solution for biosolids on this site. Parallel proposes to dewater and dry waste water sludge to Class A biosolids and recover energy that can be used in the drying process in place of natural gas. This solution will reduce greenhouse gas emissions, reduce potential environmental liabilities associated with land applying dried biosolids, generate local employment, and offer a cost-effective, secure, local option for waste water biosolids disposal for the Cities of New Bedford, Fall River, and Brockton.

A biosolids processing facility will be built to dewater sewage sludge and dry wet cake to Class A biosolids, along with a gasifier and thermal oxidizer to recover the biosolids energy and recycle the energy for use in the drying process instead of using natural gas. Appropriate emissions equipment will also be installed downstream of the thermal oxidizer.

Parallel Products is partnering with Arlis, a leader in biosolids gasification technology. Fluidized bed gasification is a process that converts carbon-containing waste material such as dried biosolids into syngas, along with a small amount of inert ash. The dried biosolids are fed into the gasifier and a controlled amount of oxygen is introduced. Once necessary temperatures are achieved and maintained, a thermo-chemical process converts the biosolids into a combustible syngas primarily composed of carbon monoxide, hydrogen and methane. Syngas can then be combusted in a thermal oxidizer in lieu of using natural gas to provide the thermal energy needed to reduce the moisture content of the incoming wet cake in the drier.

Since the patented fluidized bed gasification technology consumes little oxygen and results in lower air emissions, it is an attractive alternative to conventional disposal processes such as burning or land application. In fact, the US Environmental Protection Agency has specifically established that fluidized bed gasification is not classified as incineration.
Aries brings extensive experience in working with engineering firms, contractors, vendors to assist in the smooth integration of its gasifier into an overall biosolids treatment system. Site facilities is easier than with alternative methods due to the clean emissions profile associated with the gasification process.

**Site Description and Proposed Construction**

The site is an approximately 69-acre parcel located in the New Bedford Business Park, which was previously owned and operated by Polaroid Corporation. The site as developed by Polaroid included access roads, parking areas, storm water management features, and various buildings. The biosolids processing facility will be constructed on the northwestern corner of the site as shown in Attachment B. The site is centrally located with respect to the locations of the three WWTPs with easy access from Route 140.

The biosolids processing facility will be housed in a new building to be constructed in the northwest corner of the site. The processing equipment will include receiving tanks for incoming trucks, dewatering and drying equipment, gasifier, thermal oxidizer, and emissions control equipment. The project location and proposed layout is shown in Attachment C.

A rail-side track will be constructed from the main rail line on the western perimeter of the site, to the central portion of the site. The side track will provide the capacity to store empty rail cars to be filled with solid waste (including Class A dried biosolids, if necessary) and to store filled rail cars waiting for rail service to transport the waste to out of state landfills. The track will be constructed such that rail cars can be loaded with waste within a fully enclosed tipping building to be constructed on site as shown on the site plan included in Attachment B (Existing and Proposed Conditions Plans).

**Proposed Process**

Wet biosolids slurry (average 7% solids content) will be delivered to the site in tanker trucks from the New Bedford WWTP, and wet biosolids cake (20% solids content) in covered dump trucks from Fall River WWTP and Brockton WWTP.

Trucks will utilize Route 140 to access the site. Trucks will exit Route 140 and enter the industrial park at the Braley Road exit on Route 140. Trucks will utilize Theodore Rice Blvd to DuChaine Road.

The types of materials accepted at the facility and the maximum tonnages accepted are summarized in the table below:
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<th>Type of Waste</th>
<th>Max Daily Tonnage (wet tons)</th>
<th>Max Daily Tonnage (dry tons)</th>
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<td>Dewatered coke</td>
<td>100</td>
<td>20</td>
</tr>
<tr>
<td>Wet slurry</td>
<td>430</td>
<td>30</td>
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</tbody>
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Note: The above tonnages are representative. The facility has no constraints and will be sized to handle available tonnage for all three WWTPs.

The process flow diagram and mass balance are included in Attachment D, based on the information provided in the RFIEE. Liquid sludge accepted at the facility will be dewatered by a centrifuge or screw press. Waste water generated in the dewatering process will be sent to the New Bedford sewer system. This dewatered sludge in combination with dewatered cake accepted at the facility will be dried using heat from the gasification process. The dried biosolids will then be gasified producing non-leachable ash and syngas. The syngas will be combusted in a thermal oxidizer with the excess heat used for drying the biosolids prior to gasification, instead of using natural gas.

**Constraints**

The biosolids processing facility will be constructed to meet the needs of the three WWTPs. There are no limitations in terms of quantities of incoming wet cake and wet slurry. The gasification capacity will be designed initially to be lower than the total Class A biosolids generated by the drying process. It is assumed that the City of New Bedford will be able to accept the volume of waste water generated during the dewatering and drying process. The site has the space to handle expansion of the facility to a larger capacity.
Section 4. Value-Added Components

Value-added components of the project include the following:

- Site benefits:
  - Parallel Products' site is centrally located for all three facilities – 13 miles, 21 miles and 27 miles from the WWTPs of New Bedford, Fall River, and Brockton respectively.
  - The site is large and has adequate land to process the biosolids for all the three cities, and future expansion.
  - There is a significant natural buffer between the biosolids processing facility and the neighbors; the facility will be located over 1500 feet from its residential neighbors outside the Industrial park.
  - The site is easily accessible from Route 140 followed by an access road that runs through the industrial park.
    - The proposed operation will require about 15 trucks per day of additional traffic, and Parallel Products' site is ideally located such that these operations do not have an impact on the local neighbors.

- Parallel Products Partnership with Aries Clean Energy
  - Aries has developed a patented and proven fluidized bed gasification technology to convert biosolids to syngas which can then be combusted to provide thermal energy to the drying process. This is an environmentally friendly way of recovering energy from biosolids, producing non- Erdoğan ash, thereby reducing the volume of material to be disposed in a landfill.
  - This proprietary process does not depend on any marketing of products like Class A biosolids.

- Parallel Products will use redundant dewatering equipment and drying equipment to minimize the impact of unplanned shutdowns. In conjunction with receiving tank capacity, this increases the reliability of the process for New Bedford, Fall River and Brockton.
  - In the unlikely event that the gasification unit shuts down for unplanned maintenance, Parallel Products will still have the ability to produce Class A biosolids, so there will be no impact on the flow of incoming sludge from the three cities.
Parallel Products is already working with its expert consultants to acquire a permit to process biosolids on site and has done a significant amount of preparatory work including multiple meetings with MEPA, DEP and the City of New Bedford. Parallel Products will continue to commit significant financial and technical resources to the permitting process in parallel with the RFI/RFP process in order to ensure that it can serve the cities at the earliest opportunity.

Parallel Products is an innovative recycling and energy recovery company that is always looking to provide innovative environmentally friendly solutions to its customers. It would like to bring this same dedication and focus to the Cities’ biosolids processing needs.
Section 5. Estimated Schedule

Here is an estimated schedule for the project:

Design:

In collaboration with Aris Clean Energy, Inc, preliminary detailed design has already been completed for a 24 DT/day facility with dewatering, drying and gasification and heat recycle from the thermal oxidizer to the dryer. This design will be updated for the desired capacities in the RFPII prior to the RFP.

Financing:

The project will be financed by Parallel Products and/or its majority owner TCR Holdings, LLC. Parallel Products may also choose to seek external financing for the project but this will not impact the timing for the project.

Permitting:

Parallel Products is currently in the midst of seeking permits for the 69 acre site (100 Duchaine Boulevard) for both biosolids and municipal solid waste processing. It has met with MEPA and DEP, defined the scope of the projects, and is currently working on an Expanded Environmental Notification Form. If the permitting process goes as planned, Parallel Products expects to receive the required permits (including Authorization to Construct (ATC) Application, Review, and Decision by the DEP) by the first quarter of 2020.

Construction:

Construction will begin after the ATC Application review by the DEP. Construction is expected to be completed by the end of 2020.

Operation:

Startup and operation will begin in late 2020/early 2021.
Section 6. Site Selection

Parallel Products will compare the attributes of the site being offered by the City of New Bedford with the site it owns and is permitting at 100 Duchaine Boulevard. Parallel Products forecasts that the Duchaine facility will offer a lower cost of development and operation, and therefore currently plans to build the biosolids processing facility on its site at 100 Duchaine Boulevard.
Section 7. Constraints

Parallel Products does not foresee any constraints for project development, permitting, financing, construction, operation and marketing products.
Section 8. Prior Facilities

Parallel Products will build its first biosolids processing facility in New Bedford. The company has extensive processing and recycling experience in the design, construction, and operation of recycling plants at various locations in the US.

Parallel Products is partnering with Aries Clean Energy in the design, construction, and operation of the facility. Aries’ experience in designing, building and operating systems is described in detail in the ensuing examples. Parallel Products will be using commercially available equipment for dewatering and drying.

Parallel Products has done detailed design and engineering, and economic evaluations on its biosolids facility with the assistance of Aries and is confident that it will be able to offer savings to all three cities for their biosolids processing needs.

Here are three examples of past projects executed by Aries—

Sanford – Fluidized Bed Gasification

**Summary:** In 2007, the Sanford, Florida, Utility Department sought to identify an onsite biosolids management and disposal system that could be integrated within their South Sanford Water Treatment Facility. The intended biogasification system would be a cost effective long-term solution, that is regulatory compliant and environmentally superior.

**Problem:** When natural gas prices skyrocketed in the mid-2000s, the city wanted to eliminate the costs associated with the drying of biosolids from the wastewater treatment process and establish a green disposal method.

**Approach:** Install and operate one MaxWest FB2000 biosolids gasification system. This system was developed specifically for processing municipal sewage sludge. The system applies a thermo-chemical conversion of the wastewater residuals to generate thermal energy. This renewable energy was then recovered to reduce or eliminate other energy sources, providing energy savings and biosolids destruction for customers, and operates on the following specifications:

- **Input Materials:** Processes 100% of municipal biosolids in its MaxWest FB2000 system.
- **Process:** Utilizes energy embedded in the biosolids as a source of renewable heat energy to dry biosolids to Class A standards, replacing the use of natural gas.

**Results:** The fluidized bed gasification system yielded waste, energy, and emissions benefits for Sanford:
• Waste: More than 30 wet tons of biosolids diverted from land-application and/or landfills each day
• Energy: Elimination of natural gas bills to the city over the 20-year life of the project
• Emissions: The city was able to meet regulatory requirements for air emissions witnessed by the Florida Department of Environmental Protection

Covington – Waste-To-Energy Gasification Plant

Summary: Progressive civic leaders in Covington, Tennessee, knew there was a better solution to disposing of wood waste and sludge – the PHG SF12 gasifier.

Problem: The city of Covington wanted to find a better way to deal with wood waste and sludge – one that would eliminate costly trips to the landfills.

Approach: Aries Clean Energy developed the PHG SF12, a 12 ton per day capacity throughput downdraft gasification system that operates on the following specifications:

• Input Materials: Wood is chipped, mixed with sludge, and pre-dried to control moisture content before gasification
• Process: Syngas produced is combusted in an industrial thermal oxidizer (an emissions control device). Thermal energy is transferred to heat oil fluid, which drives a 125 Kw General Electric Organic Rankine Cylinder generator that offsets the electrical usage at the wastewater treatment plant next door.
• Output: 8% of input results in biochar that is 70% carbon and recyclable

Results: The PHG SF12 downdraft gasification system yields waste, energy, and emissions benefits for Covington.

• Waste: More than 4,000 tons diverted from landfills each year
• Energy: More than 750,000 KWH generated over 20 year life of the project
• Emissions: More than 900,000 lbs carbon emissions averted per year
• Process: In July 2015, Aries assumed operation and fiscal responsibility for the plant, which is currently being used for advanced energy R&D purposes

Lebanon – Commercial Waste-To-Energy plant

Summary: The world’s largest downdraft gasifier was commissioned in October 2016 in Lebanon, Tennessee.

Problem: The city of Lebanon, Tennessee, wanted to find a new way of waste disposal that would eliminate landfill trips and expenses and improve its sustainability footprint.
Approach: Aries Clean Energy developed the PHG LF64 (64T/day) downdraft gasification system on half acre in Lebanon, Tennessee, that operates on the following specifications:

- **Input Material:** Waste wood is cut to 1- to 3-inch size; sludge is blended with wood before gasification.
- **Process:** Syngas produced (92% by volume input) is combusted in an industrial thermal oxidizer (an emissions control device). Thermal energy is transferred to hot water, which drives three Organic Rankine Cylinder generators with a total output capacity of 420 kW that offsets the electrical usage at the wastewater treatment plant.
- **Output:** 10% of input results in biochar that is 70% carbon and recyclable.

Results: The Aries Clean Energy downdraft gasification system yields waste, energy, and emissions benefits for Lebanon, Tennessee:

- **Waste:** More than 16 million pounds diverted from landfills each year
- **Energy:** More than 36 MW-hrs generated over the 20 year life of the project
- **Emissions:** More than 5,000 pounds of carbon emissions averted annually
Section 9. Statement of Benefits

Parallel Products appreciates the opportunity to submit this RFEI to the Cities of New Bedford, Brockton, and Fall River. If selected in the final RFP, it offers the following benefits—

- Parallel brings a wealth of experience in deploying innovative renewable and environmentally friendly technologies, chemical engineering process operations, patient capital and strong investor support from TCR.

- An innovative environmentally friendly patented process that includes dewatering, drying, gasification, and energy recovery that is unique, proven, cost effective and reduces environmental liability of residual byproducts. Parallel is partnering with Ares Clean Energy in the deployment and operation of this technology.

- Logistics – Parallel believes that construction of the biosolids facility on its 100 Duchaine Boulevard site offers unique logistical advantages as it is centrally located to all three Cities and has easy access from I-140 directly into the New Bedford Industrial Park without having to drive through residential or commercial neighborhoods. In addition, the presence of a rail spur on site provides special advantages to the disposal of non-leachable ash left over after gasification either in local or out of state landfills.

- Location – The biosolids facility location in the Parallel site is in the middle of the industrial park, well over 1500 feet from the nearest residential or other non-industrial neighbor.

- Operations – The biosolids facility will be in a Parallel Products location that will also house recycling, MSW operations, and solar power generation. This provides an opportunity to optimize and leverage the infrastructure in a number of ways, for instance if Parallel wants to convert the thermal energy to electricity in the long run, it can use the existing utility infrastructure to do so.

- Environmental – The gasification and subsequent conversion to thermal energy in lieu of natural gas, in conjunction with the future potential to convert to electricity, provides New Bedford and other local municipalities with an environmentally friendly option that will be sustainable for the long term. Also, the disposal of non-leachable ash does not pose any environmental threats to soil and can easily be disposed of in landfills, potentially as alternative daily cover.

- Economics – Parallel is confident that it can offer competitive costs to New Bedford, Brockton, and Fall River.

- Plant reliability – Parallel is planning to design the facility with buffer tankage, multiple units (dewatering, drying) to avoid unplanned shutdowns of the entire facility. In the...
unlikely event that the gasification process experiences an interruption, the plant will continue to process incoming slurry and wet cake to Class A biosolids and thereby prevent the WWTPs from facing a service disruption. This level of redundancy will eliminate the instances when Parallel has to rely on outside partners to dispose of incoming materials.

- Permitting — Parallel is in the midst of applying for a permit to process biosolids at its location. The company intends to pursue its permitting process in tandem with the New Bedford RFP so that it can be operational as early as the second half of 2020 pending approvals of its permit applications.

In summary, Parallel Products offers a reliable, environmentally friendly, cost-effective, long-term sustainable solution to biosolids management to the cities of New Bedford, Fall River, and Brockton, that it can implement quickly if chosen in the final bidding process.
Attachment D - Process Flow and Mass Balance

Liquid Sludge
430 T/day
30 Dry T/day
7% Solids

Dewatered Cake
100 T
20 DT
20% Solids

Recycled Thermal Energy

Dewatering
150 T
30 DT
Dewatered Biosolids

Drying
206 T or
~55,000 gal
Water

Gasification
44.4 T
40 DT
Dried Biosolids

Syngas
8 T
Ash

Thermal Oxidizer

Emissions Control
Exhaust

All values on a per-day basis.

DT = Dry tons
T = Total tons
Request for Expression of Interest (RFEI)

City of New Bedford, Massachusetts

Permit, Design, Build, Finance, Own, Operate and Maintain

Organics to Energy Sludge Processing Facility

Solicitation Number – 19192009

July 12, 2018

Submital By:
Denali Water Solutions, LLC
Cambi Inc.
Southland Holdings
July 12, 2018

Ms. Susan Bruce  
Director of Purchasing  
City of New Bedford  
133 William Street  
New Bedford, MA 02740

RE: Request for Expression of Interest to Design Build, Finance, Own, Operate, Maintain and Market Product from An Organics-to-Energy Sludge Processing Facility

Dear Ms. Bruce:

I am pleased to provide our Request for Expression of Interest (RFEI) to the City of New Bedford, Massachusetts ("New Bedford" or "The City") for the Design, Build, Finance, Own, Operate, Maintain and Market Product from An Organics-to-Energy Sludge Processing Facility from the Team comprised of Denali Water Solutions, LLC (Denali), Cambi Inc. (Cambi) and Southland Holdings (Southland). Together the companies intend to form a Joint Venture Partnership to develop the project under the name New Bedford JV.

Our Team is comprised of industry leaders in their respective fields and together will provide for a state of the art Biosolids-to-Energy project utilizing best in class engineering, technology, construction, operations and maintenance and product distribution services. Joining our team will be the Ardurra Group and GHD Engineers to provide planning, permitting and engineering services.

Additionally, GI Energy and Quasar Energy will provide equipment, systems and process design support.

Denali is the second largest manager of municipal biosolids in the United States. Denali provides biosolids, organics and residual waste management solutions as well as a variety of goods and services to the municipal, agricultural, and environmental industry. Services include contract operations of municipal biosolids facilities, merchant processing of municipal waste, contract management of biosolids and organic waste, technology supply, and project development, distribution, marketing and beneficial use of recycled biosolids as fertilizer, compost and soil amendments. Denali is an industry leader in the conversion and manufacturing of Class A biosolids products and has developed an extensive network of customers in the agricultural and reclamation markets.

Cambi is the leading provider for the Thermal Hydrolysis Process (THP) for Class A biosolids disinfection in the world. THP is a high-pressure steam pretreatment for anaerobic digestion of municipal bio-waste. Founded in Norway in 1989, Cambi is a privately held company that has been involved in the development of environmental technology and is known as the world leader in THP. Cambi is a leading provider of technology to convert biodegradable material to renewable energy as demonstrated by its presence in the global market.
Southland through its wholly owned construction company Oscar Renda Contracting Inc. will provide construction services for the New Bedford JV. Southland was established in 1929 and combines the strength of five companies to create a multi-faceted Heavy and Civil Engineering Construction Firm. Today, Southland is managed by industry leaders who are the next generation of our founders. They continue to show dedication and innovation in bettering the lives of millions through building critical infrastructure projects.

Southland is one of the largest and most profitable Heavy and Civil Engineering Construction Firms in the world. We are active in 46 U.S. States and 9 Countries including two Canadian Provinces. We have successfully executed 4000+ projects, $34 billion dollars in total revenue and have grown to more than 2,500 dedicated full-time employees.

Our team has the experience, proven track record, financial strength and vision to make this project a reality. Our team can provide any additional information requested and is happy to answer any questions you may have. Additionally we invite you to visit any of our project references.

I would like to thank you for reviewing the contents of our RFEI submittal. Should you need additional clarification please contact Tom Bintz at 832-687-2299 (c) or Thomas.bintz@cambi.com or me, Michael Nicholson at 419-349-5402 (c) or email at michael.nicholson@denaliwater.com. Again, thank you for the opportunity to submit our submittal and we look forward to the next steps.

Thank you.

Very truly yours,

Michael Nicholson
Senior Vice President Development
Denali Water Solutions, LLC
New Bedford JV

Cc. Jeffrey J. LeBlanc, President, Denali Water Solutions
    Tom Bintz, Senior Vice President, Cambi Inc.
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Executive summary

The Background

The City of New Bedford (“City”) owns a secondary WWTP, located at 1000 Rodney French Boulevard, which treats an average of 21 million gallons per day (mgd) of sewage and in calendar year 2017 produced approximately 7,132 dry tons total of sludge. Currently, sludge is thickened and pumped into tanker trucks before being sent for final disposal at a privately-operated (Synagro) incinerator facility in Rhode Island. Costs for sludge management in 2017 were approximately $2,600,000 or $444.38 per dry ton, including transportation from the plant. The City’s current sludge disposal contract is expiring. The question now facing the City is there an opportunity to have a third-party design, build, own and operate an Organics-to-Energy to provide a more attractive option. The City will provide, under long-term lease, a site for Organics-to-Energy Facility to be located adjacent to the DPI Facility at 1103 Shawmut. In addition, the City has been in discussion with the Cities of Fall River and Brockton, whose WWTPs will, in principle, also commit 100-percent of their sludge and is open to allowing other organics to be imported.

The Project Team

The New Bedford JV is comprised of team members who are leaders in their field of expertise and together will deliver a design, build, own and operate project in cooperation with the City of New Bedford utilizing the site as provided by the City. The Team members include:

- Denali Water Solutions, LLC – Operations, Financing, Bonding
- Cambi Inc. - Technology Provider
- Southland Holdings – Construction Contractor, Construction Bonding

Supporting the JV will be:

- Ardura Group – Facility and Process Engineering
- GHD – Permitting
- GI Energy – Equipment Supply and Design
- Quasar Energy Group – Equipment supply and Design

The Project Proposal

The Team proposes to Design, Build, Own and Operate a biosolids renewable energy platform with beneficial use by utilizing the Cambi THP technology, followed by digestion, gas production, combined heat and power, nutrient management, biosolids drying and the distribution and marketing of Class A Exceptional Quality products.

Conceptually the facility will have the maximum capacity to process 84/Dt/Day of biosolids with an average operating capacity of 70/Dt/Day.

The facility will produce:

- **Biogas:** 656/CFM 62% Methane approximately
- **Pipeline Gas** 217,000 Decatherm’s pipeline gas approximately
- **Electricity** 1.5 MWe to meet the estimated needs of the plant
- **Soil/Compost** 22,238 tons 60% solids
Anticipated Project Benefits
We will provide an Organics to Energy Facility in which the Team will Design, Build, Own and Operate, providing the City an opportunity to innovate and develop a sustainable organics program at a reduced cost with the following attributes:

- 100% Renewable Extraction-Energy, Nutrient Soil and Clean Water
- Facility that generates more energy than its parasitic load, thus minimizing any risk associated with future power cost to operate the facility
- Stable predictable pricing over contract period
- No Negative Impact on Neighbors
- Exceptional Quality End Product with no offensive odors or regrowth of bacteria
- Product Marketing plan to deliver secure product movement
- Lowest GHG footprint of any proven biosolids technology
- Significant revenue sharing on power generation (CNG-RINs, Electric Power Generation Revenues)
- Royalty on Merchant Volumes
- Proven Technology and Team to execute the project

Our team believes we have developed an optimal solution to achieve the regulatory requirements for the project and maximize the economic benefit to the City in a complete biosolids treatment project.

We trust that our history of successful projects, innovative conceptual technical solutions, and ability to own the risk of the solution will allow our Team to progress to receive an RFP and partner with City to develop a world-class sustainable biosolids solution that exceeds the initial goals set by the City.
1 General Description of Contractor

As this project encompasses planning, design, construction, commissioning, operations, and financing, we have assembled a team that essentially puts the right asset in the right location to seamlessly manage the risk of each piece of work. The New Bedford JV includes a Joint Venture between Denali Water Solutions, LLC, Cambi Inc., and Southland Holdings ("JV Partners") with Technology provided by Cambi, GI Energy and quasar energy group, Engineering Services to be provided by the Ardurra Group and permitting services provided by GHD (collectively the "Team").

- **The Proposer:** New Bedford JV is the proposer and is comprised of the following team members; Denali Water Solutions, LLC, Cambi, Inc, and Southland Holdings. The Team will provide the scope of service envisioned, including design-build, operation and maintenance of the facility and management of the Class A product, financing and bonding.

- **Proposer Contacts:**

  Tom Bintz, Senior Vice President
  Cambi, Inc.
  279 Great Valley Parkway Malvern 19356
  Thomas.bintz@cambi.com
  832-687-2299 (c)
  855-800-8441 (f)

  Michael Nicholson, Senior Vice President Development
  Denali Water Solutions, LLC
  3308 Bernice Ave, Russellville AR 72802
  Michael.nicholson@denaliwater.com
  419-349-5402 (c)
  479-498-0500 (o)

- **The Project Guarantor:** The New Bedford JV through the parent companies of the JV partners will provide the required guarantees including the bonding requirements for the construction and operations for the project.

- **Facility and Process Design Engineer:** Ardurra Group

- **Permitting Engineer:** GHD

- **Construction Contractor:** Southland Holdings

- **The Technology Providers:** Cambi, GI Energy and quasar energy group will provide the core technology.
- **The Operator:** New Bedford JV
- **Product Marketing:** New Bedford JV
- **The Financer:** Denali Water Solutions and/or Southland Holdings
Reference Projects

**Project 1: Cambi THP Digestion**
**DC Water, Washington, DC**

Cambi served as the subcontractor providing a turnkey supply of the Cambi THP Digestion process, including the following key elements:

- 4 lines of Cambi B-12.
- 4 Pulper
- 24 Reactors
- 4 Flash tank
- 4 Flash Tank Pump
- Sludge coolers
- Odor Control

**Applicability to the City:**
- Large Facility 400DT/Day Capacity
- US Installation
- Cambi advanced THP Technology
- Green Energy Produced 14MW
- Class AA Cake marketed to local farmers
- Reduction of Carbon Footprint

**Owner Name** Chris Peot, Biosolids Manager, DC Water

**Address** 5000 Overlook Avenue, SW, Washington, DC 20032

**Phone** 202.787.4329

**Email** cpeot@dewater.com

**Role of Team Members** Cambi was responsible for design, construction and transition of the facility;

**Plant Size** 400DT/Day

**Feedstocks** Primary and Secondary Sludge

**Products** 65% Air-dry Soil, 33% Soil Product, 14MWe

**Type of Arrangement** DB

**Term of Agreement** Two-year agreement that was extended for an additional 6 months to aid in transition

**Capital Costs** $37M

**O&M Costs Savings:** ~$15M per year

**Type of Financing** Financed by municipality

**Project Status** Contract started in 2013 and completed in 2015
Project 2: Thames Water Chertsey, England

The Cambi THP plant at Chertsey, just west of London, England was built in 1988 and is owned by Thames Water. It was designed to treat 8,000 tons of dry solids annually, which has produced at Chertsey, Leatherhead, Esher and other wastewater treatment plants.

Cambi designed and built the THP facility in 1996, which nearly tripled the digester capacity. Cambi subsequently designed, built and financed an upgrade of the facility and in 2004, Cambi signed an operations contract with Thames Water to operate the THP plant for seven years with an option to extend for an additional three-year period. The plant has been operating successfully since September 2005.

The Cambi THP Digestion process included the following key elements:
- 1 lines of Cambi B-12
- 1 Pulper
- 2 Reactors
- 1 Flash tank
- 1 Flash Tank Pump
- Sludge coolers
- Odor Control

This project's relevance to the City include:
- Successfully operating for 18 years
- Cambi advanced THP Technology
- Operations and Maintenance Contract
- Class AA Cake marketed to local farmers
- No Odor Issues
- Client has built 6 other facilities since this project started and is still purchasing Cambi THP technology

Owner Name  Paul Fountain, Senior Process Expert Biosolids, Thames Water Utilities
Address  Clearwater Court-4th East, Reading, Berks RG1*DB
Phone  +07747 645-430
Email  Paul.Fountain@ThamesWater.co.uk

Role of Team Members  Cambi was responsible for design, construction of the original project and design, construction and financing of the upgrade while also taking over operations:

Plant Size  30,000 WT
Feedstocks  Primary and Secondary Sludge and Imported Biosolids
Products  31% Ag Soil, 333MWe
Type of Arrangement  DBFO
Terms of Agreement  Contract expired 2016
Capital Costs  $3M
O&M Costs  $66K/MTH in 2016
Type of Financing  Initial project financed by Thames Water; upgrade financed by Cambi

Project Status  Project started in 1996; operations contract 2004-2016
Project 3: ECOPRO, Verdal, Norway

On 20 June 2006 the Ecopro AS Board signed the main contract with Cambi AS for the delivery of a complete “Turn-Key” bio-waste sterilization and biogas plant in Verdal, Norway. The biogas plant was designed, built and operated by Cambi for 2 years and then transferred to Ecopro for operation.

Owner Name Tore Floan, Managing Director, Ecopro, AS
Address Ravlovegen 324, Skjordalen, 7650 Verdal
Phone +47 74 07 65 90
Email post@ecopro.no
Role of Team Members Cambi was responsible for design, construction and transfer after 3 years of operating the facility
Project Size 30,000 WT
Feedstock Imported Biosolids, FOG and Food-waste
Products 31% AG Soil, 1.56MWe
Type of Arrangement DBOT
Term of Agreement 2 years +1
Capital Costs $20.2 Mil
Type of Financing Financed by Ecopro
Project Status Operation started in 2008 and were transferred 2011

- 1 Flash tank
- 1 Flash Tank Pump
- Sludge coolers
- Odor Control
- CHP and related gas cleanup
- Food Waste Cleaning

The plant uses Cambi’s patented Thermal Hydrolysis Process and other innovative processes to secure a safe and efficient treatment. The plant treats both solid and liquid waste totaling 30,000 tonnes/year. The feedstock currently being treated includes source separated household waste (food waste), organic industrial waste (food processing industries), sewage sludge, fish waste and animal by-products category II and III (slaughterhouse waste).

The produced biogas generated, and landfill gas is converted into electricity through gas engines. The produced pathogen-free bio-fertilizer is nutritious and a well-suited product for the agricultural sector. The required manning to run the plant is based on 5 persons (normal working hours). The process is designed to be in operation 365 days per year.

The plant is among the most advanced plants in the world in treating sewage sludge and bio-waste and was based on experience from Cambi’s sewage sludge projects and on its bio-waste plant, “Mjøsanlegget”, in Lillehammer, Norway.

The Cambi THP digestion process included the following key elements:
- 1 lines of Cambi B-12.
- 1 Pulper
- 2 Reactors
This project's direct relevance to the City's project include:

- Co-digestion Facility
- Cambi advanced THP Technology
- Green Energy Produced
- Class AA Cake marketed to local farmer
- Reduction of Carbon Footprint
- Design, Build Own and Transfer
### Other New Bedford JV Team Project References

Projects over the last 10 years. The required Reference Projects most like those proposed are included in Section 1 and 8 of this RFEI.

<table>
<thead>
<tr>
<th>Project</th>
<th>Company</th>
<th>Type</th>
<th>Organic</th>
<th>Service</th>
<th>Capacity Tons/Annual</th>
<th>Contract Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC Water</td>
<td>Cambi</td>
<td>DB</td>
<td>Biosolids</td>
<td>Advanced Digester</td>
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<td>Cambi</td>
<td>DBOT</td>
<td>Biosolids, Food</td>
<td>Advanced Digester</td>
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<td>NYC Dept. of Sanitation</td>
<td>Donnel</td>
<td>O</td>
<td>Yard Waste</td>
<td>Composting</td>
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<td>NYC Dept. of Sanitation SSO Contract</td>
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<td>DBOD</td>
<td>Food Waste</td>
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<td>DRCO</td>
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<td>Composting</td>
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<td>DRDCO</td>
<td>Biosolids</td>
<td>Composting</td>
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<td>Donnel</td>
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<td>Land Application</td>
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<td>City of Los Angeles, CA</td>
<td>Donnel</td>
<td>O</td>
<td>Biosolids</td>
<td>Heal and Manage</td>
<td>75,000 T/yr</td>
<td>$9.6 M/yr</td>
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<td>City of San Diego, CA</td>
<td>Donnel</td>
<td>O</td>
<td>Biosolids</td>
<td>Heal and Manage</td>
<td>120,000 T/yr</td>
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<td>City of Fort Worth, TX</td>
<td>Southland</td>
<td>DB</td>
<td>WWTP</td>
<td>Expansion</td>
<td>35 MGD</td>
<td>$51 M</td>
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<tr>
<td>City of Dallas, TX</td>
<td>Southland</td>
<td>DB</td>
<td>WTP</td>
<td>Expansion</td>
<td>540 MGD</td>
<td>$197 M</td>
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<td>City of Dallas, TX</td>
<td>Southland</td>
<td>DB</td>
<td>WTP</td>
<td>Pump Station</td>
<td>189 MGD</td>
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<td>DC Water</td>
<td>Arurda* (Geometry)</td>
<td>DB</td>
<td>Biosolids</td>
<td>Advanced Digester</td>
<td>145,000 T/yr</td>
<td>$51 M</td>
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<td>League City Southwest WWTP TX</td>
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<td>DCMAR</td>
<td>Biosolids</td>
<td>Centrifuge Dewatering</td>
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<td>DBR</td>
<td>Biosolids</td>
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<td>Savannah Street WWTP Storm Cell Rehabilitation, Jackson, MS</td>
<td>Arurda*</td>
<td>DBB</td>
<td>Biosolids</td>
<td>Belt Press</td>
<td>1,600 T/yr</td>
<td>$9 M</td>
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<td>Pearlmand John Hargrove Water Reclamation Facility</td>
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<td>DBB</td>
<td>Biosolids</td>
<td>Centrifuge Dewatering and Belt Filter Press</td>
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<td>Pellezzi Water Plant, Pinellas County, FL</td>
<td>Arurda</td>
<td>DB</td>
<td>Biosolids</td>
<td>Regional Drying Facility</td>
<td>1,883 T/yr</td>
<td>$5.2 M</td>
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<tr>
<td>South Cross River Southweight Facility Sludge Thickening &amp; Miscellaneous Improvements, Pinellas County, FL</td>
<td>Arurda</td>
<td>DB</td>
<td>Biosolids</td>
<td>Rotary Drum Thickeners</td>
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<td>Pellezzi-Manatee County, FL</td>
<td>Arurda</td>
<td>DB</td>
<td>Biosolids</td>
<td>Regional Drying Facility, Regenerative Thermal Oxidizer</td>
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<td>Biosolids Recycling Center Philadelphia, PA</td>
<td>Arurda</td>
<td>DRCO</td>
<td>Biosolids</td>
<td>Regional Drying Facility, Regenerative Thermal Oxidizer</td>
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<td>Cleveland, OH</td>
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<td>DBQ</td>
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<td>Wooster, OH</td>
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<td>DBT</td>
<td>Biosolids, Food Waste</td>
<td>AD to Electricity</td>
<td>100,000 T/yr</td>
<td>$7 M</td>
</tr>
</tbody>
</table>
2 History, Expertise and Experience of Lead Company

The New Bedford JV partners are committed to working together and are forming a company to deliver Biosolids management programs using Cambi’s proprietary Thermal Hydrolysis Process (“THP”) that provides municipalities sustainable solutions, harvesting the full potential of residuals including; maximizing energy value and providing environmentally friendly recyclable products throughout the United States and Canada. In addition, Ardurra will be a strategic partner providing engineering support. These established relationships will offer staff cohesiveness and a collaborative culture that will extend into the New Bedford project. Our hands-on experience encompasses biosolids design, construction, commissioning, facility operations, and maintenance and product distribution services.

Our project portfolio includes an unmatched number of innovative technical solutions as well as progressive DB, DBO, DBOO assignments for wastewater plants. Coupled with our experience in delivering some of the world’s most complex infrastructure projects, we offer significant insights into how to successfully deliver large scale, capital projects on an aggressive schedule that yield award-winning, world-class facilities.

Our Core Project Team includes:

**Denali Water Solutions, LLC (Denali)**
Michael Nicholson, Senior Vice President Development  
3308 Bernice Ave  
Russellville, AR 72802  
Corporate Phone – 479-498-0500  
Cell- 419-349-5402  
Email- Michael.nicholson@denaliwater.com

Denali is a Limited Liability Company headquartered in Russellville, Arkansas and is a leading national biosolids management company, with over 1 million tons of biosolids managed annually. Denali provides biosolids, organics and residual waste management solutions as well as a variety of good and services to the municipal, agricultural and environmental industry. Services include contract operations of municipal biosolids facilities, merchant processing and disposal of municipal waste, contract management of biosolids and organic waste, technology supply and project development, distribution, marketing and beneficial use of recycled biosolids as fertilizer, compost and soil amendments. Denali is an industry leader in the conversion and manufacturing of Class A biosolids products and has developed an extensive network of customers in the agricultural, horticultural, turf and soil industries. Denali products are recognized under the trade names WeCare Compost® and WeCare Ag-Advantage™.

Denali provides operations, maintenance services and product distribution services for organics processing facilities. Organics Facilities are operated and maintained in accordance with good management practices and all state and federal laws and regulations.
All process control, routine preventative and corrective maintenance, sampling and analysis, product marketing, reporting and record keeping, and housekeeping are provided as needed to meet the conditions of the operating contract, permits and other regulatory requirements.

Technical support is provided from Denali’s Corporate office in cooperation with key equipment vendors to ensure that the managers, electricians, maintenance personnel and operators are properly trained in their perspective duties including, equipment operation and maintenance, chemical and materials handling, safe work practices, use of personal protective equipment, use of air monitoring equipment, etc. It is mandatory that all employees undergo extensive training for operational and safety procedures. Denali maintains an office in East Hampton, Massachusetts.

Cambi Inc. (Cambi)
Thomas Bintz, Senior Vice President
279 Great Valley Parkway Malvern 19355
Thomas.bintz@cambi.com
832-687-2299 (c)
855-800-8441 (f)

The “cornerstone” technology envisioned for the New Bedford Project is the Cambi Thermal Hydrolysis Process (THP). THP is a high-pressure steam pretreatment for anaerobic digestion of municipal bio-waste. Founded in Norway in 1989, Cambi is a privately held company that has been involved in the development of environmental technology and is known as the world leader in THP. Cambi is a leading provider of technology to convert biodegradable material to renewable energy as demonstrated by its presence in the global market.

Cambi’s THP system is a proven and reliable technology that, since 1995, has been installed in 49 plants worldwide processing over 1 million dry tons; the oldest plant has been successfully operating for over 20 years without incident. The process disintegrates cell structure/organic materials and dissolves naturally occurring cell polymers (exo-polymeric substances or EPS), a form of protein, into an easily digestible feed for anaerobic digestion. The first US installation of the Cambi THP system is at the 370-MGD Blue Plains advanced wastewater treatment plant operated by DC Water.

Through THP, the New Bedford Project will see the following benefits:

- Significantly lower cost
- Increased biogas production with 30% increase in gas production over standard mesophilic digestion
- Pathogen-free and stabilized end product with increased cake dewaterability, requiring significantly less energy and equipment to generate a Class A exceptional quality dried product.
- Besides optimizing energy efficiency and lowering operating costs, THP also eliminates odor problems associated with the treatment of organic materials.
The Cambi Thermal Hydrolysis Process meets the USEPA’s 40 CFR Part 503 regulations pathogen destruction requirements for time and temperature criteria to achieve Class A pathogen reduction under Alternative 1 and when combined with AD will meet Vector Attraction Reduction Requirements (VAR) for volatile solids reduction to meet Exceptional Quality (EQ) standards.

In addition to being the technology provider, Cambi will be part of the New Bedford JV providing support for the design, construction and operations of the facility.

The following map and chart demonstrates the breadth of locations worldwide that have embraced Cambi’s THP process based on the significant cost savings and other benefits.

Southland Holdings and Oscar Renda Contracting Inc. (Southland)
Southland Holdings “Southland” through its wholly owned construction company Oscar Renda Contracting Inc., will provide construction services for the New Bedford JV. Southland was established in 1929 and combines the strength of five companies to create a multi-faceted Heavy and Civil Engineering Construction Firm. Today, Southland is managed by industry leaders who are the next generation of our founders. They continue to show dedication and innovation in bettering the lives of millions through building critical infrastructure projects.
Southland is one of the largest and most profitable Heavy and Civil Engineering Construction Firms in the world. We are active in 46 U.S. States and 9 Countries including two Canadian Provinces. We have successfully executed 4000+ projects, $34 billion dollars in total revenue and have grown to more than 2,500 dedicated full-time employees.

We have expanded our market presence geographically to be prime choice to our partners and clients around the globe. Our commitment to each project guarantees we have the planning, organization and execution skills necessary to complete any project on time and on budget.

Since 1974, Oscar Renda Contracting, Inc. (ORC) is a proven contractor for safety, value engineering, and performance. With over 44 years of diverse water and wastewater construction experience we have built a team of industry leading professionals that offer our clients efficiency, enthusiasm and a “can do” “get the job done” attitude. This mindset consistently brings our projects in on time and within budget. It is our philosophy to work closely with our clients to establish a dynamic Project Team to solve unique challenges faced by pipeline projects.

Oscar Renda Contracting, Inc. became part of the Southland Holdings family of companies in 1998. Southland Holdings is privately held company by principals Frank Renda, Rudy Renda and Tim Winn.

Ardurra Group

Ardurra Group, LLC (Ardurra) will draw upon its extensive experience with innovative wastewater treatment, biosolids and energy management strategies throughout the United States to support this effort. Ardurra’s professionals have been instrumental in the development, design and implementation of cutting-edge, first-of-its-kind wastewater and biosolids projects across the United States. Specifically, Ardurra’s Dan Gerrity served as Principal-In-Charge for DC Water’s thermal hydrolysis pretreatment (THP) Cambi project.

Ardurra has established itself as a leader in facilitating development of large public infrastructure programs using a range of innovative delivery methods, including: DB, DBO, DBOO, DBOT, PPP and CMAR with staff that have led some of the largest capital projects, including wastewater treatment and biosolids management projects in New York, Texas, Louisiana and Florida.
GHD

GHD has extensive experience with assisting clients through the Massachusetts Environmental Policy Act (MEPA) review process. Nearly all our large wastewater and biosolids projects have met MEPA thresholds for "large and complicated" projects and required a multi-phase review in accordance with MEPA guidelines. These have included completion of an Environmental Notification Form (ENF) and mandatory Environmental Impact Report (EIR). Within the past 10 years, these projects have included the following wastewater collection and treatment facilities in:

Town of Barnstable, MA
Town of Chatham, MA
Town of Falmouth, MA
Town of Mashpee, MA
Town of Oak Bluffs, MA (currently active)

GHD has previously assisted Denali with preparation and issuance of a Recycling, Composting, and Conversion (RCC) Permit that was not subject to Site Assignment requirements or MEPA. This permit process is applicable to organics processing facilities, including anaerobic digestion facilities, for sludge and source separated organics pending a pre-application review with the MassDEP. With a local office in Hyannis MA, GHD has direct access and existing relationships with representatives of MassDEP in the Lakeville MA Office (Southeast Region) and Boston Office."

GI Energy

In addition, we have added an Energy Provider to the project to insure we extract the maximum value of the gas as well as meet the current and future needs of the facility park for heat/cooling and power.

GI Energy specializes in providing consulting, development, engineering, management, construction and advisory services to building owners and property developers with a specific focus on energy efficiency and distributed energy resources (DER). GI Energy helps customers utilize advanced technologies to hedge against high/volatile energy prices, improve energy reliability and reduce environmental impacts and greenhouse gas emissions, all while increasing the value of the underlying real estate asset. The firm maintains offices in New York, Illinois and California, and leverages the expertise of seasoned energy and financial analysts, engineers, project development professionals and operations and maintenance technicians.

They have specific expertise in designing, constructing, interconnecting, and maintaining medium- to large-scale cogeneration plants (1 to 10 MW).
The GI Energy team has decades of combined experience in all aspects of cogeneration development including engineering, procurement, and construction (EPC) services, managing incentive application processes and coordinating with utilities to develop technical solutions to resolve unique interconnection challenges. The GI Energy team has been responsible for a number of "firsts" in the cogeneration market, including the first-ever parallel electric interconnections of a cogeneration system in New York City and San Francisco, and the first-ever parallel steam interconnection with Con Edison’s district steam system in New York City. We also maintain a talented team of analysts skilled at developing CHP dispatch strategies optimized for overall efficiency, energy cost savings, or other site-specific or owner-defined parameters.

In January 2018, Shell New Energies US purchased a controlling interest in GI Energy. Shell’s New Energies business was set up in 2016 to build on Shell’s experience in lower-carbon technology, exploring new commercial models in the power sector. As on-site energy infrastructure design, construction and operations specialists, with a track record of highly innovative projects and the creation of new business models, GI Energy supports Shell’s mission in developing and deploying clean energy assets around North America and throughout the world.

**quasar energy group**

quasar energy group ("quasar") is a Cleveland, OH based company specializing in turnkey anaerobic digester systems to sustainably manage biosolids and other organic waste. quasar was originated from a family-owned business with decades of experience managing biosolids and other organic waste streams, primarily through composting and soil blending. In 2006 quasar was founded to focus wholly on providing turn-key anaerobic digestion systems with a US based design, supply chain, and construction. quasar’s in-house engineering, construction, regulatory, and operations teams collaborate throughout project lifecycle to develop a streamlined, cost-effective anaerobic digestion system. Since our founding, quasar has designed and constructed fifteen (15) anaerobic digestion systems that co-digest biosolids with other organic feedstock, recover energy, and create quality product for beneficial reuse. No other firm has designed, installed, and operated more digesters in the US that co-digest biosolids with other organic feedstock such as food waste and fats, oils and grease (FOG).

quasar has significant experience in executing projects in conjunction with municipalities to sustainably manage sludge material while creating renewable energy. Municipal biosolids are the primary feedstock for the majority of quasar’s anaerobic digestion systems. quasar currently manages biosolids for dozens of municipal clients and our facilities have the capacity to manage in excess of 700,000 tons of organic waste annually. In addition, quasar has significant experience in utilizing biogas as a transportation fuel, with multiple facilities registered with the EPA as RIN generators.

quasar will function as a specialty anaerobic digestion and biogas utilization technology and services provider to the New Bedford JV. quasar’s scope will include responsibility for process design, equipment supply, and commissioning/start-up of digestion systems, materials handling, gas conditioning and cleaning.
quasar's operations team and two in-house anaerobic digestion laboratories will support the New Bedford JV and Denali O&M team in optimizing the design and operations of the facility for biological health and consistent, efficient performance.

3 Treatment Technology and Process

Description of Technology and Process
We propose to design, build, own and operate the Cambi THP Digestion System, which includes pre-dewatering, sludge loading, reception area for both low solid and high solids sludge, food waste and FOG treatment. 3 Cambi THP process trains (redundancy), digesters, green energy center and post dewatering and low temperature dryer facility for materials designated for soil manufacturing and land application. Nutrient management will also be included to meet regulatory requirements.

Cambi THP Technology
All Cambi solutions are designed using Cambi's proven patented Thermal Hydrolysis Process (THP). Cambi THP pressurizes and superheats the digested sludge ("Biosolids") with steam and then pressurizes the superheated biosolids. After achieving time and temperature conditions to meet regulatory requirements pressure is quickly released (flashed) to degrade the extracellular polymeric substances (EPS). EPS is a hydrated material consisting primarily of long chain carbohydrates and proteins that form the bulk of biological floc and can bind up to 80% of the water in the biosolids.

The graphic below (Table A) summarizes the key elements of the overall process:

<table>
<thead>
<tr>
<th>RAW SLUDGE</th>
<th>THERMAL HYDROLYSIS</th>
<th>HYDROLYZED SLUDGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Living bacteria</td>
<td>PULPER Preheated to ~97°C</td>
<td>Process gases are cooled and compressed before sent to digesters to be broken down</td>
</tr>
<tr>
<td>Dead bacteria</td>
<td>REACTOR Batch process 165°C / 6 bar, Retention time 20 min.</td>
<td>Homogenized material 14 - 15% DS</td>
</tr>
<tr>
<td>Inert suspended solids (SS)</td>
<td>FLASH TANK Temp 130°C Retention time ~15 h</td>
<td>Steam 11 bar</td>
</tr>
<tr>
<td>EPS</td>
<td></td>
<td>Hydrolyzed material 12 - 13% DS (1.5 - 2 bar)</td>
</tr>
</tbody>
</table>

18
The resulting less viscous (more fluid) sludge results in:
1) More than doubled digester loading, significantly lower the amount of digester capacity needed
2) Increased biogas production (on average 30% increase)
3) Increased VS destruction reducing the amount of end solids
4) Improved dewaterability to over 30%, which in this case creates an end product with greater net energy that current dewatered undigested sludge
5) Pathogen-free and stabilized end product (Class A)

Anaerobic Digestion
Following Cambi THP, the hydrolyzed sludge is cooled and fed into the digesters at a solids content of about 11% solids, over twice the typical digester feed solids content (this is successful because of reduced viscosity of the sludge). This along with a reduced retention time, reduces digestion capacity needs by 75% and minimizing the facility footprint. Specifically, we expect the digestion process to achieve between 62% and 65% Volatile Solids Reduction (VSR), based on performance elsewhere, with similar quality and characteristics of feed sludge. Prior to digestion, the hydrolyzed sludge will be cooled to mesophilic temperature.

Final Dewatering
After digestion, the final dewatering system should achieve over 31% solids cake content on either centrifuges or belt filter presses (BFPs). This performance is based on over 40 operating THP/digestion systems around the world. DC Water’s final dewatering systems (using BFPs) are achieving an average of 31% solids cake. As indicated, this cake product can be used directly in a variety of ways, or further dried to manufacture soil/compost.

Low Temp-Drying
THP Digestion facility will produce an exceptional quality Class A cake that is over 30% solids suitable for composting, soil blending and direct land application. The material is very storable with little odor. Also due to the high temperature treatment there is no regrowth issues. Currently, DC Water is landfill applying 100% of its dewater cake without issue. The current market surrounding New Bedford is seasonal with limited local agriculture, which means the production of a soil product will be essential for distribution and marketing success. Since space is limited it is our intent to a further dry the product utilizing a low temp drier to scalp additional moisture using low temp waste-heat to produce a more marketable 60% soil/compost, that is non-odorous and non-dusty for market distribution. The facility will produce approximately 22,238 tons of material annually at 60% solids. This is an ideal product solids for the utilization of the product as a soil amendment and as a top-soil additive.
Green Energy Center

The Facility is expected to produce enough continuous biogas energy to provide the 2.7 MWe of power and will design to allow for the flexibility of producing renewable natural gas (RNG), electricity and heat.

Currently there are minimal federal tax credits or incentives for CHP; however, cleaned biogas in the form of RNG has significant value when utilized as a transportation fuel to generate Renewable Identification Numbers (RINs) under the Renewable Fuel Standard (RFS). It is planned that the digester gas will be cleaned, compressed, and either utilized on-site by retrofitting the existing ABC Disposal fueling station, constructing a new fueling station, or injected into the nearby pipeline. Significant cost savings and revenue sharing opportunities exist with the City of New Bedford and other partner communities should the municipalities have an interest in converting and fueling municipal vehicles at the CNG station. If federal incentives no longer support the cleanup of biogas, the gas can be re-routed to the CHP to meet all the facility’s needs for power generation and the CNG station can return to being operated on natural gas.

We will however be providing (1) 1.5 MW modern stationary four-stroke AVUS Biogas Engines with lean Mixture Combustion, optimized for high Efficiency; Water-cooled with Exhaust Gas Mixture Turbocharging and Intercooling, or equivalent, providing 1.0MW’s of power to the facility. This equipment will initially run on natural gas but will have the ability to be powered by the digester biogas should the economics for biogas utilization change in the future. The CHP Unit is an Integrated Package with a fully closed Loop Water Circuit Design that offers an efficient and environmentally friendly way of providing heat and electricity simultaneously.

The power island will be equipped with a feed water system including deaerator and condensate system. Noise suppression will be incorporated into the design of the power island by use of sound attenuating equipment enclosures and low noise features. A Selective Catalytic Reduction System (SCR) is added to provide emission reduction for oxides of nitrogen (NOx), and carbon monoxide (CO) to reduce emissions to Massachusetts’s air permit standards.

Nutrient Management

Evaporator

The most reliable, efficient approach to extract nutrients from the high concentration ammonia centrate is through Evaporation. The Evaporator will convert the water component in the centrate to clean vapor that condenses into equally clean water, that can be recycled through the process drastically reducing water needs, and a concentrated nutrient sludge containing nitrogen and phosphorous. This product will either be marketed directly or blended with the soil product. The remaining clean recycled water will be discharged through the sewer system or deliver to the Golf Course next door if the City desires.
Facility Size, Daily and Annual Processing Capacity

Maximum Capacity 84/DT Day
Average Capacity  70/DT/Day

Redundancy

The facility will have three process trains each capable of processing up to 28DT/Day, insuring 100% uptime with no material having to be redirected for maintenance.

Space Required

The amount of land necessary will be minimized because of the nature of Cambi THP digestion process, which requires only 75% of the digestion capacity of traditional digestion. The THP Digestion facility will easy fit on the site designated by the City. A copy of the layout is included below in the Conceptual Site Plan section. A larger copy is included at the end of the document.

Type and Quantity of Waste Materials to be Processed

The facility will accept the following types of sludge:
- Undigested/Digested Biosolids Cake
- Undigested/Digested Biosolids Liquid
- Food-waste and FOG

There is no quantity limitation on the type of sludge, however the facility capacity will be 70 DT/Average and 84 DT/Max excluding FOG.

Type and Quantity of Energy and Material Products to be Produced

Biosolids will be treated through Cambi THP system generating biogas that is used to create green energy, and a >30%, soil that will be further dried to 60% solids and beneficially used as a soil/compost product. These feedstocks will generate revenues through tip fees, energy sales, energy credits and potentially product sales.

<table>
<thead>
<tr>
<th>Biogas:</th>
<th>656/CFM 62% Methane approximately</th>
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</thead>
<tbody>
<tr>
<td>Pipeline Gas</td>
<td>217,000 Decatherm's pipeline gas approximately</td>
</tr>
<tr>
<td>Electricity</td>
<td>1.5 MWe to meet the estimated needs of the plant</td>
</tr>
<tr>
<td>Soil/Compost</td>
<td>22,238 tons 60% solids</td>
</tr>
</tbody>
</table>
Odor, Noise and Other Environmental controls, Air emissions, Wastewater Discharge

**Odor**
The advance digestion system proposed will not increase the current odor profile. The pre-digestion and digestion system is self-contained with limited air emission at the sludge hopper. The sludge hopper will be hocked up to an odor control system.

Cambi’s odor management philosophy for high intensity odors from the hydrolysis process is:

- Contain it
- Do not dilute it
- Treat it continuously
- Duty / standby (assist) system, particularly on rotating equipment

To avoid leakage in any part of the system, the following precautions are taken:

- The vessels are 100% leak proof pressure vessels (certified pressure vessels)
- All valves in the process gas system are leakage proof
- All connections are flanged

The odor compounds from the hydrolysis process consist mainly of mercaptans, amines and H2S. All flash steam from the process ends in the pulper. To secure the outlet of the non-condensable gases, a controlled flow is released from this vessel. The gases released from the pulper first pass a water-cooled process gas cooler. All condensed liquid is fed back into the pulper. The process gases are then decomposed biologically, either in the digester or in aeration lanes in the wastewater treatment plant. If required, the gases may be compressed to the necessary pressure, for example by using closed circuit ejectors.

The Biosolids receiving areas will be odor controlled and the holding tanks will be connected to the same odor control system.

Odor further down the system as the product coming from the digester to post-dewatering will be a Class A Biosolid with 99.99 percent pathogen kill and have significant vector reduction and minimal odor.

**Noise**
The system proposed does not produce significant noise. The pre-digestion and digestion systems are operated using electric pumps that do not generate significant noise. Any additional dewatering will be performed using centrifuges or belt presses that will be located in a building. This configuration should not increase noise levels greater than the current system.
**Air Emissions**

Our plan will reduce the City overall air emission footprint for biosolids disposal. The plan will eliminate the City's need to haul and incinerate its sludge by building a THP digestion Facility at its Solid Waste Transfer Station for biosolids that significantly reduces the amount of methane released into the atmosphere. In addition, transportation miles will be significantly reduced further improving air quality.

The facility will include the generation 1.5 MWe electric power through CHP with an electric efficiency of over 38%, This will meet the energy needs of the plant excess power or additional power can be wheeled to the City if economic.

When designing the CHP process a SCR – Selective Catalytic Reduction System will be added to provide Emission Reduction for Oxides of Nitrogen (NOx), and Carbon Monoxide (CO) to reduce emissions to Massachusetts Air Permit standards.

The facility will be accepting increased volumes that will require additional trucking generating new emissions. In addition, the movement of the final product will require trucking. This impact will be minimized through backhauling.

**Waste Water Discharge**

As addressed in Nutrient Management section above, the centrate will be processed through an evaporator. This process will generate clean water that will be recycled, and nutrient slurry that will be marketed or blended with the soil product produced by the process. The remaining clean water will be discharged through the sewer system or provided to the golf course upon request of the City.

**Traffic**

There will be additional traffic to import outside materials to be treated. The importing of outside feedstocks will increase both trucks entering the facility with material to digest and leaving the facility with Exceptional Quality Class A soils. The Cambi process will minimize the loads by accepting high solids material and providing the highest rate of volatile solids destruction and further drying the material, based upon the estimated feedstocks there will be approximately 12 inbound liquid trucks, 12 inbound solids trucks and 3 outbound final product trucks a day. Best efforts will be made to backhaul material reducing outbound traffic.
Schematic Diagram to Describe Flow of Material and Individual Components of the Process

Below you will find the Process Flow Diagram for the Proposed Facility.
Conceptual Site Plan

The Conceptual Site Plan identifies the key components of the proposed facilities and demonstrates the ability to place the facilities on the site provided. The entrance road and turn around are acceptable for the largest vehicles we anticipate utilizing.

Plan to meet Discharge Requirements

An evaporator will be installed to extract phosphorous and Nitrogen from the centrate and generate a solid to be blended with the soil or sold separately depending on economics. The other end product is clean water that will be recycled to its full extent with the remainder being discharged through the sewer system. We will also look at working with the Golf Course to determine their potential need for recycled water.
Market Plan and Marketability of Products

Electricity

All Electricity will be used internally on-site or wheeled to New Bedford WWTP if economic.

Pipeline Gas

Or Renewable Natural Gas (RNG), cleaned and compressed from the digesters, can be utilized either on-site with upgrades to the existing CNG station, or will be injected into the system and sold as transportation fuel depending on the local fleet demand, interconnection costs, and final economics. We will then generate a pathway with our energy partners to produce D3 RINs, which can be monetized to add significant value to the biogas.

New Bedford JV and its Energy partner Gl Energy (parent Shell New Energies US) will work with Shell Trading and Supply to maximize energy value. Shell Trading and Supply is one of the largest energy trading operations in the world. This global organization combines our network of trading companies, industry-leading shipping and maritime capabilities and an integrated network of supply and distribution activities, to act as the central nervous system for Shell. Our trading capability, deep market knowledge, global portfolio and end-to-end integration within Shell effectively creates opportunities to deliver value for our customers and for Shell across its Upstream, Downstream and Integrated Gas businesses. Our main offices are in London, Houston, Singapore, Dubai and Rotterdam, where we trade crude oil, natural gas, LNG, electrical power, refined products, chemical feedstocks and environmental products. We have the experience and international scope to capitalize on trading opportunities inherent in Shell’s asset and market positions around the world to deliver sustained and growing cash returns.

Within the Shell Trading and Supply organization sits Shell Energy, the unit that manages natural gas, power, renewables and CO2 trading and marketing and employs more than 500 staff across the Americas, Europe, Asia and Australia.

Soils/Compost

Denali will provide for the overall management of the Class A, Exceptional Quality biosolids product produced from the Facility. WeCare Organics, a wholly owned subsidiary of Denali, will manage the distribution and sales of the product. Our plan will be to utilize the product as a soil amendment and topsoil additive. We are confident that all the material produced will be highly desired in the southeastern MA market place. Our plan will include adequate storage for the product both on site and within the distribution network.

Denali’s management team has 20 years of experience in the development and implementation of organics processing technologies and the production of organics derived products. The wide range of organics processed through the years, as well as the company’s constant focus on the development of technologies and management practices are key factors that have enabled Denali to develop highly efficient operations that will guarantee the quality and marketability of the end product. Denali is staffed with agricultural and service professionals who understand the specific needs of each customer.
They remain in constant communication with the market place and provide keen insight on ways to improve products and services offered to its customers. Over the years, Denali has distributed products to a customer base encompassing agriculture, nurseries, greenhouses, sod farms, sports turf and topsoil manufacturers. This success in part is due to the wide acceptance of organics derived products in agricultural and horticultural, along with the strong support created through research and development by land grant Universities and Colleges, the United States Department of Agriculture (USDA), the USEPA, and each individual State. Because Denali is implementing a marketing strategy that stresses high-quality end products for high end uses at an economical cost, we plan to capture a substantial portion of the agricultural and soil amendment market.

Identify if technology is designed to accept biosolids in liquid and/or cake form.

The facility will accept both solids and liquids. The majority of liquids will be used to dilute the cake solids to 16.5% solids, which is the plant optimal loading. This mean that a portion of liquids would not have to be dewatered saving significant operating costs. The facility will also have capacity to dewater the remaining liquid imports.

Quantity and Quality Limitations

The plant is designed to accept both liquid and solid biosolids and will be limited to 84DT/Day max. Food-waste and FOG will be unlimited as additional digester capacity can be added if total volume exceeds built digester capacity. In addition, it should be noted that while the renewable fuel standards program remains intact, Food-waste and FOG would have to be digested separately to maximize the incentives. Therefore, the potential for additional digesters will be included in our design.

All products will have to continue to meet basic metals and other regulatory requirements currently in place to be accepted at the facility. There will also be additional contamination constraints on the food-waste.

Intention to integrate (and how this would be accomplished) the septic receiving facility, the transfer station, and any/all other buildings on the site including but not limited to the abandoned incinerator.
At this time there is no intention on integrating the septic facility, the abandoned incinerator, or any other building on site except the Transfer Station. The Transfer Station including the scale and office will be modified to accept sludge in both liquid and cake form to be conveyed or pumped to the THP system. We can add septic if requested.

For the transfer station, provide information on the ability to return service to the City.

In reviewing layout option, the best alternative to have the least impact is to convert the transfer station to a sludge receiving facility. Although, the modification to the building would be minor the right of way will be permanently altered, likely preventing a return to service. As the cost for the conversion is minimal it seems more prudent to build a new transfer station if needed. We would be willing to incorporate that option into a final agreement.

Conceptual site renderings showing what the facility will look like on the site from a minimum of three angles (golf course, Shawmut Avenue View and one additional view of the site)

Based on the limited time to provide a response the team was unable to pride a site rendering; however, the only new structures will be the digesters and their size and placement are flexible.

4 Description of any added value components to the project.

The following are additional added value components for consideration:

- Pipeline Gas Cleanup and Injection
- Power Generation
- FOG and Food-waste Receiving
- Generation of Exceptional Quality Class A soil product
- Nutrient extraction from centrate
- Maximum utilization of all energy including biogas and waste-heat
5 Schedule

The type of facility we are proposing to implement can be completed in as little as 18 months or up to two years. The major milestones that will impact the implementation schedule will be permitting and environmental clearances.

Our team has implemented equally complex projects in similar timeframes. We look forward to meeting with the town to develop a fuller understanding of the requirements and we will then develop a detailed implementation schedule.

We believe we can acquire volumes for sources separate from the volumes currently taken into the facility that require beneficial reuse and are not currently viable to this facility.

6 Description of your intent to use, or not use, the existing incinerator building, transfer station and/or any equipment.

With the exception of the transfer station, which is addressed above, no other buildings and equipment will be used.

7 Identification of any constraints foreseen for project development, permitting, financing, construction and operation, and marketing products.

The team does not foresee any constraints in development, permitting, designing, construction or operations of the facility; including the procurement of merchant materials. The marketing and distributing of the soils will not be an issue and will be blended with other materials at topsoil blending partners teamed with Denali in Southeastern MA.

The Energy plan being implemented takes advantage of the currently available energy credits for pipeline gas. These incentives can change, although we do not see that for the foreseeable future (4 years). We have therefore designed the project to allow for the redirection of the gas to generate the plant power should a change take place. These incentives do not drive the project but rather enhance the economics and will be shared with the City for as long as they exist.

8 Project References and Contacts

One of the big advantages of working with the Cambi Team besides its breath and depth of experience is its advanced digestion technology.
Cambi has a large installed customer-base that allows our future customers to find operating plants with attributes similar to theirs as reference. These reference plants significantly reduce the risk of a project, providing concrete support for proposed project attributes. We have provided three relevant Cambi THP facility references that highlight a multitude of key attributes for this project:

**DC Water, Washington, DC** - is the largest bio-energy facility at a wastewater treatment plant in the world, and it is operating in the US.

**Thames Water Chertsey** - highlights the longevity of a facility having operated for over 20 years; the upgrade was financed and operated by Cambi for over 13 years. Finally, Thames Water is a repeat purchaser having purchased seven Cambi systems and has plans for others in the future.

**ECPRO, Verday Norway** - is a merchant that accepts Biosolids, FOG and Food-waste. This project was designed, built and operated for 3 years by Cambi before its transfer to the client. In addition, this is a merchant facility built at a landfill.
Project 1: Cambi THP Digestion DC Water, Washington, DC

Cambi served as the subcontractor providing a turnkey supply of the Cambi THP Digestion process, including the following key elements:

- 4 lines of Cambi B-12
- 4 Pulper
- 24 Reactors
- 4 Flash tank
- 4 Flash Tank Pump
- Sludge coolers
- Odor Control

Applicability to the City:
- Large Facility 400DT/Day Capacity
- US Installation
- Cambi advanced THP Technology
- Green Energy Produced 14MWe
- Class AA Cake marketed to local farmers
- Reduction of Carbon Footprint

Owner Name Chris Peot, Biosolids Manager, DC Water
Address 5000 Overlook Avenue, SW, Washington, DC 20032
Phone 202.787.4329
Email cpeot@dewater.com

Role of Team Members Cambi was responsible for design, construction and transition of the facility;

Plant Size 400DT/Day

Feedstocks Primary and Secondary Sludge
Products, 65% Air-dry Soil, 33% Soil Product, 14MWe

Type of Arrangement DB

Term of Agreement Two-year agreement that was extended for an additional 6 months to aid in transition

Capital Costs $37M

O&M Costs Savings: ~$15M per year

Type of Financing Financed by municipality

Project Status Contract started in 2013 and completed in 2015
**Project 2: Thames Water Chertsey, England**

The Cambi THP plant at Chertsey, just west of London, England was built in 1998 and is owned by Thames Water. It was designed to treat 8,000 tons of dry solids annually, which it produced at Chertsey, Leatherhead, Esher and other wastewater treatment plants.

Cambi designed and built the THP facility in 1996, which nearly tripled the digester capacity. Cambi subsequently designed, built and financed an upgrade of the facility and in 2004, Cambi signed an operations contract with Thames Water to operate the THP plant for seven years with an option to extend for an additional three year period.

The plant has been operating successfully since September 2005.

The Cambi THP Digestion process included the following key elements:
- 1 lines of Cambi B-12.
- 1 Pulper
- 2 Reactors
- 1 Flash tank
- 1 Flash Tank Pump
- Sludge coolers
- Odor Control

This project’s relevance to the City include:
- Successfully operating for 18 years
- Cambi advanced THP Technology
- Operations and Maintenance Contract
- Class AA Cake marketed to local farmers
- No Odor issues
- Client has built 6 other facilities since this project started and is still purchasing Cambi THP technology

**Owner Name** Paul Fountain, Senior Process Expert Biosolids, Thames Water Utilities

**Address** Clearwater Court 4th East, Reading, Berks RG1 4DB

**Phone** +07747-645-430

**Email** Paul.Fountain@ThamesWater.co.uk

**Role of Team Members** Cambi was responsible for design, construction of the original project and design, construction and financing of the upgrade while also taking over operations:

**Plant Size** 30,000 WT

**Feedstocks** Primary and Secondary Sludge and Imported Biosolids

**Products** 31% Ag Soil, 333MWe

**Type of Arrangement** DBFO

**Terms of Agreement** Contract expired 2016

**Capital Costs** $3M

**O&M Costs** $66K/MTH in 2016

**Type of Financing** Initial project financed by Thames Water; upgrade financed by Cambi

**Project Status** Project started in 1996; operations contract 2004-2016
Project 3: ECOPRO, Verdal, Norway

On 20 June 2006 the Ecopro AS Board signed the main contract with Cambi AS for the delivery of a complete “Turn-Key” bio-waste sterilization and biogas plant in Verdal, Norway. The biogas plant was designed, built and operated by Cambi for 2 years and then transferred to Ecopro for operation.

The plant uses Cambi’s patented Thermal Hydrolysis Process and other innovative processes to secure a safe and efficient treatment. The plant treats both solid and liquid waste totaling 30,000 tonnes/year. The feedstock currently being treated includes source separated household waste (food waste), organic industrial waste (food processing industries), sewage sludge, fish waste and animal by-products category II and III (slaughterhouse waste).

The produced biogas generated and landfill gas is converted into electricity through gas engines. The produced pathogen-free bio-fertilizer is nutritious and a well-suited product for the agricultural sector.

The required manning to run the plant is based on 5 persons (normal working hours). The process is designed to be in operation 365 days per year.

The plant is among the most advanced plants in the world in treating sewage sludge and bio-waste and was based on experience from Cambi’s sewage sludge projects and on its bio-waste plant, “Mjøsanklegget”, in Lillehammer, Norway.

The Cambi THP digestion process included the following key elements:
- 1 lines of Cambi B-12.
- 1 Pulper
- 2 Reactors
- 1 Flash tank
- 1 Flash Tank Pump

Owner Name Tore Floan, Managing Director, Ecopro, AS
Address Ravlovegen 324, Skjordalen, 7650 Verdal
Phone +47 74 07 65 90
Email post@ecopro.no

Role of Team Members Cambi was responsible for design, construction and transfer after 3 years of operating the facility

Project Size 30,000 WT
Feedstock Imported Biosolids, FOG and Food-waste
Products 31% AG Soil, 1.56MWe
Type of Arrangement DBOT
Term of Agreement 2 years +1
Capital Costs $20.2 Mil
Type of Financing Financed by Ecopro
Project Status Operation started in 2008 and were transferred 2011
This project’s direct relevance to the City’s project include:

- Co-digestion Facility
- Cambi advanced THP Technology
- Green Energy Produced
- Class AA Cake marketed to local farmers
- Reduction of Carbon Footprint
- Design, Build Own and Transfer

9 Statement of Benefits
Our Project Team is committed to meeting the project goals as established by the City of New Bedford. In addition to meeting and exceeding the goals of the City the Project approach will provide the following Benefits to the City.

- Delivery of Proven Technology and Experience Team to execute the project
- Reduction in disposal costs
- Sustainable biosolids management solution
- 100% Renewable energy
- 100% Reusable biosolids and clean water
- Energy Independents- generation of energy eliminate future power cost increase
- Stable predictable pricing over contract period
- No negative impact on neighbors
- Exceptional Quality End Product with no offensive odors or regrowth of bacteria
- Lowest GHG footprint of any proven biosolids technology
- Continuation of current septic program
- Ability to accept FOG and food waste
- Willingness to Design, Build and Operate a new transfer station
- Willingness to accept yard waste if landfill space is made available
- Maximum monetization of digester gas
- Significant revenue sharing on power generation (CNG-RINS, Electric Power Generation Revenues)
- Royalty on merchant volumes
- City plant can be energy independent relative to electricity with excess energy available to participating communities
- Additional permanent local jobs
- Temporary construction jobs
EXPRESSED INTEREST
ORGANICS-TO-ENERGY
SLUDGE PROCESSING FACILITY

CITY OF NEW BEDFORD, MASSACHUSETTS
BID NUMBER 19192009

Submitted By:

PACE ENERGY

JULY 12, 2018
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EXECUTIVE SUMMARY

The PACE Energy, LLC, project team will design, permit, build, own, and operate an organics-to-energy sludge processing facility (O2E Facility) that consists of anaerobic digestion, biogas refining, and renewable compressed natural gas (RcNG) fuel compression and distribution. The proposed core unit operations consist of:

1) Biosolids – organic feedstock receiving/storage
2) Feedstock mixing/equalization
3) Co-digestion
4) Dewatering
5) Thermal drying
6) Foul air capture and odor control system
7) Biogas clean-up/upgrading/renewable natural gas (RNG) injection and/or compressed natural gas (CNG) delivery

The proposed project would be constructed on the Transfer Station Property at the City’s Department of Public Infrastructure (DPI) Site. The conceptual design will not impact the existing transfer station, septage receiving station, and incinerator building. The only building that may be impacted is the existing and abandoned incinerator maintenance building.

The O2E Facility would process regional biosolids from the Cities of New Bedford, Brockton, and Fall River. The anticipated biosolids quantity available from these sources is approximately 45 dry tons per day. Equipment will process biosolids in either liquid or cake form. Additionally, the system would co-process more than 37,000 gallons per day (gpd) of fats, oils, and grease waste. Waste organics will be processed using a series of thermophilic (~130 Deg F) and mesophilic (~95 Deg F) anaerobic digesters to convert volatile organic matter into biogas and digestate.

At this conceptual stage, the PACE Energy, LLC, project team estimates the anaerobic digestion system will generate more than 550 cubic feet per minute (cfm) of biogas. Biogas impurities will be removed and the resultant biomethane gas will be compressed to produce RcNG. The project team estimates RcNG production would be more than 3,700 gasoline gallon equivalent (gge) per day. The RcNG product will either be injected into existing natural gas infrastructure or transported off site using a virtual pipeline technique. Digestate will be dewatered and dried to form a pelletized product that will be marketed as an organic fertilizer. Profit sharing will be included to provide economic benefits to the City of New Bedford.

Liquids from the process would primarily be reused throughout the O2E Facility. A proprietary treatment technology will be installed to ensure any discharged liquids meet effluent standards set forth by the City of New Bedford. A pump station would be included to connect the facilities liquid wastewater to the City’s existing pipeline infrastructure. Odors at the plant will be handled using a combination of chemical and biological treatment. The odor control technologies will meet the strict guidelines set forth by the City.
This regional O2E Facility will support the goals of New Bedford and surrounding communities to develop a sustainable biosolids treatment and disposal solution. The project will divert organic materials from landfills, reducing greenhouse gas emissions and land, air, and water pollution. Additionally, the system will be used to convert unwanted waste materials into renewable energy and fertilizer. Overall, the O2E Facility is a closed-loop process to repurpose existing wastes and generate value-added products that will provide economic and environmental benefits to the City of New Bedford and surrounding communities.
SECTION 1 – GENERAL DESCRIPTION

PACE Energy, LLC, will lead a collaborative Design-Build-Finance-Own-Operate-Maintain (DBFOOM) effort to cost-effectively convert organic materials from the City of New Bedford and surrounding communities into value-added products. The project team consists of the following entities:

<table>
<thead>
<tr>
<th>Firm/Contact Person</th>
<th>Role</th>
<th>Contracting With</th>
</tr>
</thead>
<tbody>
<tr>
<td>PACE Energy, LLC</td>
<td>Finance and own the project</td>
<td></td>
</tr>
<tr>
<td>Alan Litt, President</td>
<td></td>
<td></td>
</tr>
<tr>
<td>655 Third Avenue, 21st Floor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>New York, NY 10017</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P: 646.844.3601</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F: 646.844.3610</td>
<td></td>
<td></td>
</tr>
<tr>
<td><a href="mailto:allitt@monticelloam.com">allitt@monticelloam.com</a></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C.H. Nickerson &amp; Co., Inc.</td>
<td>Turn-key construction of proposed facilities</td>
<td>PACE Energy, LLC</td>
</tr>
<tr>
<td>Kenneth O'Hara</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vice President, Estimating</td>
<td></td>
<td></td>
</tr>
<tr>
<td>49 Hayden Hill Road</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P. O. Box 808</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Torrington, CT 06790</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P: 860.489.0455</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F: 860-496-0483</td>
<td></td>
<td></td>
</tr>
<tr>
<td><a href="mailto:kohara@chnickerson.com">kohara@chnickerson.com</a></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RETTEW Associates, Inc.</td>
<td>Engineering and permitting services</td>
<td>PACE Energy, LLC</td>
</tr>
<tr>
<td>Jason Wirt, PE, BCIE, ENV SP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Senior Technical Engineer/National</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Market Leader 3020 Columbia Avenue</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lancaster, PA 17603</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M: 814.933.2819</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F: 717.798.9879</td>
<td></td>
<td></td>
</tr>
<tr>
<td><a href="mailto:jwirt@rettew.com">jwirt@rettew.com</a></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Veolia Water Technologies (VWT)</td>
<td>Provide anaerobic digestion technology, biosolids drying,</td>
<td>C.H. Nickerson &amp;</td>
</tr>
<tr>
<td>Sudhakar Viswanathan</td>
<td>and sidestream wastewater treatment equipment</td>
<td>Co., Inc.</td>
</tr>
<tr>
<td>National Sales Manager – Biosolids</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&amp; Bioenergy, Kruger</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4001 Weston Pkwy.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cary, NC 27513</td>
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<tr>
<td>F: 919.677.0082</td>
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<td></td>
</tr>
<tr>
<td><a href="mailto:sudhakar.viswanathan@veolia.com">sudhakar.viswanathan@veolia.com</a></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Successfully Completed Projects

The following projects represent the PACE Energy, LLC, project team’s experience relative to the Organics-to-Energy sludge processing facility project.

- Artois Methanisation Merchant Facility – Graincourt, France
- Co-Digestion for Wastewater Treatment Plant Zero Net Energy – Gresham, Oregon
- Hermitage Cogeneration and Biogas Generation Optimization – Mercer County, Pennsylvania
- Renewable Energy Biosolids Facility – Wilmington, Delaware
- Co-Digestion and CHP Facility – South Budapest, Hungary

Please see the project reference sheets provided in Appendices 8-1 through 8-5 for project descriptions, dollar values, and reference information.
SECTION 2 - HISTORY, CAPABILITIES, AND EXPERIENCE

At its heart, design-build-finance-own-operate-maintain (DBFOOM) contracting is the marriage of financing, engineering design, permitting, procurement, construction execution, and operations in a committed team that focuses on the client's end goals. By having a focus on the end project goals, the DBFOOM team relies upon its internal strengths to manage the competing interests of engineering detail, project budget, and project schedule. Each participant on the team executes within their area of expertise, with the overall project lead providing the necessary management to ensure a complete and integrated execution strategy. PACE Energy, LLC, has assembled an outstanding team of professionals and industry leaders to form the DBFOOM team to execute the lease of City property to develop an Organics-to-Energy Sludge Processing Facility (O2E Facility) for the City of New Bedford (i.e., RFP). While PACE Energy, LLC, will own the facility, the DBFOOM team provides skill and focus on the key elements required for a successful partnership with the agencies.

PACE Energy, LLC, is a Special Purpose Entity created by Alan Litt, Jonathan Litt, and Thomas Lally for the purposes of investment to own and operate renewable energy facilities under their Monticello Energy Finance, LLC, platform. PACE Energy, LLC, has been involved in the execution, construction, and ownership of diverse renewable energy assets such as floating solar arrays, ground mount solar arrays, battery energy storage systems for frequency regulation and peak shaving, anaerobic digestion for biogas development (municipal biosolids, co-digestion), and biogas refining for vehicle fueling. The founders and owners have extensive experience in development and construction and bring a combined 75+ years of experience to technical, legal, and financial issues.

CH. Nickerson & Co., Inc., will be responsible for the turn-key construction of the proposed facilities and will contract directly with PACE Energy, LLC, including providing financial security (performance and payment bonds). CH. Nickerson & Co., Inc., is a full-service general contracting and design-build service provider founded in 1939. They are a self-performing general contractor with more than $80 to $100 million in environmental construction work per year. Over the course of seven decades, the company has built or rehabilitated more than 200 water and wastewater treatment facilities in the Northeast, establishing a reputation for project quality, safety, technical innovation, and on-time and on-budget performance. Typically, CH. Nickerson & Co., Inc., self-performs the majority of its projects, providing all site work — concrete, masonry, carpentry, equipment installation, and process piping — with its own forces. As a self-performing general contractor with in-house engineers and a great deal of engineering expertise, CH. Nickerson & Co., Inc., is well-positioned to respond to the increasing popularity of the design-build format.

RETTEW Associates, Inc. (RETTEW), will provide engineering and permitting services under direct contract to PACE Energy, LLC. Ranked by Engineering News-Record as one of the top design firms in the United States, RETTEW provides a wide range of engineering, environmental, surveying, planning, safety, and related consulting services. Since 1969, RETTEW has been committed to the communities and clients they serve. RETTEW's team of more than 350 dedicated professionals offers depth of experience in a variety of alternative and renewable energy systems, from initial strategy and design to funding and implementation. Their dedicated staff has hands-on experience with energy distribution systems from a myriad of waste products,
waste gases, solar and photovoltaics, wind, and waste heat. RETT EW has designed, permitted, and managed more than a dozen significant projects in the last five years that used manure, food waste residuals, and wastewater sludge systems for resource recovery via anaerobic digestion. In 2018, RETT EW was named winner of the Climate Change Business Journal 2017 Award for Greenhouse Gas Mitigation (Consulting) for our work on renewable energy projects.

Veolia Water Technologies (VWT) will provide the anaerobic digestion technology, biosolids drying, and sidestream wastewater treatment equipment under contract to C.H. Nickerson & Co., Inc., for their installation. Veolia North America (Veolia North America North East, LLC) will provide commissioning services, along with long-term operations and maintenance of the project, under direct contract to PACE Energy, LLC. Veolia will provide these services throughout the term of the project and agreement period.

The Veolia Environnement (VE) group, which traces its founding in 1853, is the global leader in environmental resources management. With more than $30 billion in annual revenue and 163,000 employees worldwide, VE designs and provides energy, water, and waste management solutions for the sustainable development of communities and industries. Veolia has more than three decades of experience in providing operation and maintenance (O&M) services to municipal clients in the State of Massachusetts and the Northeast region of the United States and has operated the 30-mgd New Bedford Wastewater Treatment Plant since 1990. Veolia has extensive capabilities and experience in the planning, development, and implementation of organic materials processing to produce biogas for reuse in strategic applications of combined heat and power (CHP), compressed natural gas (CNG), renewable natural gas (RNG), and thermal heat recovery. Veolia ranks as the largest and most successful DBO and O&M services provider, holding an industry-leading position in terms of two critical metrics – market share and revenue.

PREVIOUS TEAM COLLABORATION

There is extensive collaboration between the existing team members for similar project work throughout the Eastern United States. RETT EW serves as the Program Manager for all of PACE Energy, LLC’s, renewable energy efforts and has completed project development and engineering for projects totaling more than $70 million dollars in the last two years related to this program. Additionally, the PACE Energy, LLC, consortium, which includes Veolia for O&M services, was selected in late 2017 for the turn-key development and delivery of one of the nation’s largest anaerobic digestion plants to produce bioenergy fuels (CNG and RNG) and the long-term management of the stabilized solids to beneficial use. This DBOOM project is the solids handling and anaerobic digestion for a 147-mgd municipal wastewater plant in northern New Jersey. This facility will anaerobically digest a combination of primary and waste-activated sludge to produce more than 800 cfm of anaerobic digestion biogas for cleanup and direct injection of 510 cfm of RNG.
SECTION 3 - PROPOSED TREATMENT TECHNOLOGY AND PROCESSES

General Description

The conceptually-planned organics-to-energy sludge processing facility (O2E Facility) by the PACE Energy, LLC, project team is an organics-to-energy solution for the City of New Bedford and other regional Massachusetts municipalities (e.g., Brockton and Fall River) for their municipal biosolids and local commercial sources of fats-oil-grease (FOG) organics. The planned O2E Facility will receive and process biosolids and FOG organics via a wet co-digestion process to produce biogas for cleanup and conversion into renewable natural gas (RNG) for grid injection to Eversource Gas and Algonquin Gas via the gas distribution and transmission network as being adjacent to the City’s Department of Public Infrastructure (DPI) Site.

Alternatively, or in addition to production of RNG, the PACE Energy, LLC, project team may elect to produce compressed natural gas (CNG) for beneficial use in the City’s vehicle fleet, as well as targeted supply of supplemental CNG fuel to ABC Disposal, as also adjacent to the City’s DPI Site for the planned O2E Facility.

The digestate will be dewatered and thermally dried to produce an Exceptional Quality (EQ)/Class A solids as granulated organic fertilizer and soil amendment for marketing/distribution to beneficial uses. Any foul air and odors produced from the organics receiving, storage, dewatering, and drying processes will be exhausted to a biofilter unit for odor control and treatment prior to discharge to the atmosphere. The ultimate foul air capture and odor control system for the planned O2E Facility may include multi-stages of ammonia wet scrubbing, enclosed biofiltration, carbon polishing, and dilution air for stack discharge.

Liquid wastes from the digested solids via dewatering and thermal drying condensate will be treated on site in a sidestream treatment system for efficient and effective removal of ammonia-nitrogen and soluble organics to meet the City required discharge requirements as a pumped sewer flow to the City’s wastewater treatment plant. The volume of treated liquid waste as effluent flow from the planned O2E Facility will necessitate the provision of a pump station and force main that will pump the treated effluent (as meeting the City discharge requirements for the specified parameters [of COD, TS, TN and NH₃-N] maximum concentrations [mg/L], on a daily average and maximum month monitoring basis) along Shawmut Avenue for tie-in to the City’s existing gravity sewer for transmission to the wastewater treatment plant.

The intended location of the planned O2E Facility is behind the City’s transfer station on the 7.78-acre property, as adjacent to the City’s DPI Site at 1103 Shawmut Avenue. The PACE Energy, LLC, project team intends to leave in place, the existing City solid waste transfer station and septage receiving facility, as well as the abandoned incinerator building, capped Shawmut Avenue landfill and the sludge only landfill areas. The PACE Energy, LLC, project team may elect to demolish and/or repurpose the older and abandoned incinerator maintenance building at the DPI Site.

In summary, the general approach for a public-private partnership-developed O2E Facility by the PACE Energy, LLC, project team provides a regional biosolids and FOG co-processing solution for the Cities of New Bedford, Fall River, and Brockton, as well as planned reserve capacity to accommodate local commercial organic (FOG) waste generators to produce marketable bio-energy (CNG/RNG) and EQ/Class A biosolids dry fertilizer.
Core Approach

The core approach of the PACE Energy, LLC, project team’s planned O2E Facility at the City’s DPI Site is to indicate the capability of our DBFOOM project team to develop and turn key deliver a technically reliable solution for co-processing thickened and cake biosolids with FOG organics into bio-energy and beneficial use sustainable products.

As further highlighted herein, the technology scheme is a proven core technical approach to achieving the above stated objectives for the O2E Facility. Overall, the O2E Facility is planned to be sized for co-processing the daily average and maximum monthly biosolids production from the Cities of New Bedford, Brockton, and Fall River (as summarily analyzed from the Appendix A information provided in the City's RFEI for data from 2015 through 2017), as well as up to 20 to 25 percent merchant capacity to receive and process other local organic materials (e.g., FOG).

The proven co-processing technologies of anaerobic digestion (AD), dewatering, and thermal drying as planned by PACE Energy, LLC, project team are robust technical systems and established equipment to ensure long-term (20+ years) and sustainable operations. The PACE Energy, LLC, project team will provide back-up biosolids disposal solutions and third-party disposal outlets, should the O2E Facility be out of service for an interim period for performing major maintenance or lifecycle asset refurbishments.

The planned O2E Facility will not initially handle food waste that may become source separated by City residents at community waste drop-off facilities/transfer stations. The PACE Energy, LLC, project team may consider a phased approach for the incorporation of food waste (FW) by way of an expansion of the planned O2E Facility via a second parallel AD system, with additional dewatering and thermal drying. However, the initial scope of the planned O2E Facility will only co-process biosolids and FOG and exclude FW as well as yard waste. This is in part due to changes in regulatory standards related to environmental attributes by the federal government and some pending modifications which could impact FW co-digestion.

As illustrated in Figure 3-1, the PACE Energy, LLC, project team’s focus for the planned O2E Facility is the production of RNG from cleanup upgrading and compression of the biogas generated from wet co-digestion of biosolids and FOG. We see the most technically reliable and economically viable O2E Facility solution is production of bioenergy in the primary form of RNG and/or CNG as compared to combined heat and power (CHP) as “green” electricity. For the environment in New Bedford, the core fuel product is RNG and/or CNG.
Preliminary Layout

A conceptual layout of the proposed O2E Facility is provided in a high-level site plan as Appendix 3-1. It shows the general arrangement of the proposed core unit operations:

1) Biosolids – organic feedstock receiving/storage
2) Feedstock mixing/equalization
3) Co-digestion
4) Dewatering
5) Thermal drying
6) Foul air capture and odor control system
7) Biogas cleanup/upgrading/RNG injection and/or CNG delivery

These core unit operations for the planned O2E Facility are to be constructed on the transfer station property at the City’s DPI Site. The ultimate spatial layout of the planned O2E Facility will need to work around the existing transfer station and septage receiving facility and may also include demolishing the abandoned and inactive incinerator maintenance building. These design details will be included in the definitive scope and price proposal by the PACE Energy, LLC, project team for the design-build-finance-own-operate-maintain (DBFOOM) delivery, as well as permitting and products marketing/distribution services.

Conceptual Design Values, Indicative Performance Metrics, and Conceptual Process Flow Diagrams

More concept details in the form of a block process flow diagram (PFD) for the planned core technical solution are provided as Appendix 3-2. From an optimized financial viability perspective, the preliminary approach for the thermal energy systems would be to purchase natural gas (NG) and market all the produced biogas into the CNG fuel and/or grid Injected RNG to maximize the RINS values under the U.S. Environmental Protection Agency’s RFS program. A dual driver for project financial viability is the core technical approach of maximum solids mass and volume reduction via digestate dewatering and thermal drying into a bulk fertilizer product for marketing and distribution to regional customers for beneficial uses.
Preliminary conceptual design values of the planned O2E Facility are summarized below in Table 3-1. As shown, the PACE Energy, LLC, project team has summarized key daily average processing values as compared to preliminary design capacity levels. The highlighted performance metrics are indicative values and intended to illustrate the planned processing levels as compared to the contemplated design capacity.

<table>
<thead>
<tr>
<th>O2E SPF Processing Parameter</th>
<th>Units</th>
<th>Daily Average</th>
<th>Design Capacity</th>
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<tbody>
<tr>
<td>Regional Biosolids Loading</td>
<td>DTPD</td>
<td>43.5</td>
<td>65.0</td>
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<tr>
<td>Local (Merchant) FOG Flow</td>
<td>GPD</td>
<td>37,500</td>
<td>49,400</td>
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<td>Organic Solids Mixing Flow Rate</td>
<td>GPM</td>
<td>120</td>
<td>175</td>
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<td>Feedstock EQ Tank Retention Time</td>
<td>Hours</td>
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<td>Thermophilic Tanks Retention time</td>
<td>Days</td>
<td>3.5</td>
<td>4.0</td>
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<tr>
<td>FOG Loading for Co-Digestion</td>
<td>%OLR</td>
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<td>25.0</td>
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<tr>
<td>Mesophilic AD Solids Retention Time</td>
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<td>AD Organic Solids Loading Rate</td>
<td>Lb VS/ dy/Kcf</td>
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<td>0.22</td>
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<td>Cleaned Biogas Flow for Upgrading</td>
<td>CFM</td>
<td>555</td>
<td>700</td>
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<tr>
<td>Dewatering Solids Flow Rate</td>
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<td>145</td>
<td>175</td>
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<tr>
<td>Dewatering Solids Loading Rate</td>
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<tr>
<td>Thermal Dryer Solids Loading Rate</td>
<td>Lb/hr</td>
<td>3,940</td>
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<td>Thermal Dryer Evaporation Demand</td>
<td>Lb H2O/hr</td>
<td>2,270</td>
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<tr>
<td>Dried Solids Silo Storage Time</td>
<td>Days</td>
<td>2.2</td>
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<tr>
<td>Wastewater EQ Tank Retention Time</td>
<td>Days</td>
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The following conceptual schematic (Figure 3-2) illustrates the proposed PFD for organic feedstock (biosolids and FOG) co-digestion for biogas conversion into RNG. Purchased natural gas will be used for the hot water heater to support co-digestion and the thermal oil heater for heat drying.
Figure 3-2: Conceptual Process Flow Diagram of Organics Co-Digestion and Biogas Conversion into RNG

Table 3-2 below, summarizes the O2E Facility indicative performance metrics for organics co-digestion, production of biogas as a bio-energy resource for conversion via cleaning/upgrading into RNG product.

<table>
<thead>
<tr>
<th>O2E SPF Processing Parameter</th>
<th>Units</th>
<th>Daily Average</th>
<th>Monthly Maximum</th>
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<tbody>
<tr>
<td>New Bedford Thickened Solids Load</td>
<td>DTPD</td>
<td>19.0</td>
<td>23.0</td>
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<tr>
<td>Brockton and Fall River Cake Solids Load</td>
<td>DTPD</td>
<td>24.5</td>
<td>29.5</td>
</tr>
<tr>
<td>Local/Regional FOG Processing</td>
<td>DTPD</td>
<td>9.5</td>
<td>12.5</td>
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<td>Co-Digestion Organic Loading Rate</td>
<td>Lb/hr VS</td>
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<td>Co-Digestion Total Solids Reduction</td>
<td>%TSr</td>
<td>49.0</td>
<td>42.0</td>
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<tr>
<td>Co-Digestion Volatile Solids Reduction</td>
<td>%VSr</td>
<td>57.5</td>
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<td>Biogas (Yield) Production Rate</td>
<td>cf/lb VSr</td>
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<tr>
<td>Biogas Production Flow Rate</td>
<td>cfm</td>
<td>555</td>
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<td>RNG Production Flow Rate</td>
<td>cfm</td>
<td>330</td>
<td>405</td>
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<tr>
<td>RNG Product Volumetric Rate</td>
<td>GGE/day</td>
<td>3,750</td>
<td>4,600</td>
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The following conceptual schematic, illustrates the planned PFD for digested solids dewatering and thermal drying, as well as the sidestream treatment of liquid wastes from the dewatering and drying processes. The treated wastewater will be pumped to the New Bedford Wastewater Treatment Plant for final disposal.

**Figure 3-3:** Conceptual Process Flow Diagram of Digested Solids Processing and Sidestream Treatment

Table 3-3 below, summarizes the O2E Facility indicative performance metrics for digested solids dewatering and thermal drying as well as the sidestream treatment of liquid waste for pumping to the sewer main.

<table>
<thead>
<tr>
<th>O2E SPF Processing Parameter</th>
<th>Units</th>
<th>Daily Average</th>
<th>Monthly Maximum</th>
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<tr>
<td>Dewatering Feed Solids Processing</td>
<td>DTPD</td>
<td>27.0</td>
<td>31.0</td>
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<tr>
<td>Dewatering Solids Capture Rate</td>
<td>%</td>
<td>95.0</td>
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<tr>
<td>Dewatered Cake Production</td>
<td>DTPD</td>
<td>25.5</td>
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<tr>
<td>Thermal Dryer Feeds Solids Loading</td>
<td>WTPD</td>
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<td>110</td>
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<tr>
<td>Thermal Drying Solids Recovery Rate</td>
<td>%</td>
<td>98.5</td>
<td>98.0</td>
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<tr>
<td>Dried Product (Granules) Mass</td>
<td>TPD</td>
<td>27.5</td>
<td>33.0</td>
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<tr>
<td>Sidestream (MBBR) Treatment Flow</td>
<td>KGPD</td>
<td>267.5</td>
<td>301.5</td>
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<tr>
<td>Treated Effluent Flow to Sewer Main</td>
<td>KGPD</td>
<td>183.5</td>
<td>217.5</td>
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<tr>
<td>Sidestream Treatment Removal - TSS</td>
<td>%</td>
<td>60.5</td>
<td>60.0</td>
</tr>
<tr>
<td>Sidestream Treatment Removal - COD</td>
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<td>98.0</td>
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<td>Sidestream Treatment Removal - NH₃</td>
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<td>98.0</td>
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<tr>
<td>Sidestream Treatment Removal - TN</td>
<td>%</td>
<td>98.0</td>
<td>97.5</td>
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</table>
Feedstock (Biosolids and FOG) Co-Processing

PACE Energy, LLC’s, plan for feedstock co-processing is to provide the DBFOOM with a new O2E Facility at the New Bedford DPI Site, which is designed in total capacity for handling 65 dry tons per day (DTPD) of biosolids. This indicative design capacity value is derived from the maximum annual production levels (in 2015 through 2017) for the combined loadings from the New Bedford, Brockton, and Fall River Wastewater Treatment Plants and using a 1.20 maximum month (peaking factor) plus 20 percent reserve capacity for growth or merchant FOG.

The FOG merchant feedstock supply characteristics will be conducted during the RFP response period to convert the indicative values (as highlighted below in Table 3-4) to definitive values in support of a comprehensive DBFOOM submission proposal offering to the City of New Bedford of an O2E Facility project.

These indicative values represent a preliminary analysis by the PACE Energy, LLC, project team of the RFEI and Appendix A information provided by the City with respect to its historical biosolids production and related characteristics of dewatered biosolids from the Cities of Brockton and Fall River. In respect of the City’s concern and sensitivity to hauling odors of dewatered cake biosolids from its wastewater treatment plant, the PACE Energy, LLC, project team intends to receive and mix thickened biosolids with the cake biosolids from Fall River and Brockton via Veolia’s Ecrusor™ mixing technology to prepare an engineered solids slurry for co-digestion with merchant FOG via a two-phase thermophilic treatment and mesophilic stabilization.

<table>
<thead>
<tr>
<th>O2E SPF Processing Parameter</th>
<th>Units</th>
<th>Daily Average</th>
<th>Monthly Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Bedford Thickened Solids</td>
<td>GPD</td>
<td>65,600</td>
<td>79,130</td>
</tr>
<tr>
<td>New Bedford Wet Biosolids Mass</td>
<td>WTP</td>
<td>275</td>
<td>330</td>
</tr>
<tr>
<td>Brockton Dewatered Cake Solids</td>
<td>WTPD</td>
<td>40</td>
<td>48</td>
</tr>
<tr>
<td>Fall River Dewatered Cake Solids</td>
<td>WTPD</td>
<td>60</td>
<td>72</td>
</tr>
<tr>
<td>Combined Biosolids Wet Mass</td>
<td>WTPD</td>
<td>375</td>
<td>450</td>
</tr>
<tr>
<td>Regional (Merchant) FOG</td>
<td>GPD</td>
<td>37,600</td>
<td>49,400</td>
</tr>
<tr>
<td>Merchant FOG Solids Loading</td>
<td>DTPD</td>
<td>9.5</td>
<td>12.5</td>
</tr>
<tr>
<td>Combined Dry Mass Solids Loading</td>
<td>DTPD</td>
<td>53.0</td>
<td>64.5</td>
</tr>
<tr>
<td>Combined Organic Solids Loading</td>
<td>TPD</td>
<td>41</td>
<td>47.5</td>
</tr>
</tbody>
</table>

As highlighted above, the combined wet loading of both thickened and dewatered cake biosolids on a daily average basis (e.g., 7 days per week and 52 weeks per year), which based upon the average solids content of each municipal feedstock, the equivalent dry mass is approximately 43.5 DTPD. Merchant import of 20 percent FOG loading would add another 9.5 DTPD for a combined dry mass loading of 53 DTPD. An average volatile solids content of 77.5 percent (VS), the organic solids loading is 41 tons per day (TPD).
Biosolids Fertilizer Product Marketing

PACE Energy, LLC's, plan for product sales of the dried granules as an EQ/Class A product will be handled by Veolia. Veolia intends to implement a marketing and bulk distribution program for beneficial use of the dried granules to targeted end users (e.g., topsoil dealers, fertilizer users, and landscapers). Summarized in Table 3-5 are indicative performance metrics for product sales of dried granules.

| Table 3-5. Indicative Values of Dried Granules Product Sales, Marketing, and Distribution |
|---------------------------------|----------------|----------------|----------------|
| OzE SPF Processing Parameter    | Units          | Daily Average | Monthly Maximum |
| Dried Granules Production       | TPD            | 27.5          | 32.5           |
| Dried Granules Solids Content   | %TS            | 91.0          | 90.0           |
| Dried Granules Product Storage Time | Days       | 2.2           | 2.0            |
| Dried Granules Product Distribution | Loads/Day | 2             | 2.5            |

The application of indirect thermal drying via low to medium temperature belt dryer by VWT-Kruger (BioCon™) to produce an EQ/Class A dried fertilizer product, which may be marketed by Veolia as is or undergo a further processing step via a pellet mill unit to produce a higher density and more uniform sized “granule” for bulk distribution.

Bio-Energy Production and Distribution

PACE Energy, LLC's, plan for bio-energy production and product distribution would be cleaning and upgrading of the biogas into fuel products (CNG and/or RNG). The target customers for the CNG fuel would be ABC Disposal's existing CNG fueling station, as well as the City of New Bedford's municipal vehicle fleet. PACE Energy, LLC, would lead the project team's scope and delivery of this virtual pipeline solution of CNG. Alternatively, the production of RNG would be distributed into the adjacent grid for Eversource Gas via the gas distribution network in the region and the gas transmission network operated by Algonquin Gas.

Summarized below in Table 3-6 are indicative production metrics for bio-energy products distribution.

| Table 3-6. Indicative Values of Bio-Energy Production and Fuel Products Distribution |
|---------------------------------|----------------|----------------|----------------|
| OzE SPF Processing Parameter    | Units          | Daily Average | Monthly Maximum |
| Biogas Production               | Kcf/day        | 800.5         | 915.5          |
| Bio-Energy Production           | MMBtu/hr       | 20.0          | 23.0           |
| Cleaned / Upgraded Biogas Yield | Kcf/day        | 477.5         | 545.0          |
| Compressed Natural Gas Product  | GGE/day        | 3.750         | 4.280          |
| Renewable Natural Gas Product   | MMBtu/day      | 285           | 325            |
The PACE Energy, LLC, project team would determine during the RFP phase the optimal approach for use of the biogas and related bio-energy value attributes to propose the most technically reliable and cost favorable solution for the planned O2E Facility and share economic benefits with City of New Bedford.

The production of biogas will be accomplished by Veolia’s BioMET™ technology, which provides an initial thermophilic temperature treatment of the blended organics (slurry biosolids and FOG), followed by a stabilization phase via mesophilic AD tanks, to yield optimized biogas production and solids destruction. The AD tanks will be heated via a hot water system.

**Foul Air Capture and Odor Control**

PACE Energy, LLC’s, plan for foul air capture and odor control at the planned O2E Facility would include essential fresh-air ventilation, foul-air exhaust, and multi-stage odor treatment to achieve the City’s RFEI specified Odor Control Standards as listed below:

- Plant Site Boundary – H2S < 5 ppb/v
- Collection System Site Boundary – H2S < 10 ppb/v
- Odor Control System – H2S > 99 percent removal
- Plant Site Boundary – Odor < 5 D/T.

The key process areas that would necessitate foul air capture and odor exhaust ventilation to the odor control facilities would include the feedstock (biosolids and FOG) receiving area/storage bins, slurry organics EQ tank, digestate dewatering, thermal drying exhaust (via wet condenser of indirect air flow), and cake solids conveyance/storage, as well as the finished dried product conveyance/truck load-out.

Although more specific details will be engineered during the RFP phase for submission of a definitive scope and price proposal, a preliminary benchmark odor control flow is estimated at 26,000 cfm. The multi-stage odor control system may include a first-stage wet acid scrubber to sufficient remove NH3-N prior to an enclosed biofilter for H2S and organic sulfides removal, followed possibly by a carbon column polishing step for final odor and VOCs removal prior to atmospheric discharge via a dilution fan/stack.

**Liquid Waste Management**

The management of liquid waste from the planned O2E Facility will be treated on site for reduction of organics (COD), solids (TSS), and ammonia-nitrogen (NH3-N). The indicative values for performance of the planned sidestream treatment system (via Veolia’s AnitaMox™ MBBR System) at the O2E Facility are highlighted below in Table 3-7. As shown, the projected quality of treated effluent from the O2E Facility as a pumped waste discharge to the City’s wastewater collection system for ultimate disposal at its wastewater treatment plant, substantially meets the RFEI specified discharge quality limits for the following summarized parameters.
Table 3-7: Indicative Values of Sidestream Treatment at the Planned O2E Facility

<table>
<thead>
<tr>
<th>Sidestream Treatment Parameter</th>
<th>Daily Average</th>
<th>Maximum Month</th>
<th>City Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSS Concentration Discharge, mg/L</td>
<td>250</td>
<td>300</td>
<td>&lt;720</td>
</tr>
<tr>
<td>COD Concentration Discharge, mg/L</td>
<td>20</td>
<td>25</td>
<td>&lt;430</td>
</tr>
<tr>
<td>TN Concentration Discharge, mg/L</td>
<td>30</td>
<td>35</td>
<td>&lt;50</td>
</tr>
<tr>
<td>NH₃ Concentration Discharge, mg/L</td>
<td>10</td>
<td>15</td>
<td>&lt;30</td>
</tr>
<tr>
<td>pH Range, s.u.</td>
<td>7.0 - 7.2</td>
<td>6.8 - 7.0</td>
<td>6 - 8</td>
</tr>
</tbody>
</table>

As indicated above in Table 3-7, the City specified limits for ammonia-nitrogen (NH₃-N) and total-nitrogen (TN-N) would necessitate a multi-step liquid waste treatment system, consisting of flow and load equalization, nitrification and denitrification (via the MBBR system), as well as final clarified effluent polishing (via a disc filter). Alkalinity/pH adjustment may also be needed to achieve the discharge limits.

Noise and Other Environmental Controls

The O2E Facility will be designed to limit noise and other environmental discharges. The noisiest items of equipment will be the biogas compression system and the dryer/dewatering equipment. This equipment will be enclosed in sound-limiting enclosures and/or buildings to ensure proper decibel levels for operations staff and sound levels at the property line. Additionally, the O2E Facility is located on the west side of the property near the existing landfill. There are few developed areas near this portion of the site. Therefore, noise pollution will be limited. The O2E Facility will comply with all local, state, and federal regulations regarding noise and other environmental discharges such as air and water pollution.

Limitations Regarding Quantity or Quality of Sludge Received from the City

The O2E Facility is designed to process all available sludge from the City of New Bedford and has backup capacity to handle commercial sources of FOG waste. Veolia's Ecrusor™ mixing technology and BioMET™ digestion system is designed to break down even the poorest quality sludges from municipal sources. Therefore, there are no anticipated limitations of the technology regarding sludge quality. If reduced quantity of sludge is provided, major equipment will be operated on a reduced operating schedule and digestion equipment will be operated at longer hydraulic retention times (HRTs). This will only serve to enhance feedstock degradation and biogas production.

Intentions to Integrate Existing Facilities

As mentioned previously, the septage receiving facility, transfer station, and abandoned incinerator will remain in place. The project may involve demolition of the already abandoned incinerator maintenance building. Existing services conducted at these facilities will remain unaffected by the proposed O2E Facility. Please refer to Appendix 3-1 for further details.
Key Process O2E Technology and Systems

The key process O2E technology and systems planned by the PACE Energy, LLC, project team for the O2E Facility would include the following proven systems for biosolids and FOG co-processing, as applied in North America and in Europe. A summary overview of each key process O2E technology is provided in the following subsections as well as brochures and relevant case studies (as attachments to this Section 3).

- Ecrusor® Solids and Organic Wastes Depackaging and Mixing
- BioMET™ Co-Digestion for Organic Solids Pre-Treatment and Stabilization
- BioCon™ Belt Drying for Evaporation of Moisture from Dewatered Digestate
- ANITA™Max Moving-Bed Biofilm Reactor (MBBR) System with Polishing Disc Filter
- Biogas Cleanup and Upgrading to CNG Vehicle Fuel Standards
- CNG Fuel Transportation and Distribution via Tube Trucks and Specialty Dispensing Trailers

As illustrated below in Figure 3-4, the core processing approach for the planned O2E Facility for regional biosolids and merchant FOG would be a three-step scheme of pre-treatment (organics mixing for slurry control), thermophilic hydrolysis (organics homogenization and volatile fatty acids fermentation), and mesophilic digestion (organics stabilization and methanization). This three-step co-digestion scheme illustrates an energy efficient bio-refinery for biosolids and FOG to yield stabilized solids and biogas.

Figure 3-4. Steps of Veolia's BIOETM Co-Digestion Process
Organics Pre-Treatment >> Thermophilic Hydrolysis >> Mesophilic Digestion
Ecrusor® Organics Mixing Technology

The Ecrusor® organics cleaning and mixing technology involves the steps of thickened and solid organics in a pre-treatment system of sorting, screening, washing, and pulping into a high-quality paste or slurry for co-digestion. The Ecrusor® mixing system has a proven history in multiple European facilities for handling a wide stream of solid wastes, packaged foods and beverages, and other organic materials, such as biosolids.

Ecrusor® is an ideal solution for the depackaging and preparing of food waste, liquid beverages, and/or the mixing of thickened and dewatered cake biosolids for co-digestion to generate bio-energy and beneficial use of the digestate. The process itself, is compact and robust. As a patented process by Veolia, it has been applied for more than a decade in various European projects to help those communities achieve resource recovery of organic wastes and implement a circular economy approach using wastewater treatment assets for co-processing with municipal biosolids into stabilized products.

As illustrated in the adjacent graphic, its simple operation includes the loading (pumping and/or dumping) of both thickened and cake biosolids, as well as packaged and unpackaged pre-consumer food wastes into a receiving hopper. In Ecrusor®, the bulk organic solids and/or packaged food waste are first broken apart for separation of the inorganic waste from the organic material. Cake biosolids, as well as packaged or unpackaged food waste, are dumped into the Ecrusor’s receiving hopper. The Ecrusor® unit is capable of processing up to 50 cubic yards of organic waste every hour.

The Ecrusor® unit has an end plate equipped with several chopping/cutting teeth that facilitate the destruction of the packaging material (unwanted material) and the release of the desired organic material. The Ecrusor® unit contains 8mm perforated plates located below the grinding screws to separate the organic and waste product. The grinding screws press the organic material through the perforated plate to three collection screws that convey the organic slurry out of the system.

As shown in the adjacent photo, the mixing is done with spiral grinding screws which move forward and backward, while agitating, distributing, and breaking apart the waste. An end plate is equipped with several chopping / cutting teeth that facilitate the destruction of the inert packaging material, while not making it so small to pass through the effluent perforated plates. The perforated plates retain the inert material and allow the puree of organic material to flow through. An extraction screw removes the unusable inert packaging waste remaining on the perforated plates. Residual organic matter on the inert packaging material is washed off as it moves up and out of the extraction...
screw. The washed inert waste is collected in a waste container for disposal. The screen retained organic material above perforated plates is also washed and thoroughly mixed to produce an engineered organic slurry, which is pumped to an equalization tank prior to co-digestion.

Ecrusor® is a very low-energy operating system that can be installed below grade and indoors of a solid waste transfer station, or on the front end of an O2E facility, if the organic solids and/or pre-consumer SSO food waste are received directly to the plant. Provided as Appendix 3-3, is a summary sheet on the Ecrusor® equipment/technology. Ecrusor® has been successfully applied as both a food waste depackaging system and/or an organic solids mixing system. This compact unit and robust technology transforms discarded food waste and the conversion of dewatered cake biosolids into an engineered organic soup or puree for pumping to co-digestion and production of biogas and renewable bioenergy.

BioMET™ Co-Digestion Technology
A key unit process of O2E technology for the planned New Bedford O2E Facility proposed by the PACE Energy, LLC, project team includes wet AD technology via Veolia’s BioMET™ co-digestion process. The adjacent photo shows a BioMET™ co-digestion plant, which is two-stage thermophilic hydrolysis/mesophilic stabilization system. The actual AD processing technology is separated into two key steps: high temperature (thermophilic range of 122°F to 131°F) to achieve the hydrolytic and acidogenic phases of organic stabilization, and then moderate temperature (mesophilic range of 95°F to 104°F) to achieve the acetogenic and methanogenic phases of organics stabilization and methane gas production.

Pretreatment of the biosolids and FOG are necessary to ensure an adequate level of organic solids concentration feed (target range of 5 percent to 9 percent total solids, TS) to the thermophilic hydrolysis tank and provide an organic biomass that is constant, mixed, heated, and quasi-homogenous for thermophilic hydrolysis and mesophilic AD. Uniform feeding of the organics to the separate hydrolysis step provides better organics stability and AD performance for achieving maximized production of biogas/methane.

Implementing the thermophilic hydrolysis in a separate step that requires a typical solids retention time (SRT) of three to four days and a vertical tank size that is 15 to 25 percent the volume of the mesophilic anaerobic digester. The mesophilic AD is a fully mixed, complete-stirred tank reactor (CSTR) system that primarily achieves organics stabilization and production of methane biogas at an average SRT of 15 to 18 days.

The shorter SRT and higher operating temperatures in the first-stage thermophilic hydrolysis tanks, will break down the more recalcitrant and complex organic substrates (e.g., proteins and carbohydrates) in the municipal biosolids as well as the fats and grease in the FOG material to set up the acidogenic phase for conversion into fatty acids prior to the second-stage lower temperature mesophilic digestion phase (acetogenic and methanogenic steps) for conversion into biogas (methane).
The thermophilic and mesophilic digesters are steel bolted tanks with complete mixing systems using both a nozzles system and external chopping pumps for ease of servicing. These digestion reactors are optimized to minimize thermal losses, reduce foam production, control rapid rise conditions, and remove floating residue deposits. A brochure of Veolia’s BioMET co-digestion process and related reference application information is provided at the end of this Section 3 as Appendix 3-4, with relevant case studies of Veolia’s Artois’ Methanization Facility in Graincourt, France, and the biogas plant in Lodl, Italy.

BioCon™ Belt Drying Technology

Another key unit process for the planned New Bedford O2E Facility for achieving production of a marketable fertilizer product from the dewatered digestate is indirect heat drying via Veolia’s BioCon™ belt drying technology. Veolia developed the BioCon™ dryer system to be the safest, simplest, and most efficient thermal drying system on the market today. Special consideration was taken during the development of the BioCon™ dryer system to ensure flexibility, while minimizing noise, odor, and dust production.

The BioCon™ belt drying system is built primarily of standard off-the-shelf equipment, simplifying operation and maintenance while reducing the need for stocking spare parts. The BioCon™ belt drying system can be placed in either parallel or series layouts, which adds flexibility to design considerations.

The BioCon™ belt drying systems are designed to be efficient and environmentally friendly using the following design aspects of moisture evaporation at relatively low temperatures (e.g., 300 to 350 Deg F), utilization of indirect heating of drying air via a closed loop of hot thermal oil and operation of the drying cabinet under negative pressure to prevent process air from escaping into the building surroundings.

The BioCon™ belt dryer unit is the safest biosolids thermal processing unit on the market as the highest temperature in the drying cabinet is approximately 355 °F as the biosolids enters the unit. Temperature is reduced in the end zone well below the ignition temperature of dried biosolids, in which the BioCon™ dryer unit also empties itself during shutdown periods. Dust generation is minimized by the gentle material handling within the dryer cabinet as controlled by the slow-moving belts and the single pass-through flow scheme, without dried product agitation and/or recycle back through the drying process.

The BioCon™ belt dryer uses a high exchange rate of the drying air to minimize gas in the dryer. For additional safety measures, the BioCon™ belt dryer is equipped with several safety features. Strategically-placed temperature switches will activate the sprinkler system if the drying air temperature rises above high temperature set points. Temperature detectors are connected to the SCADA system, which issue an alarm if temperatures reach preset levels. The dryer cabinet also contains infrared level switches and belt speed velocity switches to detect if biosolids
are not properly moving through the system. The BioCon™ dryer system does not require a fugitive dust control system, as particulates that fall through the belt on the dryer are collected in areas in the bottom of the dryer cabinet and the bag station does not require dust control. The BioCon™ dryer cabinet is also equipped with a water sprinkling system for quenching of any sparks.

As illustrated in the BioCon™ belt drying process flow schematic overview (as Figure 3-5) below, the dewatered cake is pumped into the drying system from a storage bin via progressive cavity pumps and into the unit via oscillating depositors on the top of the slow-moving belt at the top of the dryer cabinet.

**Figure 3-5:** Process Schematic Overview of the BioCon Belt Dryer Unit for Biosolids Thermal Drying

The BioCon™ dryer cabinet is insulated and contains the core components of biosolids depositing nozzles and drying belts. As illustrated in Figure 3-5, biosolids are deposited onto the first dryer belt through rubber nozzles where it will be dried to a minimum solid content of 50 percent DS, avoiding the sticky phase. At the end of the first belt, the biosolids fall to a second belt where the biosolids are dried to a minimum of 90 percent DS. The dried biosolids are then transported out of the dryer by a screw conveyor.

The thermal energy for the BioCon™ drying process is most efficiently supplied by use of a closed-loop hot thermal oil pumping system heater and heat exchanger. The drying air is heated indirectly in all cases. The energy is transferred from the heat exchanger to the drying air via circulation fans. A portion of the circulation air is sent through a vertical surface condenser and/or condensing heat exchanger to remove water vapor absorbed from the biosolids drying process. The condenser water will be treated in the on-site liquid waste sidestream treatment system. The thermal energy required for effective moisture evaporation in the BioCon™ drying process is very efficient and results in no combustion by-products exhaust. The exhausted foul air volume for odor control is quite low when compared to other dryers.

Provided as Appendix 3-5 is a brochure of the BioCon™ belt drying technology, as well as some relevant case studies of its application in the United States at Buffalo, Minnesota; Lynwood, Washington; and Western Wake in Cary, North Carolina.
ANITA™ Mox MBBR Treatment Technology

Another key unit process for the planned New Bedford O2E Facility is the on-site liquid waste treatment for meeting the specified effluent discharge limits for COD, TSS, pH, NH₃-N, and Total-Nitrogen (TN) to the City's sewer collection system for ultimate treatment and disposition at the New Bedford Wastewater Treatment Plant. An efficient and effective side-stream treatment of liquid wastes from anaerobic co-digestion and thermal drying systems is Veolia's ANITA™ Mox Moving-Bed Biofilm Reactor (MBBR) technology system. It is a single-stage nitrogen removal process that combines aerobic nitritation and anoxic ammonia oxidation.

As a single-stage nitrogen removal process, the ANITA™ Mox process is specifically designed for treatment of waste streams with high ammonia concentrations. It can achieve ammonia typical removals of up to 80 to 90 percent and total nitrogen removals of up to 75 to 85 percent. The treatment method uses only 40 percent of the oxygen demand of conventional nitrification, and it requires no external carbon source. The aerobic and anoxic reactors occur in the single MBBR reactor system, which is equipped with specially designed plastic media carriers that support the biofilm, thereby preventing washout of the bacteria from the reactor.

More specifically, the ANITA™ Mox deammonification process consists of an aerobic nitritation reaction and an anoxic ammonia oxidation (anammox) reaction. As mentioned previously, the two steps take place simultaneously in the reactor. Nitritation occurs mainly in the mixed liquor suspended solids (MLSS) developed by the clarifier RAS, while the anammox reaction occurs in the biofilm layer on the media. Approximately 55% of the influent ammonia-nitrogen (NH₃-N) is oxidized to nitrite-nitrogen (NO₂-N) by ammonia oxidizing bacteria (AOB).

The anammox population uses the nitrite produced and the remaining ammonia and converts them to nitrogen gas (N₂) and a small amount of nitrate-nitrogen (NO₃-N). In the cases of very low Total Nitrogen (TN) concentration levels for discharge requirements, a second-stage reactor unit is used for expanded denitrification to convert higher levels of the NO₃-N to N₂ gas. This very well may be the required design scenario for the planned O2E SPF.
The core and innovative technology approach of the ANITA™ Mox process as a continuous flow liquid waste (sidestream) treatment system is its non-clogging biofilm reactor containing carrier elements or a moving-bed of media. The media flows with the water currents in the reactor and does not require backwashing or cleaning. The reactor effluent flows into a clarifier where the solids are settled and either returned to the bioreactor or removed from the system via wasting. The anammox biomass that treats the wastewater is attached to the surfaces of the moving bed media.

The moving-bed media is designed to provide a large protected surface area for the biofilm and optimal conditions for biological activity when suspended in the wastewater. Media of different shapes and sizes provide flexibility to use the most suitable type depending on wastewater characteristics, discharge standards, and available volumes. AnoxKaldnes media is made from polyethylene and has a density slightly less than water. The anammox biomass on the AnoxKaldnes media is retained in the reactor by media screens. This biomass retention is an important characteristic of the system, since the anammox bacteria growth rate is very slow when compared to conventional wastewater bacteria growth rates.

Veolia has substantial experience in the specialty design of high-strength ammonia and soluble COD liquid waste and related sidestream treatment systems at organic processing plants and industrial wastewater treatment plants. The application of flow and loading equalization, followed by the ANITA™ Mox MBBR system with treated effluent polishing via the Hydrotech Discfilter unit, as an effective liquid waste treatment technology package. Provided as Appendix 3-6 is a Veolia brochure on the ANITA™ Mox MBBR technology and a relevant case study of a system in South Durham, North Carolina.

**Biogas Cleanup and CNG Upgrading Technology**

As highlighted previously in this Section 3 on the PACE Energy, LLC, project team’s planned technical approach for using cleaned biogas for either vehicle fuel as CNG via a virtual pipeline distribution approach and/or upgrading to pipeline quality methane as a grid injected RNG product, there are core processing solutions and strategic vendors to be considered and incorporated into the scope package.

One such group is the Byfield, Massachusetts-based group, BioSpark Clean Energy. BioSpark is a strategic vendor on other B2E/O2E projects for Veolia as well as the larger project team members of PACE Energy, LLC. BioSpark’s biogas cleaning and upgrading system is capable of treating the 550 to 700 scfm of projected biogas from the co-digestion systems via dual-train skid-mounted systems which, at an inlet pressure of approximately 7 psig, can supply a BioCNG system for vehicle fueling or upgrading for pipeline injection.
The AD biogas would be treated in a multi-stage process to remove moisture, hydrogen sulfide (H₂S), siloxanes, and VOCs before stripping out carbon dioxide (CO₂) and any other non-methane gases. The core and proven technology package for biogas cleaning by BioSpark is to effectively and efficiently remove the moisture, H₂S, and siloxanes. The removal system typically consists of vertical tanks filled with media by a specialty vendor as delivered in half ton supersacks and loosely filled from the topside. The BioSpark gas compression and moisture removal system is a containerized system with ancillary equipment (e.g., chiller and piping, heat exchange tower for moisture removal, particulate filter, etc.). Multiple siloxane removal tanks are installed on a common skid with interconnecting (lead/lag) piping. Siloxane removal (activated carbon) media are also delivered in half ton supersacks and loosely filled from the topside of the tank vessels.

The stripping of CO₂ and other inert (non-methane) gases is typically accomplished by either pressure swing adsorption (PSA) or use of membrane separation. Based upon the size and potential fluctuating flow of cleaned-up biogas for upgrading to BioCNG, the PACE Energy, LLC, project team envisions using membrane separation for the removal of CO₂ and other inert gases. A two-stage membrane stripping system as mounted on a common skid and complete with first-stage tail gas piping, enclosed flare, second-stage tail gas piping, and associated interconnecting piping. The CO₂ membrane cartridges are vertically mounted in parallel racks for each of access and periodic change-out.

An alternative biogas conditioning system is the Greenlane Biogas Treatment System as provided by Unilever, a global company that makes equipment and sells technology under more than a thousand brand names worldwide. As illustrated in Figure 3-6, this biogas cleaning and refining system includes a water chiller, scrubbing and stripping vessels, as well as compression and control systems.

**Figure 3-6:** Graphical Illustration of a Typical Biogas Cleaning and Upgrading System for CNG/RNG
CNG Transportation Tube Trucks and CNG Fuel Distribution Units

During the RFP phase of New Bedford’s O2E Facility project, the PACE Energy, LLC, project team will further evaluate the most technically reliable and economically favorable technical approach for the additional upgrading of the conditioned biogas for vehicle fuel (as CNG) or pipeline injection (as RNG).

If the optimal pathway for using the cleaned/conditioned biogas is CNG as vehicle fuel to other regional customers (beyond the City's municipal vehicle fleet and/or ABC Disposal's adjacent CNG filling station to the DPI Site), the PACE Energy, LLC, project team has a strategic vendor relationship with Compass Natural Gas, LLC, to implement a virtual pipeline or mobile transportation program via trucks and trailers for distribution to end customers.

Trailers specifically designed as nationally rated vessels can carry 325 MCF (or 325,000 standard cubic feet) at a nominal pressure of 3,600 psi. The conditioned biogas must undergo additional compression to more than 3,600 psi (via electric-driven reciprocating compressors) to match the capacity of the specialty-design trailers (typically by Hexagon-Lincoln, a worldwide provider of this trailer designed technology as also commonly hauled by CNG power semi-trucks). The normal filling time for a tube trailer ranges from 12 to 20 hours, dependent upon the flow rate of the CNG filling station.

The cleaned/conditioned biogas must meet the gas refinement and quality specifications (SAE J1616 Standards) for use as BioCNG vehicle fuel and/or grid-injection RNG product. The upgrading and refining of cleaned biogas to pipeline quality or vehicle fuel quality is uniquely defined by the quality metrics typically found in a gas producer’s tariff with the Federal Energy Regulation Committee (FERC).
As such, the cleaned-up biogas flows through a double-block and bleed shut-off valving system for safety and emergency shut-off, as well as metering and pressure regulation to control and protect the dryer for removal of moisture to less than 2.0 pounds of water vapor per million cubic feet of biogas. The reciprocating compressors then boost the pressure to more than 3,600 psi for storage and trailers filling via ports at connection points to the tube trailers. As shown previously in Figure 3-6, these units are housed in cold-weather containers and mounted on vibration isolation platforms to reduce the possibility of CNG/RNG line breakage at the tube truck filling station and accommodate seismic activity.

The CNG dispenser will operate like a typical gasoline dispenser in various configurations for truck filling. The dispenser typically has a keypad for ease of operations and tracking dispensed volumes of BioCNG. Hexagon-Lincoln uses composites as their pressure vessel material for hauling the CNG in tubes on their trailers, and thus, can meet the weight requirements on major North American roadways and highways.

These tube trailers can then be connected via high pressure to a stationary or mobile fuelling station. Compass Natural Gas, LLC, has mobile units (called CNGP Pathfinder trucks) that safely dispense BioCNG at rates of 8 to 16 gasoline gallon equivalents (GGE) per minute. Typical fuel tanks on fleet vehicles are 40 GGE or 90 GGE, thus yielding a quick turnaround time for the end user. The illustration photo below of the CNGP Pathfinder shows a cutaway version of the trailer unit. It contains multiple safety zones used to isolate components and thereby reduce the hazard level of the filling site for BioCNG distribution to end users. These customer-serving vehicles occupy a small mobile footprint for product staging and end use.
SECTION 4 - ADDED VALUE COMPONENTS

This project is a regional organics-to-energy sludge processing facility (O2E Facility) that supports New Bedford and surrounding communities such as Fall River and Brockton. The project will allow the City of New Bedford to develop a green bioenergy system that will divert organic materials from landfills and enhance the production of renewable fuels. The O2E Facility will provide reserve capacity to treat local and regional fats, oils, and grease (FOG). This will limit FOG discharges to local wastewater treatment plants, improving operations and treatment efficiencies. Additionally, the supplementation of FOG to the anaerobic digestion process will further amplify biogas generation and renewable compressed natural gas production. The dried digestate from the facility will be marketed as an organic fertilizer, which will lead to more sustainable farming operations in the local community. Overall, the O2E Facility provides a closed-loop process to repurpose existing wastes to generate value-added products that will provide economic and environmental benefits to the City of New Bedford and surrounding communities.

The conversion of the biogas to renewable natural gas (RNG) for vehicle fueling provides added environmental benefits beyond the economic considerations of a lower fuel cost. The RNG burns cleaner, reducing emissions and providing a significant enhancement to regional air quality over traditional gasoline and diesel vehicles. Vehicle owners also report increased vehicle life, further reducing carbon emissions.
SECTION 5 – SCHEDULE FOR FACILITY DEVELOPMENT, PERMITTING, DESIGN, FINANCING, DESIGN/CONSTRUCTION, AND OPERATION

With the development of a project financial model meeting minimum economic requirements, the identification of numerous sources of interested feedstock, and the development of a suitable off-take, the proposed O2E Facility could be feasible. If the City would elect to pursue a public-private partnership for this project, the anticipated timeline for the PACE Energy, LLC, project is as follows:

<table>
<thead>
<tr>
<th>Task</th>
<th>Anticipated Completion after Project Initiation</th>
</tr>
</thead>
<tbody>
<tr>
<td>City Decision to Proceed with Public-Private Partnership</td>
<td>Project Initiation</td>
</tr>
<tr>
<td>Development and Negotiation of Agreements with Key Feedstock Vendors and Fuel Purchaser to Confirm Project Economics</td>
<td>6 months after project initiation</td>
</tr>
<tr>
<td>Redevelopment of Project Economic Model and Capital/Operating Costs</td>
<td>9 months after project initiation</td>
</tr>
<tr>
<td>Execution of Lease Agreement and Project Agreement with City</td>
<td>12 months after project initiation</td>
</tr>
<tr>
<td>Submission of Key Permits for Project Execution</td>
<td>12 months after Project Initiation</td>
</tr>
<tr>
<td>Receipt of Key Permits for Project Execution</td>
<td>18 months after project initiation</td>
</tr>
<tr>
<td>Initiate Construction</td>
<td>24 months after project initiation</td>
</tr>
<tr>
<td>Completion of Construction</td>
<td>48 months after project initiation</td>
</tr>
<tr>
<td>Completion of Commissioning Period</td>
<td>50 months after project initiation</td>
</tr>
<tr>
<td>Initiation of Commercial Operations</td>
<td>50 months after project initiation</td>
</tr>
</tbody>
</table>

As in all projects within a regulatory and legal framework, the project team’s goals would be to conclude in advance of the above anticipated completion dates; however, this represents a realistic schedule for completion of the tasks considering governmental approval cycles, availability of equipment, and the schedule for the construction of an advanced organics material processing facility.
SECTION 6 – INTENT TO USE, OR NOT USE, THE EXISTING INCINERATOR BUILDING, TRANSFER STATION, AND/OR ANY EQUIPMENT

The initial intent is to leave the existing incinerator building in place. If the PACE Energy, LLC, project team discovers during the RFP stage the incinerator building will be repurposed, we will follow all local, state, and federal regulations to ensure the building is safe for continuous operations. The transfer station and septage receiving facility will remain in place and will not impact construction or operations.
SECTION 7 – CONSTRAINTS

Given the conceptual nature of the proposed O2E Facility and the uncertain economic constraints at this time, the PACE Energy, LLC, project team did not contract with a Massachusetts consultant to develop a permit-specific approach. However, by focusing on the O2E Facility on biosolids, FOG, and septage, this reduces the overall project burden and the considerations for co-digestion of food waste. There are no known project constraints or technology implementations that would be considered novel in Massachusetts permitting. The PACE Energy, LLC, project team believes the project schedule has sufficient slack to accommodate meetings and regulatory interaction for a successful implementation.

As mentioned in Section 6, the proposed project will not involve demolition of the existing incinerator building. At this time, the proposed plan is to leave the incinerator building in place, which will not impact the O2E Facility operations. If the incinerator building is repurposed, asbestos containing material (ACM), PCBs, and/or lead-based paint will be removed according to industry standard and local, state, and federal regulatory requirements. Repair of gas leaks at the adjacent landfill are not included within the scope of the proposed project. These issues are expected to be solved by responsible parties prior to construction.
SECTION 8 – KEY REFERENCE FACILITIES

The PACE Energy, LLC, project team provides the following list of reference facilities that have been successfully undertaken with respect to co-digestion of biosolids and FOG for the production of bio-energy and beneficial use solids products. As detailed herein, the team members of Veolia and RETTWEB detail several relevant O2E and biosolids-to-energy (B2E) projects that closely match the planned O2E Facility for New Bedford. Highlights of these relevant projects and reference facilities are provided in the following sub-sections with key attributes provided in summary tables. More detailed information with respect to organic wastes processing capacity and operations, as well contact information and some cost data are provided in the key project profiles and case studies as attachments to this Section 8.

The key reference facilities for the PACE Energy, LLC, project team are listed in Table 8-1:

Table 8-1. PACE Energy, LLC, Project Team’s Key Reference Projects and Facilities

<table>
<thead>
<tr>
<th>Reference Facility (location)</th>
<th>Service Contract (type)</th>
<th>Key Features (scope)</th>
<th>Project Overview / Facility Summary (description)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C.H. Nickerson</td>
<td>Construction</td>
<td>Wastewater Facilities</td>
<td>Construction of new structures and buildings, and facilities upgrades to the 5 65-mgd WWTP (including biosolids processing equipment)</td>
</tr>
<tr>
<td>Farmington WPCF – Farmington, Connecticut</td>
<td>Construction</td>
<td>Biosolids and Odor Control</td>
<td>Expansion and upgrades to the 80-mgd WWTP, which includes modifications to biosolids pumping/dewatering, 2.5 MW CHP, and odor control (fans and biofilter system)</td>
</tr>
<tr>
<td>Hartford WPCF – Hartford, Connecticut</td>
<td>Construction</td>
<td>Water Treatment</td>
<td>Joint-venture partner in the design-build delivery of a 30-mgd water treatment plant</td>
</tr>
<tr>
<td>Stamford WTP – Stamford, Connecticut</td>
<td>Design-Build</td>
<td>BioCon™ Belt Dryers &amp; Pellet Mill</td>
<td>18.0-mgd municipal WWTP using natural gas as thermal energy for belt drying of cake biosolids into EQ/Class A dried granules/pellets</td>
</tr>
<tr>
<td>Kruger (VWT)</td>
<td>DBFOM (2012)</td>
<td>Ecursor® and BioMET AD</td>
<td>Diversified food waste streams (packaged and slurry organics) for co-digestion with FOG and biosolids via thermophilic/mesophilic AD, CHP</td>
</tr>
<tr>
<td>Artois’ Methanization Plant – Graincourt, France</td>
<td>Design / Equipment (2013)</td>
<td>ANITATM Ox MBBR</td>
<td>Wastewater sidestream treatment of digestion returns by single-stage MBR unit</td>
</tr>
<tr>
<td>Western Wake WWTP – Cary, North Carolina</td>
<td>Design / Equipment (2013)</td>
<td>O2E Facility</td>
<td>Co-digestion (thermophilic/mesophilic) of food waste and biosolids at a 7.7-mgd WWTP, biogas for 0.5 MW CHP, biosolids beneficial use</td>
</tr>
<tr>
<td>Hermitage Municipal Authority – Mercer County, Pennsylvania</td>
<td>Design / Permitting / O2E Start-Up</td>
<td>B2E Facility</td>
<td>120-DPTD biosolids-to-energy (B2E) plant via biological THP and AD, EQ/Class A cake solids 570 cfm biogas upgrade to 425 cfm of RcnG</td>
</tr>
<tr>
<td>Middlesex County Utility Authority – Sayreville, New Jersey</td>
<td>DBFOM</td>
<td>CNG Terminal</td>
<td>Turn-key delivery of 20 MM scf/day CNG filling station for 350,000 sf transportation trailers. Phase I facility includes a 4 bay fueling station.</td>
</tr>
</tbody>
</table>

Veolia Water
### Table 8-1. PACE Energy, LLC, Project Team’s Key Reference Projects and Facilities

<table>
<thead>
<tr>
<th>Reference Facility (location)</th>
<th>Service Contract (type)</th>
<th>Key Features (scope)</th>
<th>Project Overview / Facility Summary (description)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Artois’ Methanization Plant – Givencourt, France</td>
<td>DBFOM</td>
<td>O2E Facility</td>
<td>Diversified food waste streams (packaged and slurry organics) for co-digestion with FOG and biosolids via thermophilic/mesophilic AD, CHP</td>
</tr>
<tr>
<td>Gresham WWTP – Gresham, Oregon</td>
<td>O&amp;M</td>
<td>O2E Facility</td>
<td>Co-Digestion of FOG and food waste with 9.5-dtpd of biosolids for biogas use in CHP (zero net energy achieved for the 20-mgd WWTP)</td>
</tr>
<tr>
<td>South Pest WWTP – Budapest (South), Hungary</td>
<td>Design and O&amp;M</td>
<td>O2E Facility</td>
<td>Diversified food waste streams (packaged and slurry organics) for digestion with FOG and biosolids (thermophilic / mesophilic AD), CHP</td>
</tr>
</tbody>
</table>

#### Key O2E Projects and Reference Facilities

The PACE Energy, LLC, project team and, more specifically, RETTEW and Veolia have extensive capabilities and experience in the planning, development, and integrated implementation of organic materials processing from the municipal solid waste stream (e.g., FOG, food wastes, and other source separated organics) with municipal biosolids to produce biogas as a renewable energy for reuse in strategic applications of CHP, RNG, RNG, and thermal heat recovery. Veolia operates more than 20 organics co-digestion projects globally and several in North America. These co-digestion plants process both municipal biosolids and other organic waste streams (primarily FOG and food wastes). The biogas produced is cleaned and efficiently converted into bio-energy products, namely CHP plants. The digestate solids are typically dewatered and further processed via composting or thermal drying.

RETTEW and Veolia have been selected to implement a large B2E project via a DBFOM contract with the Middlesex County Utilities Authority (MCUA) in New Jersey. Preliminary design engineering has commenced to proceed with permitting of a 100 DTPD B2E facility at MCUA’s 147-mgd central wastewater treatment plant in Sayreville, New Jersey. The new B2E facilities will include biosolids thickening, biological thermal hydrolysis, FOG co-digestion, dewatering, and cake beneficial use for alternative daily cover (ADC) material at the Middlesex County Improvements Authority (MCIA) landfill, with biogas cleanup and upgrading for pipeline injection as renewable natural gas (RNG). This very comparable and large-scale B2E project includes a two-year design-build period, followed by a 25-year O&M period.

Veolia uses its FW/SSO depackaging and mixing technology, Ecru sor™, for pre-treatment of the organic materials for Integration with thickened biosolids and co-stabilization in Veolia’s BioMET™ co-digestion process (a two-stage anaerobic digestion system of thermophilic and mesophilic treatment). The digested and dewatered solids are often thermally dried by Veolia’s BioCon™ belt drying system, which used indirect heating (via hot air from the re-circulation of thermal oil) for the production of dried granules for beneficial uses as agricultural soil amendment, potting media, and organic fertilizer.

The biogas is then strategically used for producing on-site heat and power (CHP) or further processed (cleaned and compressed) into bio-energy fuel products (e.g., vehicles CNG and/or grid quality RNG).
Five key relevant projects that best demonstrate the PACE Energy, LLC, project team’s proven capabilities and experience in integration of organic materials with biosolids for co-digestion at municipal wastewater treatment plants or via stand-alone organic processing facilities are:

1) Artol’s Methanization Plant in Graincourt, France
2) Gresham Wastewater Treatment Plant in Gresham, Oregon
3) Hermitage Utility Authority in Hermitage, Pennsylvania
4) Renewable Energy Biosolids Facility in Wilmington, Delaware
5) South Pest Wastewater Treatment Plant in Budapest, Hungary.

As highlighted below in Table 8-2, these completed and operational O2E projects include co-digestion of municipal biosolids and other organic materials (FOG and food wastes) into bio-energy and beneficial use solids products. They are further described herein, with additional details provided in project profiles or case study material, as appendices.

<table>
<thead>
<tr>
<th>AD / Bioenergy Projects (location)</th>
<th>Organic Materials (type)</th>
<th>Biosolids (DTPD)</th>
<th>Co-Digestion and Bioenergy (processing description)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Artol’s Methanization Plant – Graincourt, France</td>
<td>FOG, Food Waste, Beverages, Commercial, and Industrial Wastes</td>
<td>28</td>
<td>FOG and FW co-digestion via thermophilic / mesophilic AD and biogas co-generation to produce 8,000 MWh of electricity and 27,000 MMBtu of heat annually, and Class A solids via composting for beneficial use on farmland</td>
</tr>
<tr>
<td>Gresham WWTP – Gresham, Oregon</td>
<td>FOG and Food Wastes</td>
<td>9.5</td>
<td>FOG pre-treatment, biosolids co-digestion and biogas for hot water and 0.8 MW of CHP</td>
</tr>
<tr>
<td>Hermitage Utility Authority – Mercer County, Pennsylvania</td>
<td>FOG and Food Wastes</td>
<td>15</td>
<td>FW depackaging, thermophilic hydrolysis, co-digestion, and biogas for 0.5 MW of CHP</td>
</tr>
<tr>
<td>Renewable Energy Biosolids Facility – Wilmington, Delaware</td>
<td>FOG and Septage</td>
<td>30</td>
<td>FOG pumping, co-digestion (mesophilic AD), centrifuging dewatering, thermal drying and biogas for 4.0-MW of co-generation (CHP)</td>
</tr>
<tr>
<td>South Pest WWTP – Budapest (South Hungary)</td>
<td>FOG, Food Wastes, and Packaged SSO</td>
<td>41</td>
<td>FOG/FW co-digestion with thickened biosolids via thermophilic / mesophilic AD, and biogas clean-up for 1.5 MW of co-generation (CHP)</td>
</tr>
</tbody>
</table>

**Artol’s Methanization Plant in Graincourt, France**

In 2012, Veolia commissioned its stand-alone Artol’s Methanization Plant in Graincourt, France. This O2E plant receives biosolids and other organic HSW (FOG, food waste, beverages, commercial and industrial wastes) for conversion into biogas, bio-energy, and Class A solids via composting. In 2011, construction started on the Artol’s anaerobic digestion facility and CHP plant, representing an investment of more than $10.3 million (with $1.4 million provided by the EU through the European Regional Development Fund and $389,000 from the Environment and Energy Management Agency, ADEME).

Sede Environnement, a subsidiary of Veolia Environnement (our global parent company), has owned the Artol’s food waste anaerobic digestion and open-air static pile/windrow composting site in Graincourt-les-Havrincourt, to the southeast of Arras, France, since 2000. Originally this 8.5-hectare site was used exclusively for static pile...
composting of municipal wastewater biosolids in the area and has been expanded for regional organics processing, digestion, and a CHP plant.

Veolia delivered the new O2E methanization facility using a design/build/operate/maintain (DBOM) contract with Graincourt. The Veolia owned and operated O2E facility has a total solids processing capacity of 50,000 tons per year, with an integrated technology system to handle 25,000 tons per year of source-separated organic matter (SSOM).

This stand-alone facility covers an area of 2.2 acres, and represents a turn-key O2E project that began processing all types of organic waste in 2012. This includes wastes from agriculture (biomass, endive roots, etc.), industry (biological sludge and floating greases, rejects, meat waste, and FOG from catering), municipalities (grass cuttings, canteen leftovers, wastewater biosolids), as well as the local commercial sector for organic materials (FOG, solid food wastes, and packaged beverage liquids).

The Artois' methanization anaerobic digestion facility uses Veolia's to extract the organics from the mixed organic streams. The system features a multi-receiving tank mixing and storage of the organic soup. The pretreated organic material is then pumped to Veolia's BioMET™ co-digestion process (which comprises a first-stage thermophilic hydrolysis treatment, followed by second-stage mesophilic anaerobic digestion). The methane produced by these organic materials at the Artois methanization anaerobic digestion plant is cleaned and used in a CHP system to generate enough electricity to meet the needs of more than 6,500 people. The recovered thermal energy as heat from the CHP plant is beneficially used on site for the co-digestion process.

The BioMET™ co-digestion process generates 7,000 metric tons of digestate that is dewatered and composted on site, and the product is beneficially used as an organic soil amendment on regional farmland. The Artois composting and anaerobic co-digestion site also demonstrates the excellent collaboration between Veolia's different activities. The process equipment was supplied by STI, a Veolia subsidiary, while Sede Environnement group, also a Veolia subsidiary, provides the O&M services. A detailed project summary is profiled and provided in Appendix 8-1.

The link provided below is to a video presentation that details the operations of Veolia's Artois Methanization process in Graincourt, France: https://www.youtube.com/watch?v=4dS2dHouTU
Gresham Wastewater Treatment Plant - Gresham, Oregon

In partnership with the City of Gresham, Veolia planned and implemented a phased O2E program via FOG and food waste co-digestion with biosolids at the 20-mgd Gresham Wastewater Treatment Plant. Veolia has been the O&M services provider for the City at their wastewater treatment plant since 2005. The annual average wastewater treatment plant flow is 13-MGD with a daily biosolids production of 9.5 DTPD, which is anaerobically digested and dewatered. In 2012, Gresham initiated the first phase of an O2E solution by implementing FOG co-digestion with biogas use for CHP to achieve 55 percent energy sustainability at the wastewater treatment plant. As a result of the success of FOG supply, as well as piloting of other source-separated organics (SSO) as liquid and slurry food wastes, a second phase to the O2E program was successfully implemented in 2014. The capacity of the organic materials feedstock receiving and storage facility was doubled from 20,000 gallons to 40,000 gallons.

A second 400-KW engine generator was installed. In combination with the City’s installation of a 295 kilowatt solar array, which yields a peak of 420 KW, the Gresham Wastewater Treatment Plant became net zero energy in March 2015. The collaboration of Gresham and Veolia has enabled the wastewater treatment plant to not only sustain its net zero energy status, but now it has become an positive net energy facility with sales of surplus electricity.

Veolia’s reliable operations of the City’s O2E program at its wastewater treatment plant has successfully maintained the 100 percent power sustainability as just the third wastewater treatment plant in the United States at that time to achieve this accomplishment. The Gresham facility has been recognized by the American Biogas Council (ABC) for national O2E awards. A detailed project summary of Gresham’s O2E achievements is profiled in Appendix B-2.

Hermitage Municipal Authority – Mercer County, Pennsylvania

In 2014, RETTEW designed the advanced anaerobic digestion complex at the 7.7-mgd wastewater treatment plant in Mercer County for the Hermitage Municipal Authority. The new O2E facility uses temperature-phased (thermophilic hydrolysis followed by mesophilic stabilization) anaerobic digestion to produce a biogas for cogeneration and electricity use. The anaerobic digestion biogas is 65 percent methane content and it is collected, stored, and purified before being used at the 0.5 MW CHP plant. The Hermitage Municipal Authority now exclusively relies upon its own power generation as a result of an expanded co-digestion process via the import and co-processing of packaged and bulk food wastes with its biosolids.
The Authority accepts a wide array of packaged and bulk containerized food wastes, including grease, beer and wine, dairy products, vegetables, and other expired products (e.g., honey). RETTEW designed a food de-packaging system to enable the co-processing of more than 3,000 tons per year of imported food wastes to yield an average increase in biogas production of nearly 20 percent and optimize the CHP plant. A project summary of the Hermitage anaerobic digestion and food depackaging systems is provided as Appendix 8-3.

**Renewable Energy Biosolids Facility - Wilmington, Delaware**

Veolia has operated the 134-mgd Wilmington Water Pollution Control Facility (WPCF) for more than three decades. The company’s contract services include the long-term O&M of the WPCF, pumping stations and the start-up/commissioning of the 3G-DTPD renewable energy biosolids facility (RWEBF). Veolia’s scope of O&M services includes the WPCF and all of its biosolids processing systems (thickening, anaerobic digestion, dewatering, thermal drying, and final disposition of EQ/Class A biosolids to beneficial end users and customers. Veolia worked with the City on the conceptual design of a B2E solution and then actively supported the City’s ESCO partner in their design-build installation of the REBF on the footprint of the Wilmington WPCF.

Veolia was hired by the ESCO contractor to provide startup and commissioning services for the $35 million REBF to achieve 90 percent energy sustainability of the WPCF via dual use of cleaned anaerobic digestion biogas and adjacent landfill gas to two 2.0-MW cogeneration units. Heat recovery from the CHP facility within the REBF is used to heating hot water for the AD process, as well as hot thermal oil for the indirect thermal dryer.

FCG is co-pumped with the wastewater influent to the WPCF, as well as septage solids receiving at the treatment plant. All of these organic residual solids are co-processed via five mesophilic anaerobic digesters (MADs) for solids stabilization and then dewatered via two high-solids centrifuges for belt conveyance to the REBF for thermal drying via the single-train in-direct dual-screw heat drying unit. The dried granules are stored in a vertical silo for rapid filling of trucks for beneficial use to land application.

Veolia maintains a strong OSHA compliance record, meeting the requirements for environmental health and safety and the WPFC and including the REBF. Veolia’s performance has maintained an excellent compliance record over three decades of contract O&M performance, including being a co-permittee of the National Pollutant Discharge Elimination System (NPDES) Permit for the WPCF with the City of Wilmington. This large wastewater treatment and Class A biosolids project has been a recipient of Gold and Silver Peak Performance Awards from the National Association of Clean Water Agencies (NACWA), as well as a two-time recipient of EPA’s Region III Operations and Maintenance Excellence Award. A detailed project summary of the Wilmington WPCF and relevant biosolids processing facilities, including the new REBF is provided in Appendix 8-4.
South Pest Wastewater Treatment Plant - Budapest, Hungary

Veolia is a joint-owner of the concessionaire company (Budapest Sewage Works) with the Municipality of Budapest. Under this ongoing partnership, the company has provided planning, development, and operational implementation of a re-engineering program, with a focus to achieve energy autonomy at the 21-mgd South Pest Wastewater Treatment Plant. Veolia has been successfully operating this project since 2004, which has required considerations of biosolids processing with the liquid treatment train during periods of design and construction. The South Pest Wastewater Treatment Plant now achieves nearly 86 percent electrical autonomy by processing 41-DTPD of biosolids into biogas for co-generation of green power.

In 2007, Veolia undertook a plant re-engineering program, which involved designing and implementing various energy efficiency improvements projects, including a new B2E program. That work involved re-engineering the existing anaerobic digestion system to include co-digestion of source separated organics (FOG and food wastes) and biogas resource recovery for on-site cogeneration of electricity. Working with a team of contractors and subcontractors, Veolia completed the design-build and commissioning of the B2E facility to achieve a 20 percent reduction in wastewater treatment plant electrical consumption and more than 40 percent increase in digesters biogas production. The B2E facilities included Veolia’s Ecrusor® FW de-packaging/mixing system and the BioMETH Co-Digestion process as a two-stage stabilization system of thermophilic/mesophilic treatment of the organic materials to produce a cake solid for composting. A detailed project summary of the South Pest B2E facilities is profiled and provided in Appendix 8-5.
Experience in Organic Materials Processing Technology and Design

The PACE Energy, LLC, project team, via Veolia Water Technologies (VWT) has extensive capabilities and experience in the process design and technology supply of organic materials processing to stabilize the solids for conversion into reusable products and bioenergy. VWT provides core process design and technology supply services, as an integrated team member within the design-build consortiums for the turn-key delivery (e.g., DBFOM) projects at municipal wastewater treatment plants, as well as stand-alone organics processing plants and bio-energy facilities.

As previously highlighted, VWT has a suite of proprietary and patented technologies that are suitable for organic materials processing and conversion into bioenergy, which handle food waste feedstock, co-process with FOG and biosolids, enhance cake solids into dry granules as organic fertilizer, and compact/high-efficiency liquids treatment systems for managing solids plant wastewater streams, which often contains soluble organics, refractory solids and nutrients (e.g. nitrogen and phosphorus).

Table 8-3 below, highlights some key projects experience by VWT in North America and globally for the core technology and processing systems proposed by PACE Energy, LLC, for the Yarmouth OMPF project. As shown, these VWT technologies include the Ecurus™ depackaging/mixing system, BioMET™ co-digestion process, BioCon™ thermal (belt) drying, and the ANITA™ Mox sidestream treatment system.

| Table 8-3. VWT’s Key Projects of Organics Processing Technology at Bioenergy Plants |
|-----------------------------|-----------------------------|-----------------------------|-----------------------------|
| Technology Projects (location) | Service Contract (type) | Organics (TPY) | Processing System and Bioenergy Facility (technology description) |
| Artolis’ Methanization Plant – Graincourt, France | DBFOM (2012) | 32,000 | Diversified food waste streams (packaged and slurry organics) for co-digestion with FOG and biosolids via thermophilic/mesophilic AD, CHP |
| Nagykoros Biogas Plant – Gater duls (Southeast region) Budapest, Hungary | DBOM (2014) | 32,500 | Diversified food waste streams (packaged and slurry organics) for co-digestion with FOG and agricultural biowastes, dewatering and CHP |
| North Pest WWTP – Budapest (North) Hungary | DBOM (2010) | 50,375 | Agricultural biowaste mixing - homogenization and biosolids co-digestion via pasteurization and mesophilic AD, biogas cleanup and CHP |
| South Pest WWTP – Budapest (South) Hungary | Design and O&M (2007) | 20,375 | Diversified food waste streams (packaged and slurry organics) for digestion with FOG and biosolids via thermophilic/mesophilic AD, CHP |
| BioMET™ – Anaerobic Co-Digestion |
| Artolis’ Methanization Plant – Graincourt, France | DBFOM (2012) | 32,000 | Diversified food waste streams (packaged and slurry organics) for co-digestion with FOG and biosolids via thermophilic/mesophilic AD, CHP |

Key Reference Facilities 8-8
Table 8-3. VWT’s Key Projects of Organics Processing Technology at Bioenergy Plants

<table>
<thead>
<tr>
<th>Technology Projects (location)</th>
<th>Service Contract (type)</th>
<th>Organics (TPY)</th>
<th>Processing System and Bioenergy Facility (technology description)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Billund Biorefinery Plant –</td>
<td>DBFOM (2015)</td>
<td>40,000</td>
<td>Agricultural bio-waste and commercial food waste for co-digestion with industrial organics and biosolids via hydrolysis/thermophilic for co-digestion and production of biogas, CHP.</td>
</tr>
<tr>
<td>Billund, Denmark</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EAL-Compost Biogas Plant –</td>
<td>DBO (2017)</td>
<td>34,000</td>
<td>Organic fraction of solid waste co-digestion and biogas for CHP and digestion composting</td>
</tr>
<tr>
<td>Lodoli, Italy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>North Pest WWTP – Budapest (North), Hungary</td>
<td>Design and O&amp;M (2010)</td>
<td>50,375</td>
<td>Agricultural biowaste mixing-homogenization and biosolids co-digestion via pasteurization and mesophilic AD, biogas cleanup and CHP</td>
</tr>
<tr>
<td>South Pest WWTP – Budapest (South), Hungary</td>
<td>Design and O&amp;M (2007)</td>
<td>20,175</td>
<td>Diversified food waste streams (packaged and frozen organics) for digestion with FOG and biosolids via thermophilic/mesophilic AD, CHP</td>
</tr>
</tbody>
</table>

BioCon™ – Thermal (Belt) Drying

<table>
<thead>
<tr>
<th>Technology Projects (location)</th>
<th>Service Contract (type)</th>
<th>Organics (TPY)</th>
<th>Processing System and Bioenergy Facility (technology description)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffalo WWTP – Buffalo, Minnesota</td>
<td>Design / Equipment (2009)</td>
<td>1,850*</td>
<td>4.3-mgd municipal WWTP using heat recovery as thermal energy for belt drying of cake biosolids into E0/Class A dried granules</td>
</tr>
<tr>
<td>Picnic Point WWTF – Lynwood, Washington</td>
<td>Design / Equipment (2012)</td>
<td>2,470*</td>
<td>6.0-mgd municipal WWTP using natural gas as thermal energy for belt drying of cake biosolids into E0/Class A dried granules</td>
</tr>
<tr>
<td>Western Wake WWRF – Lynwood, Washington</td>
<td>Design / Equipment (2004)</td>
<td>2,920*</td>
<td>18.0-mgd municipal WWTP using natural gas as thermal energy for belt drying of cake biosolids into E0/Class A dried granules</td>
</tr>
<tr>
<td>Wlodawek WWTP – Wlodawek, Poland</td>
<td>Design / Equipment (2008)</td>
<td>3,750*</td>
<td>9.0-mgd municipal WWTP using digester biogas as thermal energy for belt drying of centrifuge cake biosolids into dried granules</td>
</tr>
</tbody>
</table>

ANITA™ Mox – Sidestream Treatment

<table>
<thead>
<tr>
<th>Technology Projects (location)</th>
<th>Service Contract (type)</th>
<th>Organics (TPY)</th>
<th>Processing System and Bioenergy Facility (technology description)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grinsted WWTP – Grinsted, Denmark</td>
<td>Design / Equipment (2002)</td>
<td>245**</td>
<td>Wastewater sidestream treatment of FW and biosolids co-digestion returns by MBBR unit</td>
</tr>
<tr>
<td>Holbaek WWTP – Holbaek, Denmark</td>
<td>Design / Equipment (2002)</td>
<td>265**</td>
<td>Wastewater sidestream treatment of digestion returns by single-stage MBBR unit</td>
</tr>
<tr>
<td>Locarno WWTP – Locarno, Switzerland</td>
<td>Design / Equipment (2014)</td>
<td>660**</td>
<td>Wastewater sidestream treatment of digestion returns by single-stage MBBR unit</td>
</tr>
<tr>
<td>Vaxjo WWTP – Sundets, Sweden</td>
<td>Design / Equipment (2012)</td>
<td>950**</td>
<td>Wastewater sidestream treatment of co- digestion returns by single-stage MBBR unit</td>
</tr>
</tbody>
</table>

Note: * dry tons per year of processed cake biosolids and ** lbs per day of nitrogen treated wastewater

Key case study examples of these VWT technology applications for Ecruor™ organic solids mixing, BioMET co-digestion, BioCon™ thermal drying, and ANITA™ Mox MBBR for sidestream treatment can be found in the appendices. These key O2E processing technology references (as also listed above in Table 8-3) include Veolia’s Artois Methanization Facility; South Pest Wastewater Treatment Plant in Budapest, Hungary; Buffalo Wastewater Treatment Plant in Buffalo, Minnesota; Picnic Point Wastewater Treatment Plant in Lynnwood, Washington; the Western Wake WWRF in Cary, North Carolina; and the South Durham WRF in Durham, North Carolina.
SECTION 9 – STATEMENT OF BENEFITS

The proposed technologies allow PACE Energy, LLC, to convert the byproducts (biogas and dried organic material) into valuable commodities such as renewable compressed natural gas and fertilizer. These commodities will provide a substantial percentage of the total revenue of the proposed D2E Facility. The remainder of the proposed revenue would be provided by the tipping fees for the Cities of New Bedford, Brockton, and Fall River and from commercial generators of FOG disposed on site. All environmental attributes and related commodities will be the property of the PACE Energy, LLC, project team.

The PACE Energy, LLC, project team will pay the City of New Bedford a portion of the revenue earned for renewable attributes for the RNG each year as a marketable byproduct related to profit sharing. The City shall be paid a portion of sales related to the D3 RIN (renewable attribute associated with biogas-derived compressed natural gas) above a certain threshold price. For example, if the threshold price is negotiated to $2.00 per D3 RIN, and the D3 RINs associated with PACE Energy, LLC’s, operations at the City of New Bedford were purchased at $2.50 per D3 RIN, the City would receive $0.50 per D3 RIN. The strike price would not be indexed yearly, so as D3 RIN prices increase, the City’s benefit would continue to increase. Note the RNG fuel price and the D3 RIN are both market-based commodities with market risk associated with the predicted pricing. The actual price for these commodities will vary and the resulting profit sharing will correspondingly fluctuate. Current pricing from recent market summation is attached as Appendix 9-1 for consideration on the D3 RIN Pricing.

Aside from significant economic benefits to the City of New Bedford, this project will provide environmental, operational, and logistical benefits to local communities. The proposed technology will limit the quantity of organic waste sent to landfills, reducing greenhouse gas (GHG) emissions and local water pollution. The production of renewable compressed natural gas will have multiple benefits. First, the renewable compressed natural gas (RcNG) can be supplied to existing CNG infrastructure in the City of New Bedford at low cost, which will improve operations and logistics in the City. If desired by the City of New Bedford, the PACE Energy, LLC, project team could install vehicle fueling for more CNG vehicles and sell RNG in a compressed form with high-volume, fast-fill technology. The use of RcNG will allow local vehicles to operate on a sustainable fuel, which will limit fossil energy consumption and enhance the reputation of New Bedford as an environmentally sustainable community.
APPENDIX 3-1

CONCEPTUAL LAYOUT OF

PROPOSED O2E FACILITY
APPENDIX 3-2

BLOCK PROCESS FLOW DIAGRAM
APPENDIX 3-3
ECRUSOR® EQUIPMENT/TECHNOLOGY
SUMMARY SHEET
**Ecrusor™**
*Depackaging System Transforming Waste to Resource*

Solution for depackaging and preparing biodegradable wastes for energy generation

**The Process**
Ecrusor™ is the ideal solution to turn food waste and other wastes high in caloric value into useful energy. A compact and robust process, Ecrusor depacks food waste from its packaging in order to extract the organic material. Inert waste packaging material is sent one direction; energy-rich organic material is macerated and sent another. The patented process creates a homogenous mixture of liquid and solid organics that can then be conveyed to an anaerobic digester to produce biogas. Using CHP or other tools, this biogas can then be converted into energy for use at the facility or for sale back to the grid. Ecrusor thus helps turn waste treatment facilities into revenue-generating resource recovery facilities in a circular economy approach.

**Simple Operation**
Packaged or unpackaged waste is dumped into Ecrusor's receiving hopper. In Ecrusor, the bulk packaged waste is first broken apart, separating inorganic waste from the organic material. This is done with spiral grinding screws that move forwards and backwards, agitating, distributing, and breaking apart the waste. Ecrusor has an end plate that is equipped with a number of chopping/cutting teeth which facilitate the destruction of the inert packaging material without making it so small that it could pass through the effluent perforated plates. The perforated plates thus retain the inert material but allow the pured organic material to pass on to digestion.
Performance

Two perforated plates located below the grinding screws separate the organic and inorganic material. The grinding screws puree the organic material, allowing for the organics to pass through the perforated plate to three collection screws that convey the organic slurry out of the unit. The unusable inert packaging waste remains on the perforated plates and is removed with an extraction screw. Residual organic matter on the packaging material is washed off as it moves up and out of the extraction screw. The washed inert waste is then collected in a waste container to be transported off-site.

Advantages

- Ecrusor removes plastic, metal and mixed material packaging simultaneously
- Very low operating energy while producing a slurry that generates electricity
- Over 10 years of full-scale operation at multiple installations
- Installed below grade, outdoors or within truck off-loading stations to receive material directly from vehicles
- Ecrusor is capable of processing up to 52 cubic yards of waste every hour

Once separated, the organic slurry is pumped to the plant's anaerobic digesters for digestion and generation of biogas and energy.

Contact your local Veolia representative for more information:

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4001 Weston Pkwy - Cary, NC 27513
Phone: 919-677-8310 - Fax: 919-677-0082
usmunicipal@veolia.com

www.veoliawatertech.com
APPENDIX 3-4
ARTOIS' METHANIZATION FACILITY
CASE STUDIES
An optimized solution to meet your needs

Specializing in the design and build of water treatment plants, Veolia Water Technologies recovers and recycles your biomass and biowaste in order to extract the most added value from it.

BIOMET™

A wet methanization process leveraging on an external agitation system with continual crushing.

BIOMET™ guarantees your energy and environmental performance by combining two separate steps:

Hydrolysis:
- Mixture breakdown by hydrolytic bacteria in order to obtain increased availability of organic matter and better yields

Anaerobic digestion:
- Producing biogas through the action of methanogenic bacteria

BIOMET™ benefits:

- Performance
  - Secures a biogas production of 10 to 20% more than conventional digestion/post-digestion processes
  - Allows for optimized agitation at all steps

- Flexibility
  - Accepts a very wide range of inputs
  - Adapts to the evolution of future waste inputs
  - Tolerates a mixture with a higher rate of dry matter (24% and more) than conventional processes which are limited to 17%

Operational simplicity
- Stable performance whatever the loading rate due to the hydrolysis stage
- Easy maintenance thanks to external stirring and heating systems
- Allows the digester to be powered seven days a week while limiting the input reception to five days

Compactness
- Reduced retention time = reduced footprint (from 25 to 50%)

Methanization principle

Methanization (also called digestion or co-digestion) is the anaerobic degradation, due to lack of oxygen, of organic matter in the inputs. This takes place in a digester at a temperature between 35 and 55°C. Methanization allows biogas to be produced. It is the result of many physical, chemical and biological combined processes.
Veolia Water Technologies' assets

- A key player in methanization processes for over 60 years
- A modular and standardized approach for efficient support throughout project
- Customized technical solutions adapted to your needs
- Optimized investment costs
- Controlled operating costs
- The ability to manage the combined flow of waste products and energy on your site
- Integrating the methanization unit into existing structures
- Access to partners for financing, operating and service
- Field experience and local presence
- The solidity, creativity and experience of a leading group
- A dedicated and committed team
- Feedback from operational sites around the world

Among our references

**Artois Methanization**  
(Northern France)  
*Quantity of waste processed:* 32,000 tons/year  
*Inputs:* Industrial sludge and grease, WWTP sludge, solid and category III waste, deconditioning, chicory roots...  
*Electric power produced:* 8,000 MWh/year

**Conserve Italia**  
(Pomposa, Italy)  
*Quantity of waste processed:* 35,000 tons/year  
*Inputs:* 1/3 fruit & vegetables, 1/3 WWTP sludge and 1/3 corn silage  
*Electric power produced:* 8,400 MWh/year

**Samoëns**  
(French Alps)  
*Quantity of waste processed:* 8,000 tons/year  
*Inputs:* WWTP sludge and biowaste.  
*Electric power produced:* 785 MWh/year
Resourcing the world
Anaerobic digestion
Innovation serving green energy

With anaerobic digestion, innovation is at the heart of the production of green energy.

What is anaerobic digestion?
Anaerobic digestion uses bacteria to transform organic waste into energy in the complete absence of oxygen. This transformation occurs in nature, in marshes, for example. In order to be useable on a larger scale, the process has been tamed and optimized in closed tanks called digesters. The microorganisms digest the organic fraction of the waste and convert it into biogas, a source of renewable energy. The residual organic matter (fraction not degraded during the process) forms the digestate that is dewatered, composted and used as a fertilizer by farmers.

Anaerobic digestion: why and for whom?
Anaerobic digestion delivers two types of recovery from organic waste in a virtuous carbon circle: agronomic with the production of compost, and energy in the form of biogas, electricity or heat. This technology is widely used across Europe and is gaining momentum all around the world.

It provides an answer to one of the current challenges facing the farming sector: designing new models of production taking into account environmental constraints and improving competitiveness. Anaerobic digestion is not just used by the agricultural sector. It targets all types of organic waste, whether it is derived from farming, food and beverage industries or municipalities, such as green waste from parks and gardens and the by-products from wastewater treatment plants.

What does anaerobic digestion mean for Veolia?
With anaerobic digestion, Veolia is stepping away from the linear production and consumption approach and moving towards the circular economy, an economy in which the waste discarded by one systemically becomes valuable resources for others.

Artois Anaerobic Digestion Plant is a perfect illustration of the convergence between environmental services and energy efficiency from anaerobic digestion at Veolia.
VEOLIA'S PROCESS AT THE ARTOIS ANAEROBIC DIGESTION PLANT

Since April 2012, on a 9,000 m² site in Graincourt-lès-Havrincourt (northern France), the Artois anaerobic digestion plant recovers all types of organic waste from farming (agricultural biomass, endive roots, etc.), industry (biological sludge, flotation grease, production waste, meat waste and restaurant grease), municipalities (grass clippings, municipal canteen waste and treatment plant waste) and the mass retail sector.

Each year, this anaerobic digestion plant recovers 25,000 metric tons of waste and generates 8,000 MWh, the equivalent electricity consumption of 6,500 people. The 7,000 metric tons of digestate, or organic material, not degraded by the process, is composted and used to fertilize the surrounding farmland.

Waste delivery. The waste is delivered in bulk and liquids are stored in storage tanks. Pasty and solid waste is directly transferred to the preparation pits. Packaged waste is first unpackaged to extract the organic matter.

Anaerobic digestion with Blomet™ process. All this waste forms the energy mix which is fed into the hydrolysis tank. For 3 days, hydrolytic bacteria degrade the waste. After hydrolysis, the energy mix is fed into a digester. For 30 days, methanogen bacteria produce methane from the energy mix. The digestate, or residue from this fermentation, is delivered to a post-digester to complete the degassing process. The biogas storage tank above this post-digester is used to control supply to the cogeneration motor.

Energy recovery. The biogas, 60% methane and 40% CO₂, is treated prior to its use in a cogeneration motor. Each year, this process produces several million cubic meters of biogas. The biogas is used as a fuel to produce electricity that is then fed into the French national grid.

Agricultural recycling. The digestate undergoes stabilization heat treatment at 70°C for one hour prior to being dewatered in a centrifuge. At the exit from the centrifuge, the solid fraction of the digestate is composted and ready for recovery as a fertilizer that can replace the chemical fertilizers used by farmers.
The Client

The Client is a private company EAL-COMPOST with an existing composting site in Terranova del Passerini (Lodi). He was treating 12000 t/y of "OFMSW" (1) producing compost.

The Biogas project increase the plant capacity to 34,000 t/y (1st step) and 64,000 t/y (2nd step) improving turnover both for site capacity (~ 75 €/t of OFMSW) and Green Electric Energy production (~ 0.17 €/kWh)

The Client's Needs

Increase site treatment capacity from 12 kt/y OFMSW (1) to 34 kt/y and 64 kt/y in the short future.

Before the Anaerobic new plant construction the site was limited to 12-15 kt/y of OFMSW by the design of the aerobic composting plant.

The new Anaerobic pre-treatment step reduces the quantity and also the organic content of the digestate solid fraction that needs to be treated at aerobic composting step. The result is a site capacity improving (3 to 5 times), a better quality of the produced compost and, mostly, the biogas production and valorization. A very interesting and quick Return of Investment is guaranteed by the turnover improving.

The Solution

BIOMET™ anaerobic process was selected for the project thanks to its high flexibility and stability in organic wastes that are very variable in quantity and quality. A pre-treatment step has been designed to remove inert and plastic, that can be present even if the OFMSW is collected door-by-door, and to prepare BIOMET feeding.

A CHP cogenerator step produces Green Electric Energy sent to the greed and thermal energy used in the anaerobic process.

(1) OFMSW: Organic Fraction of Municipal Solid Waste – from selected collection
Process Description

The plant is shown in the Block Scheme; it is designed to be fed with 34,000 t/y of OFMSW at the 1st step and with 64,000 t/y at the 2nd step (future).

Pretreatment: designed for 20 t/h of OFMSW. It can treat the daily feed in 1 work-shift @ 34 kt/y and in 2 shifts @ 64 kt/y;

Anaerobic BIOMET™: designed at thermophilic conditions (55°C) with Hydrolysis reactor (1200 m³) and 2 digestors (2100 m³ each) @ 1st step and 4 digestors @ 2nd step;

Cogenerator: produces 1000 kW of Electric Power @ 1st step. At 2nd step a biomethane upgrading plant will be installed.

Results (1st step)

Site capacity: from 12 to 34 kt/y → turnover increase + 1,85 M€/y

Green Electric Energy: 8000 MWh/y → turnover increase + 1,36 M€/y

Better quality of produced compost → market price increasing
APPENDIX 3-5
BIOCON™ BELT DRYING TECHNOLOGY
BROCHURE
BioCon™
Biosolids Drying & Energy Recovery

WATER TECHNOLOGIES
**The BioCon™ Dryer**  
*Safe, Simple, and Efficient*

BioCon™ is a dual-belt dryer designed to be one of the safest dryers on the market while maintaining easy and efficient operations. In much the same way a convection oven speeds up the baking process in the kitchen, BioCon™ uses hot air circulation to evaporate the water from the biosolids. The air drying temperatures in the BioCon range from 350°F to 175°F as the biosolids complete the drying process. Additionally, the BioCon™ meets EPA 503 Class A requirements.

---

**Efficient Evaporation Without Odor**

Energy is supplied indirectly by heat exchangers to heat the drying air. Circulation fans provide the necessary air velocity around the biosolids, thus increasing the drying efficiency and the water evaporation from the biosolids. Also, the entire dryer is kept at a low negative pressure to avoid the odor associated with most other drying technologies. The hot air used for drying in the BioCon™ unit is recirculated through a condenser to remove moisture. The dried and cleaned air leaves the condenser and is reheated by heat recovered from air leaving the dryer. This closed loop air flow ensures a low odor operation.

---

**Solids Into the Dryer**

The system accepts dewatered cake from 10% to 30% dry solids. Primary, secondary or digested biosolids are pumped from a storage tank through the sludge depositors in thin strings in order to create a large available surface area for drying. This large evaporative surface area created by the sludge depositing step allows:

- Low drying temperature
- Short retention time
- Elimination of back-mixing
Automation and Controls

BioCon™ is furnished with Veolia’s SCADA and controls system which allows unmanned operations for extended extended periods of time. Veolia offers the availability of remote monitoring for occasions when no operator is on site.

Waste Heat Utilization

The BioCon™ dryer operates at lower temperatures. As a result, waste heat sources can now be used for solids drying. Over the past 10-15 years, more and more waste energy sources have been utilizing the gas they produce to generate electricity. Whether gas engines, micro-turbines, or turbines are used, Veolia can capture the heat produced by the electrical generation equipment and use it to heat the BioCon™ dryer.

The End Product

Processed biosolids are dried to a minimum dry solids content of 90%. The desirable end product is easily handled and spread. The end product meets Class A requirements for vector attraction and pathogen reduction. Beneficial reuse of the end product is preferred application because of the high organic content which improves soil quality.
BioCon™ Energy Recovery System

The BioCon™ drying system can be expanded with the addition of an Energy Recovery System (ERS). Veolia uses a furnace that reduces the output of the plant to 5% of its original quantity. The compact design, which also includes flue gas treatment, may provide all necessary energy for the BioCon™ dryer. This makes the BioCon™ system a totally self-sufficient energy process.

BioEnergy & Biosolids Options

- Digester
- Biosolids
- Heat Exchanger
- Reciprocating Engine
- Gas Microturbine
- BioCon Dryer
- Electricity
- ERS Furnace
- Class A Biosolids
Advantages of the BioCon™

Safe
- BioCon operates at low drying temperatures ≤ 350°F
- No drying air or dust is released into the surroundings
- The air is recycled, making it a contained process
- The drying vessel operates at a negative pressure
- Low agitation of biosolids during drying process due to minimal noise and dust
- End product meets EPA Class A quality requirements

Simple
- Automatic start, stop and operation, requiring minimal operator attention
- Reliable machinery consisting of few moving parts and many years of full-scale operational experience
- Designed for intermittent or continuous
- Easy to upgrade for an Energy Recovery System

Efficient
- System designed with energy savings in mind resulting in significant heat recovery
- Large evaporation surface area for biosolids are dried in thin strings, enabling low drying temperature
- A supplemental odor control system is not necessary
- Significant mass reduction with reduced storage, transportation and disposal costs

Flexible Energy Sources

BioCon has the flexibility to use any of the following energy sources:
- Oil, Natural Gas, or Biogas
- Gas Engines or Microturbines
- Steam
- Flue Gases
- BioCon Energy Recovery System

Additionally, given its low operation temperature, BioCon can make use of waste energy sources in a practical manner.
Resourcing the world
The Challenge

The City of Buffalo was faced with numerous challenges such as rising disposal costs, odor issues, and an increase in plant capacity due to the expected increase in population from approximately 15,000 to 30,000 by 2025. Furthermore, the EPA 503 Class A disposal standards needed to be met, as well as meeting the requirements in the limited site footprint.

Process Solution

The BioCon® Drying Process removes moisture from biosolids via thermal drying. Dewatered sludge cake is pumped from a bin into the dryer cabinet through oscillating depositories that extrude thin ribbons through nozzles onto a slowly moving belt located inside the dryer. The ribbons provide a large drying surface area for safe and efficient drying at temperatures less than a conventional oven (< 350°F).

Heat is transferred to the biosolids by circulating air between heat exchangers and biosolid ribbons. Moisture is removed from the drying air by continuously extracting a portion of the air from the dryer, transferring it through a condenser and back to the dryer. The temperature during the drying process decreases as the solids dry. The temperature is the highest when biosolids enter the dryer and the lowest when dry solids exit the dryer. Screw conveyors transport the solid material from the dryer to a solids hopper for utilization as fuel in the energy recovery system.

End User Benefits (20 yr Life Cycle)

<table>
<thead>
<tr>
<th>Benefit</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel Savings</td>
<td>$3.5 Million</td>
</tr>
<tr>
<td>Disposal Savings</td>
<td>108,994 Wet Tons</td>
</tr>
<tr>
<td>Disposal Costs</td>
<td>$8 Million</td>
</tr>
<tr>
<td>Equivalent Anthropogenic CO₂</td>
<td>4.2 Million Tons</td>
</tr>
</tbody>
</table>

The processes allowed the plant to increase its' biosolids capacity to 1,850 tons of dry solids per year. The ERS provides over 80% of heat for the dryer from renewable fuels, and reduces the biosolids mass by 95%.
Biosolids and BioEnergy Solutions

Kruger offers both Biosolids and BioEnergy options for various configurations for different styles of plants. Benefits include up to 90% operational savings over disposal costs, Class A biosolids for beneficial reuse and a payback on investment in as little as 3.5 years. These solutions are for plants with or without digestion, are environmentally friendly and “Green Solutions,” as well as can potentially provide carbon credits and renewable energy credits to plants.

Kruger’s solutions include BioEnergy Drying and:

- Digester Energy Exchange
- Engine Heat Recovery
- Energy Recovery System

Conclusion

The effectiveness of Kruger’s BioCon® Dryer and ERS systems allowed the Buffalo WWTP to reduce the amount of biosolids that can be safely and easily handled. This solution was executed in a small footprint that contains the odor and meets the Class A requirements while also saving the plant 70-80% of the required thermal energy that leads to a smaller carbon footprint.

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www.krugerusa.com
BioCon®: A Class A Solution
Biosolids | Case Study

Alderwood Water and Wastewater District

The Client

The Picnic Point Wastewater Treatment Facility is located in Edmonds, WA and is operated by the Alderwood Water and Wastewater District out of Lynnwood, WA. The BioCon® dryer has been operational since 2013. The plant has a design flow of 4 MGD, expandable to 6 MGD.

The Client's Needs

The Picnic Point Wastewater Treatment Facility was faced with reaching their plant processing capacity. The plant was sending its biosolids to be incinerated and part of this challenge was to find a way to manage the biosolids produced by this facility. Hauling and disposing of this sludge was difficult and becoming expensive. It was desirable to have a Class A biosolid to alleviate this concern and be more environmentally conscious.

The Solution

The Picnic Point WWTF is a new activated sludge plant using MBR's and a Veolia BioCon Dryer. The facility also includes a headworks facility, UV disinfection and plant operations building.

Upgrading the facility with Veolia's BioCon® biosolids dryer has reduced the amount of biosolids to be disposed of as well as producing a Class A biosolid. Having a Class A biosolids allows the Alderwood Water and Wastewater District to explore other sludge disposal options. In this case, dried biosolids from the BioCon are utilized by a third party to fertilize nearby agriculture. With the help of the BioCon dryer, the plant doubled its sewage treatment capacity, ensuring the site will be able to handle increased biosolids loads for the foreseeable future.

The Benefits

- Reduces biosolids disposal rate
- Produces Class A biosolids
- Doubles sewage treatment capacity
- Allows for alternative sludge disposal options
Process Description

BioCon operation is safe, simple, and efficient. Dewatered sludge cake is pumped into the drying system through oscillating sludge depositors on top of the dryer cabinet. These depositors are used to distribute the biosolids onto a slow moving belt for drying. BioCon is a dual-belt dryer. Biosolids are deposited onto the first dryer belt and fall to a second belt where the desired dryness is reached before being removed from the dryer by a screw conveyor. BioCon uses hot air circulation to evaporate water from biosolids, in much the same way a convection oven speeds up the baking process in the kitchen. The air drying temperatures in the BioCon range from 350°F to 175°F as the biosolids complete the drying process. The BioCon indirectly heats the biosolids with drying air that is recycled in a closed circuit and the entire dryer is operated under negative pressure to prevent any odor from escaping the dryer.

The operation of a BioCon is entirely automated from startup, to monitoring operation, to shut down. Start-up procedures consist of starting the burner and feed systems and will take approximately 30 minutes to start drying sludge. Shut down is also automated and is set to dry and evacuate all sludge from the dryer and cool down.

Results

The effectiveness of Veolia’s BioCon Dryer allows the Alderwood Water and Wastewater District to reduce the amount of biosolids that are safely and easily disposed. This solution was executed in a small footprint and allows the municipality to produce a valuable end product, meeting Class A requirements. The newly constructed BioCon building includes an odor control system which eliminates odor. This system coupled with the production of Class A biosolids has earned the plant the support of the surrounding community.

Kruger Inc.
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tel. +1 919-677-8310 • fax +1 919-677-0082
www.krugerusa.com
The Client

Town of Cary, NC

Plant Capacity: 18 MGD
Current Operating Capacity: 5 MGD
Serves Towns of Cary, Apex & Morrisville (Western Wake Partners)

Hydrotech Discfilter Units

Contracted: April 2011
Installed: Jan 2014 – April 2014
Startup: June 2014

Scope: (8) HSF2220-2F Discfilters
System Capacity:
  Average: 15.3 MGD
  Peak: 47.3 MGD
  Effluent: TSS ≤ 5 mg/l

The Client’s Needs

The Western Wake Partners constructed the Western Wake Regional Water Reclamation Facility (WWRWRF) with the region’s future growth in mind. The facility is located in North Carolina’s Research Triangle region, a part of the United States that has seen tremendous residential and economic growth. The plant, operated after construction by the Town of Cary, treats to strict nitrogen and phosphorus standards for both permitted discharge to the Cape Fear River and for reclaimed use at the plant. The WWRWRF produces a Class A, exceptional quality biosolids.

The WWRWRF’s biological treatment process is an advanced five-stage process for biological removal of nitrogen and phosphorus followed by secondary clarifiers. The clarified effluent flows by gravity to the Discfilter units. The downstream disinfection process is UV. Sludge is dewatered with belt filter presses and then dried with Kruger BioCon dryers. The final Class A end product is sold and transported off-site by an outside vendor and applied as an agricultural soil amendment.

The Discfilter Solution

Kruger supplied eight (8) HSF2220-2F Hydrotech Discfilters along with PLC controls and required field services. The system is designed to an effluent TSS of ≤ 5 mg/L based on the peak hourly flow with a peak influent TSS of 20 mg/L and an average TSS of 10 mg/L.

Kruger was selected as the filtration equipment provider because of the maintenance and operational advantages of the Discfilter system. In addition, the Hydrotech Discfilter has a record of being a reliable and proven filtration technology.
The BioCon® Solution

Kruger's scope of supply included two (2) wet sludge cake silos, two (2) BioCon dryers, a dry product handling and storage process, including a pelletizing and screening system, and an inert gas and dust collection system. Two dryers will initially operate in an alternating manner. As flows increase, the two dryers will eventually function as two full time parallel units.

Kruger supplied a two dryer system capable of evaporating 7,600 lbs H2O/hr. For this plant, this means that this is about 1,370 dry pounds of sludge every hour. The plant's current lower loading is 3 dry tons/day. The buildout capacity is 14 dry tons/day.

In addition to the sludge dryers, Kruger supplied an end product particle sizing system and dried product storage silos. The end product is shaped to a required density and size using this system and then conveyed to the two silos located outside the biosolids building. These silos are emptied into a transport truck as often as needed and the dried pelletized end product is hauled away. The facility has made arrangements to have a third party nutrient management company purchase the pelletized end product.

The Western Wake Partners had two main objectives when developing the biosolids portion of the plant: (1) Safety and (2) End Product Quality. Maintaining a safe environment was a priority, which is one of the main reasons the BioCon belt dryer technology was selected. Also, the ability to sell the end product as a fertilizer within the local community reinforced the partners' commitment to sustainability. This drove the pelletizer design of the BioCon.

Kruger has provided the Western Wake Partners, including the Town of Cary, with a complete and fully automated dryer and end product handling system. This solution will serve to not only minimize the amount of sludge to be removed, but allows the facility to produce a desirable and marketable end product.

BioCon® System

Contracted: June 2012
Startup: August 2015

Scope: (2) BioCon Dryers, Pelletizer, and End Product Storage Silos
Design Capacity: 34,000 wet tons/yr
End Product: 90%DS, meeting Class A standards

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APPENDIX 3-6
VEOLIA ANITA™ MOX MBBR
TECHNOLOGY BROCHURE AND
CASE STUDY
ANITA™ Mox
AnoxKaldnes™ MBBR and IFAS

Solution for High Strength Ammonia Streams
Anammox Process
ANITA™ Mox is a single-stage nitrogen removal process based on the MBBR (Moving Bed Biofilm Reactor) technology. The ANITA Mox process is used for treatment of streams highly loaded in ammonia, such as effluents from anaerobic sludge digestion, drying condensates, industrial wastewaters, and landfill leachates.

The ANITA Mox process combines aerobic nitritation and anoxic ammonia oxidation (anammox).

The two steps take place simultaneously in different layers of a biofilm. Nitritation (aerobic) occurs in the outer layer of the biofilm. A portion (55%) of the influent ammonia is oxidized to Nitrite (NO₂⁻). Anammox (anoxic) activity occurs in the inner layer. In this step, the nitrite produced and the remaining ammonia are utilized by the anammox bacteria and converted to nitrogen gas (N₂) and a small amount of Nitrate (NO₃⁻).

The aerobic and anoxic reactions occur in a single MBBR reactor equipped with specially designed plastic carriers that support the biofilm, thereby preventing washout of the bacteria from the reactor.

The ANITA Mox process, using a single-stage MBBR with a proven aeration control strategy, achieves ammonia removal up to 90% and total nitrogen removal in the range of 75 to 85% without external carbon addition and with lower energy costs compared to conventional nitrification-denitrification.

Process conditions in the reactor are monitored and maintained to provide the optimal environment for the combination of bacteria.

The ANITA Mox effluent screens provide a positive barrier to loss of anammox bacteria, since they keep the media and biofilm in the reactor.

### Operating Parameters, Ammonia Removal in Digester Dewatering Stream

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conventional Nitrogen Removal</th>
<th>ANITA™ Mox</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygen Requirement (lb O₂ / lb N)</td>
<td>4.6</td>
<td>1.9</td>
</tr>
<tr>
<td>Methanol Consumption (lb / lb N)</td>
<td>3.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Sludge Production (lb VSS / lb N)</td>
<td>0.5 - 1.0</td>
<td>0.1</td>
</tr>
</tbody>
</table>
The IFAS Advantage

IFAS (Integrated Fixed Film Activated Sludge) technology using suspended carriers has been a proven application of the MBBR process for more than 20 years. Applying the same concept to ANITA Mox has shown some significant benefits.

As with any IFAS system, the suspended growth is retained using a clarifier. In IFAS ANITA Mox, the return of biomass to the system shifts much of the nitrification step from the biofilm to the suspended phase, where the conversion of ammonia to nitrite takes place more rapidly. IFAS ANITA Mox can achieve higher volumetric removal rates than any other anammox process, thereby reducing the size of the biological reactor. This results in a tremendous advantage in equipment sizing, reactor footprint, and overall value. Still, the choice between MBBR and IFAS ANITA Mox is site-specific. With IFAS ANITA Mox, our expert team now has two highly efficient ANITA Mox processes to offer in a complete solution.

A Key Element of the ANITA™ Mox Process: The Carriers

A key element of the MBBR/IFAS technology is the AnoxKaldnes™ carriers, also called media. The very slow growth rate of the anammox bacteria makes their retention a critical objective of the process. Compared with other technologies, the ANITA Mox effluent screens provide a positive barrier to loss of anammox bacteria, since they keep the media and biofilm in the reactor. The media is also designed to provide a large protected surface area for the biofilm and optimal conditions for biological activity.
Resourcing the world
Meeting Strict TN Limits: ANITA™ Mox
Biological Treatment | Case Study

South Durham Water Reclamation Facility

The Client

The City of Durham is located in the Research Triangle Region of North Carolina. The City operates two wastewater treatment plants – the North Durham Water Reclamation Facility and the South Durham Water Reclamation Facility, both permitted to treat 20 million gallons per day (MGD).

The Client’s Needs

In 2011, the City of Durham completed a comprehensive wastewater master plan that evaluated different treatment techniques for meeting strict total nitrogen (TN) limits at the South Durham Water Reclamation Facility (SDWRF). The SDWRF will need to meet a TN limit of 3 mg/L at its design flow to comply with the total maximum daily load (TMDL) in the Jordan Lake Watershed, which serves as a source of drinking water in the region. The SDWRF uses anaerobic digesters to break down the plant’s sludge. Downstream of the digesters, the plant uses belt filter presses for dewatering. The resulting liquid – the pressate from dewatering, or what is referred to as “sidestream” flow – historically accounted for about 20 percent of the nitrogen load in the plant’s biological nutrient removal (BNR) process. While this sidestream nitrogen contribution sounds high, it is typical for many plants with anaerobic digestion.

The Solution

As a result of the evaluation, Durham selected Veolia’s ANITA™ Mox sidestream deammonification system for ammonia and total nitrogen removal. The City studied mainstream and sidestream treatment alternatives to meet its TN limits. In its cost comparisons, ANITA™ Mox was calculated to be three times lower in cost per pound of nitrogen removed when capital and operating costs were considered. ANITA™ Mox was estimated to cost $0.93 per pound of nitrogen removed ($/lb N), while the most cost-effective mainstream BNR solution was estimated at $2.66/lb N. The City thus selected ANITA™ Mox as the most cost-effective nitrogen removal alternative.

WATER TECHNOLOGIES
Process Description

ANITA™ Mox is Veolia's sidestream deammonification technology for short-cut nitrogen removal. When compared to conventional mainstream nitrification/denitrification, ANITA™ Mox uses about 60% less oxygen, requires no external carbon source, and produces less sludge.

ANITA™ Mox is offered in both Moving Bed Biofilm Reactor (MBBR) and Integrated Fixed Film Activated Sludge (IFAS) configurations, depending on site conditions. As such, the system consists of engineered polyethylene carriers—in this case AnoxKaldnes™ K5 media—to provide ample protected surface area for biofilm to thrive. The K5 media (approximately the diameter of a quarter) host two types of bacteria in the same reactor. The outer layer consists primarily of ammonia oxidizing bacteria (AOBs) which convert about half of the ammonia to nitrite. The inner layer consists mainly of anammox (anaerobic autotrophic ammonia oxidizer) bacteria. These bacteria utilize the resulting nitrite and much of the remaining residual ammonia and convert them to nitrogen gas, which is released harmlessly to the atmosphere.

Since ANITA™ Mox has a high removal rate and treats the smaller sidestream flow at a wastewater plant, it has a compact treatment footprint. At many plants, the system can fit into a spare or abandoned tank on site. At the SDWRF, for example, the MBBR system was constructed in an abandoned aerobic digester.

Results

At the SDWRF, the ANITA™ Mox MBBR system was started up in 12 weeks—an efficient time given the slow growth of anammox bacteria. Now operating full-scale, the system is achieving greater than 80% ammonia removal and 70% total inorganic nitrogen (TIN) removal—both exceeding guaranteed values. The ANITA™ Mox system is thus helping the SDWRF meet its strict effluent nitrogen limits using the most cost-effective solution.

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Artois Methanisation Merchant Facility – Graincourt, France

Veolia – Sede Environnement group delivered a turn-key (design-build-own-operate) merchant methanization facility in Graincourt, France. The Artois’ Methanisation co-digestion biogas plant was built on an existing Veolia operating site (an aerated static pile composting facility) which already have needed infrastructure. This eco-friendly solution provides organics stabilization, energy and nutrients recovery for more than 30 commercial and industrial customers at design capacity of 139 tons per day. Biogas storage and cogeneration utilization yields up to 2.0-MW of power.

Commercial co-digestion and combined heat & power facility operations commenced in early 2012 with an average organics daily loading of 88 tons per day. Organic feedstock is food waste from restaurants, colleges and hospitals, as well as food & beverage manufacturing wastes (solids/liquids). Wastewater biosolids (primary sludges) and FOG are co-digested at Artois’.

Veolia’s Methanisation Facility in Graincourt includes the following assets:

- Three truck-bay in-ground organics receiving up to 139 tons per day
- Veolia’s Bcrusor® organic solids and liquids depackaging technology
- Veolia’s BioMet™ Two-Stage Anaerobic Co-Digestion technology
- Biogas utilization for CHP at average yield of 231,000 cubic feet per day
- Digestate dewatering via high solids centrifuges and composting of cake
- Centrate liquid side-stream treatment and soil nutrients (N&P) recovery
- Class A Biosolids as compost product for agricultural land application
- One biogas engine generator gross capacity of 2.0 megawatts of power

Project Reference
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Project Location
Graincourt, France

Project Dates
2010 - Facility Design
2011 - Construction
2012 - Commercial Operations
Ongoing Operations

Annual Performance Metrics
32,000 tons of Mixed Organics
18,700 tons of Digestate Cake
8,000 MWh of Electricity Yield
27,000 MBtu of Heat Recovery

Operational Status
Project is operational by Veolia

Organics-to-Energy (O2E)
Technology Approach
- Co-processing of a mixed organics stream of SSO and packaged food and beverages
- Depackaging of food wastes and dated beverages using Veolia’s Bcrusor technology
- Multi-receiving tank mixing and storage of “organic soup”
- Veolia’s BioMet™ anaerobic co-digestion process - first stage thermophilic hydrolysis and second-stage mesophilic
- Digestate dewatering and cake composting into Class A bulk solids product for agriculture, with nutrients recovery via liquids side-stream treatment
- Biogas storage and utilization for combined heat and power
Anaerobic Co-Digestion
Veolia-Sede Environnement designed and delivered its two-stage BioMet™ co-digestion process, which is comprised of thermophilic hydrolysis and mesophilic anaerobic treatment in glass reinforced carbon tanks. These AD tanks have both submersible mixers and external pumping (Vaughan’s Rotamix™) with a combined design hydraulic retention time of 36 days. The capacity flow rate of the “organic soup” is approximately 33,000 gallons per day (gpd) and an organic loading rate of 139 tons per day (TPD). The co-digestion process generates an average of 160 cubic feet per minute (cfm) of biogas with a thermal energy value for co-generation of approximately 6.2 MMBtu/hr. The equivalent volume of biogas for co-generation is more than 230 thousand cubic feet per day (Kcf/d), and the biogas is collected in a membrane covered storage tank for cogeneration. Cleared biogas is beneficially used for a Jenbacher co-generation unit, which generates up to 2.0 megawatts of power and 7.2 MMBtu/hr of recovered heat for heating water as thermal energy for the co-digestion tanks.

Organic Feedstock
Co-digestion of source-separated organic matter (SSOM) at the Artois’ merchant methanization facility includes both Fats-Oil-Grease (FOG) and pro-consumer food wastes from food and beverage manufacturers. A significant portion of the food waste supply is packaged spoils and containerized beverages. These solids and liquids feedstock are depackaged using Veolia’s Ecrusor® technology and co-mingled with the other organic feedstock (wastewater biosolids and FOG). On a wet mass loadings basis for co-digestion, wastewater biosolids comprises approximately 24% (or 12,000 tons per year) and FOG is approximately 7% (or 3,600 tons per year). The balance is food wastes, of which approximately 12% is liquid wastes (or 6,000 tons per year) and the remaining solid organics being comprised of dairy products, vegetables, meat spoils, and some other agricultural solids (animal by-products) and industrial sludges (biological by-products).

Digestate Management
The digestate from the BioMet™ co-digestion process is dewatered by a centrifuge to approximately 20% total solids. Approximately 7,000 tons per year of this digestate cake material is then composted on-site for conversion into Class A biosolids as a bulk soil product for beneficial use in surrounding agricultural land. The nutrient rich centrate is also treated on-site in an aeration system prior to effluent discharge. Digestate testing and liquids side-stream treatment quality monitoring are performed at the on-site laboratory. Veolia’s lab includes pilot testing of the organic feedstock.
APPENDIX 8-2

GRESHAM CO-DIGESTION FOR
WASTEWATER TREATMENT PLANT
PROJECT REFERENCE SHEET
Co-Digestion for WWTP Zero Net Energy – Gresham, Oregon

Veolia has been providing operations, maintenance and management (OM&M) services for the City of Gresham, Oregon since 2005 at their 20-MGD WWTP. This long-term, 17-year OM&M agreement includes biosolids management and operations of the 9.5 dry tons per day (DTPD) co-digestion facility and 0.8-MW combined heat and power plant. In March 2015, the Gresham WWTP became the 3rd municipal treatment plant to achieve “net zero energy” and 100% electric power sustainability.

In 2012, Gresham initiated co-digestion and CHP to achieve 55% energy sustainability via biogas production and cogeneration as a Phase I solution. In 2014, the Source Separated Organics Matter (SSOM) as FOG and food waste receiving facility and CHP system was doubled in size as a Phase II solution to achieve net zero energy sustainability and now even net positive.

The Organics-to-Energy in Gresham is comprised of the following assets:
- Two SSOM Pre-Treatment Tank System receiving 12,500 gallons per day
- Source Separated Organic Waste heating, mixing, pumping and piping
- Two Anaerobic Digesters processing an average of 9.5 dry tons per day
- Three Stage Biogas Cleaning System for avg. 280,000 cubic feet per day
- Three Gravity Belt Thickeners for AD loading of 80 wet tons per day
- Two Belt Filter Presses for digestate dewatering of 4.6 dry tons per day
- Class B Biosolids land application of digestate cake at 23 tons per day
- Two Reciprocating Engine Generators yielding 800 kilowatts of power

Project Reference
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Project Location
Gresham, OR WWTP

Project Dates
Project Start in 2005 – Ongoing

Incremental Capital Value
$3.2 Million (Phase I)
$3.5 Million (Phase II)

Operational Status
Project is currently operated and maintained by Veolia with management and co-marketing of SSOM supply with the City.

Organics-to-Energy (O2E) Phased Implementation
- 2005 installation of 400 KW engine generator using biogas
- 2012 installation of 10,000 gal FOG receiving tank and pilot co-digestion at 5,000 gpd flow
- 2013 upgrades of FOG tank heating, mixing and receiving station of screening/grinding, & three-stage biogas cleaning
- 2014 addition of a 12,000 gal FOG/food waste receiving tank and a 400 KW engine generator with heat recovery
- 2015 full-scale co-digestion of SSOM and WWTP thickened biosolids, and 95% upturn of dual RICE cogeneration units to achieve “net zero energy”
Anaerobic Co-Digestion

Veolia operates two mesophilic anaerobic digesters at the Gresham WWTP to achieve organics stabilization as a co-digestion facility. Each tank is one million gallons in volume and operates in parallel as a single-stage co-digestion process which yields an average of 17.5 cubic feet of biogas per pound of volatile solids reduced (lb/VSc) at an average hydraulic retention time of 22 days. Based upon an organics loading of 95-tpd, the production of digester biogas approximates 195 cubic feet per minute (cfm) with a thermal energy value for co-generation of 5 MMBtu/hr. The equivalent volume of biogas for co-generation is nearly 280 thousand cubic feet per day (Kcf/d). Beneficial use of the digester biogas for combined heat and power requires a three-stage cleaning system to reduce impurities of hydrogen sulfide, moisture and siloxanes.

Source-Separated Organic Matter

Co-digestion of source-separated organic matter (SSOM) includes both Fats-Oil-Grease (FOG) and pre-consumer food wastes. During both the Phase I pilot operations and Phase II full scale operations, various food wastes (FW) have been processed (including cheese curds and whey, yogurt, beer, cherry brine, and sugar slurry from vitamin pill production). The mixed blend of SSOM (as FOG & FW) are highly variable in feedstock characteristics (e.g. solids and volatile solids content, pH and debris fractions). The heated SSOM slurry feed control to the digesters is on a daily basis in the range of 15 to 20% by volume with treatment plant thickened biosolids.

Digestate Management

The Class B digestate is dewatered to approximately 20% total solids via belt filter presses and agriculturally dewatered on City land. The nutrient rich filtrate from the digestate dewatering process is returned to the headworks of the WWTP for co-treatment with the average daily flow of 13-MGD influent wastewater. Recovered heat from the dual train cogeneration system is used as thermal energy via hot water heat exchangers for the digesters and the SSOM system tanks, with a target mesophilic operating temperature of 95 degree F.

Biogas Co-Generation

Cleaned digester biogas is used as bio-fuel to two 400 KW lean burn Caterpillar Reciprocating Internal Combustion Engine (RICE) generators. The average annual uptime availability to "green power" generation is 94% with a fuel consumption requirement of approximately 3.7 MMBtu/hr at 100% of the rated load. The design co-generation system efficiencies are approximately 40% for mechanical and 39% for electrical with an average parasitic load of approximately 0.25%. The electric net yield of 750KW achieves "energy net zero" at the WWTP.
APPENDIX 8-3
HERMITAGE MUNICIPAL AUTHORITY
CODIGESTION AND BIOGAS GENERATION
OPTIMIZATION
PROJECT REFERENCE SHEET
The Hermitage Municipal Authority wanted to optimize biogas production to help reduce their system's energy consumption and use their renewable energy equipment to recycle the residual waste and ultimately lower energy costs. Biogas is created when biodegradable matter and bacteria ferment and can be converted into electricity.

RETTEW's anaerobic digestion experts were brought in to guide the Authority through the permitting process and help manage the biogas system conversion process. Due to Pennsylvania Department of Environmental Protection regulations, specialized permits are required for municipal wastewater treatment plants to receive and regulate liquid residual waste. RETTEW's staff helped obtain the necessary permits and began coordinating with the Authority on the advanced anaerobic digestion system. By optimizing the system to increase biogas production from residual waste such as municipal waste, sewage, and plant matter, each year the Authority will eliminate approximately 250,000 gallons of residual waste from entering landfills, while saving the plant more than $100,000 in energy costs and providing up to 200 kilowatts of electricity. Through this project, the Authority is not only increasing its overall sustainability, but is also eliminating its electrical costs and providing the community with renewable attributes and the broader business community with a cost-effective recycling method for residual waste.

**SERVICES PROVIDED**

- Anaerobic Digestion Operations
- Biogas Optimization
- Residual Waste Permitting
- Waste Identification and Solicitation

**CONTACT INFORMATION**

Thomas Darby, Manager
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APPENDIX 8-4
WILMINGTON RENEWABLE ENERGY
BIOSOLIDS FACILITY
PROJECT REFERENCE SHEET
Renewable Energy Biosolids Facility – Wilmington, Delaware

Veolia has been providing operations, maintenance and management (OM&M) services for the City of Wilmington, DE at their 134-MGD WWTP since 1998. This long-term, 20-year OM&M agreement included $15 million of capital program management (CPM) services during the first two years of the full-scope OM&M contract. Veolia served as the design-builder for these capital improvements, including the upgrade of dewatering facilities with two high-solids centrifuges and a plant-wide SCADA system.

As a service component of Veolia's OM&M responsibilities at the WWTP include biosolids master planning and systems energy efficiency initiatives. In 2011, Veolia collaborated with the City and its city-wide Energy Services Company to develop, deliver, commission and now operate the Renewable Energy Biosolids Facility (REBF). Veolia participated in each phase of the project with lead roles in the thermal drying processing technology concept using recovered heat from the co-generation system as renewable thermal energy in the form of hot oil for producing EQ/Class A biosolids product.

The Wilmington WWTP and REBF are comprised of the following assets:

- Six Anaerobic Digesters handling an average of 50 dry tons per day
- Two High Solids Centrifuges handling an average of 33 dry tons per day
- One In-Direct Heat Dryer Train processing up to 150 wet tons per day
- One Dried Biosolids Granules Silo for product storage up to 4 to 5 days
- One Biogas Treatment System cleaning up to 300,000 cubic feet per day
- Two Reciprocating Engine Generators yielding 4 megawatts of power
- Dual Co-Gen System Heat Recovery yielding up to 19 MMBtu per hour

Client Name/Reference
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Louis L. Redding City/County
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Project Location
Water Pollution Control Facility
in Wilmington, Delaware

REBF Project Dates
Project Start in 2011 - Ongoing
with Design Phase in 2012-13
and Construction in 2013-14

Commissioning of Biosolids
Facilities (In-Direct Heat
Drying, Co-Generation and
Heat Recovery Project) in 2015

Design/Build Value
$35 Million

Operational Status
Project is currently operated
and maintained by Veolia with
management and finalization of
systems commissioning and
performance testing by ESCO.

Biosolids-to-Energy (B2E)
Technology Approach

- In-direct heat drying via hot oil for water evaporation of biosolids via thermal energy recovery from co-generation.
- Digester biogas and landfill gas blending and cleaning as bio-fuels for co-generation.
- Co-generation system heat recovery for hot water via boiler to support digesters and a thermal oil heater for recirculation with the dryer.
Digeste Biogas Utilization
Veolia uses five of the six anaerobic digesters for biosolids stabilization and yields approximately 13.5 cubic feet of biogas per pound of volatile solids reduced (lbs/VSr) in the digestion tanks. Based upon a biosolids loading of approximately 50-dtpd, the production of digester biogas approximates 350 cubic feet per minute (cfm) with a thermal energy value for co-generation of 12 million British Thermal Units per hour (MMBtu/hr). The equivalent volume of biogas for co-generation is nearly 500 thousand cubic feet per day (Kcf/d). The beneficial use of digester biogas for co-generation requires a three-stage cleaning and treatment system to remove key impurities of hydrogen sulfide, moisture and siloxanes.

In-Direct Heat Drying
The single-train in-direct heat dryer system is an IC-12,000 Bioscram® unit from ThermoFlite. It is the largest in-direct heat drying unit operating in a municipal WWTP in North America, with an evaporative capacity to handle up to 6.7 wet tons per hour of cake biosolids (equivalent to 150-WTPD of cake solids at 24% TS). This thermal drying unit can handle 100% of the cake production at the Wilmington WPCF with a daily average loading of 30-dtpd and a maximum month processing rate (1.2 peak factor) of 36-dtpd. The average solids retention time is approximately 100 minutes within the dryer to evaporate the moisture to yield a 92% dry granule for subsequent cooling via a water jacked screw conveyor and temporary storage in a 225 cubic yard silo. The annual production of nearly 11,500 tons as Exceptional Quality (EQ)/Class A biosolids dried granules product is marketed for bulk distribution to organic fertilizer dealers.

Dual-Fuel Co-Generation
A dual-fuel of cleaned biogas and landfill gas is supplied to two 2-MW Cummins Reciprocating Internal Combustion Engine (RICE) generators (Model C2000-N6C). The design annual uptime availability to “green power” generation is 94% with a fuel consumption requirement of approximately 17.4 MMBtu/hr at 100% of the rated load. The design co-generation system efficiencies are approximately 40% for mechanical and nearly 39% for electrical to yield 2.0 MW of gross power. Landfill gas up to 1,200 cfm is supplemented with the biogas to meet the peak demands of both RICE units. Net of parasitic loads, the RICEF generates enough electricity to satisfy more than 80% of the treatment plant’s electric loads.

Heat (Thermal Energy) Recovery
The dual Cummins RICE co-generation system yields approximately 14.5 MMBtu/hr of recoverable heat. On average 4.0 MMBtu/hr is beneficially used via a new hot water boiler to heat the digesters to a target temperature of 95 °F. The balance of 10.5 MMBtu/hr of recovered heat from the exhaust of the RICE generators is used in a 15.0 MMBtu/hr thermal oil heater. The hot oil is re-circulated through the dual-screws within the T-F dryer unit, at an average temperature of 450 °F and close-loop flow rate of 575 gpm. This hot oil system is safety equipped with an expansion tank and a dump tank.
APPENDIX 8-5
SOUTH PEST WASTEWATER TREATMENT PLANT
PROJECT REFERENCE SHEET
Co-Digestion and CHP Facility – South Budapest, Hungary

Since 2004, Veolia provides operations, maintenance and management (OM&M) services via a 25-year contract with the Municipality of Budapest, Hungary. This joint-venture concession, called the Budapest Sewage Works Ltd. (FCoM) includes the city’s three wastewater treatment plants. The 80-MLD South Pest WWTP provides wastewater services for 296,000 population equivalent (PE) as an advanced secondary activated sludge plant with a 41-DTPD Biosolids-to-Energy (B2E) plant using Veolia’s BioMet™ co-digestion process. The AD facility includes thermophilic and mesophilic tanks to co-process wastewater biosolids, FOG and septage solids, and beneficially uses the AD biogas to produce 1.5-MW of cogenerated power.

As joint-owner of FCoM, Veolia designed and implemented in 2007, a re-engineering program of the base B2E facility to include a new Organics-to-Energy (O2E) approach for achieving WWTP energy autonomy. This upgrade included the addition of food waste receiving, de-packaging, and pre-processing (pasteurization tank) technology to enhance co-digestion. The O2E facilities at the South Pest WWTP, includes the following assets:

- Food waste organics receiving and pre-treatment of 81 tons per day
- Chopped/slurried food waste “soup” in Single-Stage Pasteurization tank
- Veolia’s Bcruisor® organic solids and liquids depackaging technology
- Veolia’s BioMet™ Two-Stage Anaerobic Co-Digestion technology
- Digestate dewatering via high solids centrifuges and composting of cake
- Biogas utilization for CHP at average yield of 252,000 cubic feet per day
- Two reciprocating generators gross capacity of 1.46 megawatts of power

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Project Location
South Budapest, Hungary

Project Dates
2004 – Base B2E Facility
2007 – Expanded O2E Facility
Ongoing Operations

Annual Performance Metrics
20,178 tons of Mixed Organics
5,475 tons of Digestate Cake
10,800 MWh of Power Yield
39,500 MBrUs of Heat Recovery

Operational Status
Project is operational by Veolia

Organics-to-Energy (O2E) Technology Approach
- Co-processing of a mixed organics stream of SSOM and packaged food and beverages
- Depackaging of food wastes and dated beverages using Veolia’s Bcruisor technology
- Pasteurization tank, chopping and mixing of “organic soup”
- Veolia’s BioMet™ anaerobic co-digestion process – first stage thermophilic hydrolysis and second stage mesophilic
- Digestate dewatering via high-solids centrifuges and cake composting / land application
- Biogas storage and utilization for combined heat and power via two engine cogenerators
Anaerobic Co-Digestion
Veolia's designed and implemented re-engineering improvement in for the biosolids handling approach at the South Pest WWTP included a retrofit of the existing mesophilic anaerobic digestion system. Veolia installed its two-stage BioMet™ co-digestion process, which is comprised of thermophilic hydrolysis and mesophilic anaerobic treatment. To provide co-digestion of food waste organics a 2,000 m³ (528,400 gallon) thermophilic digester as a glass reinforced carbon tank was added in front of the four existing 2,600 m³ (687,000 gallons each) mesophilic digesters. The operating temperature in the thermophilic tank is 55 °C (or 131 °F) with a target hydraulic retention time of 8 to 10 days. The operating temperature in the mesophilic AD tanks is 37 °C (or 99 °F) with a target hydraulic retention time of 12 to 15 days. The combined organics loading to the BioMet™ co-digestion process is 55 dry tons per day (DTPD). The enhanced co-digestion process generates an average of 175 cubic feet per minute (cfm) of biogas, which is an equivalent volume of more than 252 thousand cubic feet per day (Kcf/d). The biogas is all used at the combined heat and power plant.

Organic Feedstock & Digestate Management
Co-digestion of additional source-separated organic matter (SSOM) as mixed food wastes (e.g. grease, kitchen spoils, expired dairy products and packaged beverages, as well as bakery and meat products) required an expanded front-end receiving and pre-treatment system. The solids food wastes are screened, chopped, grinded and homogenized. The packaged food wastes are processed in Veolia's Rensnor® technology to extract the organics. This organic feedstock is then pre-treated in a 7 m³ (1,850 gallon) and heated to 70 °C (or 158 °F) for approximately one hour to achieve some pasteurization prior to thermophilic AD. The average digestate production of 15-DTPD is then centrifuge dewatered to a total solids content of 28 to 30 (%TS). The digestate cake is then composted or land applied.

Biogas Cogeneration
The biogas generated from the co-digestion system is collected in a membrane covered storage tank for cogeneration and first treated for removal of sulfides and then moisture reduction. The cleaned biogas is beneficially used for two Jenbacher co-generation units, which generates up to 1.46 megawatts of power and 5.3 MMBru/hr of recovered heat for heating water as thermal energy for the pasteurization and co-digestion tanks. The addition of second reciprocating internal combustion engine (RICE) unit increased the energy autonomy of the South Pest WWTP from 33% to 85% on an annualized operating basis.
APPENDIX 9-1
PFL WEEKLY RECAP
PFL Weekly Recap

Aug 14, 2017 To Aug 18, 2017

The run up in E17s that closed out last week lost steam as we started the week with a number of trades seen printing 92-92.25 cents, down around half a penny. B17s fell back around a penny with several dips going through to 106.5. Tuesday saw RBs rebound, back to the previous week's levels, with E17s trading 92.95 and B17s 106.10-107. Another court ruling, Wednesday, led to a sell-off in the RBs market. The ruling, impacting small refinery exemptions, saw E17s trade through the 91.85 range. B17s also sold off down to 106. Thursday was a tale of two halves as E17s dropped another cent, B17s were up just under a cent from yesterday's close. Friday saw B17s jump almost 2 cents, E17s were flat on the day. THE B17/E17 spread ended the week between 19 and 20 cents.

Corn started the week up, with little effect on Ethanol prices but fell sharply Tuesday taking the fuel down with it. Further bearish stats, released Wednesday, with continued corn weakness saw prompt Argo values dropping over 4 cents. The sell-off continued into Thursday as traders were still offloading after the weekly stats numbers. Friday saw ethanol markets stabilize as corn turned back into positive territory.

It was a quiet start to the week for LCFS with only a couple of 5,000X trades reported at $9. By the end of the week prices were hovering around $9.8, with another 10,000X trade reported.

<table>
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<th>D5 - 10</th>
<th>D5 - 17</th>
<th>D5 - 16</th>
<th>D5 - 17</th>
<th>D4 - 16</th>
<th>D4 - 17</th>
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<td>1-Oct</td>
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<td>145.25</td>
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<tr>
<td>1-Aug</td>
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<td>1-Aug</td>
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<tr>
<td>1-Sep</td>
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<td>1-Oct</td>
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<td>1-Oct</td>
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<tr>
<td>1-Nov</td>
<td>(3.35)</td>
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<td>1-Nov</td>
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RIN Values - 15 Day - D4 D5 D6

RIN Values - D3

PFL 2016-17 D6 Outlook

2017 Projections (July STEO)
- EIA Projected Gasoline Consumption (STEO est.) 9,670 mb/d
- Fuel Ethanol Blended into Gasoline (STEO est.) 980 mb/d
- Fuel Ethanol Production (STEO est.) 1,010 mb/d
- Ethanol demand at 10% [calc] 1,030 mb/d

Chg from Jun July '16
- 110 9,600
- 10 970
- 20 940
- 20 1,010

2017 D6 RINS
- Weekly average Ethanol production 1,059.0 week ended 8/11/2017
- Most recent 4 week average 1,023.3 4 wks ended 8/11/2017
- YTD avg 1,021.8 through 8/11/2017
- D6 RINS from ethanol based on ytd avg. 15,664 million RINS
- Jan-Dec EMTS D6 RIN data 6,107.1 million RINS
- Annualized D6 Production based on EMTS 7,333 million RINS

PFS2 Data

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<tr>
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<td>Cellulosic</td>
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<tr>
<td>Biomass-based</td>
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<tr>
<td>Renewable</td>
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## PFL Daily Breakdown

### RINS cents/RIN

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<tr>
<th>Date</th>
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### LCFS $/MT

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### S/gallon

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###OUNCE/gallon

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### DOE STORAGE

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team@progressivefuelslimited.com
Thursday, July 12th, 2018

RE: Request for Expression of Interest

To Permit, Design, Build, Finance, Own, Operate & Maintain and Market Products from an Organics-to-Energy Sludge Processing Facility

Dear Ms. Bruce:

Lystek International Inc. & Energy Systems Group (ESG) are pleased to provide you with our response to this RFEI for potential biosolids processing technologies and management methods for New Bedford. We have carefully reviewed this RFEI and its terms prior to submission.

Lystek’s patented, proprietary biosolids technology converts biosolids from a wastewater treatment facility and other similar organic materials into a USEPA Class A or Class A Exceptional Quality (EQ) biofertilizer product, which is also registered with the Canadian Food Inspection Agency (CFIA). Additionally, the generated product may be recycled back through wastewater treatment systems, adding efficiencies to systems utilizing Biological Nutrient Removal, replacing carbon sources such as methanol or glycerol, and aiding in the generation of added biogas for systems incorporating anaerobic digestion.

Lystek International, backed by majority shareholder The Tomlinson Group, is a North American company based in Canada with over 60 years of experience in general construction, with over 20 of those years in environmental waste and organics management. With a 500+ million dollar valuation, Lystek has the financial backing and support to develop projects of any specification, and has worked with numerous entities in the municipal, private and public marketplaces. Combining the Lystek technology along with Anaerobic Digestion from ESG, we bring to this offer the unique capability to both process the biosolids and organics in the region and enhance the digestion process and renewable energy generation potential of the facility.

We look forward to your feedback regarding Lystek and future discussion. Please contact me should you require any additional information.

Best Regards,

Jim Belcastro
Lystek International Inc.
Request for Expression of Interest (RFEI)

City of New Bedford

Expression of Interest, Organics-to-Energy Facility, New Bedford, Massachusetts.

Bid Number 19192009

To Permit, Design, Build, Finance, Own, Operate & Maintain and Market Products from an Organics-to-Energy Sludge Processing Facility

Prepared By: Listek

Nothing wasted. Everything to gain.
City of New Bedford

Request for Expression of Interest (RFEI)

Expression of Interest, Organics-to-Energy Facility, New Bedford, Massachusetts.

Bid Number 19192009

Prepared For:

Ms. Susan Bruce, Director of Purchasing:
City of New Bedford
133 William Street
New Bedford, MA 02746

Tel: 508-979-1550
Fax: 508-961-3054
Email: purchasing@newbedford-ma.gov

Prepared By:

Lystek International LTD
1014 Chadbourne Road
Fairfield, California
94534-9700

Contact Person:

Jim Belcastro
Business Development Manager
Ph. 508-463-5444
E: jbelcastro@lystek.com

RFEI Due: July 12, 2018
Time: 3:00 pm
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Diagram 1

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EXECUTIVE SUMMARY

Lystek and its partner Energy Systems Group (ESG) confirm they fully understand the RFEI and all addenda provided. Lystek/ESG are submitting this RFEI to confirm they are capable of meeting the requested objective by New Bedford, MA and its partner communities to Permit, Design, Build, Own, Operate and Market Products from an Organics-to-Energy Sludge Processing Facility.

Lystek International Ltd. (Lystek), a US incorporated company was originally founded in 2000 at the University of Waterloo, Ontario, Canada. It has developed and commercialized treatment technologies for biosolids and other non-hazardous, organic waste materials. The company is focused on beneficial use and best practice solutions for the management of these materials.

Today, the company is owned by its management and R.W. Tomlinson Ltd. (Tomlinson) of Ottawa, Ontario. R.W. Tomlinson Ltd. (Tomlinson) a 60-year-old, private, family-owned company, is the primary shareholder in Lystek. They provide environmental and construction services to a large and ever-expanding customer base primarily in the governmental (municipal & provincial) and institutional sectors. Tomlinson’s revenues are well into the nine-figure range. They are routinely awarded projects in the eight-figure range. As part of Tomlinson, Lystek has the financial resources to take on and provide security for a project of the size and term length set out in this RFEI. See Appendix A for our Scotia Bank Letter.

Along with the support of Tomlinson and their more than 60-year track record of supporting their clientele, Lystek is willing and able to provide a long-term solution for New Bedford and its partners’ biosolids processing needs.

Lystek is an award winning company, with a range of innovative, proven and cost-effective solutions for biosolids and residuals management, supported by a highly qualified and experienced Project Team and eleven (11) reference facilities in North America. The process is patented and proven and has been in successful operation for over 10 years.

Lystek provides a low-temperature thermal hydrolysis solution that is proven, reliable, and economically viable. Lystek is willing and able to support multiple strategic financial scenarios to deliver this solution to its clients.

Lystek is willing and able to provide a long-term solution for New Bedford’s biosolids processing needs by utilizing the multiple benefits of the Lystek process at New Bedford, along with the contracting and technology offerings of its strategic partner, Energy Systems Group (ESG).

Lystek is also able to offset costs and enhance benefits for the client by providing adequate merchant revenues of its high-solids liquid biofertilizer, and offering host community benefits based upon volumes of biosolids and organics received at the regional plants it develops.
For this project, Lystek, along with ESG, is a fully encompassing solution using technologies with environmental benefits that provide:

- Less odor concerns surrounding biosolids and organics processing and land application
- The ability to handle volumes of biosolids and organics in flexible ways, including fats, oils, grease and other organics not including leaf and yard waste.
- Enhancement of combined heat and power systems through improved anaerobic digestion kinetics, providing added biogas generation potential and additional renewable fuels
- Improved nutrient management goals by production of a carbon source for utilization in biological nutrient removal, eliminating the need for outside sources
- Ability to meet EPA Class A and/or Class A EQ federal acceptance requirements, and Massachusetts Type 1 requirements

Lystek / ESG Propose The Following Solution to New Bedford:

Permit, Design, Build, Maintain, Operate, Market a solution which would include the following:

- An ESG anaerobic digestion solution integrated with a Lystek sytem to process biosolids and organics post digestion, providing sufficient capacity to serve the three municipalities identified (New Bedford, Brockton, Fall River), as well as third party customers. This process will produce a high solids liquefied product (15%-17%) (Namely LysteGro(R)), which will be marketed, sold and applied through subsurface land injection. The LysteGro(R) product will be Class A Exceptional Quality (EQ) / Massachusetts Type 1.
- Refeed a portion (20% +) of the material back into mesophilic digesters. As a result this post digestion low temperature, low-pressure thermal hydrolysis solution will substantially increase gas yields, establish additional volatile solids breakdown and as a result reduce biosolids volumes. No side stream waste is produced from the Lystek process in this solution.
- ESG is very experienced at developing and monetizing incentive values for biogas under the Federal Renewable Fuel Standard (RFS) Renewable Identification Number (RIN) program, as well as under California’s Low Carbon Fuel Standard. The RIN program provides incentives for the use of biogas as a transportation fuel (via CNG or LNG). The LCFS is one of a group of programs designed to reduce greenhouse gas (GHG) emissions enacted through AB 32, the 2006 Global Warming Solutions Act. The LCFS program is designed to reduce the carbon intensity of fuels used in California, and awards incentive to low carbon intensity fuels, in this case, CNG and LNG as well. ESG has completed two projects that purifies biogas for pipeline injection. Although preliminary to determine, in today’s market these transportation fuel use incentives provide the maximum economic value.
- The potential to assist in improved combined heat power solutions. ESG is very experienced at CHP with biogas and has developed CHP solutions for the beneficial use of biogas at six of its anaerobic digester projects, as well as at eleven landfill gas projects. We also currently have two more CHP projects under development at
municipal wastewater treatment plant digester projects. The economics of CHP depends on numerous client specific variables, including electric prices, energy use, and site specific considerations.

- The potential to additionally thermally hydrolyze fats, oils, greases, and organics prior to processing, resulting in substantially increased efficiency while avoiding digester foaming issues.
SECTION 1 - GENERAL DESCRIPTION OF THE CONTRACTOR

Lystek International Ltd., partnered with Energy Systems Group

Lystek’s team consists of experienced experts in the fields of Waste Water Management, Organic Waste Management, Waste Management, Consulting and Engineering, Marketing and Sales and Communication. The Management has a proven track record in the design, construction, operation, and maintenance of facilities in the field of biosolids management, organic waste management, waste water management as well as marketing of products and communication with relevant stakeholders. Lystek is a well established company, with 8 facilities up and running and 3 facilities under construction in Canada and the US, Lystek designs and constructs all of its facilities. Lystek designed, owns and operates a few of its biggest facilities: a 150,000 wet tonne facility in Ontario, Canada as well as a 150,000 wet ton facility in Fairfield, California, which have been in operation since 2012 and 2016, respectively.

Lystek has developed an innovative, proven, biosolids treatment solution to help wastewater utilities produce more biogas and reduce biosolids volumes, costs, odours and greenhouse gases (GHGs). It also produces a fertilizer product, LysteGro®. This technology, termed Lystek Thermal Hydrolysis process (Lystek THP®), transforms raw or digested sludge into a multi-purpose end use product. High speed shearing, alkali addition, and low-pressure steam are applied simultaneously in an enclosed reactor. Despite having a solids content of 14-16%, the end product remains fully pump-able with conventional liquid handling and application equipment (viscosity <5,000 centipoise). The product can be sold as a high quality fertilizer (LysteGro®) and/or recycled to digesters or BNR systems to deliver process enhancements. Recycling up to 25% of the “LysteMized®” product to the digester increases biogas yields by 40% or more and enhances biodegradation, reducing output by 25% or more. The treated product can also be utilized in BNR systems as an alternative carbon source, replacing costly products like methanol or glycerol. This product is termed LysteCarb®. Lystek has managed over 700,000 tonnes of biosolids and organic wastes since 2008, with 100% beneficial reuse of the material as agricultural fertilizer.

ESG has over 25 years of experience in carrying out energy infrastructure projects and has a specialized unit, the Sustainable Infrastructure Group, that is dedicated to wastewater treatment plant management. ESG has a specialized focus on anaerobic digestion (AD) and organics co-digestion. Currently, ESG is an owner, operator, designer, and constructor of anaerobic digester facilities. In Wisconsin, ESG owns and operates three co-digestion facilities at major dairy farms, producing 2.4 megawatts of electricity annually.

ESG has a track record of developing organics-to-energy facilities for municipal clients that utilize cogeneration and nutrient recovery. It has developed several net-zero energy wastewater facilities utilizing alternative delivery and procurement methods.

Its recent energy facility project with the Frederick-Winchester Service Authority in Winchester, Virginia, became operational in 2016 and can now take over 125,000 gallons per day of high-strength waste. The facility currently takes FOG, DAF and dairy waste. ESG
is currently bringing another facility on-line in Beckley, West Virginia, and nearing the final stages of construction at another in Niskayuna, New York. From the design and construction of organics-to-energy facilities to the post-construction life of these facilities in which relationships with organics providers must be managed, ESG is experienced and on the cutting edge of the organics-to-energy field.

**Contact:**

<table>
<thead>
<tr>
<th>Jim Belcastro</th>
<th>Business Development Manager, Eastern USA</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-mail: <a href="mailto:jbelcastro@lystek.com">jbelcastro@lystek.com</a></td>
<td>Lystek International Ltd</td>
</tr>
<tr>
<td>1014 Chadbourne Road</td>
<td>1014 Chadbourne Road</td>
</tr>
<tr>
<td>Fairfield, California 94534-9700</td>
<td>Fairfield, California 94534-9700</td>
</tr>
<tr>
<td>Cell: 508-463-5444</td>
<td>Office: 226-444-0186 x 212</td>
</tr>
<tr>
<td></td>
<td>Fax: 888-501-6508</td>
</tr>
</tbody>
</table>

At Energy Systems Group (ESG) LLC, energy efficiency, modernized infrastructure, clean energy, and smart financial planning are not only the outcomes of the solutions we provide; they serve as the foundation of ESG’s strategic vision and sustainability goals. ESG has implemented energy and cost optimization projects since 1994 and has been awarded projects in communities across the United States and the Caribbean with a total value in excess of $2.8 billion. *These projects have encompassed improvements ranging from simple lighting retrofits to comprehensive wastewater treatment process improvements and complex central utility plants.*

ESG is accredited by the National Association of Energy Service Companies (NAESCO) as an energy services provider (ESP). As an ESP, ESG develops and implements turnkey, comprehensive energy efficiency projects, distributed generation, cogeneration or combined heat and power projects, and waste-to-energy solutions. Of the 45 energy service companies that are NAESCO members, ESG is one of eight companies that have achieved the ESP accreditation, the highest level of the association.

A key difference between a design/build firm and an Energy Services Company (ESCO) like ESG is the ESCO’s willingness and ability to provide a long-term financial performance guarantee for its customers. *Currently, ESG has ongoing performance guarantees on 115 projects that total over $1.4 billion. In addition to this, ESG has successfully fulfilled an additional 397 guarantees valued at more than $1 billion.* With some guarantees lasting up to 20 years, ESG’s willingness to stand behind the results of its projects for the long-term is another indication of ESG’s financial strength, now and in the future.

Through its core business of performance contracting and extensive network of utility partnerships, ESG provides innovative solutions for the modernization of buildings and energy infrastructures in the government, education, healthcare and commercial sectors. ESG also designs, builds, and operates waste-to-energy facilities and cogeneration plants, and offers renewable energy technology solutions. ESG’s full range of services include:

- Energy Audits
- Design Engineering
REQUEST FOR EXPRESSION OF INTEREST (RFEI)  City of New Bedford

- Providing or arranging project financing
- Construction Management
- Commissioning
- Operations and Maintenance of Energy Efficiency Technologies
- Verifying Energy Savings
- Development and implementation of build/own/operate distributed generation, cogeneration or combined heat and power (CHP) projects
- Wastewater Treatment
- Waste-to-Energy – wastewater, landfill gas facilities, biomass
- Renewable Energy Technologies – solar, wind, geothermal

Contact:

<table>
<thead>
<tr>
<th>Dave Jones</th>
<th>Sales Manager, Sustainable Infrastructure Group, ESG</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-mail: <a href="mailto:djones@energysystemsgroup.com">djones@energysystemsgroup.com</a></td>
<td>Energy Systems Group LLC</td>
</tr>
<tr>
<td></td>
<td>9877 Eastgate Court, Newburgh, IN 47630</td>
</tr>
<tr>
<td></td>
<td>Fax: 833-846-8630</td>
</tr>
</tbody>
</table>

REFERENCE PROJECTS:

Dundalk – Southgate, Ontario - The Southgate Organic Materials Recovery Center was completely designed and constructed by Lystek in 2012. Lystek also owns and operates this state-of-the-art facility that is able to divert and process up to 150,000 tonnes of biosolids annually. The material is converted into LysteGro, a high-quality, federally registered (CFIA) biofertilizer product. To date, this facility has produced and sold over 400,000 tonnes of LysteGro, derived from a wide range of municipal biosolids from over 20 generators ranging from smaller surrounding towns and communities to large urban centers, such as the City of Toronto.

Client Reference: Simon Meulendyky, Plant Manager, 519-923-3539

Fairfield Suisun Sewer District (FSSD) - California, U.S.A. - In 2015 Lystek signed its first, major contract in the U.S. with FSSD, a multi-award-winning, California-based agency. The new Lystek Organic Materials Recovery Center-FSSD facility started receiving materials in 2016. The 150,000 ton per year project was designed and constructed by Lystek as an on-site deployment, with a Public-Private Partnership (PPP) agreement. It features a retrofit strategy to make better use of existing, previously under-utilized FSSD infrastructure under a 20-year (plus 10), Design Build Own Operate agreement. Initially, the OMRC-FSSD started to process biosolids materials from FSSD. Since Fairfield’s inception, we have received materials from San Francisco, Petaluma, East Bay MUD, Santa Rosa and other Agencies in the Bay Area. The system will convert feedstock into a Class A EQ (Exceptional Quality)
biofertilizer product (as defined by US EPA), which will then be marketed under the LysteGro® brand for use in agriculture, horticulture and a variety of other applications.

The Class A EQ designation also opens the market with fewer restrictions on its use and greater long-term certainty that re-use and diversion goals can be achieved far into the future, even if/when landfill bans are extended to include biosolids.

Client Reference: James Dunbar, General Manager, 707-419-0084

**Frederick-Winchester Service Authority Green Energy Facility**—Winchester, Virginia—Operational since the summer of 2016, the centerpiece of the Frederick-Winchester Service Authority’s Opequon Water Reclamation Plant is the new Green Energy Facility, which is one of the first facilities in the United States to add anaerobic digestion – sized and designed, from inception, for high strength organic waste co-digestion. ESG designed and constructed the facility, which has acceptance capability of 125,000 gallons per day of organic waste and co-digests this material with plant sludge. The organics currently accepted include trap grease, dairy processing waste, meat processing DAF sludge, biofuels by-products, and pre-treatment/municipal biosolids. The biogas produced will run 848 kilowatts of electrical cogeneration.

In addition to the cogeneration, ESG installed three 1.25 million gallon digesters, 800 kW diesel backup, a high-strength food waste and FOG receiving facility with segregated waste storage, and a resource recovery station among many other scope items.

The system also includes the Ostara Pearl® Process to recover and reduce phosphorus nutrient loading of anaerobic side streams to the liquid portion of the plant. With dairy waste, which is high in phosphorus, forecasted to be a considerable portion of the incoming organic waste, Ostara® was determined to be the most cost-effective solution for side stream treatment.

Client Reference: Dick Helm, Executive Director, 540-722-3579 (office), 540-664-2092 (cell)
SECTION 2 - CONTRACTOR’S HISTORY, CAPABILITIES, AND EXPERIENCE

Lystek has been commercially operating since 2008, and since then has successfully expanded operations throughout North America, to include 11 facilities by the conclusion of 2018. A reference listing of these facilities is below:

<table>
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<tr>
<th>Location</th>
<th>Status</th>
<th>Capacity (WT/Y)</th>
<th>Site</th>
<th>LysteGro Class A EQ/CFIA</th>
<th>Lystemize Digester Enhancement</th>
<th>Lystecarb BNR Carbon Source</th>
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<tr>
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<td>Languedoc</td>
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<td>Demo</td>
<td>On-Site</td>
<td>Yes</td>
<td>See Below</td>
<td>See Below</td>
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Lystek’s team consists of experienced experts in the fields of Waste Water Management, Organic Waste Management, Waste Management, Consulting and Engineering, Marketing and Sales and Communication. The Management has a proven record of accomplishment in the design, construction, operation, and maintenance of facilities in the field of biosolids management, organic waste management, wastewater management as well as marketing of products and communication with relevant stakeholders. The company has management with both European as well as Canadian and U.S. backgrounds. Lystek as a company is well established with 8 facilities up and running in Canada and 1 in the United States. design and construct all of our DBT facilities and we designed, own and operate two, large, regional processing facilities, including the Southgate OMRC, a 150,000 wet tonne facility in Ontario,
Canada as well as a 150,000 wet ton OMRC in Fairfield, California. Lystek has managed over 700,000 tonnes of biosolids and organic wastes since 2008, with 100% beneficial reuse of the material as agricultural fertilizer.

Energy Systems Group (ESG), which was founded in 1994, is an indirect, wholly owned subsidiary of Vectren Corporation (NYSE: VVC), which is a publicly-traded holding company that owns a regulated, multi-state electricity and gas utility company and other non-regulated businesses. In addition to its corporate office, ESG has 17 additional offices throughout the Midwest, Mid-Atlantic, and Southeast United States.

ESG is unique as it is the only energy service company to ever provide a true financial guarantee on anticipated new revenue from receiving organic waste. Currently, ESG has multiple contracts with guarantees of hundreds of thousands of dollars in annual organics revenue. The guarantee creates a minimum amount that the municipal utility can use to create budget certainty for its organization.

ESG's Sustainable Infrastructure team members have worked together closely on all of its organics-to-energy projects, which include the Town of Niskayuna, NY, Beckley Sanitary Board in Beckley, WV, and the Frederick-Winchester Service Authority in Winchester, VA. Its team members are leaders in the wastewater field and, in addition to the aforementioned projects, are currently developing several other projects in the United States.

<table>
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<td>Frederick-Winchester Service Authority, VA</td>
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</tbody>
</table>
SECTION 3 - PROPOSED TREATMENT TECHNOLOGY AND PROCESSES

Lystek THP is a low temperature physical/chemical thermal hydrolysis technology, which is installed after dewatering. The technology has a very small footprint and can be installed as an on-site solution as well as an off-site, stand-alone solution. The process produces a multi-purpose, hydrolyzed, high solids liquid product which can be used:

- To refeed into anaerobic digestion, enhancing kinetics, biogas generation and decreasing biosolids product volumes produced
- To refeed into BNR, as a carbon source, replacing commercial methanol or glycerol as a carbon source
- As a high solids liquid U.S. EPA Class A EQ / Mass Type 1 product which can be applied through subsurface Injection.

The scientific basis of the process (see Diagram 1) can be summarized as follows: a combination of high-speed shearing, alkaline addition and steam injection from a low-pressure boiler executed simultaneously in an ambient pressure environment causes:

- Cell disintegration & hydrolysis of complex, organic molecules into simpler compounds
- Makes the residual, recalcitrant volatile solids in digested biosolids amenable to further biodegradation
- The hydrolyzed product provides readily available organics for AD and BNR plus nutrients for soil/plants
- The product contains > 40% SCOD out of TCOD
- The product contains 10 fold higher VFA compared to biosolids cake

For New Bedford, the proposed facility would occupy one of the parcels of land provided by the City. In addition to the area required for the Anaerobic Digestion / Lystek process and tankage, piping associated with refeeding / integration of recirculation option utilizing LysteGro® for Anaerobic Digestion optimization will be required.

Lystek processes raw and digested sewage sludges/biosolids, organics, and food waste in 1%-35% solids concentration within enclosed buildings, in enclosed reactors. This process produces our multi-purpose, high solids liquid biofertilizer product LysteGro®. Enclosed piping systems will connect the different components. The storage tanks for LysteGro® would also be enclosed.

This ensures that little to no odors are emitted to the environment.

Product storage of LysteGro® is in lined, covered fertilizer reservoirs or tanks until it is needed. Typically, Lystek will provide a minimum of 6-9 months of storage capacity. Transport to land application will occur in tanker trucks. The product can be injected into the soil, diluted, sprayed or mixed with other products.

Conceptual Facility Schematic: See Appendix B – Anaerobic Digester Operation to be Constructed Within Lystek Footprint.
PROPOSED SOLUTION

Lystek is proposing the following solution(s) to New Bedford as highlighted below:

Anaerobic Digestion with Thermal Hydrolysis, Conversion into Class A EQ Product and Refeeding

(Equipment Listing / Process Flow Diagram for this option is included in Appendix B)

In this solution, Lystek would install an onsite solution to process the biosolids post digestion, post dewatering. Up to 20% or more of the product would be refed into anaerobic digestion, and the remaining product would be marketed and sold as a Class A EQ / Type 1 product.

The processing conditions involved in Lystek cause liquefaction resulting in disintegration (cell lysis / hydrolysis) of microbial cells and particulate organic matter. The lysis of cells and hydrolysis of macromolecules break down complex organic molecules into simpler units, e.g., starch and cellulose into glucose, proteins into amino acids, and lipids into fatty acids, etc. which are rapidly degradable carbon sources. Particulate organic matter in Lystek biosolids range from around 53%-58%, total COD (TCOD) and soluble COD range between 100,000 – 140,000 mg/L and 40,000 – 70,000 mg/L, respectively. Lystek processed biosolids contain around 40-50% SCOD of TCOD, compared to only 10% SCOD of TCOD in dewatered cake biosolids. Furthermore, VFA concentrations in Lystek biosolids are typically greater than an order of magnitude higher than raw municipal wastewater.

In this solution, Lystek will install an on-site Lystek system post AD, post dewatering in a new building. Lystek will process part or all of the dewatered biosolids and would convert this material into high solids (15%-17%) Class A EQ fertilizer product.

Typically Lystek processing requires dewatering to between 17% and 19% before feeding into the Lystek system. The biosolids are collected in a storage tank/hopper system. Subsequently, the biosolids are pumped into the Lystek Processing Reactor. The Processing Reactor provides a mixture of high-speed shearing, steam injection (>70 °C or 168 °F) and the addition of alkali.

The average retention time in the Process Reactor is 60 minutes. The operation would be executed as a batch process. The process is fully automated operating on a continuous basis subject to the availability of feedstock.

The Class A EQ / Massachusetts Type 1 product will be stored onsite or shipped to off-site storage. Subsequent land application is through subsurface injection.

In addition, by refeeding a portion of the generated LysteGro® product into the digester, 40-45% excess biogas yields can be achieved on average, enabling the harnessing of this biogas for process optimization or resale to power grids.
Estimated performance indicators for this solution:

- Footprint for the processing system: 50,000+ wt = 2,500 sq ft. The Lystek system would be installed in an enclosed building, ideally near the dewatering operation.
- Energy use: 58 kWh per DT
- Natural gas: 530 ft³ per DT
- Man-hours: the system is SCADA controlled. Normally 8 man hours per day management attention is required to monitor/oversee the operation of the system.
- Maintenance for the system: typical maintenance on the system is about 5% of the operating cost.
- Depending on the customer for the product KOH/NaOH or Ca(OH)₂ can be used for the process. Typically performance indicators for this solution:
  - KOH/NaOH = 220 lbs/DT or Ca(OH)₂ (pH 9) 370 lbs/DT

The end result is a remarkable product with predictable NPK values that is high in solids (15%-17%) and organic matter (>40%) while remaining low in viscosity and pumpable with conventional liquid handling and application equipment.

Through the Lystek process, the inherent value in the biosolids feedstock is preserved; while odors are reduced and pathogens are eliminated. This results in the creation of a product that has a high agronomic value and is safe for agricultural applications. The LysteGro® product is beneficial to farmers for several reasons, specifically:

- Cost Savings: the material will be marketed to the agricultural sector at an affordable price based on the Nitrogen, Phosphorus, and Potassium (N-P-K) content of the material. By using the Lystek material, farmers will save on input costs that they would normally pay for inorganic fertilizer
- Micronutrient addition: micronutrients important for crop growth such as Calcium, Sulphur, Zinc, Copper, Boron and several others that are inherent in biosolids provide the farmer with an affordable option for addition to their soils
- Organic matter: the addition of the LysteGro® product, which is high in organic matter, improves soil structure, tilth, and the ability to mitigate compaction.

In order to ensure the nutrients remain in the soil, where they are most beneficial, the Team employs a direct injection approach to application.

In the Ontario market, LysteGro® biofertilizer products are already displacing and/or offsetting the need for chemical fertilizers in some farming operations because they provide the agricultural sector with a safe, scientifically advanced alternative for many crop applications.

In 2013, a Water Environment Federation (WEF) workshop report stated that; “due to concerns with pathogens and odors, there is a distinct shift away from Class B land application and towards more advanced, Class A treatment options.”
It is also well known that global supplies of mined phosphorus, a key ingredient in the manufacture of chemical fertilizers, are being rapidly depleted. Therefore, there is a role for New Bedford to play in helping to ensure that organic resources, such as biosolids, are beneficially utilized for agricultural sustainability.

The need for good, high-quality, affordable fertilizer product is increasing (and will continue to do so) and, in most cases, far exceeds the available feedstock. This ensures a continuous, sustainable, end market program.

However, manufacturing and marketing a Class A / Class A EQ product that consistently meets and/or exceeds this US EPA designation while remaining compliant with Massachusetts regulations requires the attention, expertise and knowledge the Lystek Project Team can provide.

Lystek has been able to develop a very successful marketing program for LysteGro® in Ontario, and we believe we can do the same for New Bedford.

Part of the key to the manufacturing approach developed and successfully implemented by the Project Team involves making sure the proper nature and amount of feedstocks are flowing into the processing facility and subsequently, into the marketplace.

Another part of the Project Team’s management strategy will be to approach local agricultural groups and leaders to explain the features and benefits of the Lystek process and LysteGro® product in order to educate and develop a stable, long-term market, with loyal customers.

Additionally, the team will identify alternative use options in the region where LysteGro® can be used as a replacement for inorganic fertilizers (i.e., golf courses, orchards, biomass production, etc.).

With Lystek as its partner, New Bedford would not need to worry about any aspects of this program. Our experienced and qualified team would assume complete responsibility for New Bedford wastewater residuals management program.

In addition to the above, the LysteGro® product generates incredible demand from the agricultural sector. For example, during the 2013 growing and harvest season we produced, delivered and applied over 350,000 tonnes of LysteGro® product from our owned and operated, Regional Organic Materials Recovery Center (OMRC), in Ontario, Canada.

Growers are happy to invest in this recognized (U.S. EPA, Class A EQ & CFIA – Canada) biofertilizer product because of its predictable NPK values, high organic content, the way it can be incorporated into the soil during application and, most importantly, its performance.

Studies and actual field results show that the quality-controlled, LysteGro® product is superior to conventional, commercial fertilizers for crop growth, yield and preserving/restoring soil health. For further information, please see Appendix F.

This is how Lystek’s combined solutions can effectively turn wastewater treatment plants into Resource Recovery Centers.
In fact, Lystek is a recipient of a Regional Innovation Award for Sustainable Development from the National Research Council of Canada, and its technology has been twice recognized with awards from the Water Environment Association of Ontario for Exemplary Biosolids Management & Technology Development.

In 2017, the company was further recognized with two national Water’s Next Awards in Canada and a GEELA Award from the Governor of California and CalEPA. See Appendix G.

The company holds a number of patents in Canada and the United States with additional patents extending the technology options currently pending. See Appendix C.

In collaboration with GHD Limited, Waterloo, Ontario and Western University, London, Ontario, Lystek has run full-scale pilot tests on AD enhancement at the municipally owned wastewater treatment facility in Guelph Ontario. A six-month study evaluated the impact of re-feeding LysteMized biosolids into a full-scale (test) digester in comparison to a control digester. Results showed that re-feeding this material can improve biogas yield by > 40% and reduce solids by >20%. See Appendix D.

In addition to the above, Manhattan College in New York (Jeanette Brown & Robert Sharp) as well as Los Angeles County have performed independent, confirmatory testing on AD and BNR enhancement.

The initial lab results of the AD study at the Manhattan College indicated that LysteMized biosolids are >50% biodegradable and help improve biogas production.

When lab tested as a potential carbon source for BNR, the material was found to be equal to, or better than, conventional, chemical carbon sources such as methanol and glycerol. Additional confirmatory studies are underway and are expected to lead to pilot scale studies. See Appendix E.

In another collaborative research program with the Chicago MWRD, independent testing by the Chicago lab indicated that the Lystek biosolids are an excellent source of volatile fatty acids and are as good a carbon source for biological phosphorus removal as the most easily biodegradable carbon sources, acetate.

**Product Marketing, Sales & Distribution**

At each of its locations in operation currently, Lystek has a robust product sales, marketing and distribution network that provides subsurface land application of LysteGro® within a radius of up to 60 miles from each production location. In addition, Lystek is undertaking research and development of product applications above and beyond its current use, to include application as a soil amendment, fabricated top soil, potting soil, as well as in a liquid form appropriate for use in irrigation networks within turf farms, nurseries, among others.

For purposes of this project, Lystek will seek out land application clients throughout New England, as well as consumers in the industries mentioned prior.
SECTION 4 - ADDED VALUE COMPONENTS

In addition to the benefits provided in the executive summary, Lystek / ESG are capable of providing the necessary technology to add significant value to New Bedford and its partner communities in the following ways:

- Streamlined Biosolids Handling Equipment & Process – Long Term Sustainable Solution 20+ Years that Eliminates Biosolids Waste from Landfill, Providing Beneficial Reuse
- Enhanced Anaerobic Digester Operation
- Overall potential biosolids volume reduction through recirculation (LysteMize®) 20% or more
- Patented, proven technology with over 10 years in operation, first of its kind in Eastern U.S.
- Production of Class A EQ/ Type 1 product for beneficial reuse to agriculture and other uses, with minimal permitting & compliance cost
- LysteGro®, LysteCarb® Revenue / Revenue Sharing
- Landfill tipping fee & transportation cost offset for participating communities
- Local Partnerships – Southeastern Massachusetts Agriculture Community
- Typical LysteGro® land application rates are 15-18 wet tons per acre, requiring a smaller agricultural footprint for utilization than other fertilizer products
- Regional acceptance of biosolids = Tip fee revenue
- Landfill Diversion & Organics Bans – Increasing restrictions and cost – Driving additional volumes to facility = Tip fee revenue
- Excess Biogas – To be utilized via LysteMize® process to feed cogeneration for the operation of combined heat and power systems & optimizing the anaerobic digesters, in the goal of net zero energy consumption for New Bedford, with the sale of electricity back to grid in and / or creation of clean fuel for fleet vehicles

SECTION 5 - SCHEDULE FOR FACILITY DEVELOPMENT

Pending award, Lystek / ESG anticipates a design phase of 6 months for its proposed facility, with permitting occurring concurrently. After permit phase is completed, the construction / delivery phase will commence to ensure completion / commissioning of the facility for the December 2020 timeline set out in the RFEI document.

SECTION 6 - INTENT TO USE – BUILDING, TRANSFER STATION AND EQUIPMENT

Lystek does not intend to use any of the buildings available for the project and will look to utilize lands available for development on the properties provided in the RFEI document. Best designation of those properties will be determined in an RFP phase; however, Lystek/ESG are confident that the properties provided will be sufficient for utilization without any decommissioning or occupation of any existing buildings offered.
SECTION 7 - PROJECT DEVELOPMENT

Lystek / ESG will develop its proposed project to comply with all site constraints identified in the ASTM Phase 1 report, along with any additional constraints identified by the team.

SECTION 8 - A LIST OF REFERENCE FACILITIES

Lystek – Southgate Organic Materials Recovery Centre, ON

Dundalk, Ontario – Lystek’s Dundalk facility receives outside biosolids and generates LysteGro® for sale and land application taking place at the plant.

Tonnage of biosolids involved: This project involved the approval, design, construction, and operation of a state of the art organics (primarily dewatered biosolids) receiving and processing Centre capable of receiving 150,000 tonnes of organics per year. As the General Contractor, Lystek directly managed the design and construction of this facility along with its key internal and outside team members.

Since the facility began operation in 2013, we have processed, and land applied over 350,000 metric tonnes of biosolids through this center. As a regional operation, we have (and/or continue to) provide management services to wide range of Ontario municipalities, including (but not limited to); the City of Toronto, Region of Halton, Region of Waterloo, the Cities of Guelph and Orangeville, the communities of Walkerton, Tay Township and more.

Nature of services provided: Depending on the nature of the engagement with our customer, the liquid or dewatered cake material is loaded into either our customers or our subcontractor’s transportation vehicles at the point of generation. It is subsequently transported to the Southgate OMRC for conversion into the CFIA registered, LysteGro® biofertilizer product. The product is stored in covered and lined storage facilities until such time that it is sold, and land applied at area farms. We are also responsible for finding the farm customers, doing the soil testing at the farm site and developing best practice management plans and application rates to meet the agronomic needs of the crops being grown.

Revenues Generated: Lystek’s Dundalk plant has a revenue generation model based on a tipping fee charged to clientele to process biosolids and residuals, and the subsequent sale / land application of the LysteGro®product. Current market pricing for LysteGro® is determined based upon conditions existent at the time of operation.

Images of the Dundalk facility are attached hereto:
AERIAL VIEW OF DUNDALE PLANT

TOUR ATTENDEES VISITING DUNDALE
AT A PUBLIC OUTREACH EVENT
INTERIOR OF DUNDALK PLANT
LYSTEK REACTORS
LYSTEGRO SAMPLING FROM REACTOR
LINED, COVERED FERTILIZER STORAGE RESERVOIR

(1 OF 2 PICTURED)

TRUCK LOADING – 5-10 MINUTES LOAD OUT OF LYSTEGRO PRODUCTS OFFLOADING STATION FOR LIQUID
Lystek – Fairfield Suisun Sewer District, Fairfield, CA

In 2015, Lystek signed a 20-year agreement with 10-year option to design, build, finance, operate and manage a 150,000 wet tons per year “merchant” style plant at the Fairfield Suisun Sewer District. Lystek is installed in a post anaerobic digestion configuration, with recirculation of LysteGro® taking place to enhance the operation of the digester and biosolids program. This plant also executes agreements to receive third party biosolids from outside communities, and process these feedstocks with Fairfield digestate to generate LysteGro® for sale to many established markets. Multiple communities have signed on to deliver volumes to Lystek, including San Francisco, Petaluma, Delta Diablo, Benicia and Palo Alto. Pictured above is an aerial photograph of the facility layout. The facility has been in operation since 2016 and continues to grow year over year.
CAKE RECEIVING PIT

BIOSOLIDS EXTERNAL CONVEYOR SYSTEM

BIOSOLIDS STORAGE BIN
LYSTEK REACTOR

TRUCK LOADING STATION

LINED, COVERED FERTILIZER STORAGE RESERVOIR
SECTION 9 - STATEMENT OF BENEFITS

In building a solution with Lystek / ESG, New Bedford and its partners have the potential to develop a long term regional facility for biosolids and organics management that will:

- Divert thousands of tons of biosolids and organics from traditional management methods such as landfill & incineration
- Generate new local jobs both during construction and operations phases
- Reduce the carbon footprint of regional generators that would normally bypass the area to manage their feedstocks that would ship to this facility
- Provide a Class A exceptional quality / type 1 Massachusetts fertilizer product to market, beneficially reusing all of the volumes produced
- Provide biogas to convert into renewable fuel sources for the city, and take advantage of available credit / offset programs nationally
- Build a structure of economic benefit sharing potential in the receipt of outside volumes, fertilizer sales, and energy production

Lystek / ESG look forward to the potential that a project of this magnitude brings to New Bedford and the Southeastern Massachusetts / Greater New England Region.
REQUEST FOR EXPRESSION OF INTEREST (RFEI)
City of New Bedford

Diagram 1
Diagram 1

- High Speed Mixer
- Alkali Storage Tank
- Mixing Tank
- Dewatered Biosolids
- Solid Feedstock Hopper
- Bridge Breaker
- Boiler
- Progressive Cavity Pump
- Product Pump
- Steam
Appendix A

Scotiabank Letter
July 26, 2013

Attn: Bay Area Biosolids to Energy Facility SOQ

Bay Area Biosolids to Energy Coalition
2500 Pittsburgh-Antioch Highway
Antioch, CA 94509

Re. R.W. Tomlinson Limited/Lystek International Inc.
1425 Bishop St. N. Unit 16, Cambridge ON N1R 6J9

Dear Sirs:

Re: RFP # P2013-09

We confirm that R.W. Tomlinson Limited has dealt with our bank for over 15 years and Lystek International Inc. since 2011. R.W. Tomlinson Limited reports revenues in the nine figure range and currently maintains an eight figure revolving line of credit which currently has no balance. The full limit of this facility is available to the company at any time. All term debt facilities have been repaid in accordance with the terms of their agreements.

R.W. Tomlinson Limited and Lystek International Inc. also maintain their current accounts with our bank. There have been no NSF cheques and adequate balances are consistently maintained.

Based on the current cash deposits held and credit facilities available with our bank, they maintain the financial capacity to manage multiple contracts in excess of $15 million.

If you require further details, please call the undersigned.

Yours truly,

B. Lynch
Director, Credit Solutions Group
Tel. 613-564-5177

"YOUR INDEPENDENT VERIFICATION REQUIRED. The information contained in this report is strictly confidential and may not be disclosed by you to any other person other than your customer requesting this report. The report should not be construed by you or your customers as a representation or guarantee by us of the reliability or creditworthiness of the subject of this report. The report is based only on our banking experience with the subject of this report. You and your customer must make whatever further investigations of the subject which you deem necessary or advisable to protect your interests. We are not the only source of information with respect to the reliability or creditworthiness of the subject of this report."
November 25, 2014,

City of Ottawa, Supply Branch
Finance Department
100 Constellation Drive, 4th Floor, West Tower
Ottawa, Ontario K2G 6J8

Attention: Jennifer Herold, Purchasing Officer
Telephone: 613-580-2424 ext. 25823
E-mail: Jennifer.herold@ottawa.ca

Re. R.W. Tomlinson Limited/Lystek International Inc.
1425 Bishop St. N. Unit 16, Cambridge, ON N1R 6J9

Dear Sirs:

Re: RFP no. 25414-95812-P01
Project – Contingency Services for Biosolids Beneficial use Program

We confirm that R.W. Tomlinson Limited has dealt with our bank for over 20 years and Lystek International Inc. since 2011. R.W. Tomlinson reports revenues well into the nine figure range and currently maintains eight figure revolving line of credit which currently has no balance. The full limit of this facility is available to the company at any time. All term debt facilities have been repaid in accordance with the terms of their agreements.

R.W. Tomlinson Limited and Lystek International Inc. also maintains their current accounts with our bank. There have been no NSF cheques and adequate balances are consistently maintained.

Based on the current cash deposits held and credit facilities available with our bank, they maintain the financial capacity to manage contracts in excess of $75 million.

If you require further details, please call the undersigned.

Yours truly,

[Signature]

Luigi Bastianelli
Director, Market Lead
Tel. 613-564-5142

“YOUR INDEPENDENT VERIFICATION REQUIRED. The information contained in this report is strictly confidential and may not be disclosed by you to any other person other than your customer requesting this report. The report should not be construed by you or your customers as a representation or guarantee by us of the reliability or creditworthiness of the subject of this report. The report is based only on our banking experience with the subject of this report. You and your customer must make whatever further investigations of the subject which you deem necessary or advisable to protect your interests. We are not the only source of information with respect to the reliability or creditworthiness of the subject of this report.”
Appendix B

Facility Equipment
Appendix C

LysteGro™ Product Brochure
# LysteGro Fertilizer Composition

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<th>Component</th>
<th>LysteGro Average</th>
<th>Max. Allowable Concentration</th>
<th>Units</th>
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<td>Organic Matter Content</td>
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<tr>
<td>Total Organic Carbon</td>
<td>3.85</td>
<td>% on a wet weight basis</td>
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<tr>
<td>Total Nitrogen (TKN)</td>
<td>5.58</td>
<td>% on a dry weight basis</td>
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<tr>
<td>Total Available Nitrogen (Ammonium + Nitrate)</td>
<td>3.01</td>
<td>% on a dry weight basis</td>
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</tr>
<tr>
<td>Total Organic Nitrogen</td>
<td>2.57</td>
<td>% on a dry weight basis</td>
<td></td>
</tr>
<tr>
<td>Total Phosphorus (elemental)</td>
<td>3.66</td>
<td>% on a dry weight basis</td>
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<td>Total Phosphorus (P$_2$O$_5$)</td>
<td>8.38</td>
<td>% on a dry weight basis</td>
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<tr>
<td>Total Potassium (elemental)</td>
<td>1.91</td>
<td>% on a dry weight basis</td>
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<tr>
<td>Total Potassium (K$_2$O)</td>
<td>2.30</td>
<td>% on a dry weight basis</td>
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<table>
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<th>Max. Allowable Concentration</th>
<th>Units</th>
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<tr>
<td>Arsenic</td>
<td>3.98</td>
<td>170</td>
<td>mg/kg</td>
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<tr>
<td>Cadmium</td>
<td>2.37</td>
<td>34</td>
<td>mg/kg</td>
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<tr>
<td>Cobalt</td>
<td>3.89</td>
<td>340</td>
<td>mg/kg</td>
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<tr>
<td>Chromium</td>
<td>77.52</td>
<td>2800</td>
<td>mg/kg</td>
</tr>
<tr>
<td>Copper</td>
<td>738.57</td>
<td>1700</td>
<td>mg/kg</td>
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<tr>
<td>Mercury</td>
<td>0.31</td>
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<td>mg/kg</td>
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<td>Molybdenium</td>
<td>10.58</td>
<td>94</td>
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<td>Nickel</td>
<td>23.19</td>
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<td>Lead</td>
<td>34.72</td>
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<td>Selenium</td>
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<tr>
<td>Zinc</td>
<td>837.75</td>
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<tbody>
<tr>
<td>Boron</td>
<td>0.026</td>
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<td>lbs/1,000 gallons</td>
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<tr>
<td>Calcium</td>
<td>46.79</td>
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<tr>
<td>Copper</td>
<td>0.00</td>
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<tr>
<td>Magnesium</td>
<td>7.42</td>
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<td>Manganese</td>
<td>0.44</td>
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<td>Sulphur</td>
<td>15.00</td>
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<tr>
<td>Zinc</td>
<td>1.02</td>
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<td>lbs/1,000 gallons</td>
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<th>Trace Elements</th>
<th>LysteGro Average</th>
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<tr>
<td>Total Nitrogen</td>
<td>67.95</td>
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<td>Total Available Nitrogen</td>
<td>40.16</td>
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<td>Total Phosphorus (P$_2$O$_5$)</td>
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<td>Total Available Phosphorus (P$_2$O$_5$)</td>
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<tr>
<td>Total Potassium</td>
<td>27.56</td>
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<td>Total Available Potassium (K$_2$O)</td>
<td>25.17</td>
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<td>lbs/1,000 gallons</td>
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*a* Values represent the mean of 12 samples collected on a monthly basis throughout 2015  
*b* As per Ontario Regulation 338/09, Schedule 5  
*c* The sum of Ammonium + Nitrate + assume 40% mineralization of Organic Nitrogen during first growing season  
*d* Assume 40% availability of Phosphorus during first growing season  
*e* Assume 90% availability of Potassium during first growing season

Organic Materials Recovery Center - 191 Eco Parkway, Dundalk, ON N0C 1B0  
T. 519.923.3539  F. 888.501.7429  E. SouthgateOMRCC@lystek.com  
www.lystek.com
Nothing wasted. Everything to gain.

As chemical fertilizer prices steadily increase and alternative sources of valuable organic matter become harder and harder to source, LysteGro provides an economical, sustainable and highly effective alternative to traditional fertilization.

Leveraging its patented and proven technology, Lystek processes biosolids and other organics into a pathogen free, Canadian Food Inspection Agency (CFIA) registered biofertilizer product.

LysteGro is an organically-based, concentrated, liquid biofertilizer with a full complement of nutrients suitable for a wide range of fertilization requirements.

N-P-K: LysteGro contains high concentrations of all three macronutrients (5.5–8–2.5), resulting in a robust and valuable biofertilizer product.

MICRONUTRIENTS: In addition to the macros, LysteGro provides a variety of valuable micronutrients including high concentrations of Sulphur, Calcium, Iron and Magnesium.

ORGANIC MATTER: LysteGro is also ideal for building soil structure due to a uniquely high concentration of organic matter within the material, which helps to improve water retention, soil tilth and pore space.

MULTI-YEAR BENEFIT: Similar to manure, LysteGro is high in organic matter and valuable nutrients that are released slowly, over time, thus providing essential benefits for several years after application.

QUALITY & SAFETY: Lystek's patented and proven, quality controlled, manufacturing approach leverages a combination of heat, high-speed shearing (lysing) and the addition of alkali, to produce LysteGro. The result is a truly unique biofertilizer product that is healthy for the soil, safe, reliable and pathogen free.

"Farmers who know, use LysteGro!"
Appendix D

Awards
2005 Regional Innovation Award
for Sustainable Development
Ontario Region
Awarded to
Lystek International Inc.

In recognition of your innovative contribution
to the advancement of Sustainable Development

Tony Rahilly
Director General

Peter Cashmore
Executive Director

Canada
27 March 2013

Frederick Mosher, President
Lystek International Inc.
1425 Bishop Street North, Unit 16
Cambridge ON
N1R 6J9

RE: Nomination of Lystek International Inc. for the WEAO Exemplary Biosolids Management Award

Dear Mr. Mosher,

The Residuals and Biosolids Committee of WEAO has reviewed your nomination for the Exemplary Biosolids Management Award for 2013 and I am pleased to inform you that Lystek International Inc. will receive the award in the category of Technology Development.

The Lystek process demonstrates sustained excellence in advancing our knowledge of technologies for managing residuals and biosolids, technology with potential for use in many locations, operational proof of performance, improvement of biosolids handling and nutrient recovery, and improvement of biosolids quality for beneficial use.

You will receive a complementary registration to the WEAO Annual Conference, April 7 to 9 at the Toronto Congress Centre. Your award will be presented during the Awards Luncheon on Monday April 8, 12:00 to 2:00 pm. You are also invited to provide a short presentation of your process during the Biosolids Session on Monday afternoon, April 8. If you have any questions please do not hesitate to contact the WEAO office.

Yours sincerely,

Shirley Anne Smyth
Coordinator, Exemplary Biosolids Award Program
Residuals and Biosolids Committee

42nd ANNUAL TECHNICAL SYMPOSIUM & EXHIBITION
APRIL 7-9, 2013
THE TORONTO CONGRESS CENTRE
TORONTO, ONTARIO
BE IT KNOWN BY THIS CERTIFICATE THAT

Ajay Singh

HAS EARNED
0.55 CONTINUING EDUCATION UNITS
FOR PARTICIPATION IN

Emerging Contaminants in Wastewater Systems Seminar
Toscana Banquet and Conference Centre, Vaughan, ON
May 29th, 2014

Julie A. Vincent
W.E.A.O. Executive Administrator
EXEMPLARY BIOLOGICAL MANAGEMENT AWARD

Presented to

Lysol International Inc.

In the

TECHNOLOGY DEVELOPMENT CATEGORY

2013
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<td>No.</td>
<td>Application Number</td>
<td>Filing Date</td>
<td>Country</td>
<td>Description</td>
<td>Inventor(s)</td>
<td>Publication or Status</td>
<td>Priority</td>
<td>Filing Date</td>
<td>Number</td>
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<td>19</td>
<td>GB 1218103.8</td>
<td>October 9, 2012</td>
<td>GB</td>
<td>Process for removal of chemical contaminants from biological wastes</td>
<td>TBA</td>
<td>None</td>
<td>Priority</td>
<td>NA</td>
<td>NA</td>
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<tr>
<td>20</td>
<td>14/048,191</td>
<td>October 28, 2013</td>
<td>US</td>
<td>Contaminant-free fertilizer from liquidized sewage sludge</td>
<td>Ward, OP; Singh, A</td>
<td>GB 1218103.8</td>
<td>Granted</td>
<td>9,139,483</td>
<td>22 Sep 2015</td>
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<td>21</td>
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<td>October 28, 2013</td>
<td>Canada</td>
<td>Contaminant-free fertilizer from liquidized sewage sludge</td>
<td>Ward, OP; Singh, A</td>
<td>GB 1218103.8</td>
<td>Pending, examination requested</td>
<td></td>
<td></td>
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<tr>
<td>22</td>
<td>GB 1510219.7</td>
<td>11 June 2015</td>
<td>GB</td>
<td>Stable biosolids-containing product</td>
<td>TBA</td>
<td>None</td>
<td>Priority</td>
<td>application only</td>
<td></td>
</tr>
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<td>23</td>
<td>US 15/180,721</td>
<td>13 June 2016</td>
<td>US</td>
<td>Procedure for stabilizing high pH levels in biosolids - containing processed sewage sludge</td>
<td>Ward, OP; Singh, A</td>
<td>GB 1510219.7</td>
<td>Published, Sep 15, 2016, being examined</td>
<td></td>
<td></td>
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<tr>
<td>24</td>
<td>GB 1907541.5</td>
<td>15 June 2017</td>
<td>GB</td>
<td>Procedure for obtaining and improving pumptability of high to very high biosolids containing dewatered sewage sludge</td>
<td>TBA</td>
<td>None</td>
<td>Priority</td>
<td>application only</td>
<td></td>
</tr>
<tr>
<td></td>
<td>GB 1711996.7</td>
<td>25 July 2017</td>
<td>GB</td>
<td>Procedure for improving dewaterability of biosolids cake, and production of highly dewatered biosolids cake</td>
<td>TBA</td>
<td>None</td>
<td>Priority application only</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: All of the Patents / Applications assigned to Lystek International Inc. Patent Attorney - Anthony Asquith / Gordon Clarke (Ph: 519-746-6732)
Appendix F

Guelph Case Study
From demo to full-scale operation

City of Guelph leverages Lystek technology to support Biosolids Management Master Plan

The City of Guelph wanted a new biosolids processing technology that would take it well into the future.

ABOUT
Located in Southern Ontario, Guelph is home to 120,000 residents and designated by the Province of Ontario as a place to grow. www.guelph.ca

CHALLENGES
- Increasing quantity of biosolids due to population growth and rising costs of landfill
- A legacy composting technology that was not likely to meet changing regulatory requirements

SOLUTION
- Integration of Lystek biosolids management solution into existing Wastewater Treatment Plant
- Demonstration trial leading to full-scale deployment

RESULTS
- Lystek demonstration project met and exceeded the specified performance objectives
- Year round potential for processing of biosolids
- Converts dewatered biosolids into a federally registered (CFIA), nutrient rich biofertilizer product with the potential for a variety of end uses
- Reduced landfill costs and carbon footprint (GHG’s)
- Opportunity to eliminate need for landfilling of a valuable, organic resource material

THE CHALLENGE OF GROWTH

With a population that is expected to surge beyond 175,000 by 2031, the City of Guelph is a growth powerhouse in Southern Ontario. A diversified economy, high quality of living, and low unemployment make it a highly desirable community to call home.

While growth generates tremendous economic benefits, it also creates challenges. Among them is an increasing volume of sewage “waste.” To further define the challenge, Guelph’s wastewater operation produces approximately 20,000 tonnes of dewatered biosolids every year. Dealing effectively with that volume of biosolids is a top priority for the City.

In Canada and the U.S., municipalities tend to manage biosolids in one of three, primary ways; recycling for beneficial use, incineration, or by burying these materials in a landfill. There are various levels of stress involved with each of these approaches due to a combination of technical, regulatory, and financial considerations.

Incineration in particular, is expensive and impractical for most Canadian municipalities. Landfilling these materials is not easy and certainly, there can be concerns with odors, plus space is at a premium. The fact is that neither one of these options are considered sustainable over the long term.
CHANGING ENVIRONMENTAL GUIDELINES

In 1996 the Ontario Ministry of Environment published new, stringent guidelines that would have to be met before biosolids could be considered appropriate for agricultural use. Unfortunately, the legacy compositing technology the City had in place at that time was not likely to meet changing, regulatory requirements.

A NEW VISION FOR BIOSOLIDS

Confronted with rising landfill costs, the City embarked on a bold vision to create a new Biosolids Management Master Plan (BMMP) in 1996. This plan would provide direction on the City’s approach to biosolids management through to the year 2025 and recommend a strategy that would be “economically viable, meet regulatory requirements, able to be maintained in the long term and that is supported and endorsed by stakeholders and, ultimately by City Council.”

To mobilize this plan, a more innovative and cost effective technology was required to process the liquid component of wastewater received by the existing Wastewater Treatment Plant (WWTP). “We wanted a new biosolids processing technology that would take us well into the future,” says Kiran Suresh, Plant Manager of Wastewater Services, City of Guelph. “It needed to reliably divert our biosolids from landfill and convert them into a safe, regulated fertilizer product that can be beneficially utilized” she adds.

DEMO PROJECT IS PLANNED

Supported by a leading engineering, environmental, and construction firm that was already providing services to the City of Guelph – and an IRAP (Industrial Research Assistance Program) grant from NRC (National Research Council Canada) – the City entered into an Agreement with Lystek in 2002 to implement an initial demonstration project at its WWTP.

The project was designed to showcase Lystek’s cutting edge biosolids and organics treatment technology and assess its potential for a full-scale, commercial application at the Guelph facility. “A key objective of the project was to determine whether the Lystek process could efficiently treat dewatered biosolids such that the processed material could qualify as a true, CFIA registered fertilizer product,” says Suresh.

AWARD-WINNING LYSTEK TECHNOLOGY IMPLEMENTED

Lystek’s technology was championed because it addresses a number of health and environmental concerns posed by increasingly stringent guidelines across Canada and the U.S. – and around the world. “Lystek is an industry leader that is revolutionizing the technology for treatment of biosolids,” says Suresh. It’s a process whereby municipalities can economically raise the bar in terms of quality while reducing Operating & Maintenance costs and greenhouse gas potential.

Using a proprietary combination of chemical and physical processes, Lystek treats biosolids and organics and produces a material that is in the range of 14 to 17 percent solids with viscous properties similar to liquid material. The resulting product is a stable, high-solid, low viscosity, dust-free biofertilizer that meets or exceeds U.S. EPA, Class A EQ (Exceptional Quality) standards – and that is registered by the Canadian Food Inspection Agency (CFIA) in Canada. The end product, now branded and trademarked as LysteGro™, has many diverse uses such as agriculture, sod farming,

“The addition of the state-of-the-art, Lystek solution to our Wastewater Treatment Plant operations is playing a vital role in contributing to our goal of being a progressive, industry leader in biosolids management,” confirms Suresh.

1City of Guelph, Biosolids Management Master Plan, Final Report, November 2006

Nothing wasted. Everything to gain.
horticulture and more. Due to its registration as a true, commercial fertilizer, it can be stored virtually anywhere, including on the farm or at a suitable, third-party facility.

Another significant advantage of the Lystek system is that it can be easily integrated into existing plant infrastructure and requires very little space. "We liked the fact that Lystek is a stand-alone technology with a small footprint that does not interfere with the general plant processes," says Tim Robertson, Manager of Operations, for the City of Guelph.

FROM SUCCESSFUL DEMONSTRATION TO FULL SCALE OPERATION

The demonstration project successfully met and exceeded all of the objectives specified in the Initial Agreement.

On the heels of this success, the City approved a full-scale operating agreement resulting in commercial application of the Lystek process – funded by the City and Federation of Canadian Municipalities (FCM) through a Green Municipal Fund (GMF).

Since 2008, the proven and affordable full scale Lystek solution has been operated by City staff and successfully processing biosolids at the facility. "The addition of the state-of-the-art, Lystek system to our Wastewater Treatment Plant operations is playing a vital role in contributing to our goal of being a progressive, industry leader in biosolids management," confirms Suresh.

AN EVOLVING STORY

An innovative City, Guelph is committed to fully leveraging advanced wastewater management strategies to deal with continued population growth. In 2010, the City approved a full-scale, 6-month pilot study on recycling of Lystek processed biosolids to one of its anaerobic digesters. This process, called "LysteMizing," was able to demonstrate potential benefits in terms of increases in biogas (methane) production for "green energy." While this is an evolving story, indicators suggest there is potential for the City to realize additional financial benefits through use of its existing Lystek system.

About Lystek

Lystek International Inc. is an organic materials recovery firm that is helping municipalities and other generators reduce waste, costs, odors and greenhouse gas emissions through its innovative approach to biosolids and organics management. The multi-use Lystek system can be leveraged to optimize digesters and biological nutrient removal systems while also contributing to diversion and sustainability. This is achieved by transforming non-hazardous, organic materials into nutrient-rich, federally-registered fertilizers and other multi-purpose products. www.lystek.com
Appendix G

Manhattan College Case Studies on AD and BNR
Lystek Co-Digestion Preliminary Study

Purpose: The purpose of this project was to evaluate the effect of adding Lystek to bench-scale anaerobic digesters currently being used to study co-digestion at Newtown Creek in New York City. Key metrics for this project include volatile solids destruction, biogas production and methane concentration in biogas.

Introduction

The preliminary experiments used Lystek in combination with thickened waste activated sludge (TWAS) from the Newtown Creek wastewater treatment plant. Newtown Creek does not have primary treatment so their digesters receive only thickened waste activated sludge (TWAS). Newtown Creek TWAS is very different from the sludge produced at the Hunt’s Point treatment plant for example which has primary treatment and is also using a biological nitrogen removal process. Newtown Creek operates with a 1.0 day SRT, which results in the diversion of significant soluble, colloidal and particulate COD directly to the digesters, as opposed to having it oxidized in the aeration tank. This results in significantly higher volatile solids content, making the Newtown Creek sludge more biodegradable.

This study using Lystek was incorporated into an on-going co-digestion research project at Manhattan College. Since the project incorporated an extra anaerobic reactor which was not needed until May, 2014, it was possible to study the effects of Lystek addition for about a four month period. The objectives of this study were:

1. To quantify volatile solids reduction and gas production for co-digestion as a function of the volumetric ratio of Lystek product to TWAS with the volumetric ratio starting at 10% increasing to 15%;
2. To evaluate the impact of Lystek product on volatile solids destruction, gas production and methane content;
3. To determine the impact of Lystek addition on digestion process parameters (i.e. VA:Alk ratio; CH₄: CO₂ ratio, etc.).
Lab Scale Reactor

The lab scale co-digestion study used two 10-liter bench-scale reactors run in parallel (Figure 1). One reactor (ADT1) served as the control reactor and received only TWAS. The second reactor (ADT2) served as the test reactor and was fed various volumetric ratios (10 and 15%) of Lystek to TWAS. TWAS was collected weekly from Newtown Creek. A single sample of Lystek was used throughout the entire test period. Based on testing of the stored Lystek material, it does not appear that there is a significant change in characteristics over time as measured by VSS, COD, organic content, pH, and consistency.

The two reactors were operated as completely mixed, batch-fed reactors with an SRT of 15-days and a constant temperature of 35°C (mesophilic). The reactors are equipped with continuous, on-line biogas flow meters. Each of the two reactors received the same sludge collected from the Newtown Creek WWTP, with ADT2 being supplemented with Lystek as described above.
From January 29 to April 28, 2014, Lystek was added to the digester in a volumetric ratio of 10%. Beginning on April 28, Lystek was added at a ratio of 15%. This feed rate was used for a period of less than 1 SRT (Table 1) because the Lystek study had to be terminated since the reactor was needed for the Newtown Creek Food Waste Co-Digestion Project. The data from the 15% addition is not included in this report because the reactor could not reach steady-state over that short time period.

**Table 1: Feed Cycles for ADT2 Reactor in Lystek Co-Digestion Study**

<table>
<thead>
<tr>
<th>Cycle</th>
<th>Feed Volumetric Ratio (Lystek/HPS)</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10%</td>
<td>82 days (~5.5 SRTs)</td>
</tr>
<tr>
<td>2</td>
<td>15%</td>
<td>15 Days (1 SRT)</td>
</tr>
</tbody>
</table>

Feed sludge and digestate from the control and Lystek reactor were analyzed twice a week for pH, alkalinity, T5, VS, COD, ammonia, and volatile acid content. The average feed characteristics of both TWAS and Lystek are shown in Table 2. Off gas samples were collected and analyzed for methane gas, carbon dioxide, and hydrogen sulfide. Gas sampling and analysis were performed three times during each test condition. All results were compared to the control reactor based on Gas Production/Fraction VSS destroyed and Gas Production Fraction COD reduced.

**Table 2 Average Feed Characteristics**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Feed A TWAS</th>
<th>As Received LYS</th>
<th>Feed C @ 10 % TWAS/LYS</th>
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<tr>
<td>pH</td>
<td>6.13</td>
<td>8.32</td>
<td>6.4</td>
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<tr>
<td>%TS</td>
<td>8.4</td>
<td>13.3</td>
<td>8.9</td>
</tr>
<tr>
<td>%VS</td>
<td>84</td>
<td>59</td>
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<tr>
<td>TKN, mg/kg (dry)</td>
<td>23,630</td>
<td>25,030</td>
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<tr>
<td>V.A. (mg/L CH3COOH)</td>
<td>2,643</td>
<td>10,318</td>
<td>3410</td>
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<tr>
<td>NH4 (mg/L)</td>
<td>1,625</td>
<td>5,551</td>
<td>1963</td>
</tr>
<tr>
<td>tCOD(mg/L)</td>
<td>127,700</td>
<td>154,808</td>
<td>130,411</td>
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Results and Discussion

The data collected during this testing period indicate that Lystek appears to be slightly more biodegradable than Newtown Creek TWAS (Table 3), but not as biodegradable as food waste.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Digestate A (Control)</th>
<th>Digestate C (LYST)</th>
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<tr>
<td>pH</td>
<td>7.5</td>
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<td>%TS</td>
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<tr>
<td>%VS</td>
<td>70</td>
<td>68</td>
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<tr>
<td>%VS Reduction</td>
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<td>55</td>
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<td>V.A.(mg/L CH3COOH)</td>
<td>1,072</td>
<td>1,217</td>
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<tr>
<td>NH4 (mg/L)</td>
<td>4,993</td>
<td>5,210</td>
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<tr>
<td>tCOD(mg/L)</td>
<td>79,614</td>
<td>74,508</td>
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Initially, gas production from the Lystek reactor was lower than the control reactor. However, at SRT 5, gas production rates were higher than the control. Figure 2 (SRT 3) shows the lower gas production rate as compared to TWAS, and Figures 3 and 4 (SRT 5) indicate higher rates. The higher production rates associated with SRT 5 may indicate that the reactors reached steady-state. Additional study is required to confirm this.

![Figure 2 Gas production rate SRT 3](image)

Gas composition is within the expected range and the results indicate a higher percentage of methane in the Lystek reactor (55%) as compared to the control reactor (52%) which translates to a higher energy value.
Conclusion and Future Work

Based on the data collected to date, Lystek appears to be more biodegradable than Newtown Creek TWAS and there is a slightly higher concentration of methane in the biogas. The results are promising and indicate the need for further studies. It should be noted that residual organics/volatile solids after digestion are harder to degrade; however, the Lystek process makes these solids more amenable to further degradation.

Lystek is a thick and viscous material that requires proper mixing in the bench-scale reactors. During the early stages of the project, problems were encountered with mixing. Some changes were made which improved mixing but further studies will be conducted using smaller reactors to ensure a more homogeneous mixture. Further studies will be performed using sludge from the Hunt's Point Treatment Plant which is a more typical wastewater residual containing both primary and waste activated sludge (WAS). Lystek processed biosolids used in this next phase will be produced using Hunts Point dewatered sludge. Since Hunts Point is a biological nitrogen removal facility, they operate with a higher SRT so the WAS will be much different from Newtown Creek. The result from Hunt's Point can be more easily translated to potential results at other NYC wastewater treatment plants.

Jeanette A. Brown
REQUEST FOR EXPRESSION OF INTEREST (RFEI) TO
PERMIT, DESIGN, BUILD, FINANCE, OWN, OPERATE & MAINTAIN
AND MARKET PRODUCTS FROM AN ORGANICS-TO ENERGY
SLUDGE PROCESSING FACILITY

PRESENTED BY

Ameresco, Inc.
111 Speen Street
Framingham, MA 01701
T: (508) 661.2200 • F: (508) 661.2201

Proposal contains data and information that has been submitted in response to a request for proposal or similar solicitation and is provided in
confidence. The contents include proprietary information and trade secrets that belong to Ameresco, Inc., ("Confidential Information") and is disclosed
to a recipient only for purposes of evaluation. In the event Ameresco is awarded a contract or purchase order as a result of or in connection with the
mission of this proposal, Customer shall have a limited right as set forth in the governing contract or purchase order to disclose the data herein, but
only to the extent expressly allowed. This restriction does not limit the Customer’s right to use or disclose data obtained without restriction from any
source, including the proposer.
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Ms. Susan Brice  
City of New Bedford  
133 William Street  
New Bedford, MA 02746  

Subject: Solicitation Number - 19192009  

Dear Ms. Brice,

Ameresco is pleased to submit our Expression of Interest to Permit, Design, Build, Finance, Own, Operate & Maintain and Market Products from an Organics-to-Energy Sludge Processing Facility. Ameresco has a long and successful history of partnering with municipalities on similar projects. We are confident that our response will demonstrate that our level of interest, capabilities, and experience uniquely qualify the Ameresco team to be the best choice for a long-term partner to develop the Organics-to-Energy Facility. Given Ameresco's depth of experience on similar projects, lessons learned, and its detailed project delivery model, we will be able to mitigate the risks over the entire contract term that the City would have with other developers who are not as experienced and skilled as our team.

Ameresco will deploy its proven and award-winning team for this effort. Supplementing this commitment is the resource depth of the entire Ameresco organization, its exceptional credibility and financial strength. As you review our qualifications you will see the relevant experience of our team members regarding the project requirements, such as the following:

- Ameresco has developed nearly 163 MW of operational biogas projects. This represents 24 highly complex, biogas projects that team members assigned to this project have personally been responsible for. This experience speaks volumes to the team members’ experience in developing, designing, permitting, constructing, and operating biogas projects that are very similar to the City’s project.
- Overall management of environmental protection projects nationwide, ranging from the implementation of simple monitoring plans to the operation of complex biogas utilization and water treatment facilities.
- Project experience that covers a wide variety of systems including biogas, groundwater, and surface water monitoring and sampling, automatic methane detection, surface emissions monitoring, air injection, landfill gas extraction and flaring, groundwater monitoring and sample collection, and waste water treatment.
- A wealth of experience in financing energy projects with in excess of $1.2 billion in backlog. This experience, garnered over the years, includes many biogas utilization projects. Simply put, knowledge of how these projects must be structured (e.g., contracts, plant design, and permits) to successfully secure competitive financing terms.
Founded in 2000, Ameresco Inc. (NYSE: AMRC) is a leading independent provider of comprehensive energy facilities throughout North America. Ameresco, with nearly 1100 employees, will provide local expertise and resources through its headquarters in Framingham, MA, as well as our regional office located in Portland, ME. Our holistic approach has delivered over $5 Billion in sustainable solutions which includes nearly 300 MWe of energy generation projects. Ameresco has unparalleled experience and a proven track record partnering with Municipalities in delivering energy solutions on time and within budget.

As an independent energy services firm, Ameresco is not obligated to or managed by a larger parent or holding company, equipment manufacturer, utility company, construction consortium or technology. Our independent structure and guiding philosophies allows for objective decision making that is always client centric. Ameresco's independence is a direct benefit to the City of Medford, as it allows for an unbiased approach both technically and financially.

Thank you for this opportunity to provide our qualifications. We hope to be afforded the opportunity to continue in this process. Please do not hesitate to contact me at (860) 930-3657 with any questions.

Sincerely,

[Signature]

Edward J. Bludnicki
Senior Project Developer
SECTION 1: COMPANY OVERVIEW

1.1: ENTITY INFORMATION

Ameresco, Inc. (NYSE: AMRC) is a leading independent provider of comprehensive energy services, including energy generation, energy conservation, energy analytics, and supply management, for clients throughout North America and the United Kingdom, delivering long-term value through innovative systems, strategies and technologies. Ameresco's solutions range from the development, permitting, design, construction, and operation of renewable energy plants, to upgrades of facility's energy infrastructure, combined with tailored financial solutions.

Since Ameresco's inception, we have designed and implemented over $5 billion in energy projects, including over 300 MW in renewable energy solutions at many public and private mission critical facilities. Over the past five years alone, the firm has completed over $2.4 billion in energy projects throughout North America, including projects for cities and counties, state agencies, the federal government, higher education and K-12 institutions, commercial and industrial clients, and non-profit organizations.

CORPORATE/EXECUTIVE OFFICERS

The following is a list of our executive officers and their principal positions.

<table>
<thead>
<tr>
<th>Name</th>
<th>Position(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>George P. Sakellaris</td>
<td>Chairman, President and Chief Executive Officer</td>
</tr>
<tr>
<td>David J. Anderson</td>
<td>Executive Vice President and Director</td>
</tr>
<tr>
<td>Michael T. Bakas</td>
<td>Executive Vice President, Renewable Energy</td>
</tr>
<tr>
<td>Nicole A. Bulgareno</td>
<td>Executive Vice President and General Manager, Federal Solutions</td>
</tr>
<tr>
<td>David J. Corwin</td>
<td>Executive Vice President, General Counsel and Secretary and Director</td>
</tr>
<tr>
<td>Joseph P. DeMancha</td>
<td>Executive Vice President, Engineering and Operations</td>
</tr>
<tr>
<td>John R. Granara</td>
<td>Executive Vice President, Chief Financial Officer and Treasurer</td>
</tr>
<tr>
<td>Louis P. Matzezos</td>
<td>Executive Vice President</td>
</tr>
</tbody>
</table>

PRIMARY CONTACT

Mr. Ed Bludnicki, Senior Project Developer, will be the primary contact for the City of New Bedford, and the designated Ameresco team will support him in all aspects of the project. Mr. Bludnicki's responsibilities include:

- Communicating between all parties to ensure satisfaction and clarity in exchange of ideas and information
- Identifying key goals and objectives
- Ensuring that all expectations of the City of New Bedford's personnel are met or exceeded
- Ensuring the proper development of financial and technical solutions
- Developing and coordinating all agreements, terms and conditions
- Coordinating interaction with the City of New Bedford's personnel and the Ameresco team
- Coordination with Ameresco's finance team to design the project in a way that leverages all available utility rebates and incentives in the marketplace
- Expediting the approval process through all required channels

Mr. Bludnicki can be reached via the following:

Ed Bludnicki, Senior Project Developer  
508.598.3059  
EBludnicki@Ameresco.com  
111 Speen Street, Suite 410, Framingham, MA 01701
1.2: AMERESCO OVERVIEW

Ameresco’s experience working on active mixed-use, government sites, airports, higher education campuses, prisons, and hospitals throughout North America has given us unique insight into the development, implementation, and phasing of energy projects to meet the unique scheduling, logistical, and budgetary requirements of our clients. Ameresco has the expertise required to successfully design and implement projects of nearly any size or scope, including the project currently under consideration by the City of New Bedford. Ameresco delivers timely and cost-effective projects that support our clients’ financial, energy production, and conservation goals.

Ameresco’s independence from utility or equipment-manufacturing parent organizations allows us to be nimble and transparent in the development of this exciting project, always making design and equipment choices without bias and in the best interest of the City of New Bedford.

Additional strengths and capabilities include knowledge of tax codes, federal assistance programs, applicable tax credits available, and a current and informed perspective on the ever-changing local utility-based renewable energy credit programs. This understanding of the contracting requirements, permitting process, integrated work process, utility interconnection, building codes and standards, system commissioning, energy monitoring, and operating an energy system is unparalleled.

FINANCIAL AND BUSINESS STRENGTH

Ameresco recognizes that it is paramount for the City of New Bedford to have an energy partner that is not only technically qualified but also financially strong and stable with a solid track record of performance in the capital markets.

Incorporated on April 25, 2000 in the State of Delaware, Ameresco has been providing energy services under its present name for 18 years. With 2017 revenues of $717.2 million and a construction backlog exceeding $1.77 billion, Ameresco delivers long-term value through innovative systems, strategies, and technologies. For the year 2017, Ameresco had total assets of approximately $984 million, cash in excess of $40 million and an $75 million credit facility. In addition, we maintain a $750 million surety credit facility through two corporate providers, both with an AM Best Rating of “A Excellent”. Ameresco has the financial fortitude to be a long-term partner with the City of New Bedford, ensuring a successful development execution, project implementation, and operations.

Ameresco has sourced and raised more than $2.5 billion of project financing over the past 17 years, from various lending sources including John Hancock, Bayerische Landesbank, Bank of America, Capital One, Chase Bank, Crews and Associates, Union Bank, and several other financial institutions. Using existing cash resources, cash flows from Ameresco’s operating activities, and access to credit through multiple lending relationships, Ameresco has the resources necessary to develop, implement, and finance the many of our clients' projects.
ACCREDITATION & PRE-QUALIFICATIONS

Ameresco was the first energy services provider accredited by National Association of Energy Service Companies (NAESCO) and is recognized by both the U.S. Department of Defense (DOD) and Department of Energy (DOE) as a federal qualified ESCO, a designation that Ameresco has held each year that these federal agencies have pre-qualified candidate firms. Like the NAESCO accreditation process, these federal qualifications are based on independent evaluations of Ameresco’s capabilities and ability to successfully develop, finance, implement and perform long-term performance services on behalf of its clients.

Ameresco holds multiple Super ESPC indefinite delivery/indefinite quantity (ID/IQ) contracts under both the DOD and DOE programs. In the latest ID/IQ contract award (October 2013), Ameresco was selected as part of a $600 million shared capacity contract for the design and construction of supply- and demand-side energy projects by the U.S. Army Corp of Engineers.

1.3: PROPOSED TEAM

As a company with its core business solely focused on developing and implementing comprehensive energy and water projects, Ameresco has the in-house personnel to develop innovative projects of nearly any size or scope. The key factors that Ameresco typically considers in the selection of team members for its projects are:

- Technical knowledge and expertise
- Administrative, management and communication skills
- Familiarity with local market conditions
- Existing work load
- Ameresco’s staff manages and conducts its project development, project/construction management, and post-construction measurement and verification using in-house resources. At all stages of the project, a direct Ameresco employee will be responsible for management and oversight of:

  Engineering and design
  Project and construction management
  Training and commissioning
  Measurement and verification
  Finance
  Operations and maintenance, if applicable
As necessary and/or required, the team will draw upon the experience and expertise of the over 1,000 Ameresco energy professionals located throughout 70 offices in North America.

**PROPOSED KEY PERSONNEL**

<table>
<thead>
<tr>
<th>Team Member, Title and Certifications</th>
<th>Academic/ Professional Qualifications</th>
<th>Years of Experience</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Account Management and Client Satisfaction</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ed Bludnicki, Senior Project Developer</td>
<td>BS, Mechanical Engineering, Marquette University</td>
<td>20</td>
</tr>
<tr>
<td><strong>Overall Management and Finance</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Michael Bakas, Executive Vice President, Distributed Energy Systems</td>
<td>MBA, Finance/Risk Management, Boston College; BS, Mechanical Engineering, University of Massachusetts at Amherst; Member, New England Clean Energy Council</td>
<td>27</td>
</tr>
<tr>
<td>Chad Brown, Director, Structured Finance</td>
<td>MBA, Finance, University of North Carolina at Chapel Hill; BS, Engineering, Swarthmore College</td>
<td>10</td>
</tr>
<tr>
<td><strong>Energy Asset Design and Engineering</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>James Redden, Vice President, Energy Asset Development</td>
<td>BS, Engineering, Cornell University; National Association of Energy Service Companies (NAESCO), Treasurer, Executive Committee; Association of Energy Engineers (AEE) Life Member</td>
<td>42</td>
</tr>
<tr>
<td>Ryan Asselin, Associate Project Development Engineer</td>
<td>BS, Mechanical Engineering, Union College; CSHA 30 Certified; Contributing Member to 'Climate Ready Boston'; Energy Storage Association Member</td>
<td>3</td>
</tr>
<tr>
<td>Jackson Doughty, Associate Project Development Engineer</td>
<td>BS, Electrical Engineering, Union College; Institute of Electrical and Electronics Engineers Member</td>
<td>2</td>
</tr>
<tr>
<td><strong>Construction Project Management, Safety and Construction Administration</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Joseph DeManche, PE, Executive Vice President, Engineering &amp; Operations</td>
<td>MA, Master of Architecture, Harvard University; BS, Engineering, Massachusetts Institute of Technology; Member, American Society of Heating, Refrigerating and Air Conditioning Engineers; Association of Energy Engineers (AEE), Sustaining Member</td>
<td>40</td>
</tr>
</tbody>
</table>

**ACCOUNT MANAGEMENT AND CLIENT SATISFACTION**

**Ed Bludnicki – Senior Project Developer**

As Senior Project Developer, Mr. Bludnicki is responsible for developing energy efficiency and renewable energy projects, including combined heat and power plants, industrial waste processing and biomass facilities, for example, for both public and private clients. With over 20 years of Northeast and West Coast cogeneration plant experience, Mr. Bludnicki's responsibilities begin in the earliest phases of the project and continue through close-out and measurement and verification.
OVERALL MANAGEMENT AND FINANCE

Michael Bakas – Executive Vice President, Distributed Energy Systems
Serving as Executive Vice President, Distributed Energy Systems for Ameresco, Mr. Bakas has over 27 years of energy industry experience. As a pioneer in the renewable energy industry, Mr. Bakas drove and completed some of the earliest agreements that helped shape the protocols and the markets in those states that first implemented renewable portfolio standards. Since that time, he has driven the growth of Ameresco’s renewable energy portfolio to become one of the leading energy services providers in North America.

Mr. Bakas directs Ameresco’s Distributed Energy Systems Group, which is primarily responsible for the development and operation of energy generation assets both domestically and internationally, and he has been key in fostering and supporting legislation that promotes the use of renewable resources. Due to Mr. Bakas’ expertise and foresight, Ameresco and its customers have won numerous awards from the U.S. EPA, the Department of Energy, the Climate Change Business Journal, state agencies, and other industry organizations.

As an industry expert, Mr. Bakas is often invited to speak at industry and customer forums where he typically addresses topics such as energy efficiency, distributed energy systems, microgrids and renewable energy. Over his career, he has been tapped to provide his expertise and guidance regarding energy issues in numerous, as well as to participate in discussions to set direction for state and local energy policy. In June 2017, Mr. Bakas was invited to provide expert testimony before the Clean Air Congressional Roundtable session hosted by U.S. Senator Tom Carper at the U.S. Capitol.

Chad Brown – Director, Structured Finance

Mr. Brown manages the capital allocation decisions and project financing across Ameresco’s primary lines of business. He is responsible for supporting and maintaining effective relationships with project partners, as well as debt equity investors. He oversees financial modeling and project risk management as part of Ameresco’s Structured Finance Team, specializing in distributed generation, renewable energy, and energy efficiency.

ENERGY ASSET DESIGN AND ENGINEERING

James Redden, PE – Vice President, Energy Asset Development
Offering over four decades in the industry, Mr. Redden serves as Vice President of Energy Asset Development for Ameresco. Throughout his time in the industry, Mr. Redden has held positions ranging from Project Engineer to President. Mr. Redden has long experience in support of utility demand-side management (DSM) programs. This includes designing and implementing programs for utilities in both the United States and abroad. He was a major contributor to CL&P’s Energy Action Program and NYPA’s High Efficiency Lighting Program. His technical experience covers boilers, chillers, cogeneration, motors, EMS, lighting, HVAC, compressed air, pumps, fuel cells, solar and industrial process systems.

Notable recent project experience includes a 25 MW central cogeneration and chiller plant with three combustion turbines, one steam generator, 110,000 lbs/hr duct firing, 6,300 tons chilled water for the University of Connecticut, Storrs Campus; a $78M project with Portsmouth Naval Yard that includes a 500 kW/580 kWh battery energy storage system to assure power quality on the base during transitions from
grid power to island power and to provide ongoing voltage and frequency control to the ISO, as well as a new microgrid control system; and the design and construction of a $10.9M, 4.5 MW cogeneration energy plant to serve heating and cooling needs of second largest airport in New England.

Mr. Redden also developed special expertise in Measurement and Verification protocols for the ESCO industry. He served as a technical writer of the North American Measurement and Verification Protocol for the US Secretary of Energy. He wrote protocols for the NAESCO “red book”, an early standard that was used in financing energy projects, and was lead author of the NE Association of Energy Engineer Protocols that was the first introduction of the multi-tier protocols used today.

**Ryan Asselin – Associate Project Development Engineer**

Mr. Asselin joined Ameresco as an Associate Project Development Engineer, with prior experience in energy efficiency. As part of Ameresco’s Project Development Group, Mr. Asselin assists in the conceptual and detailed engineering design and bid documents, cost estimates, drawings, and specifications. He provides engineering support throughout development, construction, project commissioning, and operations, including proposals, technical reports, cost estimates, and presentations.

Mr. Asselin has provided engineering support for several different projects ranging from solar photovoltaic to cogeneration to battery energy storage. In the past year alone, Mr. Asselin developed technical designs for over 120 MW of projects.

**Jackson Doughty – Associate Project Development Engineer**

Mr. Doughty joined Ameresco as an Associate Project Development Engineer. His role is to offer support from preliminary business development and engineering design through to construction and operation.

Mr. Doughty’s responsibilities include system performance modeling for central utility plants, cogeneration, solar photovoltaics and solar thermal, and battery energy storage systems for various clients including municipalities, higher education institutions, and hospitals. Additionally, Mr. Doughty contributes to the writing and organization of financial models, proposals, and presentations for project submittals.

**CONSTRUCTION PROJECT MANAGEMENT, SAFETY AND CONSTRUCTION ADMINISTRATION**

**Joseph DeManche – Executive Vice President, Engineering & Operations**

Mr. DeManche has served as Executive Vice President, Engineering and Operations since 2002. He has more than 40 years of experience in providing energy engineering, design, construction, operations and maintenance services for a full range of municipal, commercial, institutional, industrial and utility clients. He has overseen the design, construction, and operations for hundreds of millions of dollars in shared savings and performance contracts for large-scale energy efficiency upgrade projects.

Mr. DeManche’s diverse experience includes preparation of energy master plans, new construction design reviews, and quality assurance reviews. He is accomplished in the strategic planning of corporate energy programs which enhance financial performance through the integration of energy productivity improvements, energy source substitutions, and energy procurement strategies.
SUBCONTRACTOR SELECTION

Ameresco will establish sub-consultant and subcontractor alliances on a case-by-case basis. This process keeps us vendor neutral and ensures that we are able to meet the financial, operational, Small, Women, Minority, and Service Disabled Veteran Business Enterprise utilization, and other goals identified by the City of New Bedford.

Ameresco recognizes the importance of engaging local contractors, vendors, and energy experts in its projects. As stewards of the taxpayers' dollars, the City of New Bedford has the obligation to enhance the local economy; as a trusted and long-term energy partner, Ameresco is committed to advancing that same goal. For this reason, Ameresco will work with the City of New Bedford to hire local subcontractors for the appropriate elements of the design and delivery process. Local contractors have a vested interest in the success of the project, relationships that can be leveraged in support of the project and an intimate knowledge of the context in which they are working. In recent examples, 65 percent of project costs remained in the local community for a $41.5 million project for the San Francisco Housing Authority and nearly 80 percent of project costs remained in the City of Reno, Nevada for a multi-phase $18.6 million project in that City.
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## SECTION 2: PROJECT REFERENCES

As requested in the solicitation document, below are three project references.

<table>
<thead>
<tr>
<th>Client Name:</th>
<th>Client 1</th>
<th>Client 2</th>
<th>Client 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>San Antonio Water Systems Project</td>
<td>Dallas Water Utilities Plant Biogas Utilization Project</td>
<td>Northeast Water Pollution Control Plant Biogas Project, Philadelphia, PA</td>
</tr>
<tr>
<td>Location:</td>
<td>San Antonio, TX</td>
<td>Dallas, TX</td>
<td>Philadelphia, PA</td>
</tr>
<tr>
<td>Contact Person Name:</td>
<td>Dan Titerle, Project Manager 210-233-3676 <a href="mailto:dltiterle@saws.org">dltiterle@saws.org</a></td>
<td>Richard Wagner Program Manager, Waste Water Facilities 214-948-4516 <a href="mailto:richard.wagner@dallascityhall.com">richard.wagner@dallascityhall.com</a></td>
<td>Paul Kohl Energy Program Manager (215) 685-6320 <a href="mailto:Paul.Kohl@phila.gov">Paul.Kohl@phila.gov</a></td>
</tr>
<tr>
<td>Project Description:</td>
<td>This innovative project beneficially uses biogas as a green energy source. Previously, San Antonio Water System (SAWS) burned off the gas using flares. Under this 20-year partnership, Ameresco treats and transfers at least 900,000 cubic feet of gas to a nearby commercial gas pipeline, where it is sold on the open market. In return, SAWS receives a royalty on the sale of the gas, which helps to reduce the cost of operations and keeps rates affordable. SAWS is the first large wastewater utility to partner with a private sector company. Ameresco, to actively sell biogas in the United States. Ameresco designed, financed, constructed, permitted, owns, operates, manages and maintains the gas conditioning and distribution facility and the pipelines necessary to process, deliver and sell the gas to commercial natural gas pipelines.</td>
<td>In January 2008 Ameresco was awarded this project to design, build, own, and operate a 4.3 MW cogeneration plant utilizing available digester gas and providing thermal energy to the City of Dallas’ Southside Waste Treatment Plant. The project includes three (3) reciprocating engine gensets each rated for 1,426 KW. Waste heat recovery on the jacket water and exhaust systems was incorporated to provide hot water for the waste water treatment process. Biogas processing includes dehydration with mechanical refrigeration, and solvexane removal with a temperature swing absorption system. The generators are also designed to allow the plant to operate in an island mode to serve critical loads of the waste treatment plant.</td>
<td>This project generates electricity and thermal energy for use on-site, fueled mainly by biogas from the NEWPCP anaerobic digesters. The $47.5 million construction project, generates 6.6 MW of power, and reduces PWD energy costs by over $12 million during the course of the 16-year contract. Ameresco designed, permitted, constructed and now helps maintain this biogas utilization project.</td>
</tr>
<tr>
<td>Project Cost:</td>
<td>$9.5 Million</td>
<td>$18.2 Million</td>
<td>$47.5 Million</td>
</tr>
<tr>
<td>Client Name:</td>
<td>Client 1</td>
<td>Client 2</td>
<td>Client 3</td>
</tr>
<tr>
<td>------------------------</td>
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</tr>
<tr>
<td></td>
<td>San Antonio Water Systems Project</td>
<td>Dallas Water Utilities Plant Biogas Utilization Project</td>
<td>Northeast Water Pollution Control Plant Biogas Project, Philadelphia, PA</td>
</tr>
<tr>
<td>Construction Cost:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Utility Rebates:</td>
<td>None</td>
<td>$1.9 million</td>
<td>Pennsylvania Utility Commission Act 125 Rebate ($3.8 Million Eligibility)</td>
</tr>
<tr>
<td>Client Gross Revenues (First Year):</td>
<td>$115,689</td>
<td>$282,000</td>
<td>40,000,000 kwh(savings)</td>
</tr>
<tr>
<td>Client Net Revenue (First Year):</td>
<td>$115,689</td>
<td>$282,000</td>
<td>40,000,000 kwh(savings)</td>
</tr>
<tr>
<td>Schedule:</td>
<td>Original: September 2010 Final: September 2010</td>
<td>Original: October 2010 Final: February 2011; the schedule was extended due to permitting and additional time required to change out one of the gensets due to a warranty failure.</td>
<td>Original: December 2013 Final: December 2013</td>
</tr>
<tr>
<td>Status:</td>
<td>Operational</td>
<td>Operational</td>
<td>Operational</td>
</tr>
<tr>
<td>Financing:</td>
<td>Project financed by Ameresco</td>
<td>Project financed by Ameresco</td>
<td>Long-term lease agreement</td>
</tr>
<tr>
<td>Role:</td>
<td>Develop, design, build, own, and operate</td>
<td>Develop, design/build, own, operate, and maintain</td>
<td>Design, build, and maintain</td>
</tr>
<tr>
<td>Contract Term:</td>
<td>20 years</td>
<td>20 years</td>
<td>16 years</td>
</tr>
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</table>
SECTION 3: EXPERIENCE

While the basic concept of a long-term energy supply and/or conservation project is the same from one company to another, an individual approach to the energy evaluation, engineering, equipment selection, installation and many other factors differs markedly and can have a major impact on a client's returns on investment. Ameresco's general approach to delivering a comprehensive energy project is centered upon working closely with all project stakeholders to collaboratively develop solutions that meet the client's unique operational and financial goals. Ameresco's comprehensive approach to managing an energy project is designed to ensure that we deliver the maximum value for the lowest possible cost.

Ameresco has developed, implemented, and operates many energy supply projects throughout the country for many different client types. Ameresco provides development, secures financing, designs, and constructs all of its energy supply and infrastructure projects. For example, Ameresco currently operates and maintains the following projects: Philadelphia Water Department, Portsmouth Naval Shipyard, DOE Savannah River Site, Bradley International Airport, Connecticut Juvenile Training School, and the United States Coast Guard Yard.

Further, Ameresco is a recognized leader in adapting renewable energy sources for cogeneration. These off-grid solutions meet onsite power needs with clean, energy-efficient plants that can be built out or upgraded to become independent power generation facilities with revenue potential for their owners.

District Energy refers to energy production and/or storage and distribution in a distributed manner. The two primary types of District Energy include Thermal (district heating or district cooling) and Electric (distributed generation). Accordingly, District Energy Systems include Combined Heat and Power (CHP); Cogeneration; Biomass; Biogas; Geothermal; Microgrids; Small Hydro; and even Solar. The following representative project experience demonstrates the depth and breadth of Ameresco's capabilities in a variety of District Energy applications:

<table>
<thead>
<tr>
<th>Representative Project Experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arizona State University, Tempe Campus</td>
</tr>
<tr>
<td>Arizona State University, Polytechnic Campus</td>
</tr>
<tr>
<td>Bradley International Airport</td>
</tr>
<tr>
<td>Bridgewater State College</td>
</tr>
<tr>
<td>City Centre District Energy System</td>
</tr>
<tr>
<td>City of Tucson, Arizona</td>
</tr>
<tr>
<td>Dallas Water Utilities</td>
</tr>
<tr>
<td>Harvard Medical School</td>
</tr>
<tr>
<td>Jefferson City Correction Center</td>
</tr>
<tr>
<td>National Renewable Energy Laboratory (NREL)</td>
</tr>
<tr>
<td>Naval Station Great Lakes Training Center</td>
</tr>
<tr>
<td>North Carolina State University</td>
</tr>
<tr>
<td>Novartis Institute for Biomedical Research</td>
</tr>
<tr>
<td>Philadelphia Navy Yard</td>
</tr>
<tr>
<td>Philadelphia Water Department</td>
</tr>
<tr>
<td>Portsmouth Naval Shipyard</td>
</tr>
<tr>
<td>San Antonio Water System (SAWS)</td>
</tr>
<tr>
<td>Tewksbury State Hospital</td>
</tr>
</tbody>
</table>

Combined Heat and Power Plant - 16 MW
Combined Plant - 1,200 Tons Chilled Water
Cogeneration Plant - 3.8 MW
Cogeneration Plant - 75 kW
Chilled Water Plant - 3,600 Tons
Cogeneration Plant for Tucson District Energy - 1.6 MW
Combined Heat and Power Plant - 4.2 MW
Central Chilled Water Plant - 4,600 Tons
Landfill Gas to Energy Cogeneration Plant - 3.2 MW
Renewable Fuel Heating Facility - 10 MMBtu/Hr
Cogeneration Plant - 11 MW
Combined Heat, Cooling Power Plant - 11 MW
Central Utility Plant with Combined Heat and Power - 2.8 MW
Natural Gas Fired Peaking Plant - 6 MW
Wastewater Biogas-to-Energy Facility - 5.6 MW
Combined Heat and Power - 10.4 MW
Wastewater Biogas Plant - 4.8 MW
Cogeneration Plant - 500 kW
DALLAS WATER UTILITIES

https://www.youtube.com/watch?v=29-kjUNncPY&t=6s

The City of Dallas (Dallas) entered into a 20-year agreement with Ameresco for the development of a cogeneration facility under a Public-Private Partnership. The Combined Heat and Power (CHP) plant provides Dallas a source of clean energy and aids the City in meeting state legislation calling for reduced energy consumption and utilization of renewable energy. Ameresco designed, built, operates, maintains, and owns this project.

The Southside Wastewater Treatment Plant is located on over 2,800 acres, approximately twenty miles southeast of downtown and is operated by Dallas Water Utilities (DWU). The citizens of Dallas produce about 150 tons of bio-solids each day. The plant's treatment capacity is roughly 110 million gallons of wastewater per day. Wastewater solids from the City are fed into heated digester vessels where they decompose by anaerobic digestion, which is a bacterial process carried out in the absence of oxygen. A by-product of this process is biogas, which contains 60 percent methane, and can be used as a green energy source. DWU used a portion of the biogas produced to fuel the boilers, which heated the digesters, the remaining amount of gas was flared. The average daily biogas production from the digesters is 1.3 million cubic feet per day with an energy value of 550-600 Btu. The City set a mandate to focus on reducing its energy costs while becoming as "green" as possible.

In order to meet its mandate, the City decided to leverage the by-product of its wastewater treatment process (biogas) in achieving its goals. The City decided to enter into an agreement with Ameresco to design, build, own, operate, and maintain a cogeneration facility that would use the biogas as a renewable fuel source. The end result was a successful Public-Private Partnership that provides Dallas with a source of renewable electricity and thermal for heating the digester solids, while meeting a mandate for renewable energy. Ameresco's responsibility for operating and maintaining the CHP plant reduces the City's risk and ensures that the plant functions at an optimal level. Through this project, the City mitigated some of its vulnerability to price spikes or shortages associated with the grid because the purchase price for the electricity produced by the cogeneration facility is guaranteed.

SAN ANTONIO WATER SYSTEM

https://www.ameresco.com/portfolio-item/san-antonio-water-system-saws/
https://www.youtube.com/watch?v=r6MThNMXYpo
San Antonio Water System (SAWS) partnered with Ameresco to create a biogas project that is the first sustainable project of its kind in the nation, taking biogas generated during the sewage treatment process and capturing and selling it through a commercial gas pipeline. SAWS wanted to utilize all the elements from the processing of wastewater and support a positive environmental outcome. This facility completes a "recycling triffecta," where they recycle or reuse almost all of the waste coming into Dos Rios.

SAWS serves approximately 1 million people in San Antonio and its surrounding towns. This population includes approximately 358,000 water customers and 398,000 wastewater customers. The citizens of San Antonio produce about 140,000 tons of biosolids each year. Treating these biosolids generates an average of 1.5 million cubic feet of untreated gas a day—enough gas to fill seven commercial blimps or 1,250 tanker trucks each day. SAWS' Board of Trustees approved a truly innovative project that will beneficially use biogas, a by-product of the anaerobic digestion process from biosolids (containing 60 percent methane) as a green energy source. Previously, SAWS burned off the gas using flares.

SAWS is the first large wastewater utility to partner with a private-sector company, Ameresco, to actively sell biogas in the United States. Ameresco designed, financed, constructed, permitted, owns, operates, manages, and maintains the gas conditioning and distribution facility and the pipelines necessary to process, deliver, and sell the gas to commercial natural gas pipelines. The Ameresco biogas treatment facility processes more than 1.5 million standard cubic feet of biogas a day and delivers a minimum of 900,000 cubic feet of natural gas. Over the 20-year term the project will provide significant improvement to the environment around the SAWS Wastewater Treatment Plant through the major reduction of flared emissions at the site. Through SAWS' partnership with Ameresco, the City of San Antonio will have the following annual carbon reduction equivalents: the removal of over 31,000 cars from the road; the planting of over 38,000 acres of trees; the reduction of over 19,000 tons of CO₂; and the heating of more than 4,600 average-size homes.

**PHILADELPHIA NAVY YARD**

[https://www.ameresco.com/portfolio-item/phila](https://www.ameresco.com/portfolio-item/phila)


Ameresco is currently constructing a 6 MW power plant as part of the largest private microgrid in the United States at the former 1,200-acre Philadelphia Navy Yard that has been repurposed into a dynamic and urban development, which is now home to more than 12,000 employees and 152 companies occupying 7.5 million square feet of real estate in a mix of historic buildings and new high-performance and

"This on-site generation facility will help support the energy demand for the 1,200-acre campus as businesses continue to locate here and grow, while remaining in line with the Navy Yard’s commitment to smart energy initiatives and sustainability. Ameresco is not only designing and developing a project that addresses the Navy Yard’s energy growth needs, reliability requirements, and cost targets, but one that can also provide back-up and resiliency support as required."

—Prema Kadali Gupta  
Senior Vice President, Navy Yard
LEED® certified construction.

PIDC, Philadelphia’s public private economic development corporation, partnered with Ameresco for a new 6 MW natural-gas fired peaking plant that will anchor one of the largest private microgrids in the United States located at the Navy Yard in Philadelphia. The peaking plant is expected to run during the Navy Yard’s peak demand periods and during intervals of high-cost energy and capacity from the grid. The plant will be capable of providing certain resiliency services and critical support in the event of extended grid outages, in addition to shaving the peak load requirements of the microgrid. The Project will allow PIDC to:

- Reliably meet the projected demand growth needs of the Navy Yard and its tenants
- Participate in the PJM Ancillary Service Market
- Generate revenues to help offset the cost of the increased capacity

Ameresco was responsible for design, engineering, and construction and will provide long-term operation and maintenance for the plant.

PHILADELPHIA WATER DEPARTMENT

https://www.ameresco.com/portfolio-item/philadelphia-water-department/

The Philadelphia Water Department (PWD) and Ameresco partnered in a $47.5 million project to design, build, and maintain an innovative 5.6 MW wastewater biogas-to-energy facility cultivating a more efficient energy approach, designed to optimize the facility’s energy usage, and improve the region’s water supply and management system.

- Effective wastewater and stormwater management systems
- System for refining and utilizing biogas as fuel for facility equipment
- Generate supply of electricity and thermal energy for use onsite

PWD was able to reduce annual energy costs and utilize more renewable energy resources. With the improvements made, the City takes a large step towards achieving its goals outlined in Mayor Nutter’s Greenworks Plan, including:

- Economic Opportunity Plan brought green jobs to local community
- Provide adequate and reliable water supply for community needs
- Saves the Equivalent of 27,870 tons of CO2 per year
U.S. DEPARTMENT OF ENERGY, SAVANNAH RIVER

https://www.ameresco.com/portfolio-item/savannah-river-site-biomass-cogeneration-facility/

The U.S. Department of Energy (DOE) awarded Ameresco an Energy Savings Performance Contract (ESPC) to finance, design, construct, operate, maintain, and fuel a Biomass Cogeneration Facility under a 19-year fixed price contract valued at $795 million. Ameresco operates and maintains the 20 MW electric capacity biomass-fueled steam cogeneration plant and two smaller biomass-fueled plants at the DOE Savannah River Site (SRS) in Aiken, South Carolina. The facility has been operational since January 2012.

The SRS biomass facilities are long-term national assets in the areas of environmental stewardship and innovative technology. Ameresco constructed the biomass cogeneration facility to replace a deteriorating and inefficient 1950s-era coal powerhouse and oil-fired boilers. The facility has a design capacity of 295,000 pounds per hour of steam. Combined, the plants are designed to reduce carbon emissions annually by 100,000 tons and reduce site water consumption by approximately 1.4 billion gallons of water a year from the Savannah River. The plant combusters approximately 300,000 tons of forest residue for site process steam and the generation of 100,000 MW of onsite energy annually—generating up to half of the necessary energy and steam to power the 300-square mile SRS facility.

Under the budget-neutral ESPC, the biomass cogeneration facility is expected to generate $944 million of energy, water, operations and maintenance savings. During the first three years of operation, the biomass facility generated approximately 5.8 billion pounds of steam, over 1,400 million pounds of steam exported in support site operations, and over 330,000 MW of electricity.

In 2014, DOE awarded to Ameresco a $39 million implementation value modification to the original ESPC to increase critical steam security and to provide additional electrical generation of 3 to 4 MW to SRS on average across a year and extend the performance period by a year. Under the modification, Ameresco constructed a new biomass heating plant with a new fuel yard and additional plant auxiliaries. In addition to providing O&M services for the original biomass cogeneration facility, Ameresco also provides O&M services for the new equipment over the modified 20-year performance period term.

U.S. AIR FORCE, HILL AIR FORCE BASE


In September 2003, Hill Air Force Base (AFB) awarded Ameresco the delivery order to design, construct, operate, and maintain a 2.3 MW landfill gas to energy (LFGTE) system along with several other traditional energy conservation measures. The LFGTE system has given Hill AFB a source of renewable energy and
a significant reduction in annual energy costs. Ameresco is operating and maintaining the facility and providing performance and savings guarantees throughout the 20-year contract term. The plant was commissioned in December 2004 and began commercial operations in January 2005.

Hill AFB, the largest single-site employer in the state of Utah, is a 16 million square foot industrial complex that provides aircraft overhaul and depot maintenance. The base was searching for a company that offered more than “lights and motors,” one that assisted in meeting the mandate for Federal agencies to increase their use of renewable energy, and a firm that could provide much-needed upgrades of the steam distribution system and two very large centralized compressed air systems. Additional benefits include utilizing a resource that would have otherwise been wasted, and reducing air emissions at Hill AFB and in the surrounding counties. The renewable energy source will also save on the utilization of more traditional, fossil fuel energy production, significantly reducing air emissions.

In the first five years of operation, the LFGTE has reduced the base’s electric bill by over $2 million. The solar photovoltaic (PV) system has also earned recognitions for the base as the largest ground-mount PV system in Utah. The LFGTE, solar PV, and the solar heat recovery system installed by Ameresco have pushed Hill AFB to the forefront of leadership in the use of renewable energy in the Federal government.

BRADLEY INTERNATIONAL AIRPORT

Ameresco continues to stay in front of the “technology movement”, as is the case with the Bradley International Airport Combined Heat and Power (CHP) Plant in Windsor Locks, Connecticut. The State of Connecticut expressed interest in providing highly reliable power to, and reducing operating costs of, the newly expanded airport serving the Hartford metropolitan area. Ameresco developed a unique contract proposal to design, build, and maintain a freestanding energy plant to accomplish these goals.

Ameresco designed and built, and now operates and maintains a 5.8 MW CHP plant to offset electric purchases from the local utility and to provide greater power reliability for a major expansion of the airport. The CHP plant was initially constructed in 2002 with 3.9 MW of capacity and since expanded to the full 5.8 MW of capacity in 2010. Ameresco operates, maintains, and repairs the mechanical and electrical equipment under a 20-year agreement with the airport, with an option to renew for an additional 10 years.

The electricity needs of the main terminal are met by the engine-generator. Due to equipment redundancy, the energy center can meet the main terminal’s full electrical needs in the event of a loss of grid power. In addition, because heat recovered from the engines is used for absorption cooling in the summer and heating in the winter, overall energy costs are lower than a conventional heating and cooling plant.
CITY CENTRE DISTRICT ENERGY PLANT


Ameresco designed, built and now owns and operates the City Centre Chilled Water Plant, which is a district energy plant. The Plant was built to meet the cooling needs of properties in downtown Las Vegas, Nevada and serves five businesses in an eight-block area.

Before design began, it was recognized that the City Centre Chilled Water Plant needed to be as energy efficient and as easy to operate as possible. It also required a software infrastructure that would seamlessly integrate equipment that used ‘best of breed’ controls, along with legacy systems. The system also had to provide a plethora of real-time information in order to provide energy consumption information to clients to produce billing agreements for the customers.

Finally, because the facility was going to be unmanned most of the time, the software needed to have real-time alarming capabilities to warn Ameresco personnel of problems and anomalies, and it had to be accessible via the Internet at any time, from anywhere. The City Centre Chilled Water Plant was designed for and is now controlled entirely by a Yamasa Control’s Tridium, Inc. Control System using Vycon Building Automation Suite software. The project included installation of 3,600 tons of electric centrifugal chillers, a variable speed chilled water pumping system, new cooling towers, new direct digital control energy management system, and an underground and above ground chilled water piping distribution system.

PORT ENVIRONMENT EXPERIENCE

As noted in some of the projects listed previously, Ameresco’s is adept at working with the unique conditions and requirements that exist in a Port environment. The following highlights some additional Port projects.

Norfolk Naval Shipyard
Norfolk Naval Shipyard in Portsmouth, Virginia, is one of the largest shipyards in the world specializing in repairing, overhauling and modernizing ships and submarines. It’s the oldest and largest industrial facility that belongs to the U.S. Navy and it’s also the most multifaceted.

Ameresco was selected for the development, audit, design, construction management, financing, commissioning, training, and measurement and verification of a multi-phase Energy Savings Performance Contract (ESPC) with the Shipyard. Spanning over 400 buildings, totaling 6.5 million square feet, energy improvements included lighting retrofit and controls upgrades, DDC upgrades, water conservation, compressed air system repairs, and steam system improvement.

Naval Base San Diego
Naval Base San Diego is the principal homeport of the Pacific Fleet, consisting of 46 Navy ships, one Coast Guard cutter, seven Military Sealift Command logistical support platforms, several research and
auxiliary vessels. Naval Base San Diego is home to 213 individual commands, each having specific and specialized fleet support purposes. Naval Base San Diego proper is comprised of over 1,600 land acres and 326 acres of water. The base is also responsible for Commander, Navy Region Southwest and Naval Facilities Engineering Command Southwest headquarters located downtown San Diego, Naval Medical Center in Balboa Park and Admiral Baker recreation and golf course located in Mission Valley.

Earlier this year, Amersco completed the implementation of energy improvements throughout the base, including the installation of proven technologies such as interior and exterior LED lamps and HVAC control system upgrades. Under the scope of work, Amersco is responsible for ongoing operations and maintenance (O&M) and repair and replacement costs for all installed equipment during the performance period.

U.S. Coast Guard Yard Baltimore

Under a historic intergovernmental sales agreement, the City of Baltimore provides landfill gas (LFG) to the USCG from the Quarantine Road Landfill, which sits adjacent to the Yard. Under the $41 million contract signed in October 2007, Amersco constructed a Renewable Energy Center (REC) to combust the LFG and provide electricity and steam to the USCG. The contract is the largest Energy Savings Performance Contract (ESPC) in Coast Guard history and is the Coast Guard’s largest renewable energy project ever.

Amersco designed, built, financed, and owns, operates, and maintains the LFG processing system, or delivery skid, at the landfill and the pipeline from the processing plant to the Yard’s property line. Utilizing LFG extracted from the City of Baltimore’s nearby Quarantine Road Landfill as a fuel source for the REC is a highly valuable, long-term benefit to the Yard. The vehicle used for the assessment and construction of the facility was the Department of Energy’s (DOE) Biomass and Alternate Methane Fuel Technology-Specific Super ESPC program.

The project included the installation of four 1 MW Jenbacher 320 LFG engine generators, each installed with a heat recovery steam generator (HRSG), the electrical interconnection equipment, steam system upgrades, and the construction of a new facility. To provide even greater annual energy savings, the project also included the retrofit of the burner management system of Boiler #3 located in the Yard’s existing steam plant to enable the boiler to combust LFG. The substation has been modified to allow the connection of the REC and to accommodate new pad-mounted switches with automatic normal-alternate switching.

COMMUNITY WIDE EFFORTS

Amersco believes that community-wide, comprehensive energy projects provide the greatest benefit in terms of cost and utility savings, as well as sustainability, greenhouse gas reduction, and social responsibility. Our projects most often encompass numerous facilities with diverse stakeholder groups requiring multi-jurisdictional support, approval, and collaboration.

Landfill gas projects are a prime example of projects that require high expertise in public relations and community involvement. Almost nobody initially wants a landfill gas project in their backyard; however, Amersco’s partnership with both public and private enterprises have converted landfill gas from an environmental liability into an economic and environmental benefit for biogas facilities across the United States.
For San Joaquin County, for example, Ameresco recently completed a 4.3 MWe LFGTE project at the Foothill Landfill in Linden, CA. The facility, combined with a second new facility located at San Joaquin County’s nearby landfill, are expected to generate 8.6 MWe of clean energy which will provide clean power for more than 5,100 local homes and businesses annually. In order to bring these projects to fruition, Ameresco partnered with the City of Palo Alto, a very progressive utility determined to provide the residents and local business community with clean energy at affordable prices. We are fortunate to have the citizens of Palo Alto as clients and look forward to serving them with energy from this new renewable resource.

For the Metropolitan Airports Commission, Minnesota (MAC) project (https://www.youtube.com/watch?v=8mN4s7FgT3A), we contacted seven different cities and counties in the area of the Minneapolis/St. Paul Airport in an effort to explore obtaining allocations in a federal financing program that the different municipalities had not utilized. Each local government agreed to pass on their unused allocations and even passed resolutions to affect the transfer. The allocations then went back to the State agency that administered the program and then were collected and re-awarded to the MAC for use on this project. Coordinating this reallocation and collection of this incentive was entirely conceived of and executed by Ameresco and the MAC—together. Bringing eight governmental entities (seven municipalities and the State of Minnesota) together for the benefit of a ninth was a testament to the reputation of the MAC as an entity that provides substantial value to the community. The financing for the project was $23.3 million for 21 years, and the investor, who responded through an RFP for financing that Ameresco’s finance group distributed, was a local investor, so even more of the value of the project remained in the local economy. The financing issued through this federal financing program resulted in a net interest rate of less than 1 percent fixed for the entire term. With an additional grant from the local utility, the collected allocations provided financing that was sufficient to pay for the entire project cost without extra contributions from the MAC directly.

Complexity
In addition to the unique experiences cited above, complexities of this project included:

Coordination of heavy equipment and construction activities in a restricted space.

Scheduling work to minimize the disruption to the academic calendar and insuring the safety of students in areas of high congregation and construction activity.

Connection to the newly installed north and south thermal piping sections of the South Loop required extensive planning and coordination to augment Central Plant services.

Coordination of underground services in such a way that did not disrupt ASU campus operations.

Project Reference
The ASU individuals responsible for the development of the CHP project have since retired; however, the individual responsible for the operations related to the CHP and Central Plant remains an employee with ASU and can be reached for reference as follows:

Richard Pretzman
Director of Facilities Management
Arizona State University
480.965.8907
Rick.Pretzman@asu.edu
PORTSMOUTH NAVAL SHIPYARD

https://www.ameresco.com/portfolio-item/portsmouth-naval-shipyard/

The U.S. Army Corps of Engineers and the U.S. Navy selected Ameresco to design and install three comprehensive energy conservation projects under an Energy Savings Performance Contract (ESPC), as well as a microgrid solution funded by a grant to demonstrate islanding capabilities which eliminates downtime during a loss of the electric public utility at Portsmouth Naval Shipyard in Kittery, Maine.

Ameresco served as the Prime Contractor for both phases of this project, drawing on our nearly 20 years of experience in providing preliminary facility assessments, detailed investment grade audits, engineering design, construction, financing, project management, commissioning, training, long-term operation, maintenance, repair, and measurement and verification. The project was implemented in two phases with a combined total project term of 18 years.

Ameresco was responsible for modernizing the existing central power/steam plant, raising overall plant efficiency, and streamlining plant operations. The primary upgrade included installing additional combustion-turbine-based cogeneration capacity, which provided the shipyard with the capacity to meet its year-round electricity and steam needs.

- Designed and installed comprehensive power plant upgrade
- Large-scale improvements to steam, air, and hot water systems
- 10.4 MW / 280,000 lb/hr Combined Heat and Power (CHP) plant
- Two low-emission 5.2 MW Solar Taurus 60 gas turbines
- Two 70,000 lb/hr Heat Recovery Steam Generators
- Two 70,000 lb/hr package Boilers
- Two 2 MW emergency diesel Generators
- Microgrid control system, new protective relaying with Fast Load-shed technology
- 500 kW/880kWh Battery Energy Storage System (BESS)

Improvements made to the Shipyard's various systems have allowed for the elimination of older equipment. With newly installed technologies and equipment, the Shipyard regularly saves on energy and can operate self-sufficiently, if necessary.

- Annual energy savings of up to 43,165 million kWh
- Retired 60-year-old high-pressure steam boilers
- Replaced older instruments and controls
- Repaired and improved compressed air systems
- Upgraded facility lighting
- Enhanced utility system security and reliability
- Protection against energy market pricing volatility
- Cost-effective solutions for military energy security
Enhanced reliability of electric service to the base
Provided ancillary services to the electric grid Independent System Operator (ISO)
Help meet energy, water and carbon reduction goals
Heating, cooling, electric infrastructure improvements

Ameresco was responsible for all pre-construction services, including project development; engineering; bidding; budgeting; logistics; and construction phase services, including procurement, project management, site supervision, federally-mandated payroll reporting, start-up, and commissioning. Relevant project highlights include:

PHASES I AND II

Boiler Plant Upgrade and Distributed Generation/Cogeneration
The existing central boiler/power plant consisted of four high-pressure boilers with a total output capacity of 510,000 lb/hr of steam and steam turbine generators with a total electric generation capacity of 11 MW. Ameresco designed and installed two 5.5 MW combustion gas turbines, one with dual-fuel capability. Each turbine has a heat recovery steam generator (HRSG) with supplemental duct-fire burners to provide up to 70,000 lb/hr of steam output. In addition, Ameresco installed two new, 70,000 lb/hr dual fuel package boilers. The combined 250,000 lb/hr capacity of the HRSGs and the new packaged boilers enabled the 60-year old high-pressure central boiler plant to be shut down.

The balance of plant work included an automated control system for the steam and electric plant, one three-cell crossover cooling tower with variable frequency drives (VFDs) on fans and pumps, four system-balanced boiler feed water pumps, and various other auxiliary equipment.

Because electric energy reliability is critical at this site, two 2 MW diesel generator sets were also installed to provide tertiary back-up to the combustion turbines and the grid. The back-up diesel generators also minimize the risk of demand penalties in the event of a cogeneration system outage.

Utility Monitoring Control Systems
Ameresco installed a completely new integrated digital power plant control system, replacing a patchwork of older controls and instrumentation. This work was done while maintaining all of the essential services provided by the power plant.

Water and Steam Distribution Systems
Shut Down Central Hot Water Distribution System and Portions of Steam Distribution System
Ameresco determined that roughly 35 percent of the existing, buried four miles of hot water distribution piping was no longer insulated. In addition, the system was leaky and near the end of its useful life. This system was removed from service, resulting in substantial thermal savings and reduced hot water pumping energy. Portions of the steam distribution system were also shut down. The loads were shifted to the steam distribution system via 48 new steam-to-hot-water heat exchangers in 55 buildings and to 20 new
decentralized gas or oil-fired boilers. In addition, Ameresco installed 25 new domestic water boilers serving a variety of private living quarters, and modified various electric and steam heating systems.

**Industrial Process Improvement – Compressed Air System**
The shipyard’s industrial compressed air needs are served by four 1,000 HP centrifugal air compressors. Ameresco conducted a comprehensive survey of the compressed air distribution system leaks using an ultra-sonic sensor and determined that leaks accounted for roughly 30 percent (1,116 SCFM) of the annual compressed air load. Leaks were repaired as required.

**PHASE III**
Ameresco identified, developed, and recently completed implementation of two additional energy conservation measures at Portsmouth Naval Shipyard under the Department of Energy's Mid-Atlantic Region Super Energy Savings Performance Contract (ESPC). The ECMs consist of compressed air system retrofits including two new air compressors and controls optimization, and condensate system repairs including condensate piping and pump stations.

**Compressed Air System Retrofits**
Ameresco installed two new compressors to the existing compressed air system. The first was a 200 HP Ingersoll Rand oil-free rotary screw compressor capable of delivering 868 cfm and the second was a 450 HP Ingersoll Rand oil-free centrifugal compressor capable of delivering 2279 cfm. Both are equipped with variable frequency drives. Running these compressors by themselves provides significant reduction in electricity consumption during periods of light compressed air demand. Using them as swing compressors alongside one of the existing centrifugal compressors reduces electricity consumption during demand levels where two of the large existing compressors were historically run.

**Condensate System Repairs**
The condensate return system at Portsmouth Naval Shipyard had failed in numerous places to the extent that essentially no condensate was being returned to the plant. This required large quantities of makeup water and resulted in excessive thermal energy losses and associated costs to reheat the makeup water. Ameresco replaced failed or near-failing condensate lines, as well as lines which may potentially fail within the expected life of the project.

**Portsmouth Microgrid Project**
*(not part of the ESPC, but directly enhances the cogeneration system implemented by Ameresco)*
In 2015, Ameresco successfully completed commissioning of a microgrid demonstration project and battery energy storage system, integrated with the cogeneration system to enhance the security and reliability of electric service to the base at the Portsmouth Naval Shipyard. The technical objective of this project was to demonstrate that the emerging technologies of microgrid control systems (MCS) and battery energy storage systems (BESS) can be integrated with onsite generation at military bases to enhance the security and reliability of electric service to the base, provide valuable ancillary services to the electric grid independent system operator (ISO), and generate cost savings for the government. Funding for this project was provided by a Department of Defense grant administered through the Environmental Security Technology Certification Program (ESTCP). Ameresco was awarded this grant based on a highly-competitive selection process. Over 450 applications were received, and Ameresco’s proposal was one of twenty-three selected for funding.
Ameresco installed a fast load shed (FLS) MCS provided by GE and a Saft lithium ion battery, integrating with existing on-site generation assets to provide enhanced energy security to the Shipyard, ensuring critical loads are seamlessly maintained when a loss of utility connected is experienced.

A new MCS was installed which continuously monitors critical and non-critical load, available onsite generation capacity from two 5.2MW combustion turbines and two 1.5MW emergency diesel generators, and status of the public utility connection. When a grid disturbance is sensed, the MCS takes action to prevent a site-wide outage. The MCS provides a “fast load shed” scheme to immediately balance on-site generation supply with mission-critical demand in the event of a utility outage. The control system includes new metering so the MCS can intelligently select the loads to shed in order to balance with available supply.

The 600kW/580kWh lithium ion BESS is designed to assure power quality on base during transitions from grid power to island power and to provide ongoing voltage and frequency control to the ISO.

This investment has significantly enhanced the energy security of the Shipyard by maintaining power to all critical loads in the event of a loss of grid supply, avoiding otherwise lost production time and costs. Further, incorporation of battery energy storage creates a new energy cost savings or revenue stream through utility bill management or energy market participation. The potential for broad implementation of this microgrid approach across other U.S. Government installations is promising.

Project Reference
The primary point of contact for the Portsmouth Naval Shipyard multi-phased project can be reached for reference as follows:

Russell Gagner, PE
Naval Facilities Engineering Command
Portsmouth Naval Shipyard
207.438.5980
Russell.Gagner@navy.mil
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SECTION 4: FINANCIAL CAPABILITY

As the City of New Bedford embarks on this ambitious program, it is important to have an energy partner that is not only technically qualified but also financially strong and stable with a solid track record of performance in the capital markets. With 2017 revenues of $717.2 million and a construction backlog exceeding $1.77 billion, Ameresco delivers long-term value through innovative systems, strategies, and technologies. For the year 2017, Ameresco had total assets of approximately $884 million, cash in excess of $40 million, and an $75 million credit facility. In addition, we maintain a $750 million surety credit facility through two corporate providers, both with an AM Best Rating of "A Excellent". Ameresco has the financial fortitude to be a long-term partner with the City of New Bedford, ensuring a successful development execution, project implementation, and operations.

Ameresco has sourced and raised more than $2.5 billion of project financing over the past 17 years, from various lending sources including John Hancock, Bayerische Landesbank, Bank of America, Capital One, Chase Bank, Crowe and Associates, Union Bank, and several other financial institutions. Using existing cash resources, cash flows from Ameresco’s operating activities, and access to credit through multiple lending relationships, Ameresco has the resources necessary to develop, implement, and finance the City of New Bedford Energy Project.

As a publicly traded company, Ameresco’s most current prospectus, including Balance Sheet and Cash Flow statement is provided within our audited, publicly available 10-K financial statement information filed with the U.S. Securities and Exchange Commission as follows: The Company’s most recent 10 – K for the period ending December 31, 2017 may be located using the U.S. Securities and Exchange Commission website as follows:

https://www.sec.gov/Archives/edgar/data/1488139/000148813916000015/amrc1231201710-k.htm

The Company’s most recent 10 – Q for the period ending March 31, 2018 may be located using the U.S. Securities and Exchange Commission website as follows:

https://www.sec.gov/Archives/edgar/data/1488139/000148813918000039/amrc331201810-qq118.htm

EXPERIENCE IN SECURING FINANCING

Ameresco’s business strategy is built on the idea that customers come first. We have no preference as to whom the City of New Bedford ultimately prefers as its lender and/or financing mechanism. Ameresco has the proven financial experience, resources, strength, and stability that the City of New Bedford needs in its District Energy Utility Partner. Our dedicated finance management team has the demonstrated expertise to secure optimal financial arrangement for this project.
Our finance team maintains strong relationships with the lender/investor community that can provide competitive financing offerings for the City of New Bedford to consider. Ameresco has put in place an independent, transparent, replicable bidding process to determine the right financing partner for each project. We work with lenders every day that provide competitive interest rates, interest rate locks, and have an in-depth understanding of energy-related projects. Based on experience, including Ameresco’s unparalleled track record of completing projects on budget and on schedule, and current market information, there is a high level of interest for financing Ameresco energy projects among the current pool of investors in the financing market, as well as possible new entrants to the financing market.

More than $153 Million in Project Equity to Date
Ameresco has invested over $153 million to date of its own equity into Ameresco-owned energy generation projects similar to the district energy project contemplated by the City of New Bedford. This is in addition to substantial capital (equity) raised by Ameresco from other third-party investors for projects not owned by Ameresco as well as project debt.

$75 Million Revolving Credit Facility
Ameresco maintains a commercial banking relationship with Bank of America, located at 100 Federal Street, Boston, MA 02110. This includes a $75 million revolving credit facility. For reference:

Bank of America
c/o Michael A. Palmer, Senior Vice President
100 Federal Street, Boston, MA 02110
P: 617.434.4647  E: michael.a.palmer@baml.com

By way of example, Ameresco secured financing for the single largest Federal Energy Services Project implemented to date at the DOE Savannah River Site in Aiken, South Carolina. The centerpiece of this project was the Asset Modernization. Ameresco retired, removed and replaced a 20 MW coal fired CHP facility with a new, renewable energy CHP Facility that used biomass as a fuel source. This project was executed during a very challenging time to access credit from financial markets (2009), but Ameresco was able to fully finance this project.

Additional examples demonstrating Ameresco’s financing capabilities and expertise include:

Tax exempt lease financing for municipalities, hospitals, housing authorities, and universities totaling over $815 million, including $32.4 million tax exempt lease financing for a $64 million project at a large university in Chicago, IL.

$23.3 million taxable lease purchase Qualified Energy Conservation Bond (QECB) for the Metropolitan Airports Commission (MAC) in Minnesota for the largest solar project in the state. Ameresco collected unused allocations from area municipalities and worked with the State to reallocate this federal financing incentive back to the MAC.

Non-recourse project finance debt of $127 million for $245 million of renewable energy facilities throughout the country including both biogas and solar facilities.

Successful closing of a $50 million sale leaseback facility for financing solar projects developed, constructed, and owned by Ameresco across the US.
Sale and assignment of receivables totaling approximately $1.03 billion from 65 Federal Energy Savings Performance Contracts

$22.8 million municipal advanced refunding of two separate outstanding series of Certificates of Participation for a Virginia school district in which Ameresco served as initial lessor.

$13 million financing for a city in Tennessee (private label) in which Ameresco served as initial lessor.

$24.6 million financing of two separate series of Certificates of Participation, one of which was rated AA- by S&P, for a school district in the Commonwealth of Virginia.

POTENTIAL FINANCING STRUCTURES

There are many ways in which a project proposed by Ameresco can be financed. Generally, the differences between the multiple approaches is (a) the amount of risk that is transferred from the City of New Bedford to Ameresco (or another third party) and (b) the ability to monetize tax benefits that the City of New Bedford might not otherwise be able to do itself.

Ameresco's role is to provide the City of New Bedford with options, identify the pros and cons of each along with their associated costs so that the City of New Bedford can make an educated decision on which financing approach to move forward with that best fits its needs.

Public-Private Partnership

A public-private partnership (P3) is a contractual arrangement between a public agency (City of New Bedford) and a private sector entity (Ameresco). Through this agreement, the skills and assets of each are shared in delivering a service or facility for the use of the general public.

Public-private partnerships come in the form of a variety of arrangements: A service agreement, a Power Purchase Agreement (PPA), and a Design-Build-Operate-Own-Maintain (DBOOM), to name a few. Ameresco's financing experience and entrepreneurial nature allow us to truly offer all of these solutions.

The most common deal structure behind a P3 is that a private partner builds a public customer an asset and the private partner builds and takes the risk of ownership and operation of the new asset. The real benefits to P3 are in master procurement (which ESCO statutes uniformly include) and a financing structure that manages risk.

Design-Build-Own-Operate-Maintain

Energy contracting from Ameresco includes options that eliminate the challenge posed by operating and maintaining renewable energy systems. Ameresco's contracting services free municipalities from the ongoing expense of renewable energy systems while allowing them to reap the benefits of lower energy costs. With the Design-Build-Own-Operate-Maintain (DBOOM) approach, the responsibilities for designing, building, financing, operating and maintaining are bundled together and transferred to Ameresco.

Ameresco has developed, implemented and operates many energy supply projects throughout the country of similar technical complexity and size as the project contemplated by the City of New Bedford. The firm has developed over 300 eMW of energy supply generation assets, most of which is from renewable energy resources, and Ameresco owns nearly 60 percent of these energy supply assets and operates 70 percent of the entire portfolio. This portfolio of assets operates on multiple fuel types such as natural gas, landfill...
gas, wastewater treatment biogas, woody biomass, and chipped tires. In addition, the prime movers for these assets include reciprocating engines, turbines, microturbines, and fuel cells.

Ameresco can provide complete O&M solutions or integrated solutions with training for existing staff. As an independent company with no products to sell, our customers can choose best-in-class energy equipment solutions and gain control over the costs to operate and maintain them.

**Design**: Drawing only from best-in-class energy infrastructure components without supplier bias, we can tailor a solution to maximize efficiency or to manage development costs.

**Build**: We can partner with local contractors to complete a project or recruit internationally renowned experts to oversee construction, retrofitting or installation.

**Own**: Take control of the new facility or let Ameresco run it and manage energy delivery.

**Operate and Maintain**: We can train existing staff to run onsite systems, take on all O&M responsibilities or recruit new personnel to operate and maintain energy infrastructure.

**Energy Supply Agreement Financing**

Under this arrangement, Ameresco will develop, design, permit, build, own, and operate the City of New Bedford District Energy Project in its entirety. Ameresco will retain ownership (title) of the new equipment proposed for the Distributed Energy System. Under this structure, Ameresco retains ownership of the assets that produce electricity and steam which is being sold to the City of New Bedford. This structure creates a clean line of demarcation for the term of the agreements and likely affords the City of New Bedford a favorable tax and accounting treatment while not triggering additional indebtedness covenants for the City of New Bedford.

As part of the Energy Supply Agreement, the City of New Bedford would enter into a Site Lease Agreement that would allow Ameresco to construct and operate the new facility for a twenty-year term. In addition, some form of Purchase and Sale or Title Transfer Agreement would be executed by the parties.

**Energy Savings Agreement Financing**

The financing of energy efficiency projects may be structured using Energy Savings Agreements as a means of implementing such projects without upfront capital investment. Properly structured, such arrangements may be treated as service contracts and may not be considered a debt obligation of the City of New Bedford by ratings agencies and thereby the Energy Savings Agreement would not impact the City of New Bedford’s credit rating or credit capacity. The traditional TELP financial transaction structure creates a financing obligation directly between the municipality and the lender. The TELP debt obligation is generally included by the ratings agencies for credit ratings determinations of the municipality. The Energy Savings Agreement alternative offers 100 percent financing for energy savings projects implemented by Ameresco. The alternative Energy Savings Agreement allows the City of New Bedford to realize energy savings through a structure that may not impact the credit rating agencies’ view of indebtedness.

**Tax-Exempt Lease Purchase Financing**

The most widely used financing option available to state and local governments for energy conservation projects is a tax-exempt lease purchase agreement (TELP). As a capital lease, the lease payments are a current expense payable from the operating budget of the City of New Bedford, where the savings realized from reduced consumption would then be made available to make lease payments. Ameresco is able to
structure a TELP financing option as a Master Lease Agreement whereby the City of New Bedford is lessee and Ameresco is the initial lessor for each Project that will be implemented under a Lease Schedule pursuant to the Master Lease Agreement. Under this option, Ameresco would secure third party financing via the private placement market by assigning its rights in each Lease Schedule to a lender. Ameresco has a tremendous amount of experience acting as lessor in conjunction with a TELP financing structure to provide "private label" financing for the City of New Bedford’s benefit.
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SECTION 5: DEVELOPMENT, OWNERSHIP AND OPERATION

AMERESCO HAS DEVELOPED A PROCESS THAT HAS PROVEN EFFECTIVE IN DELIVERING CLIENTS OBJECTIVES. WHATEVER APPROACH IS UTILIZED, A CLEAR, ORGANIZED DELIVERY PROCESS IS REQUIRED. Ameresco’s approach to the City of New Bedford Energy Project will deliver the following objectives:

- Reliable, cost effective delivery of electricity and hot water
- An additional source of backup power to critical loads
- Reduced regional air emissions
- Collaborative, flexible financing and ownership options
- Proactive and innovative approaches to serving required loads

OPERATING EXPERIENCE

Ameresco has financed, constructed and owns and/or operates 100+ prime movers representing nearly 300 eMW of reliable distributed generation. Most of our projects supply energy for mission critical facilities and provide high-nine availability that is achieved through designs that incorporate years of operational lessons learned.

Typically, our facilities operate 24/7 with some serving mission critical customers. Each of our facilities operates with annual financial goals, which highly depend on our hands-on experience with this kind of equipment. Our staff knows what it will take to perform to plan and how to operate so that the desired availability levels are achieved. We use our hands-on experience to approach the project from multiple perspectives, including energy efficiency, safety, environmental considerations, sustainability, and output. In addition, our facilities are monitored through a web-based, in-house, real-time energy information system. Our plant controls will monitor energy information from a variety of meters and systems and provide operating data.

In conjunction with executing an effective O&M Agreement, continuous collaboration and communication is paramount to successfully operating an energy plant on a not-to-interfere basis under a critical environment. Ameresco strives to be a data driven company and will work hard to promote transparency through freely available data and structured reporting. Our mission critical facilities demonstrate our exceptional track record. With these facilities, our onsite staff in many ways becomes an extension of our clients’ staff. Beyond regular reporting requirements, our operators participate in client staff meetings and regularly interact with their counterparts. This uninterrupted flow of communications will make the operations of the plant seamless with our customer’s internal operations and minimize disruptions to service.
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SECTION 6: RELIABLE AND COMPETITIVE SERVICE

Through a collaborative process, Ameresco's design considerations include a rigorous examination of the strategies available to reduce energy and operating expenses.

While each of the projects listed in the 'Experience' section was constructed with these strategies in mind, the following are a few notable highlights:

**Bradley International Airport:** Ameresco designed and built, and now operates and maintains a 5.8 MW CHP plant to offset electric purchases from the local utility and to provide greater power reliability for a major airport expansion.

**City Centre District Energy Plant:** The City Centre Chilled Water Plant needed to be as energy efficient and as easy to operate as possible. Ameresco collaborated with the client on the overall design to ensure a successful project.

**City of Tucson, Arizona:** The system was designed for maximum cost-effective efficiency and incorporated stainless steel material on all heat recovery piping and components, thereby allowing for higher than typical exit gas temperature from the system.

**Dallas Water Utilities:** The City set a mandate to focus on reducing its energy costs while becoming as "green" as possible. In order to meet its mandate, the City decided to leverage the by-product of its wastewater treatment process (biogas) in achieving its goals. Through this project, the City mitigated some of its vulnerability to price spikes or shortages associated with the grid because the purchase price for the electricity produced by the cogeneration facility is guaranteed.

**North Carolina State University:** On a combined basis, the project provides total installed capacity of 400,000 lbs/hr and approximately 11 MW of electricity, roughly 25 to 30 percent of the current peak campus electrical demand.

**University of Arizona:** To provide a more efficient chilled water system, Ameresco installed three new electric centrifugal chillers, two with a capacity of 1,300 tons, utilizing glycol instead of chilled water as the heat transfer medium, as well as a high efficiency 2,500-ton unit for standard chilled water applications. The ice storage system consists of approximately 100 stacked tanks, each tank storing approximately 150 ton-hours of cooling, which provides the targeted 15,000 ton-hours.

**U.S. Department of Energy Savannah River:** Ameresco constructed the biomass cogeneration facility to replace a deteriorating and inefficient 1950s-era coal powerhouse and oil-fired boilers. The facility has a design capacity of 295,000 pounds per hour of steam. Combined, the plants are designed to reduce carbon emissions annually by 100,000 tons and reduce site water consumption by approximately 1.4 billion gallons of water a year from the Savannah River.

**U.S. Marine Corps Recruit Dept Parris Island:** The Combined Heat and Power (CHP) and solar photovoltaic (PV) generation assets are integrated with a battery energy storage system (BESS), and a microgrid control system (MCS) capable of fast load shedding. This comprehensive project will further the Marine Corps Installation Command mission to ensure a reliable, secure energy supply and reduce lifecycle operating costs of the facilities while managing future commodity price volatility.
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SECTION 7: END USER AGREEMENTS

During the evaluation of any project, Ameresco works with the client to understand both the current and anticipated needs of the system and to design a project accordingly.

The following highlights instances where the system was scaled to accommodate future load projections. For additional projects, please reference the ‘Experience’ section.

Arizona State University Combined Heat and Power Plant: The CHP plant was brought on line in phases. This required studies and projections of current and future loads (capacity to supply normal power, emergency power, steam and chilled water) to build out the plant just ahead of the new loads being put onto the ASU system.

City of Tucson, Arizona: The project was completed in multiple phases to allow for scaling of the central plant capacity. The first phase of the project included the installation of a Combined Heat and Power (CHP) system that included a 1.6 MW natural gas-fired reciprocating engine generator, heat recovery boiler, and 500-ton absorption chiller (single stage). The second phase of the project included increased central plant capacity for an approximate two-mile district heating and cooling loop throughout downtown Tucson and the new Rio Nuevo project.

Philadelphia Navy Yard: The new 6 MW natural-gas fired peaking plant that will anchor one of the largest private microgrids in the United States located at the Navy Yard in Philadelphia. Ameresco also has begun work on a newly contracted expansion of the peaking plant, adding two megawatts (2 MW) of planned incremental capacity, increasing the total plant capacity to eight megawatts (8 MW) by the end of 2018. This is in anticipation of the growing waterfront business campus’ commitment to smart energy innovation, sustainability, and reliability.

Harvard Medical School: The plant design allows for an additional 2,000-ton future expansion to serve multiple facilities located within Boston’s Longwood Medical Area. Harvard Medical School benefited from highly efficient, redundant and reliable CHW capacity at Harvard Medical School’s New Research Building, a critical environment, biomedical research facility.

Naval Station Great Lakes Training Center: Ameresco converted the central heating plant a modern cogeneration facility by demolishing three old boilers and replacing them with two - 5.5 MW Solar gas turbines with Rentech heat recovery steam generators. In addition, a back-up diesel-generator system included two - 2 MW Caterpillar 3516B generators for a total of 4 MW back-up power.

This work was followed by expansion, repairs and upgrades to the installed steam distribution system. Ameresco resized the boilers for a more efficient operation and added 11 MW of electrical generation capacity, which required extensive upgrades to the electrical distribution system. Ameresco also performed upgrades to the steam distribution system.

With construction complete in over 160 buildings, Ameresco and Great Lakes are in development of additional phases to complete the remaining buildings onsite.

U.S. Department of Energy Savannah River: In 2014, DOE awarded to Ameresco a $39 million implementation value modification to the original ESPC to increase critical steam security and to provide additional electrical generation of 3 to 4 MW to the Savannah River Site on average across a year and extend the performance period by a year. Under the modification, Ameresco constructed a
new biomass heating plant with a new fuel yard and additional plant auxiliaries. In addition to providing O&M services for the original biomass cogeneration facility, Ameresco also provides O&M services for the new equipment over the modified 20-year performance period term.
SECTION 8: TECHNOLOGIES

Below, Amersco presents innovative ideas that we believe can:

Lower the sludge disposal costs below the city’s current rate;
Prepare the City of New Bedford for anticipated load growth;
Mitigate the City of New Bedford’s exposure to the volatile energy markets; and,
Reduce the community’s production of carbon emissions.

Amersco can help the City of New Bedford achieve these goals by expanding on the options identified in the studies and by evaluating other proven technologies. One of the advantages of working with a large company like Amersco, is that we will either own or guarantee the performance of these technologies removing all risk of new state of the art technologies. We will work with the City of New Bedford to determine which technologies might best apply at this site.

RENEWABLE NATURAL GAS

Within Amersco’s Energy Asset business, Amersco develops, owns and operates Renewable Natural Gas (RNG) facilities throughout the United States. These projects essentially process raw biogas generated from sources such as landfills and wastewater treatment facilities into a natural gas product that can be injected into the natural gas pipeline network and transported anywhere in the United States. This “Green Gas” has been promoted under the Renewable Fuel Standard (RFS) program.

The RFS program is a national policy that requires a certain volume of renewable fuel to replace or reduce the quantity of petroleum-based transportation fuel, heating oil or jet fuel. The four renewable fuel categories under the RFS are:

- Biomass-based diesel
- Cellulosic biofuel
- Advanced biofuel
- Total renewable fuel

Amersco commercialized its first RNG project in 2010 in a public-private partnership with the San Antonio Water System (SAWS) in San Antonio, Texas. In addition to the project details highlighted previously as part of the ‘Experience’ section, please see an excerpt about this project that was published by the Water Research Foundation. A link to the complete report may be found at:


Amersco currently produces 17,386 MTCE of offsets from RNG annually from its San Antonio project. In addition, Amersco recently brought online a new project in Michigan which will produce 62,693 MTCE of offsets from RNG annually (https://www.amersco.com/amersco-woodland-meadows-landfill-state-of-the-art-gas-to-energy-facility-now-open/) and will soon complete another project in Phoenix which will produce 34,446 MTCE of offsets from RNG annually (https://www.youtube.com/watch?v=3fVj-amSQBA). All three projects in total will produce approximately 114,524 MTCE offsets from RNG annually. In addition to these projects, Amersco is in different phases of development of many more similar projects that, when combined with the three projects previously mentioned, will produce 355,929 MTCE offsets from RNG annually.
LANDFILL GAS

In the past 10 years, Ameresco has developed more landfill gas (LFG) projects in California, than any other renewable energy developer. This portfolio of successful projects includes 10 projects throughout California.

LFG is a natural byproduct of the decomposition of organic material in landfills. LFG is composed of roughly 50 percent methane (the primary component of natural gas), 50 percent carbon dioxide (CO₂), and a small amount of non-methane organic compounds.

Instead of escaping into the air, LFG can be captured, converted, and used as an energy source. Using LFG helps to reduce odors and other hazards associated with LFG emissions, and it helps prevent methane from migrating into the atmosphere and contributing to local smog and global climate change.
ONSITE/OFF-SITE RENEWABLE AND PROCUREMENT STRATEGIES

As one of the largest solar developers in the United States, Ameresco recommends maximizing the use of onsite solar photovoltaics (PV) because 1) the carbon reduction benefit; 2) it allows the City of New Bedford to hedge its distribution charges, as well as its energy costs; and 3) it will improve resiliency. The integration of solar PV supports multiple objectives at once.

DEMAND REDUCTION AND/OR RESILIENCY THROUGH BATTERY ENERGY STORAGE SYSTEM

Ameresco has developed Battery Energy Storage Systems (BESS) for various customers with different implementation plans. BESS can be charged directly from the local grid or nearby distributed generation including, but not limited to, solar PV and hydroelectric. Two of the most common uses of storage are demand reduction and resiliency. Demand reduction allows for the smoothing of daily load curves on local distribution. This could eliminate the need for peaker plants or oversized base loading systems. Another option is to use the energy storage for resiliency. In the case of distributed generation of the local grid going down, energy storage can engage in island mode to carry critical loads until the local grid is restored. This can serve as a green approach to resiliency compared to emergency diesel generators which produce harmful emissions.
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July 10, 2018

Ms. Susan Bruce, Director of Purchasing
City of New Bedford
133 William Street
New Bedford, MA 02746

Subject: Request for Expression of Interest (RFEI) to Permit, Design, Build, Finance, Own, Operate & Maintain and Market Products from an Organics-to-Energy Sludge Processing Facility
Solicitation Number 19192009

Dear Ms. Bruce,

Please find attached 10 copies and a flash memory with our response to the above mentioned Request for Expression of Interest (RFEI).

Do not hesitate to contact me for any clarification or additional information, or to request a visit of our reference facilities.

Thank you for your consideration to our submittal.

Sincerely Yours,

BioMRF Technologies, Inc.

[Signature]

Luigi Castelli
President

BioMRF Technologies, Inc.
10620 Trena Street, Suite 230
San Diego, CA 92131
Tel. (858) 935 6070
Fax (858) 935 6001
City of New Bedford

Request for Expression of Interest (RFEI) to Permit, Design, Build, Finance, Own, Operate & Maintain and Market Products from an Organics-to-Energy Sludge Processing Facility

Solicitation Number 19192009

Response due on July 12, 2018

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LEGAL NOTES

This response to the Request for Expression of interest (RFEI) issued by the City of New Bedford is meant to provide general information on the technology and qualifications of BioMRF and its licensor, which don't assume any liability deriving from the use of the information provided herein.

The BioMRF's technical and economical proposal, including time schedule, warranties and guarantees, will be indicated in the response to the Request for Proposals (RFP) issued by the City.

The only permitted use of the information provided in this document and its Appendices is to assist the City and its Consultants to determine the viability of the proposed technology and develop the RFP.

BioMRF® is a registered trademark of BioMRF Technologies, Inc.
APPENDICES

The following Appendices are part of this Expression of Interest:

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EXECUTIVE SUMMARY

General Information

This proposal is submitted by BioMRF Technologies, Inc., San Diego CA, which has available the tunnel composting/bio-drying technology under a North America license agreement with Atzwanger S.p.A., Bolzano, Italy.

To respond to the City’s RFP, BioMRF intends to propose its bio-drying technology to one or more companies interested in submitting a design, build, own and operate proposal to the City.

The purpose of bio-drying is to produce from biosolids (or digestate) a sanitized product suitable for being used as a fuel or soil amendment.

The reuse of the existing facility will be discussed internally by the team including BioMRF prior to the submittal of the proposal. As indicated above, the BioMRF bio-drying system will be only one of the components of the proposed facility.

Proposed Technology

The project that the City of New Bedford plans to develop require a combination of technologies, such as, but not limited to the following:

- Sludge dewatering
- Biosolids drying
- Fuel and/or soil amendment pelletization
- Energy production.

Reference Facilities

The following tunnel composting references are provided relative to the proposed technology:

- Sesto Fiorentino, Italy
- Mitoyo, Japan
- Sogliano, Italy
- Edmonton, Canada

Please see also the project sheets provided in Appendices A, B, C and D.
Process Diagram

The process diagram of the proposed system is illustrated below:

The proposed biodrying tunnels are the core of the system and allow for drying the biosolids without requiring any external heat source, because the heat for the evaporation is provided by the composting process.

Biosolids Throughput Capacity

The biosolids feedstock to the proposed system is indicated in the following table:

<table>
<thead>
<tr>
<th>Generator</th>
<th>Sludge dry tons/year</th>
<th>Solids content</th>
<th>Biosolids wet tons/year</th>
<th>Biosolids lbs/cy</th>
<th>Biosolids cy/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Bedford</td>
<td>6.749</td>
<td>25.0%</td>
<td>26.996</td>
<td>1500</td>
<td>35.995</td>
</tr>
<tr>
<td>Brockton</td>
<td>4.361</td>
<td>28.8%</td>
<td>15.142</td>
<td>1500</td>
<td>20.190</td>
</tr>
<tr>
<td>Fall River</td>
<td>5.001</td>
<td>20.8%</td>
<td>24.277</td>
<td>1500</td>
<td>32.369</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>16.111</strong></td>
<td><strong>24.3%</strong></td>
<td><strong>66.415</strong></td>
<td><strong>1500</strong></td>
<td><strong>88.553</strong></td>
</tr>
</tbody>
</table>

Table 1
Technology Description

The proposed bio-drying system includes two biotechnologies which have been successfully proven to achieve the required performance without negatively impacting on the neighboring community:

- Tunnel Composting, a real in-vessel system, where the process exhaust air is captured at the source, is used for achieving the required bio-drying and PFRP (Process to Further Reduce Pathogens) performance;

- The air exhausted from the composting tunnels and collected from the feedstock pre-treatment and post-treatment building is channeled to an odor and air pollutant control system including an air scrubber and an engineered biofilter.

Tunnel composting is valued in Europe as the state-of-the-art aerobic process for organic waste, because in addition to its superior process control it allows for collecting at the source the exhaust air to be treated by a scrubber/biofilter system prior to its release to the atmosphere.

Mass Reduction

The expected mass and volume reductions are provided in the following table:

<table>
<thead>
<tr>
<th>Description</th>
<th>Unit</th>
<th>Biosolids and yard waste</th>
<th>Output (fine fraction)</th>
<th>Mass reduction</th>
<th>Volum reduction</th>
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<tr>
<td>Mass</td>
<td>wet tons/year</td>
<td>78.553</td>
<td>23.638</td>
<td>70%</td>
<td></td>
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<tr>
<td>Volume</td>
<td>cy/year</td>
<td>137.107</td>
<td>67.536</td>
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<td>51%</td>
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Table 6

The entire process, i.e. waste receiving/pre-treatment, bio-drying and post-treatment is fully enclosed and maintained under negative pressure by the odor and air pollutant control system.

Time Schedule

A tentative schedule is the following:

- Design and permitting: 6 months
- Construction: 12 months
Benefits

The environmental benefits of the proposed bio-drying system are the following:

- Low carbon footprint due to the use of biological heat (no fossil fuel is required for drying biosolids);
- Efficient PFRP (Process to Further Reduce Pathogens);
- Exhaust air is collected at the source (biotreatment tunnels), thus air pollution control is more efficient;
- Air exhausted from the tunnels is processed by an engineered biofilter, which is the most efficient and simple technology to control odors (a scrubber might be added prior to the biofilter, depending on the permitting requirements);
- No wastewater is produced.

The proposed bio-drying system is simple and economical to operate, because it does not include any external heat source.

In the BioMRF composting tunnels, a 3-way damper allows for recirculating part of the air leaving the pile is, thus it is possible to keep the uniform temperature required for an adequate bio-process and to make sure that the entire mass is exposed at a minimum temperature for a minimum time as required for an efficient PFRP (Process to Further Reduce Pathogens).

By monitoring the oxygen content of the process air, it is possible to make sure that only the required quantity of fresh air is introduced into the system and this prevents an excessive cooling and/or drying of the pile. In addition, it is known that collecting contaminated air at the source is the best practice to pursue control efficiency and low energy requirements.

Another reason for proposing a totally enclosed, not weather-dependent system is the requirement for bio-drying, which would be obviously compromised by precipitation water passing through the piles and generating wastewater. An excessive water content would saturate the material and air will not go through easily, causing anaerobic pockets with production of harmful gases.

The proposed bio-drying system achieves an expected 70% mass reduction, with consequent logistic benefits, which are significant in the event of remotely located users of the fuel and soil amendment products.

The economic benefits of the proposed bio-drying system include low Capex and Opex, in fact the system is economical to build and easy to operate.
The conversion of biosolids (or digestate) into a dry pelletized product, to be marketed as fuel and/or soil amendment, generates revenue which add to the project economic feasibility.
1 BIOMRF INFORMATION

1.1 Contact Information

This proposal is submitted by:

BioMRF Technologies, Inc.
10620 Treena Street, Suite 230
San Diego, CA 92131
Tel. (858) 935 6070
Fax (858) 935 6001
www.biomrf.com

Contact person:

Luigi Castelli, President
Tel. (858) 935 6070
E-mail: luigi.castelli@biomrf.com

1.2 BioMRF References

BioMRF has available the tunnel composting/bio-drying technology under a North America license agreement with Atzwanger S.p.A., Bolzano, Italy.

The proposed technology was developed under the direction of Luigi Castelli when he was Chief Engineer of Ecomaster/Atzwanger.

The following references are provided relative to the proposed technology:

Sesto Florentino - Design, equipment supply and civil works construction by Atzwanger of the 66,000 tpy Sesto Florentino, Florence facility including 14 composting tunnels, air scrubbers and biofilter;

Mitoyo - Design, equipment supply and commissioning by Atzwanger of the Mitoyo, Japan bio-drying facility including 6 composting tunnels, air scrubbers and biofilter;
Sogliano - Design, equipment supply and commissioning by Atzwanger of the Sogliano al Rubicone, Italy of the 43,000 tpd digestion/composting facility [11 dry digesters, 8 composting tunnels composting, 8 ASP maturation cells, and 2 biofilters];

Edmonton - Design and equipment supply by BioMRF for the 40,000 tpy Edmonton, Alberta tunnel composting facility and air scrubbers for treatment of process exhaust air prior to biofiltration (under commissioning).

Please see also the project sheets provided in Appendices A, B, C and D.

2 BIOMRF HISTORY AND QUALIFICATIONS

2.1 BioMRF History

This Expression of Interest is submitted by BioMRF Technologies, Inc. ("BioMRF/US") a California corporation.

BioMRF/Italy, established in 1993 by Luigi Castelli (engineer) and his wife Caterina (architect), has designed and built several dozen waste treatment plants, directly or through its controlled company Ecomaster, including a $13.5 million RDF/compost plant for Foster Wheeler.

In 2008, BioMRF/Italy sold Ecomaster to Atzwanger S.p.A. (Bolzano, Italy). BioMRF/US is the North America licensee of Atzwanger for the Tunnel Composting Technology, which was developed under Luigi’s technical direction, and is currently used in more than 150 tunnels built or under construction in Europe, Japan and Canada.

While BioMRF/Italy was established in 1993, BioMRF was incorporated in 2013 and in the last four years has worked for developing projects in North America.

BioMRF has provided the design and equipment for the composting and air pollution system of the HSAD (High Solids Anaerobic Digestion Facility) owned by the City of Edmonton, Alberta, which is currently under commissioning.

The Edmonton project includes the BioMRF Tunnel Composting Technology, which has been successfully confirmed by over 150 tunnels operating or under construction in Europe, Canada and Japan and is proposed for the project of the City of New Bedford.
2.2 Senior Management

Luigi Castelli, President and co-founder of BioMRF, is an Italian engineer which helped in shaping the environmental industry over the past 30 years with his innovations in the fields of solid waste treatment, renewable energy, air pollution and noise control.

BioMRF Technologies S.r.l., an Italian company he started in 1993, has developed Ecomaster, an internationally recognized affiliated company specialized in the treatment of municipal waste, which in 2008 has merged with Atzwanger S.p.A., Bolzano (South Tyrol, Italy).

Acoustics researcher at Penn State in 1982, for ten years he has been part of the management of an international EPC contractor, Daneco Danielli Ecologia.

In 1987, Luigi invented the bio-drying process, which increases the calorific value of RDF without consuming fossil fuel.

His professional experience includes a two-year position as Environment Vice-president of Danielli, a $4 billion turn-key provider of steelmaking facilities.

3 PROPOSED APPROACH TECHNOLOGY

3.1 Proposed Approach

The project that the City of New Bedford plans to develop requires a combination of technologies, such as, but not limited to the following:

- Sludge dewatering
- Biosolids drying
- Fuel and/or soil amendment pelletization
- Energy production.

To respond to the City's RFP, BioMRF intends to propose its bio-drying technology to one or more companies interested in submitting a design, build, own and operate proposal to the City.
3.2 Process Diagram

The process diagram of the proposed system is illustrated below:

The proposed biodrying tunnels are the core of the system and allow for drying the biosolids without requiring any external heat source, because the heat for the evaporation is provided by the composting process.
3.3 Facility Feedstocks and Throughput Capacity

The biosolids feedstock to the system is indicated in the following table:

<table>
<thead>
<tr>
<th>Generator</th>
<th>Sludge dry tons/year</th>
<th>Solids content</th>
<th>Biosolids wet tons/year</th>
<th>Biosolids lbs/cy</th>
<th>Biosolids cy/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Bedford</td>
<td>6.749</td>
<td>25.0%</td>
<td>26.996</td>
<td>1500</td>
<td>35.995</td>
</tr>
<tr>
<td>Brockton</td>
<td>4.361</td>
<td>28.6%</td>
<td>15.142</td>
<td>1500</td>
<td>20.190</td>
</tr>
<tr>
<td>Fall River</td>
<td>5.001</td>
<td>20.6%</td>
<td>24.277</td>
<td>1500</td>
<td>32.359</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>16.111</strong></td>
<td><strong>24.3%</strong></td>
<td><strong>66.415</strong></td>
<td><strong>1500</strong></td>
<td><strong>88.553</strong></td>
</tr>
</tbody>
</table>

Table 1

The following table provides the estimated moisture content of the input materials:

<table>
<thead>
<tr>
<th>Tunnel Input</th>
<th>Mass wet tons/year</th>
<th>Bulk density lbs/cy</th>
<th>Volume cy/year</th>
<th>Solids content</th>
<th>Moisture content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biosolids</td>
<td>66.415</td>
<td>1500</td>
<td>88.553</td>
<td>24.3%</td>
<td>75.7%</td>
</tr>
<tr>
<td>Recycled screen overs</td>
<td>10.000</td>
<td>500</td>
<td>40.000</td>
<td>75.0%</td>
<td>25.0%</td>
</tr>
<tr>
<td>Shredded yard waste</td>
<td>12.138</td>
<td>500</td>
<td>48.553</td>
<td>50.0%</td>
<td>50.0%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>88.553</strong></td>
<td><strong>950</strong></td>
<td><strong>186.428</strong></td>
<td><strong>33.5%</strong></td>
<td><strong>66.5%</strong></td>
</tr>
</tbody>
</table>

Table 2

3.4 Process Description

The proposed bio-drying system includes two bio-technologies which have been successfully proven to achieve the required performance without negatively impacting on the neighboring community:
- Tunnel Composting, a real in-vessel system where the process exhaust air is captured at the source, is used for achieving the required bio-drying and PFRP (Process to Further Reduce Pathogens) performance;

- The air exhausted from the composting tunnels and collected from the feedstock pre-treatment and post-treatment building will be channeled to an odor and air pollutant control system including an air scrubber and an engineered biofilter.

3.5 Mechanical Treatments

The facility includes also a shredder intended for processing woody yard waste prior to mixing with biosolids.

Mixing of biosolids with a bulking agent (shredded green waste and/or screen oversize fraction) is fundamental to provide the tunnel feedstock with an adequate permeability to air.

After the conclusion of the bio-drying process, the material will be transferred to the mechanical post-treatment system for the separation of the fuel/soil amendment product.

The proposed compost post-treatment equipment includes a screen which sorts the material into two fractions: minus 3/8" (10 mm) material and oversize fraction which is moved to the pre-treatment building to be reused as bulking agent in the preparation of the composting tunnels feedstock.
3.6 Tunnel Bio-drying/Composting System

Tunnel composting is valued in Europe as the state-of-the-art aerobic process for organic waste, because in addition to its superior process control it allows for collecting at the source the exhaust air to be treated by a scrubber/biofilter system prior to its release to the atmosphere.

![BioMRF Tunnel System (Edmonton)](image)

A facility including the BioMRF tunnel composting facility has been permitted and is currently under commissioning in Edmonton, Alberta. The owner of the facility is the City of Edmonton, which is well known in North America for its environmental leadership.
Composting Tunnel Aeration Scheme

Aerated Floor under Construction (Edmonton)
The composting tunnels are enclosed "garage-like" structures made of reinforced concrete provided with:

- Floor aeration system with "spigots" for air distribution;
- Detachable air-tight doors;
- Stainless steel fans with VFD motor;
- Air duct system including for each tunnel three dampers with electric actuator;
- Exhaust air suction system connected to the biofiltration system;
- Tailor-made SCADA with instrumentation for the measuring and recording of temperature (material processed, biofilter media and process air), pressure (inside tunnels and at biofilter plenum) and oxygen concentration (in the duct of recirculation to the tunnel).

Two doors carriers, with hydraulic lifting system, are provided for each bank of tunnels, thus two doors can be opened simultaneously at each bank.

The material handling in the tunnel front area is performed by wheel loader as follows:

- Loading of an empty tunnel with fresh feedstock;
- Transfer of material from the maturation are to the mechanical post-processing system.

All tunnels are provided with a leachate collection system (at the floor) and a wetting system (under the ceiling) for correction of the moisture content and recycling of waste water.
3.7 Tunnel System Sizing

The sizing of the proposed bio-drying process, based on a retention time of nine (9) days, is provided in the following table:

<table>
<thead>
<tr>
<th>Tunnels</th>
<th>Quantity</th>
<th>Width ft</th>
<th>Length ft</th>
<th>Pile height ft</th>
<th>Volume cy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nine days retention</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4.597</td>
</tr>
<tr>
<td>Volume requirement</td>
<td>5</td>
<td>23</td>
<td>115</td>
<td>10</td>
<td>4.898</td>
</tr>
<tr>
<td>Extra (load &amp; unload)</td>
<td>1</td>
<td>23</td>
<td>115</td>
<td>10</td>
<td>980</td>
</tr>
<tr>
<td>Total</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td>5.678</td>
</tr>
</tbody>
</table>

Table 3

As illustrated in the drawing of Appendix E, six (6) composting tunnels are provided.
The process air is collected from the receiving and screening hall, thus also this area is provided with the ventilation required to control odor and provide a healthy working area.

### 3.8 Process Mass Balance

The estimated mass balance of the proposed biological process is provided in the following table:

<table>
<thead>
<tr>
<th>Tunnel outputs</th>
<th>Mass dry tons /year</th>
<th>Solids content</th>
<th>Mass wet tons /year</th>
<th>Bulk density lbs/cy</th>
<th>Volume cy/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biodegraded material</td>
<td>25.228</td>
<td>75%</td>
<td>33.638</td>
<td>600</td>
<td>112.125</td>
</tr>
<tr>
<td>Loss through biofilter</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wastewater</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>88.553</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4

Table 5 provides the mass balance of the screening process (post-treatment):

<table>
<thead>
<tr>
<th>Screening balance</th>
<th>Mass dry tons /year</th>
<th>Solids content</th>
<th>Mass wet tons /year</th>
<th>Bulk density lbs/cy</th>
<th>Volume cy/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screen input</td>
<td>25.228</td>
<td>75%</td>
<td>33.638</td>
<td>600</td>
<td>112.125</td>
</tr>
<tr>
<td>Coarse fraction</td>
<td>7.500</td>
<td>75%</td>
<td>10.000</td>
<td>500</td>
<td>40.000</td>
</tr>
<tr>
<td>Fine fraction</td>
<td>17.728</td>
<td>75%</td>
<td>23.638</td>
<td>700</td>
<td>67.536</td>
</tr>
</tbody>
</table>

Table 5
The expected mass and volume reductions are provided in the following table:

<table>
<thead>
<tr>
<th>Description</th>
<th>Unit</th>
<th>Biosolids and yard waste</th>
<th>Output (fine fraction)</th>
<th>Mass reduction</th>
<th>Volume reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass</td>
<td>wet tons/year</td>
<td>78.553</td>
<td>23.638</td>
<td>70%</td>
<td></td>
</tr>
<tr>
<td>Volume</td>
<td>cy/year</td>
<td>137.107</td>
<td>67.536</td>
<td></td>
<td>51%</td>
</tr>
</tbody>
</table>

Table 6

4 ADDED VALUE COMPONENTS

4.1 Air Pollution Control System

As indicated above, the entire process, i.e. biosolids receiving/pre-treatment, biodrying and compost post-treatment is fully enclosed and maintained under negative pressure by the odor and air pollutant control system.

Scheme of Odor and Air Pollutant Control System
Although the proposed facility is totally enclosed and provided with a robust odor control system, it is anticipated that an Odor Impact Mitigation Plan will be required through the permitting process. The plan will include the following:

- Description of odor control system design and specifications;
- Description of odor control system operation and maintenance;
- Mitigation procedures during the execution of particular works, such as maintenance of the biofilter or emptying of wastewater tanks;
- Plan for odor complaints receiving, recording and consequent actions;
- The facility will include a meteorological station which will record ambient air temperature and humidity, wind direction and speed.
- A qualified and trained person of the staff will be responsible for coordinating all activities required by the odor control plan (Odor Control Manager).

4.2 Noise Control Measures

The facility will include various noise control designs and operational procedures, which will be included in the Noise Control Plan:

- The proposed facility is totally enclosed, thus the emission of excessive noise will be prevented;
- The fans of the composting tunnels and cells are provided with silencers at the air inlet to prevent the emission of excessive noise;
- The fan of the biofilter will be operating at low nominal speed and during the night hours, when no operators is present in the buildings and all doors are closed, the fans speed will be further reduced by VFD (Variable Speed Drive) to the value required to keep the buildings under slight negative pressure;
- The shredder and screen will be electrically operated;
- All mobile equipment used at the facility will be provided with an efficient muffler, which will be immediately replaced when necessary;
- The noise pressure levels at the facility boundaries will be periodically measured and the resulting values recorded.
4.3 Wastewater

The bio-drying system is designed to be a zero-wastewater system.

Depending on the local precipitations, the biofilter might be roofed for weather protection.

The runoff management plan and the erosion and sediment control plan will be prepared by the permitting specialists.

5 IMPLEMENTATION PLAN

5.1 Facility Development

It is anticipated that an LLC will be established by the proposer, to serve as an SPV (Special Purpose Vehicle) and provide the proposed services to the Cities of New Bedford, Brockton and Fall River.

BioMRF will be a nominated subcontractor of the SPV.

Upon signing of the agreements, the SPV will proceed with financing the project and, at the same time, the preliminary design required for permitting will be completed.

Upon closing of the financing and approval of the construction permits, the SPV will complete the negotiations with its subcontractors, which will receive a notice to proceed.

Prior to the beginning of the facility commissioning, staffing will have been completed, to train the personnel during the facility commissioning phase.

The facility throughput will be increased gradually up to the design capacity, to allow the biofilter to reach its full efficiency.

5.2 Time Schedule

At this time, it is difficult to provide correct information relative to the time required to complete the project, which will depend on the technologies included and the local requirements.

A tentative schedule is the following:

- Design and permitting: 6 months
- Construction: 12 months
- Cold/Hot commissioning and acceptance testing: 6 months.

6 EXISTING FACILITIES

6.1 Reuse of Existing Facility

The reuse of the existing facility will be discussed internally by the team including BioMRF prior to the submittal of the proposal.

7 SITE CONSTRAINTS

7.1 Identification of Constraints

As indicated above, the BioMRF bio-drying system will be only one of the components of the proposed facility.

The site constraints will be discussed internally by the team including BioMRF prior to the submittal of the proposal.

8 REFERENCE FACILITIES

8.1 BioMRF References

BioMRF has available the tunnel composting technology, which was developed under the direction of Luigi Castelli when he was technical manager of Ecomaster/Atzwanger, under a North America license agreement with Atzwanger S.p.A., Bolzano, Italy.

The following references are provided relative to the proposed technology:
Sesto Fiorentino, Italy - Design, equipment supply and civil works construction by Atzwanger of the 66,000 tpy Sesto Fiorentino, Florence facility including 14 composting tunnels, air scrubbers and biofilter;

Mitoyo, Japan - Design, equipment supply and commissioning by Atzwanger of the Mitoyo, Japan bio-drying facility including 6 composting tunnels, air scrubbers and biofilter;

Sogliano, Italy - Design, equipment supply and commissioning by Atzwanger of the Sogliano al Rubicone, Italy of the 43,000 tpd digestion/composting facility (11 dry digesters, 8 composting tunnels composting, 8 ASP maturation cells, and 2 biofilters);

Edmonton, Canada - Design and equipment supply for the 40,000 tpy Edmonton, Alberta tunnel composting facility and air scrubbers for treatment of process exhaust air prior to biofiltration (under completion).

Due to the European privacy laws, which regulate the transmission and filing of personal information, contact person information relative to the reference projects will be submitted upon request.

Inspection of the reference facilities by representatives of the City and its consultants can also be arranged by BioMRF with the approval of the facility owner/operator.

Detailed information relative to the reference facilities is provided in Appendices A, B, C and D.

9 STATEMENT OF BENEFITS

9.1 Environmental Benefits

The environmental benefits of the proposed bio-drying system are the following:

- Low carbon foot-print due to the use of biological heat (no fossil fuel is required for drying biosolids);
- Efficient PFRP (Process to Further Reduce Pathogen);
- Exhaust air is collected at the source (biobrading tunnels), thus air pollution control is more efficient.
- Air exhausted from the tunnels is processed by an engineered biofilter, which is the most efficient and simple technology to control odors (a scrubber might be added prior to the biofilter, depending on the permitting requirements);
9.2 Operational Benefits

The proposed biodrying system is simple to operate, because it does not include any external heat source.

In the BioMRF composting tunnels, a 3-way damper allows for recirculating part of the air leaving the pile is, thus it is possible to keep the uniform temperature required for an adequate bio-process and to make sure that the entire mass is exposed at a minimum temperature for a minimum time as required for an efficient PFRP (Process to Further Reduce Pathogens).

By monitoring the oxygen content of the process air, it is possible to make sure that only the required quantity of fresh air is introduced into the system and this prevents an excessive cooling and/or drying of the pile. In addition, it is known that collecting contaminated air at the source is the best practice to pursue control efficiency and low energy requirements.

Another reason for proposing a totally enclosed, not weather-dependent system is the requirement for biodrying, which would be obviously compromised by precipitation water passing through the piles and become wastewater.

An excessive water content would saturate the material and air will not go through easily, causing anaerobic pockets with production of harmful gases.

9.3 Logistical Benefits

The proposed bio-drying system achieves a 70% mass reduction, with consequent logistic benefits, which are significant in the event of remotely located users of the fuel and soil amendment products.

9.4 Economic Benefits

The economic benefits of the proposed bio-drying system include low Capex and Opex, in fact the system is economical to build and easy to operate.

The conversion of biosolids (or digestate) into a dry pelletized product, to be marketed as fuel and/or soil amendment, generates revenue which add to the project economic feasibility.
APPENDIX A

Sesto Fiorentino Reference Facility
| **43** SESTO FIORENTINO (FI) ITALY |
|-----------------|-----------------|
| **Year**        | 2005            |
| **Client**      | QUADRIFOGLIO SERVIZI AMBIENTALI AREA FIORENTINA SpA |
| **Operator**    | QUADRIFOGLIO SERVIZI AMBIENTALI AREA FIORENTINA SpA |
| **Partner**     | UNIECO Soc. Coop. |
| **System description** | Tunnel composting and odour control |
| **Waste processed** | Organic waste |
| **Plant capacity** | 70,000 t/ year |

QUADRIFOGLIO SpA, which carries out environmental services in the Florence area, has awarded to the joint-venture including UNIECO Soc. Coop. and ECOMASTER ATZWANGER the contract for the design and construction of a biotunnel composting plant complete with air treatment and compost refining systems.
The organic waste treatment plant built by the temporary joint-venture Ecomaster-Unesco, uses the bio-tunnel composting process. The plant has two purposes:

- Treatment of organic waste derived from the source separation of municipal waste mixed with garden waste;
- Stabilization of the organic fraction produced by the mechanical sorting (screening) of mixed municipal waste.

The quality of treated waste is fundamental for characterization of the product of the process; in fact only uncontaminated organic waste can be used for the production of compost to be used in agriculture.

The processing of the organic fraction derived from mixed municipal waste allows producing a stabilized material, that depending on the applicable rules can be used in particular applications, such as landfill cover material.

The plant includes the following sub-systems:

- Composting system including 14 bio-tunnels;
- Odour control system for the entire waste treatment complex.

Bio-tunnels are reinforced concrete built reactors having a parallelepiped shape, which are loaded by wheeled loader. Once the biological process has been completed, unloading is carried out by wheeled loader as well. Bio-tunnels are completely segregated by the other work areas with special sliding doors that contain the process.

The material sorted by screening mixed municipal waste is produced in another part of the plant (excluded from this project) and loaded into the bio-tunnels without any pre-treatment, while organic waste is mixed with shredded garden waste. Mixing with a wood-rich material ensures the presence of structural material and allows high air permeability of the mix.

The floor of the bio-tunnels consists of an aerated platform with an air distribution system set into the concrete platform itself. The system is made of plastic ducts with air distribution nozzles.

In each reactor, a fan supplies the process air, which thanks to three air damper, can be one of the following air flows:

- Fresh air sucked from the bio-tunnel material handling area;
- Air sucked from the inside of the bio-tunnels;
- A mix of the above two streams in a 0 to 100% ratio.

The three flows (fresh air, waste air and recirculated air) is controlled by electrically-driven air dampers.

The aerobic composting process is assisted by a PLC - Programmable Logic Controller based on a "fuzzy" logic (i.e. undefined), which maintains the process parameters within preset ranges.

Various process factors are controlled, such as temperature of the treated material, pressure and temperature of the process air, air pressure inside the bio-tunnel. Also, the oxygen level in the process air is monitored for each bio-tunnel.

The active composting process, that has a time length of 2 to 3 weeks, is divided in various phases: heating, pathogen control, stabilization and mass cooling.

A system for the acquisition and visualization of the process factors allows real-time monitoring of the process. All values measured are recorded and can be used for showing the trend in graphic form.

The 14 bio-tunnels are dedicated to the two different input materials (screened mixed waste and organic waste mixed with garden waste) depending on the quantities to be processed.

The two materials are always kept segregated to prevent contamination of the compost to be used for agricultural applications. The plant includes a collection system for the waste fluids, which are filtered and sprayed for recycling into the reactors that process mixed waste. Fresh water is used in the reactors that process organic waste.

The bio-tunnel intensive composting process is followed by a maturation treatment that includes turning of the material.

The plant has been built according to a phased schedule to avoid stopping the existing operations and causing organizational difficulties. The following functional lots have been completed one after the other:

- Odour control system with 3 scrubbers and bio-filter;
- First group of 5 bio-tunnels;
- Odour control system with 5 additional scrubbers;
- Additional 9 bio-tunnels.
APPENDIX B
Sogliano Reference Facility
SOGLIANO AL RUBICONE (FC) ITALY

Year: 2010
Client: SOGLIANO AMBIENTE SpA
Operator: SOGLIANO AMBIENTE SpA
System description: Dry anaerobic digestion, tunnel composting and odour control
Waste processed: Organic from mixed municipal solid waste and recyclables
Plant capacity: 50,000 t/year. Installed electrical capacity 998 kW

Sogliano Ambiente has awarded ATZWANGER with the design and construction of the equipment of an integrated waste treatment system.
The plant uses a combination of anaerobic (digestion) and aerobic (composting) processes for the treatment of organic waste with recovery of electric energy and compost.

The process includes two successive phases:

- Fermentation phase in an anaerobic environment, with degradation of the organic matter and formation of biogas (methane gas and carbon dioxide); the biogas recovered in this phase is used to fuel two engines which produce electric energy and heat;

- Composting phase, organized in two successive phases, intensive bio-oxidation and maturation (curing). The first phase, that takes place in bio-tunnels, is marked by a rapid decomposition of the organic matter, with an intense metabolic activity and rise in temperature; the resulting product is fresh compost. The second phase, called “curing”, takes place on the maturation floor and the final product is mature compost with a higher content of humic substances.

The final products of the recovery process are:

- Biogas used in gas engines for the production of electrical energy and heat;
- Quality compost to be used in agriculture;
- Bio-stabilised material.

The plant is equipped with an air extraction system and a bio-filter for the control of the odours generated by the process.

The project is completed by Sogliano Ambiente with the installation of a photovoltaic plant on the roof of the building that contains the stabilisation process.
APPENDIX C
Mitoyo Reference Facility
### 65 MITOYO - JAPAN

<table>
<thead>
<tr>
<th>Year</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Client</td>
<td>SHINWA SANGYO Co., Ltd.</td>
</tr>
<tr>
<td>Operator</td>
<td></td>
</tr>
<tr>
<td>System description</td>
<td>RDF bio-drying</td>
</tr>
<tr>
<td>Waste processed</td>
<td>Mixed MSW (Municipal Solid Waste)</td>
</tr>
<tr>
<td>Plant capacity</td>
<td>20,000 t/year</td>
</tr>
</tbody>
</table>

Producing bio-dried RDF is the purpose of this project, which will convert municipal solid waste into an alternative fuel to be co-fired in the boiler of a paper mill. Drying will not require any fossil fuel, because the required heat is self-generated by the composting process occurring in the tunnels.
After a mechanical pre-treatment process, the material to be converted to RDF is loaded by a wheel loader into six bio-drying tunnels.

The biological process occurring in the tunnels has the function of drying the organic fraction without the addition of any external heat source.

The tunnels are totally enclosed and provided with a front door and an aerated floor. They are maintained under slight negative pressure by the odor control system, which consists of an acid-base scrubber, a fan and a biofilter.

Exhaust air from the halls is used as process air for the biological process.

Each tunnel is provided with two dampers that automatically control the flow rate of fresh, process and exhausted air based on the various process parameters. The system is fully automated and operates on a 24/7 basis under the control of the PLC. The SCADA system allows for easy process monitoring and remote troubleshooting.

After the treatment in the bio-drying tunnels, the material is further processed mechanically to meet RDF specifications.
APPENDIX D

Edmonton Reference Facility
EDMONTON - CANADA

Year: 2015
Client: BioMRF Technologies, Inc.
Operator: City of Edmonton
System description: Tunnel composting
Waste processed: Material from high solids anaerobic digestion
Plant capacity: 48,000 t/year

BioMRF Technologies, Inc., the North American licensee of the Atzwanger tunnel composting technology, will provide BIOFerm USA, Inc. (Vissmann Group) with design, equipment and technical support for the construction of the aeration boxes included in the OPF (Organic Processing Facility) developed by the City of Edmonton.
The tunnel composting system included in this project has three functions:

- To further stabilize the digestate prior to final composting and curing stages;
- To reduce the moisture content of the material coming from the dry anaerobic digestion (percolation process) and facilitate the following aerobic treatment;
- To control the emissions of ammonia, VOC and sulfur compounds.

Each tunnel is provided with three dampers, which automatically control the flow rate of fresh, process and exhausted air based on the various process parameters. The system is fully automated and operates on a 24/7 basis under the control of the PLC. The SCADA system allows for a simple process monitoring and remote troubleshooting.
APPENDIX E

Bio-drying System Layout

Drawing No. 18.32-LAY-001-01-00