Waste-to-Energy in Worcester, Massachusetts

A report on the potential use of anaerobic digestion at the Upper Blackstone Water Pollution Abatement District

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**Acronyms**

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<td>Anaerobic Digestion</td>
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<td>CHP</td>
<td>Combined Heat and Power</td>
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<td>DS</td>
<td>Dry Solid</td>
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<td>EPA</td>
<td>United States Environmental Protection Agency</td>
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<td>FOG</td>
<td>Fats, Oils, and Grease</td>
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<td>FSC</td>
<td>Food Supply Chain</td>
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<td>FW</td>
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<td>DEP</td>
<td>Massachusetts Department of Environmental Protection</td>
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<td>Greater Lawrence Sanitary District</td>
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<td>Municipal Solid Waste</td>
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<td>MWRA</td>
<td>Massachusetts Water Resource Authority</td>
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<td>NIMBY</td>
<td>“Not in my backyard”</td>
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<td>Organic Municipal Solid Waste</td>
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<td>POTW</td>
<td>Publically Owned Treatment Works</td>
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<td>RPS</td>
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<td>SSO</td>
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<td>Upper Blackstone Water Pollution Abatement District</td>
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<td>WTE</td>
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Executive Summary

As of October 1, 2014, the Commonwealth of Massachusetts prohibits the disposal of source separated organic (SSO) materials - which includes food waste - in area landfills for generators producing more than 1000 tons of SSO per week. This ban represents a growing momentum for reducing food waste and other organic material in area landfills and a dynamic market in which outlets for this material continue to expand. In addition, the treatment of municipal wastewater (sewage) is an ever-present concern, requiring enormous capital expenditures to maintain and upgrade infrastructure and treatment facilities. A growing interest in renewable energy sources has brought these two sectors – solid waste management and wastewater treatment – into contact.

The purpose of this report is to provide an overview of issues related to this confluence within the waste industry; the removal of organic waste from municipal waste streams and its potential as a renewable feedstock for a process known as anaerobic digestion (AD) in conjunction with the treatment of municipal wastewater. This process produces biogas, which is mostly composed of methane and carbon dioxide, and can be refined and burned to generate heat and power, stored for future use, or injected directly into the natural gas grid. When biogas is used to produce electrical power and process heating on site, it is a form of distributed energy generation and is commonly referred to as cogeneration or combined heat and power (CHP). The full process is often referred to as AD/CHP, but AD will be used as shorthand throughout this report.

The focus of this study is on Central Massachusetts and the Upper Blackstone Water Pollution Abatement District (henceforth referred to as Upper Blackstone). This is not a feasibility study. The intention of this report is to identify current trends and critical considerations for the basis of further inquiry and necessary next steps. The information in this report was obtained through personal interviews with key stakeholders in the public policy and waste management sectors, a review of available literature and publically available reports, and through additional media coverage.

This study revealed several obstacles and opportunities for AD at Upper Blackstone, but three considerations of central importance emerged if the Upper Blackstone facility decides to move forward with plans to introduce AD.

1. The role of partnerships and the importance of forming close relationships with stakeholders who are actively developing the collection and diversion infrastructure for SSO
2. The need to take a pro-active and long-term position on the regional development of AD and organics processing
3. The importance of public perception and community engagement

It is important to note that these central considerations did not emerge independent of economic and technical feasibility, but as essential prerequisites that could both increase

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feasibility and support successful implementation. It is also important to note that all of these considerations, when acted on, would require significant commitment, staff time, and funding, and taken together comprise a dedicated effort to organize community members and build long-term cross-sector partnerships. A fuller discussion of these considerations begins at the end of the findings section at the top of page 15.

This preliminary study encountered a robust emerging market for SSO and the beginning of a cycle in which the supply of this material outweighs processing capacity. Several new ventures are underway that intend to capitalize on this existing supply of SSO, as well as aid in the development of methods and infrastructure to divert and process more of this material from the existing waste stream. Alone, these trends make projections difficult, as many players are actively pursuing different strategies and technologies, and it will likely take years to fully develop an infrastructure for SSO collection and processing and to discern clear preferences within the industry.

This study also corroborated the difficulties in producing accurate net cost estimates in determining the feasibility of AD in conjunction with existing wastewater treatment plants (WWTPs). Many factors complicate such estimates, including the assessment of capital costs, operational costs and savings, displacement of existing technology and methods, reduction in disposal costs, and revenues from tipping fees and the sale of byproducts. Most local studies have considered some cost savings, but also have relied on payback projections based on tipping fees to account for the net operating cost offsets. However, there are indications that such fees will be trending downward as more clean SSO enters the market. This suggests that feasibility models need to consider multiple factors, including potential revenue from byproducts and the potential to offset incumbent and impending investments due to existing conditions and the regulatory environment. In the case of the Upper Blackstone, there is some concern that exiting capital commitments will prohibit the adoption of new processes and that there might be an additional reluctance to incorporate new methods until existing regulatory mandates can be met.

Between 2004 and 2012, the Upper Blackstone invested $191 million in plant improvement projects to meet stricter environmental standards for effluent released into the Blackstone River. Partly as a result of these improvements 52.2% of Upper Blackstone’s budget is dedicated to annual debt payments, and user fees have increased by more than 240%. In 2008 the U.S. Environmental Protection Agency issued a new permit for Upper Blackstone with more stringent nutrient limits than the new equipment is capable of achieving. The cost to meet these new standards is estimated to be an additional $200 million. While there is serious concern both for the environment and the

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2 Sean Pontani (Center for Eco-Technology, Green Business Support Manager), in communication with the author, August 14, 2014.
3 See the Organics-to-Energy reports compiled by the Massachusetts Clean Energy Center for specific details, available at http://www.masscec.com/content/completed-organics-energy-studies.
4 Tony Barbagallo (Casella Organics, Director of Business Development), "In Communication with the Author, August 21, 2014.
5 Alan Slater (Massachusetts Department of Environmental Protection, Anaerobic Digestion & Organics Division), in discussion with the author, August 15, 2014.
need for district ratepayers to absorb the costs of the mandated improvements\textsuperscript{7}, AD may represent an opportunity to offset capital and operational costs or introduce new technology that would help mitigate many of the problems associated with the 2008 standards.

There are four general areas of influence for the successful adoption of AD at Upper Blackstone: site considerations, the regulatory environment, market considerations, and social and environmental concerns. This brief report will touch on all of these areas, but will concern itself mostly with the historic, current, and future developments in the market for organic waste materials, the deployment of AD technology, and the issues of public perception, opposition, and community engagement.

The report concludes with recommendations for further inquiry, including the need for a full economic and technological feasibility study, and lays out the primary areas of interest and a scope of work. In addition, formal assessments of external conditions will also be required, including market and stakeholder analyses, and a community engagement plan. In addition to the issues mentioned above concerning consideration of AD in light of potentially unavoidable capital improvements at Upper Blackstone, it is important to stress that external factors, in and of themselves, may not be sufficient to guide decision making; a certain amount of political will and cross-sector organizing may be necessary to move conditions from the possible to the feasible. As such, an honest internal assessment of the will and capacity to organize and sustain those efforts is essential.

\textsuperscript{7} These issues have been covered extensively in the local media; for example see: Steven Jones-D’Agostino. “Worcester DPW + Chamber Accused of Stalling Sewage Upgrades.” GoLocal Worcester.com, August 30, 2013. \texttt{http://www.golocalworcester.com/news/public-works-accused-of-stalling-on-millbury-sewage-plant-upgrades}
Introduction

As Worcester looks to become a more sustainable city it has adopted strategies that improve the quality of life while increasing the economic vitality of the area. Similarly, as the Commonwealth of Massachusetts pursues its vision to promote sustainable practices and conserve important natural resources, it favors strategies with combined benefits for the people, environment, and economy of the state. The promotion of anaerobic digestion (AD) and legislation mandating the diversion of organic materials from the waste stream is a continuation of these policies and represents attempts to stimulate the markets for organic wastes and their byproducts and to incentivize the development of waste-to-energy technologies and diversion infrastructure. As mentioned above, these technologies and products (anaerobic digestion, biogas production, and fertilizer) can help the state and local governments reduce greenhouse gas (GHG) emissions, reduce reliance on fossil fuels, and repurpose waste materials that have become highly regulated and are no longer suitable for traditional disposal methods.

In many cases the benefits of new efficiency programs are clear, and their implementation a more or less straightforward process of shifting revenue steams and savings to fund new programs and services, though initial funding for such projects and long payback periods may impede their implementation. This is certainly the case for anaerobic digestion in conjunction with food waste diversion programs. In addition, several factors may complicate feasibility assessments and make the evaluation of these proposals even more difficult. Such factors include the broad target of the new regulations on the disposal of food waste, a burgeoning, dynamic (and uncertain) market for organic materials, increasing restrictions on landfilling and sewage disposal, and existing investments in waste processing technology and facilities, among many others.

Today, converting food waste to energy, often referred to as organics-to-energy, reflects a renewed interest in old processes and technologies as a way to address a broad set of social, economic, and environmental problems. Though there is little new in our fundamental understanding of the science involved, there is a new understanding that in order to address these interrelated problems our solutions must be similarly interconnected and nuanced. The issues discussed in this report, however much the audience remains in the realm of policy makers and public servants, reflect the growing role of the private sector in responding, often in partnership with public entities, to federal, state and local mandates. Indeed, the public sector increasingly relies on private sector expertise to implement, integrate, and manage complex new systems and technologies.

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11 Ibid.
technologies, and this issue provides a good example where these relationships exist at nearly every level of consideration.

The primary aims of this report are to guide future inquiries and aid discussion on the subject of converting food waste to energy at Upper Blackstone. The issues involved in this topic lie at the intersections of different industries, public sector services, and broader social trends and policy goals. It will attempt to provide a framework in which to think about these as separate but related issues in order to clarify how they relate specifically to Upper Blackstone. This report is not intended as a guide to understanding the specific strategies or technologies involved; such introductions are readily available elsewhere. It is meant to introduce the three main areas of consideration, how they relate to the specific issue of utilizing food waste at Upper Blackstone, and provide a list of recommendations for next steps and further inquiry.
Historical Background

Anaerobic digestion (AD) is a biological process whereby organic matter is broken down in the absence of oxygen. Byproducts of AD include “biogas” (approximately 60% methane and 40% carbon dioxide), and a nutrient-rich slurry (effluent) that can be dewatered and further processed for other uses. Typically effluent will either be processed for use as a pelletized fertilizer or used as a solid fuel for waste incinerators. The industrial application of anaerobic digestion has been used to process human waste for over a century. Beginning in the late Nineteenth Century, AD has been used in the U.S. to stabilize sewage; reducing pathogens, providing a base for fertilizers, mitigating the hazards of releasing the material into the environment, as well as producing biogas (primarily composed of methane and carbon dioxide) for municipal uses. While early uses of biogas included illuminating streetlights, the primary purpose of AD was to stabilize sewer sludge, and most wastewater treatment plants (WWTPs) in the U.S. that employ AD have not traditionally utilized biogas as an energy source, preferring in most cases to flare the gas to eliminate potential dangers. During periods when the nation faced energy shortages, such as World War II and the 1970s, interest in biogas as an energy source grew. In the 1970s, approximately 140 anaerobic digesters became operational in the U.S., primarily on farms to process agricultural waste. However, there was a lack of government oversight and many facilities were too small to offset the need for other energy sources. In addition, many farmers found the facilities difficult to maintain and lacked the technical expertise to operate them properly, and when the energy crisis abated in the 1980s, most of these facilities fell out of use.

In the middle of last century small-scale community based AD grew extensively throughout parts of Asia, particularly in India, China, and Southeast Asia, because of the difficulties and health risks associated with landfilling. Similarly, interest in AD surged again in Europe and the U.S. in the 1990s, primarily because landfills were reaching capacity and the emergence of environmental problems associated with them. In 1999, the EC Landfill Directive (Council Directive 99/31/EC) required that the organic portion of all municipal solid waste be reduced by 25% by 2006, and as a result Europe has seen a proliferation of AD facilities, both stand-alone and in conjunction with WWTPs.

With the growing interest in renewable energy has come a shared desire to explore AD as both a means to offset the energy requirements at WWTPs and to provide a viable outlet

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16 Ibid, 85-86.

17 Ibid, 80.

for SSO that might otherwise be incinerated or composted.\textsuperscript{19} There is considerable potential to combine wastewater and SSO, in a process known as co-digestion, to improve the efficiency of the AD process and achieve many parallel goals.\textsuperscript{20} These goals include reducing our reliance on fossil fuels, reducing greenhouse gas (GHG) emissions, diverting organic material from the waste stream, reducing the cost of wastewater treatment, and producing a renewable source of high quality fertilizers for agricultural use.

\begin{flushright}
\textsuperscript{19} Alan Slater (Massachusetts Department of Environmental Protection, Anaerobic Digestion & Organics Division), in discussion with the author, August 15, 2014.
\end{flushright}
Discussion

The main findings of this study are summarized and discussed below.

Facility considerations

1. AD and associated technologies may have the ability to alleviate some of the environmental issues at Upper Blackstone and provide benefits exceeding the need to come under compliance with the 2008 EPA permit.
2. It is unlikely that the co-digestion of source separated organics with municipal wastewater at Upper Blackstone would be supported solely by tipping fees, energy savings, and disposal offsets; successful AD/WWTP co-digestion projects tend to address issues endemic to the treatment of human waste water
3. There is a shortage of expertise for the operation and maintenance of new AD facilities; public/private partnerships are typical and often necessary

Regulatory environment

1. There is currently a favorable regulatory and economic climate incentivizing the development of AD/CHP facilities
2. Considerably more SSO is expected to enter the market over the next decade as new regulations further limit the landfilling of organic materials and new collection and pre-processing methods are established

Market considerations

1. Due to the dynamic nature of the existing market for SSO in the generator/collection/processing chain, future methods and preferences are difficult to determine
2. Tipping fees for clean, consistent, and liquefied SSO are likely to trend downward
3. Existing and imminent supplies of SSO surpass existing regional outlets and processing capacity
4. The development of a pre-processing infrastructure will likely be supported through waste generator disposal fees
5. Stand alone AD facilities may have a market advantage due to favorable economic incentives and a lack of process constraints associated with WWTPs
6. The MWRA’s Deer Island facility will likely have a major influence on regional supplies of SSO and influence regional disposal costs

Social and environmental concerns

1. Regionally, AD is a rapidly growing industry and a successful co-digestion project at Upper Blackstone will require cross-sector collaboration and active participation in shaping the market
2. The siting, construction, and operation of waste facilities are a cause for concern for abutters, nearby communities, and other potentially impacted areas; early and
effective reciprocal communication with these parties is essential for creating dialogue and reducing tensions
3. Developing AD capacity at Upper Blackstone could result in significant reductions of greenhouse gas emissions, energy consumption, and the volume of municipal solid waste
4. The perennial need to enhance the treatment and disposal of human waste is the primary factor driving co-digestion at WWTPs; the energy potential from AD associated with SSO compliments this fundamental objective

Anaerobic digestion is a rapidly growing technology paralleling stricter landfill regulations and a renewed interest in renewable energy. Food waste diversion has also been a growing concern, both domestically and abroad. Food waste is a large component of municipal solid waste. It could be diverted to people in need or used as animal feed, and it represents the squandering of valuable resources required for food production. In Massachusetts, anaerobic digestion has traditionally been used in conjunction with wastewater treatment and the stabilization of biosolids, but renewed interest in renewable energy has spurred projects seeking to capture and utilize biogas from landfills, WWTPs, farms, and stand-alone facilities. Organics diversion programs have been around since the early 1990s, and have focused on home composting and building diversion infrastructure in cooperation with large generators and waste haulers.\(^{21}\) Supplies of SSO have grown in a cyclical manner with the available capacity to process it.

This study indicates that implementation of AD at Upper Blackstone will likely not be supported solely by technical and economic considerations associated with the diversion and co-digestion of SSO with municipal wastewater.\(^{22}\) What appears to be driving the use of co-digestion at WWTPs is a perennial need to improve the treatment and disposal of human waste, not the potential economic benefits of AD. As urban populations continue to grow and the human impact on the planet is better understood, environmental and health considerations associated with human waste have become paramount, and any methods that can improve its processing and create viable ways to divert and recycle wastes will continue to grow more attractive. The cost savings associated with biogas production for facility heat and process applications, and the marketing of digestate byproducts have the potential to offset some of the capital costs of an AD facility. However, this investigation revealed an uncertain regional market for clean, liquefied SSO\(^{23}\) as competition to capture this material continues to grow.\(^{24}\) The value of SSO will likely continue to rise with these trends, and the phasing in of regulations targeted at smaller generators may result in new and improved methods to limit or eliminate

\(^{21}\) Pontani, August 14, 2014.
\(^{22}\) See specifically the Massachusetts Clean Energy Center’s sponsored reports for the town of Ayer and Millbury.
\(^{23}\) Co-digestion of SSO with wastewater (and other “wet” digester facilities) requires that the organic material be free of contamination and in a liquefied form that can be easily pumped.
\(^{24}\) Tony Barbagallo, Casella Organics, Director of Business Development, In Communication with the Author, August 21, 2014
contamination of SSO, cheaper and more efficient collecting, hauling and pre-processing methods, and an increase in route densities for the collectors and haulers of this material.\textsuperscript{25, 26} It is anticipated that SSO generators will bear the majority of the cost burden associated with these developments, and that tipping fees for SSO will continue to decline as more processing facilities come online.\textsuperscript{27}

These considerations support previous studies that discuss the difficulties in evaluating the true costs associated with the development of AD in U.S. markets, especially in conjunction with existing technology.\textsuperscript{28} It also indicates that an economic feasibility study of AD at Upper Blackstone should not be reliant on revenue models based primarily on tipping fees, but should widen the scope to consider a variety of cost saving scenarios, funding sources, and ownership and operation models.

There is, however, a trend in public policy\textsuperscript{29} and the waste industry\textsuperscript{30} favoring the development of AD, primarily for economic and environmental reasons. AD facilities can be cheaper to operate than composting alternatives, and produce valuable benefits in the form of renewable biogas, the reduction in greenhouse gas emissions, and the production of valuable byproducts for agricultural purposes. A primary issue is what processing methods will emerge given existing supplies of SSO and variation in its quality and composition.\textsuperscript{31, 32} Three variations of AD technology are currently being used: small-scale co-digesters, typically located on farms; stand-alone digesters that can handle a variety of organic wastes; and digesters associated with wastewater treatment plants (WWTP), which typically treat sewage sludge in the absence of food waste.\textsuperscript{33} WWTPs in Central Mass. have been evaluating the addition of AD facilities to compliment existing WW treatment processes, or the modification of existing AD facilities to accept food waste. In both cases, significant capital costs are associated with the co-digestion of food waste with WW, requiring increased public debt, and relatively high tipping and/or user fees.\textsuperscript{34} Furthermore, evidence from Europe and elsewhere suggests that stand-alone AD facilities may be more nimble in meeting market demands for several reasons.\textsuperscript{35} These factors include an ability to scale operations to meet regional supplies or organic material, the ability to adopt or modify processing methods to meet the nature of available

\textsuperscript{25} Barbagallo, August 21, 2014.
\textsuperscript{26} Ibid.
\textsuperscript{27} Ibid.
\textsuperscript{29} Ibid.
\textsuperscript{30} Ibid.
\textsuperscript{31} Ibid.
\textsuperscript{32} Irene Congdon, Massachusetts Department of Environmental Protection, Municipal Assistance Coordinator, Central District, In Conversation with the Author, August 14, 2014.
\textsuperscript{34} These case studies are available through the Massachusetts Clean Energy Center's organics-to-energy program. http://www.masscec.com/content/completed-organics-energy-studies
feedstocks, and the potential ease in siting facilities in close proximity to waste generators, transfer facilities, or existing outlets, such as landfills. In addition, there is little controversy surrounding the potential composition and toxicity of digestate byproducts from AD facilities that do not process human waste, whereas significant controversy surrounds the marketing and agricultural use of fertilizers derived from human biosolids.

WWTPs with existing AD facilities will likely have an advantage over others when it comes to capturing significant SSO market share. However, proximity to SSO waste generators is critical to reduce transportation costs, and high tipping fees could deter suppliers from using these facilities. Also, there continues to be a “knowledge gap” between the dwindling expertise required to operate existing AD facilities and the growing expertise developing around new technology for the co-digestion of WW with SSO. Partly for these reasons, most experts I spoke with believe there will continue to be a lot of experimentation in the market and that it will be years before we see clear preferences in the generation/collection/processing system. Several large-scale SSO generators are developing their own collection systems and AD facilities, while several other private entities are exploring the development of stand-alone facilities that can handle a variety of organic wastes. It is likely that many of the large generators of SSO, such as supermarkets, institutions and food manufacturers, have been influenced by a variety of factors in pursuing SSO diversion programs. These include direct cost savings due to reductions in waste and waste removal services, government programs and incentives, the potential to offset energy needs, the need to comply with the new waste ban, and the desire to be a responsible environmental steward. Given the current level of experimentation and innovation in all sectors of the SSO market, and the clear incentives for large-scale producers of SSO to internalize the collection and processing of this material, it is difficult to gauge its true availability, even if generation estimates are accurate. Furthermore, it is precisely this high-quality (uniform, consistent, and often liquefied) material that has been driving the market thus far. According to one expert, the market for liquefied SSO is mature, but haulers and processors are at or nearing capacity. This has opened up the need for more pre-processing of SSO to convert it into a clean, liquefied product.

Given the significant risks associated with the large-scale co-digestion of SSO in conjunction with publically owned treatment works (POTWs), there is reason to believe that the primary driver for new AD will be to address more pressing issues directly related to the treatment of wastewater and the production, stabilization, and disposal of biosolids. Determining the feasibility of AD will therefore be tied to current methods of processing. Some factors will include the age and expense of maintaining existing equipment; assessing whether AD can be inserted into existing processes or whether

36 Barbagallo, August 21, 2014.
37 Sumner Martinson (Massachusetts Department of Environmental Protection, Director, Composting Program), in communication with the author, August 21, 2014.
38 See Appendix A for a list of generators and haulers that are pursuing or utilizing AD in Massachusetts.
39 Pontani, August 21, 2014.
40 Barbagallo, August 21, 2014.
41 Ibid.
those processes will need to be decommissioned; and meeting more restrictive water, air and landfill regulations. The production and marketing of biosolids itself can be a viable and sustainable strategy for complying with environmental regulations while offsetting the production of chemical fertilizers and generating additional revenue. Regional examples typically involve public/private partnerships, and include the New England Fertilizer Company (NEFCO) facilities in conjunction with the Massachusetts Water Resource Authority (MWRA) plant on Deer Island and the Greater Lawrence Sanitary District (GLSD).\textsuperscript{42}

If it is determined that the existing equipment at the Upper Blackstone facility is inadequate for complying with existing regulations or meeting the needs of the region, then there may be a compelling reason to pursue AD regardless of independent assessments concerning the availability of SSO. That is, the addition of SSO may help with offsetting the expense and increase the viability of a necessary new or upgraded facility. Industry experts and government officials interviewed for this study all acknowledged the advantageous location of the Upper Blackstone facility for a regional AD processing center. It is close to a major population center and many of the region’s largest food waste generators, lies at the heart of five major transportation links (including rail facilities), and lies out of range of other major POTW with AD capabilities.

However, the advantages of location alone are not enough to ensure an ability to attract suppliers of SSO. Existing and potential outlets for SSO will have a significant impact on Upper Blackstone’s capture of market share. The MWRA food waste pilot project at Deer Island will inevitably have an impact on regional supplies of SSO, especially if the project is to go to scale.\textsuperscript{43} In addition, there are other facilities in the region that are currently accepting SSO, and more are proposed. The WeCare facility in Marlborough is currently the largest outlet for organic municipal solid waste in the state, but there have been ongoing issues with this facility. WeCare leases land from the town and the future of the contract and fate of that facility remains uncertain.\textsuperscript{44} In addition, several AD projects are being proposed for the central and eastern region of the state, including a project in Millbury.\textsuperscript{45} If these projects go online they could have a major impact on the immediate and future supplies of SSO in the region.

**Primary Considerations**

Outside of technical and economic feasibility, three considerations of central importance emerged if the Upper Blackstone facility decides to move forward with plans to introduce AD. The first is public perception and community engagement. The second is the role of partnerships and the importance of forming close relationships with stakeholders who are

\textsuperscript{42} For more information see NEFCO’s website at http://www.necobiosolids.com/view-our-projects/  
\textsuperscript{43} Barbagallo, August 21, 2014.  
actively developing the collection and diversion infrastructure for SSO. The third is the need to take a pro-active and long-term position on the regional development of AD and organics processing.

In the opinion of one expert, all projects involving the transportation of waste and the siting of waste facilities are inevitably “NIMBY” issues in one way or another. Proactive community and stakeholder engagement is essential for identifying and assessing community concerns and for establishing trust and open channels of communication early in order to address real and substantive issues - including legitimate public perception concerns of health, safety, and quality of life issues. Developing and presenting a plan with the absence of community and stakeholder input is likely to lead to resentment, mistrust, and anger among communities and actors who could otherwise be among the greatest assets for identifying important issues, promoting the project and working through problem that require a broad base of public, private, and political support and coordination. It is vital that this component of project planning takes a central role in the process and receives an adequate level of funding for communication, public meetings, administration and oversight.

Partnerships also emerged as a critical component to the success of any long-term organics processing project. Securing adequate supplies of SSO is essential for realizing the financial benefits of introducing food waste into the treatment of wastewater and biosolids, and these supplies will largely be governed by the existing and future trends in the private sector. The development of AD in the U.S. is being supported in large part through public/private partnerships, both on the processing side, with much of the expertise in the area of food waste co-digestion coming from European ventures, and on the collection, hauling, and pre-processing side, with enormous movement in local approaches and experimentation with new and innovative technologies being developed in various other national markets. Securing a long-term supply of clean, consistent SSO and developing markets for digestate byproducts, therefore, will be a matter of taking an active role in market creation. If a unilateral approach is adopted, there is no guarantee that the market will respond favorably to a new outlet. Private sector entities need to see the shared value in committing to their development and actively work to move the market in that direction.

The above discussion touches on the third point, the need to take a pro-active and long-term position in the development of regional AD processing. This is similar to the position that regional WW treatment plants already have in the management and treatment of water resources and human waste, but must necessarily be extended to encompass a broader set of goals in the management of commercial and municipal solid waste. Much like the MWRA, a project of this magnitude would likely be a primary driver for the future of food waste in New England. The state’s goal of diverting a third

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46 Mark Lennon, Principal, Institutional Recycling Network, in conversation with the author, August 14, 2014.
48 Barbagallo, August 21, 2014.
49 Pontani, August 21, 2014.
50 Barbagallo, Pontani, August 21, 2014.
of all organic solid waste from landfills by 2020\textsuperscript{51} will likely be achieved in large part through the development of large-scale regional outlets, and state officials have envisioned three primary outlets for this waste in each of the Commonwealth’s three major market areas, eastern central and western.\textsuperscript{52} This investigation has revealed considerable uncertainty for the future of organic solid waste processing methods, but an equal certainty that the growing diversion of these wastes are necessary and inevitable, and that the maturation of this market will likely come at considerable risk to those stakeholders seeking to capture long-term supplies of SSO on the regional level. Projects of this size may require taking an active role in shaping and influencing market trends rather than choosing among the best options that eventually come to dominate the industry.

\textsuperscript{51} Massachusetts 2010-2020 Solid Waste Master Plan: Pathway to Zero Waste, April 2013.
\textsuperscript{52} Slater, August 15, 2014.
Recommendations

This study revealed several factors that could make implementation of AD at Upper Blackstone problematic. These include high capital costs, financial pressures due to recent and imminent investments at Upper Blackstone, a highly competitive market for clean and consistent SSO feedstock, and a downward trend in tipping fees for SSO. However, it also revealed many opportunities, some of them inherent to the existing regulatory climate and favorable regional conditions for AD, such as financial incentives, and others peculiar to Upper Blackstone and a growing local market for SSO. With this limited information it is not possible to determine whether AD is feasible at Upper Blackstone.

It is therefore recommended that a full feasibility study be performed to assess the potential for AD at Upper Blackstone. Such a study will require careful consideration of internal and external factors, including site, economic, and technical considerations at the facility, and analyses of market conditions, the regulatory environment, and relevant stakeholders. In addition, it is anticipated that any effort to pursue AD at Upper Blackstone will require significant staff time and resources to bring stakeholders together in order to build consensus around complex issues. This study revealed that some form of public/private partnership would likely be inevitable considering the disposition of the state toward private sector solutions, the cross-sector nature of the waste industry, the prevalence of private firms as large-scale waste generators, haulers and processors, the involvement of utility interests, and the expertise required to build, operate and maintain modern AD facilities. It is therefore recommended that careful consideration be paid to the myriad ways in which city, district, and state authorities could collaborate with private sector interests to improve conditions at Upper Blackstone and the waste generation/collection/processing infrastructure.

Appendix B is a suggested outline for a full scope of work that, in conjunction with the questions listed below, would provide a comprehensive analysis of AD at Upper Blackstone. Many of these topics could, and likely should, be combined into a single study, but some could be addressed separately as necessary.

Scope of Work

In assessing the potential for the co-digestion of food waste with wastewater at Upper Blackstone, the City of Worcester requires a perspective that allows for the assessment of the different components of this project independent of how the issues of wastewater treatment, the removal of food waste from the municipal waste stream, and the pursuit of renewable energy intersect.

A feasibility study that looks solely at the potential for co-digestion of SSO with WW at Upper Blackstone will be primarily concerned with the internal needs and specific pressures influencing operations at Upper Blackstone. Other issues that intersect this primary concern could be addressed as independent issues worthy of study and planning in their own right. In particular, the issue of food waste diversion, reuse and recycling is
necessarily a component of a municipal solid waste master plan, and should be integrated with broader planning efforts at the regional and state levels. Similarly, the issue of SSO as a renewable energy source may be seen as a component of a larger effort to reduce Worcester’s reliance on fossil fuels and pursue strategies to reduce energy consumption and meet predetermined goals for the reduction of greenhouse gas emissions.\textsuperscript{53}

For instance, the issue of residential food waste collection involves an assessment of options for the collection and transportation of this material, and one such suggested option has been to remove this material through source-point collection (in-sink garbage disposals) and introduce it directly into the city’s sewer system. Quite apart from issues of Upper Blackstone’s ability to handle the change in composition and volume of wastewater associated with this method is the more fundamental issue of whether residential plumbing and municipal infrastructure could handle the widespread introduction of this material. There are also associated issues with the cost, deployment, ownership, and maintenance of in-sink garbage disposals. Therefore, this becomes an issue that must be addressed through consultation and coordination with the Department of Public Works, as well as dealing with Upper Blackstone’s ability to accept and process mixed organic materials through existing infrastructure. As a note, much available information suggests that this is not a viable method due to the inability of residential and municipal plumbing to handle high volumes of suspended solids along with insoluble materials such as fats, oils, and grease (FOG), potentially causing major maintenance issues. However, recent research suggests that some of these fears may be unfounded.\textsuperscript{54}

**Primary Questions and Concerns**

The following list is of questions should be addressed in a full feasibility study, and are intended to serve as a guide to that process. A typical report layout is included in appendix B.

1. **Site Conditions.**
   - Would the management at Upper Blackstone, state authorities, and EPA allow for the introduction of AD without first coming under compliance with the 2008 federal permit?
   - Could AD and associated technologies (including pelletization of stabilized waste for fertilizer) bring the facility into compliance with the 2008 federal permit?
   - Will the introduction of AD at Upper Blackstone help alleviate other existing pressures or achieve existing goals for the facility? If so, what are the cost savings or offsets?


• What are the physical requirements of AD and associated technologies\(^{55}\) at Upper Blackstone?
• What would be the likely change in user fees compared with existing projections?
• What is the timeline; how long before an AD facility could come online?

• What is the optimal quantity of SSO feedstock required to co-digest with existing and projected quantities of sewage at Upper Blackstone? How would this affect effluent quality and residual biosolids?
• What is the existing and projected supply of SSO in the immediate region\(^{56}\)? Could this support AD at Upper Blackstone?
• Who is currently supplying or proposing to supply processing capacity for SSO in the region? How will this affect the overall regional supply of SSO?\(^{57}\)
• What are untapped sources of SSO or OMSW that could support AD at Upper Blackstone?\(^{58}\) How quickly could these sources come online?
• Who are potential partners in the collection, hauling and processing industry necessary for ensuring a long-term supply of SSO?

3. Community Concerns and Public Perception
• How would AD affect the communities around Upper Blackstone and adjacent to the Blackstone River?\(^{59}\)
• How does the city and district anticipate engaging and communicating with the public and potentially impacted communities? Who will be responsible for this and how will it be funded?
• What is the public perception of potential AD byproducts, such as pelletized biosolids? Does this affect the marketability and demand of these products?

4. Ownership Structure
• What are the potential ownership structures for an AD facility at Upper Blackstone?
• What are the cost implications for each scenario?
• Who is responsible for capital expenses and what is the affect on public debt and user fees?

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\(^{55}\) Essential associated technologies, such as pre-processing, may not be possible or desirable at the facility itself due to considerations involving the site itself, solid waste disposal regulations, and growth of a pre-processing infrastructure in the private market.

\(^{56}\) It is conventional wisdom that the distance haulers are willing to transport waste is tied to tipping fees; the less the fee the longer the distance. Therefore, tipping fees also define the catchment area for SSO, which is currently considered to be within a 20-30 mile radius of a processing facility. As tipping fees decline, it is possible that the distance haulers will be willing to travel will increase, and potential catchment areas will expand.

\(^{57}\) See Appendix A for a selected list of existing and proposed AD projects in the region.

\(^{58}\) These sources could include commercial organic waste that will enter the market as state landfill regulations become more stringent, and source-separated residential organic waste in conjunction with curbside pickup programs.

\(^{59}\) There will be potential negative impacts, such as odor and increased truck traffic to the facility, as well as potential positive impacts to the environment.
5. Costs and Revenues

- What are the costs associated with AD at Upper Blackstone?\(^{60}\)
  - Predevelopment costs
    - Siting and permitting
    - Land acquisition
    - Environmental impact assessment
    - Engineering planning and design
    - Hydrogeological investigation
  - Construction costs
    - Infrastructure (access roads, piping, utility connections)
    - Cleaning and excavation
    - Buildings and construction
    - Equipment (tanks, machinery, electronics)
    - Labor
  - Operating costs
    - Maintenance fees
    - Labor
    - Materials
    - Water and energy
    - Supervision and training
    - Insurance
    - Overheads
    - Wastewater disposal
    - Solid residuals disposal
    - Regulatory fees
    - Outsourced services
- What are the costs, if any, associated with developing new collection and pre-processing infrastructure?
  - Planning/consulting costs
  - Public outreach and education
  - Capital costs (collection equipment and distribution)
  - Labor
  - Supervision and training
  - Outsourced services
- What are the revenues associated with AD at Upper Blackstone?\(^{61}\)
  - Energy (gas, heat, electricity)
  - Tipping fees (landfill disposal offset)
  - Secondary products (compost, water, liquid fertilizer, feedstock for further downstream processes)
  - Carbon offset credits
  - Government incentives (renewable energy tax credits, price supports)
  - Technology displacement (offsets from replacing or eliminating current operational methods)

\(^{60}\) Adapted from Rappaport, et al. 2007.

\(^{61}\) Ibid.
### Appendix A

**Selected Information on Waste Processors and Water Treatment Plants**

#### Select Private Sector Food Waste Processors in Southern and Central New England

<table>
<thead>
<tr>
<th>Facility</th>
<th>Organization</th>
<th>Industry / Sector</th>
<th>Type of Facility</th>
<th>Status</th>
<th>Location</th>
<th>Website</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Barstow's Longview Farm</strong></td>
<td>Agreen Energy (w/Casella Organics)</td>
<td>Agriculture/ Commercial Waste</td>
<td>AD/CHP Co-digester</td>
<td>Active</td>
<td>Hadley, Boston, MA</td>
<td><a href="http://www.agreenenergyllc.com/">http://www.agreenenergyllc.com/</a></td>
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<tr>
<td><strong>Barway Farm</strong></td>
<td>Agreen Energy</td>
<td>Agriculture/ Commercial Waste</td>
<td>AD/CHP Co-digester</td>
<td>Active</td>
<td>South Deerfield, -</td>
<td><a href="http://www.agreenenergyllc.com/">http://www.agreenenergyllc.com/</a></td>
</tr>
<tr>
<td><strong>Hager Brothers Farm</strong></td>
<td>Agreen Energy</td>
<td>Agriculture/ Commercial Waste</td>
<td>AD/CHP Co-digester</td>
<td>Active</td>
<td>Colrain, -</td>
<td><a href="http://www.agreenenergyllc.com/">http://www.agreenenergyllc.com/</a></td>
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<tr>
<td><strong>Jordan Farm</strong></td>
<td>Agreen Energy (w/Casella Organics)</td>
<td>Agriculture/ Commercial Waste</td>
<td>AD/CHP Co-digester</td>
<td>Active</td>
<td>Rutland, Portland, ME</td>
<td><a href="http://casellaorganics.com/">http://casellaorganics.com/</a></td>
</tr>
<tr>
<td><strong>Marlborough Facility</strong></td>
<td>WeCare Organics</td>
<td>Agriculture/ Commercial/ Municipal Waste</td>
<td>Transfer Station/Biosolids Co-Composting/ Soil Production/ Distribution</td>
<td>Active</td>
<td>Marlboro, Jordon, NY</td>
<td><a href="http://www.wecareorganics.com/">http://www.wecareorganics.com/</a></td>
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<tr>
<td><strong>Fall River AD Facility</strong></td>
<td>Himark Biogas (w/ NEO Energy)</td>
<td>Commercial Waste</td>
<td>AD/CHP? High-Solids Digester</td>
<td>Proposed</td>
<td>Fall River, Edmonton, Alberta, Canada</td>
<td><a href="http://himarkbiogas.com/">http://himarkbiogas.com/</a></td>
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<tr>
<td><strong>Harvest New England (various)</strong></td>
<td>Harvest Power/Waste Management</td>
<td>Agriculture/ Commercial/ Municipal Waste</td>
<td>Mulching/Composting</td>
<td>Active</td>
<td>Ellingtonton, CT, Waltham, MA/Houston, TX</td>
<td><a href="http://harvestpow.com/ne/">http://harvestpow.com/ne/</a></td>
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<tr>
<td><strong>Pine Island Farm</strong></td>
<td>On site</td>
<td>Agriculture/ Commercial Waste</td>
<td>AD/CHP Co-digester</td>
<td>Active</td>
<td>Sheffield, -</td>
<td><a href="http://www.mass.gov/eea/agencies/massdep/climate-energy/energy/program/agricultural-uses-for-anaerobic-digestion.html#PineIslandFarmSheffieldMA">http://www.mass.gov/eea/agencies/massdep/climate-energy/energy/program/agricultural-uses-for-anaerobic-digestion.html#PineIslandFarmSheffieldMA</a></td>
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<tr>
<td><strong>Crapo Hill Landfill</strong></td>
<td>Greater New Bedford Regional Refuse</td>
<td>Municipal Landfill</td>
<td>Landfill/CHP</td>
<td>Active</td>
<td>Dartmouth, -</td>
<td><a href="http://www.gnbrmdistrict.org/crapo-hill-landfill">http://www.gnbrmdistrict.org/crapo-hill-landfill</a></td>
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James McKeag | 23 | January, 2015
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<tr>
<td>Kraft Foods/Atlantic Gelatin</td>
<td>On Site</td>
<td>Industrial Waste</td>
<td>AD/CHP</td>
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<td>Peabody</td>
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# Publically-Owned Wastewater Treatment Works with Associated Anaerobic Digestion in Massachusetts

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<tr>
<th>POTWs</th>
<th>Acronym</th>
<th>Industry/Sector</th>
<th>Type of Facility</th>
<th>Status</th>
<th>mgd avg/peak</th>
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<tr>
<td>Massachusetts Water Resource Authority (associated NEFCO plant in Quincy)</td>
<td>MWRA</td>
<td>Municipal Wastewater</td>
<td>AD/CHP</td>
<td>Active</td>
<td>365</td>
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<tr>
<td>Greater Lawrence Sanitary District (associated NEFCO plant in North Andover)</td>
<td>GLSD</td>
<td>Municipal Wastewater</td>
<td>AD/CHP</td>
<td>Active</td>
<td>30</td>
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<tr>
<td>Pittsfield</td>
<td></td>
<td>Municipal Wastewater</td>
<td>AD/CHP</td>
<td>Active</td>
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<td>Clinton</td>
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<td>Municipal Wastewater</td>
<td>AD</td>
<td>Active</td>
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<td>Fairhaven</td>
<td></td>
<td>Municipal Wastewater</td>
<td>AD/CHP</td>
<td>Active</td>
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<tr>
<td>Rockland</td>
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<td>Municipal Wastewater</td>
<td>AD</td>
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# Potential Partners Specializing in Selected Service Areas

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<tr>
<th>Company</th>
<th>Specialty</th>
<th>Location</th>
<th>Website</th>
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<tbody>
<tr>
<td>Applied Water Management (Division of Natural Systems Utilities)</td>
<td>Municipal Retrofits</td>
<td>Hillsborough, NJ</td>
<td><a href="http://www.naturalsystemsutilities.com/">http://www.naturalsystemsutilities.com/</a></td>
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<tr>
<td>Anaergia</td>
<td>Waste-to-Energy Systems</td>
<td>Burlington, ON, Canada</td>
<td><a href="http://www.anaergia.com/">http://www.anaergia.com/</a></td>
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<tr>
<td>NEO Energy</td>
<td>Organics-to-Energy Developer</td>
<td>Portsmouth, NH</td>
<td><a href="http://www.neoenergyusa.com/">http://www.neoenergyusa.com/</a></td>
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<tr>
<td>Ameresco</td>
<td>Biogas/Grid connectivity</td>
<td>Framingham, MA</td>
<td><a href="http://www.ameresco.com/">http://www.ameresco.com/</a></td>
</tr>
<tr>
<td>Alcor Energy Solutions</td>
<td>Gas Turbine Generators</td>
<td>Mesa, AZ</td>
<td><a href="http://www.alcorenergysolutions.com/">http://www.alcorenergysolutions.com/</a></td>
</tr>
</tbody>
</table>
Appendix B

Suggested Report Layout for Feasibility Study

Executive Summary

1.0 Introduction: Project Objectives and Existing Conditions
2.0 Feedstock Alternatives
3.0 Technology Review and Alternatives Development
4.0 Economic Analysis
5.0 Implementation Considerations
6.0 Summary of Findings

1.0 Introduction: Project Objectives and Existing Conditions

1.1 Project Objectives
   1.1.1 Project Description
   1.1.2 Feasibility Study Overview
   1.1.3 Goals
   1.1.4 Green Community Initiatives
   1.1.5 Massachusetts Clean Energy Center (MassCEC) Grant (If Applicable)

1.2 Existing Site Conditions
   1.2.1 Site Location & History
      1.2.1.1 Land Use and Abutters
   1.2.2 Environmental and Cultural Resources
      1.2.2.1 Historic and/or Cultural Resources
      1.2.2.2 Rare Species
      1.2.2.3 Wetlands
      1.2.2.4 Protected Open Space/ Drinking Water Resources
   1.2.3 Environmental Risks
      1.2.3.1 Potential Environmental Impact
      1.2.3.2 Potential Environmental Hazards
   1.2.4 Environmental Justice Population

1.3 Wastewater Treatment Facility Operations
   1.3.1 Wastewater Treatment Biosolids Production
   1.3.2 Wastewater Treatment Energy Usage
      1.3.2.1 Existing Electrical/Heating Infrastructure
      1.3.2.2 Facility Energy Profile
      1.3.2.3 Electrical Interconnection
      1.3.2.4 Thermal Interconnection

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62 Based on reports funded by the Mass CEC and the recommendations of the author
2.0 Feedstock Alternatives

2.1 MassDEP Proposed Ban on Organics Disposal
2.2 Current Organics Diversion Efforts
2.3 Organics Digestion Experience and Initiatives
   2.3.1 Experience
   2.3.2 Initiatives
   2.3.3 Ongoing Organics Characterization and Digestion Studies
2.4 Types and Characteristics of Organic Wastes
2.5 Feedstock Availability
   2.5.1 WWTF Sludge
   2.5.2 Food Waste
      2.5.2.1 Food Waste Analysis Methodology
      2.5.2.2 Potentially Available Food Waste
         2.5.2.2.1 State-Wide Sources
         2.5.2.2.2 Regional and Local Sources
         2.5.2.2.3 Fats, Oils and Grease (FOG)
      2.5.2.3 Feedstock Characteristics by Sector
      2.5.2.4 Generator Outreach
      2.5.2.5 Competing Facilities
   2.5.3 Summary of Feedstock Characterization
   2.5.4 Transportation Issues
   2.5.5 Potential Revenue and Costs Related to Feedstock

3.0 Technology Review and Alternatives Development

3.1 Digestion Process and Technology Overview
   3.1.1 Overview of Digestion Science and Process
   3.1.2 Review of Anaerobic Digestion Systems
3.2 Conceptual Facility Sizing
3.3 Organics Receiving and Pre-Processing Alternatives
   3.3.1 Off-site pre-processing
      3.3.1.2 Benefits and Drawbacks to Off-Site Pre-Processing
      3.3.1.2 Processing Standards and Infrastructure
   3.3.2 On-Site Pre-Processing
      3.3.2.1 Benefits and Drawbacks to On-Site Pre-Processing
      3.3.2.2 Pre-Processing System Sizing
      3.3.2.3 Pre-Processing Equipment
      3.3.2.4 Pre-Digestion Storage and Feed
      3.3.2.5 Pre-Processing Odor Control
3.4 Anaerobic Digestion
   3.4.1 Digester Tank Sizing
3.4.2 Biogas Production Estimate

3.5 Ancillary Equipment
   3.5.1 Digester Heating
   3.5.2 Digester Mixing
   3.5.3 Digester Covers
   3.5.4 Gas Handling Equipment
   3.5.5 Biogas Storage Systems
   3.5.6 Biogas Treatment and Boosting Systems

3.6 Energy Recovery
   3.6.1 Cogeneration System
   3.6.2 CHP Technology Alternatives
   3.6.2 Projected Energy Balance

3.7 Energy Outputs
   3.7.1 Biogas Output
   3.7.2 Electricity Production
   3.7.3 Thermal Energy Production
   3.7.4 Digestate Production

3.8 Solid and Liquid Products and Byproducts
   3.8.1 Digestate Storage
   3.8.2 Dewatering Technology Selection and Sizing
   3.8.3 Side Stream Treatment Considerations

3.9 Alternatives Evaluations
   3.9.1 Conceptual Site Plans
   3.9.2 Integration with Existing Facilities
   3.9.3 Summary of Process and Infrastructure Needs
   3.9.4 System Recommendations

4.0 Economic Analysis

4.1 Preliminary Financial Pro Forma
4.2 Potential Costs
   4.2.1 Capital Costs
   4.2.2 Operation and Maintenance Costs
4.3 Potential Revenues
   4.3.1 Operation and Maintenance Credits (cost offsets)
   4.3.2 Analysis of Tipping Fees
   4.3.3 Potential Grants and Loans
   4.3.4 Sale of Power and Byproducts
4.4 Other Pro Forma Assumptions
4.5 Pro Forma Summary Results
4.6 Pro Forma Conclusions
4.7 Summary of Financial Analysis
5.0 Implementation Considerations

5.1 Ownership Options
   5.1.1 Public Implementation
   5.1.2 Private Implementation
   5.1.3 Public Private Partnership/Co-Development
   5.1.4 Preliminary Comparison of Options

5.2 Industry Partnerships
   5.2.1 Partnerships with Waste Haulers and Processors
   5.2.2 Partnerships with Large Waste Generators
   5.2.3 Partnerships with Municipalities
   5.2.4 Potential Competition and Conflicts

5.3 Regulations and Permitting
   5.3.1 Regulatory Trends
   5.3.2 State and Local Permits Required
      5.3.2.1 Air Quality Permitting
      5.3.2.2 Anaerobic Digestion Permitting
      5.3.2.3 Wastewater Discharge Permitting
      5.3.2.4 Wastewater Treatment Facility Permitting
      5.3.2.5 Solid Digestate Disposal/Reuse
      5.3.2.6 Electrical Interconnection Requirements
   5.3.3 Zoning
   5.3.4 Constraints Map

6.0 Community Relations

6.1 Potential Community Impacts (Negative and Positive)
   6.1.1 Trucking Volumes and Traffic Generation
   6.1.2 Noise
   6.1.3 Odor
   6.1.4 Potential user fee offsets
   6.1.5 Reduction of airborne particulates
   6.1.6 Reduction of nutrients in area waterways
   6.1.7 Job Opportunities

6.2 Community Engagement Plan
   6.2.1 Stakeholder Analysis
   6.2.2 Community Outreach
   6.2.3 Public Participation

7.0 Summary and Recommendations
   7.1 Summary of Findings
   7.2 Conclusions & Recommendations
### Appendix C

**Selected Incentives for Anaerobic Digestion and Program Status**

<table>
<thead>
<tr>
<th>Incentive Program</th>
<th>Program Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commonwealth Organics-to-Energy Program</td>
<td>Active</td>
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<tr>
<td>Green Power Purchasing Commitment</td>
<td>Active</td>
</tr>
<tr>
<td>MTC - Clean Energy Pre-Development Financing Initiative (Loans) (Massachusetts)</td>
<td>Not Active</td>
</tr>
<tr>
<td>MTC - Large Onsite Renewables Initiative (LORI) Grants (Massachusetts)</td>
<td>Not Active</td>
</tr>
<tr>
<td>MassCEC - Sustainable Energy Economic Development (SEED) Initiative (Massachusetts)</td>
<td>Not Active</td>
</tr>
<tr>
<td>Net Metering (Massachusetts)</td>
<td>Active</td>
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<tr>
<td>Qualified Energy Conservation Bonds (QECBs) (Federal)</td>
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<tr>
<td>Renewable Electricity Production Tax Credit (PTC) (Federal)</td>
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<td>Renewable Energy Trust Fund (Massachusetts)</td>
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<tr>
<td>Renewable Portfolio Standard (Massachusetts)</td>
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<tr>
<td>Interconnection Standards for Small Generators (Federal)</td>
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<td>Renewable Energy Production Incentive (REPI) (Federal)</td>
<td>Not Active</td>
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<tr>
<td>USDA - Rural Energy for America Program (REAP) Grants (Federal)</td>
<td>Active</td>
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</tbody>
</table>
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