ORGANICS TO ENERGY: ANAEROBIC DIGESTION

Town of Greenfield
14 Court Square
Greenfield, Massachusetts, 01301
Organics to Energy: Anaerobic Digestion

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EXECUTIVE SUMMARY

I. Project Overview & Community Response

The intent of this feasibility study is to assess the potential for an anaerobic digestion (AD) system located at the Greenfield Transfer Station. The feasibility study is funded through the Massachusetts Clean Energy Center (MassCEC) Organics-to-Energy (OTE) Program. This program supports community education and technical assistance in evaluating organics to energy applications throughout Massachusetts.

Anaerobic digestion is a naturally occurring process that converts organic material, such as wastewater sludge and food waste, into biogas (methane) in the absence of oxygen. This process is replicated in air tight vessels that optimize the conditions to promote a healthy population of anaerobic bacteria, in turn enhancing methane production. The biogas (methane) is captured and used as a renewable energy generator as fuel for transportation or to generate electricity, both of which displace fossil fuel consumption. The process of analyzing a potential anaerobic digestion facility can be broken down into four basic stages. These stages include feedstock preparation, organic digestion and methane generation, gas recovery and energy generation, and digestate recovery and management.

Primary feasibility study drivers for the Town of Greenfield include:

- The reduction of disposal costs for the Greenfield Water Pollution Control Plant (WPCP), which costs the town approximately $200,000 annually.
- To provide a long-term disposal solution for organic waste generated within the Franklin County community. The MassDEP newly promulgated organic waste ban, going into effect October 1, 2014, will limit disposal options for nearly 30 Greenfield organic waste generators. The addition of an AD facility will provide a local option for affected entities to manage adherence to regulations.
- Reducing municipal vehicle transportations costs and generating additional revenue through the sale of CNG for vehicle or fleet use.

Major economic impacts that can be accrued to Greenfield include lowering the disposal costs for the WPCP and the creation of CNG for vehicle use, which can offset current fleet costs. In addition to these economic benefits, environmental benefits of the proposed anaerobic digestion facility include reduced vehicle emissions due to local waste disposal (currently trucked long distances for disposal) and the generation of renewable bio-methane for vehicle use, which has a lower emissions profile than diesel or gasoline.

Community engagement with Greenfield residents and local environmental groups has been a priority from the launch of the feasibility study. BEAM Engineering, in partnership with the Town of Greenfield, hosted a public community forum regarding the potential of anaerobic digestion in Greenfield. This forum offered an opportunity for residents to learn, voice potential concerns, and ask questions about the technology, processes, and impacts. Support has been shown by the Greenfield community and local environmental groups, specifically through the drafting of the proposed biomass zoning ordinance. Clear language excludes ‘anaerobic digestion’ from the ordinance and construction restrictions of biomass facilities, as to not limit future opportunities for the development of an AD facility within the town.

II. Baseline Project and Market Conditions

The primary stakeholders associated with the project include the Greenfield Transfer Station (site of the proposed AD facility and municipal organics collection), the Greenfield Water Pollution Control Plant (source of sludge feedstock), and the regional generators of source separated organics (SSO’s), including restaurants,
food processors, and supermarkets. Important findings related to baseline project and market conditions include:

- Three (3) acres of land are available at the Transfer Station for construction of the anaerobic digestion system (not including current operations and structures).
- The water pollution control plant (WPCP) has a high flood risk and therefore it is not a good location to site the anaerobic digestion system.
- Defined in the current Site Assignment, the Transfer Station is permitted to accept municipal solid waste, recycling, leaves, grass clippings, landscape refuse, and municipal food waste.
- Sludge disposal costs at the WPCP were $187,158 in 2012 and forecasted to exceed $200,000 in 2014.
- In evaluating potential feedstocks for the digester, the WPCP generates 7,796 tons of sludge waste annually and regional food waste generators will provide an estimated 7,108 tons annually. Traffic impacts will be minimal, with an additional one to two trucks delivering feedstock to the Transfer Station per day due to feedstock deliveries to the digester. Available data of proposed AD facilities in the region establishes that it is not likely Greenfield will have extensive competition for feedstock resources.
- Collection of municipal food waste has recently begun at the Transfer Station. This may provide additional organic feedstock to the digester, though the program is new and therefore the processing needed prior to integration into the digester will be determined in the final design stage.
- Vehicle costs for town related departments exceed $324,385 annually; major municipal departments include the DPW-Solid Waste ($63,175/year), School ($58,082/year), and the Police Department ($53,788/year).
- There are no CNG fueling stations that are currently located in the Greenfield region. Given the location at the juncture of Route 2 and I-91, there is strong stakeholder support to install a bioCNG fueling station in this area. The Massachusetts Clean Cities Coalition, an organization that promotes clean fuel vehicles, has been made aware of the project and has offered to provide support during the development process.

III. Anaerobic Digestion Equipment Research & Analysis

Commercially available anaerobic digestion technologies were explored to determine those best suited for the project. Major components of the system include feedstock processing equipment, digester types, biogas storage strategies, energy conversion systems, digestate processing, and remote system monitoring. Based upon the technical review in Section III, the following equipment strategies are recommended for Greenfield:

- Incorporate the ability for feedstock acceptance of both low-solid (pumpable) and high-solid substrates, with a trommel and chopper-pump for pre-processing.
- The anaerobic digester should be a complete mix mesophilic system with mechanical variable-angle mixers.
- Integrated PEX tubing should be used to provide heat to the hydrolysis and anaerobic digestion tanks.
- A tank mounted dual-membrane should be installed for biogas capture.
- A bioCNG fueling station should be installed for vehicle use.
- The necessary biogas cleaning and conditioning technologies will be included in the bioCNG system to ensure a high level of methane quality.
- The solid digestate is recommended to be composted on-site and used in either municipal applications, brownfield reclamation, or provided to a reseller. The liquid digestate will be returned to the WPCP through the existing sewer system.
CNG is recommended due to the interest Greenfield has in reducing municipal vehicle operational costs. CHP was explored but is not recommended due to the low electrical and thermal energy consumption at the Greenfield Transfer Station. Additionally, injecting bio-methane into the natural gas pipeline is not recommended due to the low cost of natural gas on the wholesale energy market.

IV. Design Scenario Analysis & Recommended Configuration

In order to effectively determine the optimal recommendation for Greenfield, diverse configurations were analyzed given the project’s baseline conditions and the findings related to the anaerobic digestion equipment research. Findings and recommendations include:

- Six options were selected to represent a variety of configurations and were investigated in detail given the location, energy, feedstock, and operational conditions specific to this project.
- It is recommended that Greenfield pursue an anaerobic digestion system at the Transfer Station, where the bio-methane generated in the system can be used to establish a CNG fueling station for municipal, private, and public use. The system will co-digest organic waste (7,601 tons/year, 25% solids) and wastewater sludge from the WPCP (7,796 tons/year, 3-5% solids).
- The system will consist of two (2) receiving tanks, each at 25,000 gallons; there will be a ‘high’ strength and ‘low’ strength tank to facilitate optimal recipe management within the digester. Feedstock will flow from the receiving tanks to the hydrolyzer tank (52,000 gallons, 3-5 day retention time), and then to the digester tank (265,000 gallons, 30 day retention time).
- The digestion process is estimated to generate 1,097,664 m$^3$ of methane annually.
- The CNG vehicle fueling station is estimated to generate 775 gallons equivalent of fuel daily.

V. Ownership Structures and Financial Analysis

The installation of an anaerobic digestion plant is a capital intensive project. Therefore, it is important to understand the conditions and risks associated with the investment, along with the sensitivities related to operational costs and future revenue streams. In discussions with Greenfield, the following items were established relating to ownership and contract structures:

- Greenfield has an interest in operating the anaerobic digestion side of the proposed system, though would like the CNG station to be operated by a specialty contractor under a turn-key contract.
- In order to reduce project risk during the financing period, it is recommended that the contract rates for feedstock, off-takers, and operational costs align with the period of financing where possible.
- Potential long term off-takers for the bioCNG have been determined and include vehicles owned by the Town of Greenfield, as well as a regional waste hauler who has expressed interest in converting their refuse disposal vehicle fleet to CNG.

Key revenue, savings, and costs for the recommended configuration include:

- Annual benefits are estimated to be $1,066,175/year. This value is largely driven by the sale of CNG as vehicle fuel, renewable fuel standard credits, and a reduction in the disposal cost of sludge at the WPCP. Annual net benefit, after accounting for operating and maintenance costs are $631,817.
- Capital costs for the system are estimated to be $4,048,000. These costs are largely driven by the anaerobic digestion system and feedstock processing ($2,120,000), the compressed natural gas fueling station ($1,300,000), digestate dewatering ($100,000), composting ($100,000), and project contingencies ($428,000).
- To support construction of the recommended system, grants through programs such as MassCEC Organics to Energy Program are estimated to provide $400,000 towards construction costs.
• Annual operating and maintenance costs are estimated to be $434,358. These costs are largely driven by operating costs of the anaerobic digestion system ($202,400/year) and the bioCNG fueling station ($231,958/year). The costs for the bioCNG fueling station are inclusive of bio-gas cleaning.

Key sensitivities relating to the projected financial analysis include:

• The value of high-energy organic waste as a feedstock is expected to increase as digesters are built in the region; for this reason, it was conservatively estimated that the tipping fees at the anaerobic digestion facility be zero revenue (compared to current average of $78.50/ton in Massachusetts). ‘Tipping fee’ revenue for accepting regional food waste at the digester could generate additional revenue streams and should be pursued by the project development team.

• Determining a viable off-taker for the composted solid digestate is critical to the viability of the project; our financial model assumed a modest value of $5.00/ton. The Town or development team should define a clear, long-term use for the solid digestate as well as a back-up plan for alternate uses or disposal.

VI. Regulatory, Permits, and Approvals

The process of permitting an anaerobic digester biogas to energy project may take anywhere from 4 to 12 months in Massachusetts, though could potentially take longer. Regulations are evolving and therefore all respective agencies should be consulted at time of project development.

• The Town of Greenfield Guide to Development Permits outlines a chronological step-by-step explanation of the permit process and is included in this report. Next steps include submitting a site plan design and convening a Staff Technical Review Group meeting to review the project with representatives from the following municipal entities: Planning & Development, Engineering from DPW, Fire Department, Licensing Commission, Health Department, and Building & Inspecting Department.

• Modifications to the existing WPCP Treatment Work Plan Approval (BRP WP 68) will be required to define that the anaerobic digestion system will serve as the primary sludge disposal method; the current primary disposal method should be included as a back-up.

• The proposed AD facility will accept solid food waste, pumpable food waste (FOG, food and beverage manufacturers/processors), as well as sludge from the WPCP. Given that the final permit for the Greenfield Sanitary Landfill states that as of 1996, sludge from the Greenfield WPCP would no longer be accepted at the landfill, modification to the existing site assignment will be necessary. Also, as a conversion and composting facility, the proposed operations are likely to trigger a Permit for Recycling, Composting or Conversion (16.05).

• The disposal of the separated liquid digestate will be returned to the WPCP through the existing sewer system line that runs directly from the Transfer Station to the WPCP. The additional wastewater due to the liquid digestate being returned to the WPCP has been discussed with the town and they do expect the additional flow to be acceptable given their current operations. The separated solid digestate will be composted on-site to meet state and federal requirements for land use. These disposal methods avoid the necessity of a NPDES for the digester system.

• Biosolids refer to sewage sludge that has been treated to meet federal and state standards. As sludge will serve as a primary feedstock in the digester, the digestate is therefore considered a biosolid. Both state and federal standards apply for pathogen and contaminant reduction and restrictions of use for biosolids. The EPA standards regulate the digestate to Class A and Class B, while the MassDEP classifies to Type I, II, II.

• Current Site Assignment language excludes sludge from the Transfer Station Site, so modification through traditional permitting is expected. MEPA review is a component of traditional permitting and is required when the project is seeking State Financial Assistance or requires a Permit from a State
Agency and exceeds a MEPA review threshold that is related to the subject matter of the State Permit. If it is determined that the project will not be accepting state financial assistance, it is likely that no MEPA review would be required, although if the proposed AD project accepts state financial assistance and triggers a threshold review condition, a MEPA review will likely be required.

- The BioCNG facility is a 'turnkey installation' where the responsibility to adhere to National Fire Protection Association regulations and the Massachusetts Board of Fire Prevention Regulations covering Compressed Natural Gas Containers and Systems should lie with the developer.

VII. Next Steps

The project has been determined to be feasible from a technical, economic, regulatory, and community perspective. If Greenfield would like to continue to pursue the project, the following key items should be defined as the project shifts to the pre-design and request for qualification (RFQ) or request for proposal (RFP) phase:

- Ownership and operational structure(s)
- Establish agreements for feedstock availability and type
- Digestate application or off-taker agreements
- CNG fleet vehicle agreements
- Establish grant and incentives through “offer letters” issued by the governing agency
- Civil site assessment for Transfer Station location
- Conceptual site plan submitted for a Greenfield Staff Technical Review Group meeting and to MassDEP for a permitting review meeting
**PROJECT CONTACTS**

The following personnel were key contacts throughout the development and execution of this project.

**Greenfield Personnel and Contact Information**

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### DEFINITIONS AND ACRONYMS

<table>
<thead>
<tr>
<th><strong>Term</strong></th>
<th><strong>Definition</strong></th>
</tr>
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<tbody>
<tr>
<td>Aerobic Digestion</td>
<td>The decomposition of the organic matter by micro-organisms in the presence of oxygen.</td>
</tr>
<tr>
<td>Ammonia (NH₃)</td>
<td>A colorless gas with a characteristic pungent smell. It dissolves in water to give a strongly alkaline solution.</td>
</tr>
<tr>
<td>Anaerobic Bacteria</td>
<td>Microorganisms that live and reproduce in an environment containing no &quot;free&quot; or dissolved oxygen. Used for anaerobic digestion.</td>
</tr>
<tr>
<td>Anaerobic Digestion (AD)</td>
<td>Anaerobic digestion is a collection of processes by which microorganisms break down biodegradable material in the absence of oxygen. The decomposition process produces a gaseous byproduct often called &quot;biogas&quot;.</td>
</tr>
<tr>
<td>Best Management Practice (BMP)</td>
<td>Method or technique that has consistently shown results superior to those achieved with other means, and that is used as a benchmark.</td>
</tr>
<tr>
<td>Biogas</td>
<td>A combustible gas created by anaerobic decomposition of organic material, composed primarily of methane and carbon dioxide.</td>
</tr>
<tr>
<td>Biogas Conditioning/Biogas Scrubbing</td>
<td>Removes contaminants, reduces sulfur dioxide emissions, reduces equipment corrosion, and offers cost savings associated with lower maintenance requirements and results in greater energy recovery.</td>
</tr>
<tr>
<td>Biomethane Potential (BMP)</td>
<td>This is a standard laboratory technique used to measure the anaerobic biodegradability and associated methane yield from a given substrate. The test is run until no further gas production is detected and can last up to 100 days. The results can be influenced by the substrate concentration and particle size, the inoculum source, the food to microorganism ratio, and the presence or buildup of inhibitory compounds among others.</td>
</tr>
<tr>
<td>Biochemical Oxygen Demand (BOD)</td>
<td>It is determined by the amount of oxygen required to metabolize the organic matter in the water and is used as a measurement to indicate the ability of effluent to pollute. It is expressed in mg/l.</td>
</tr>
<tr>
<td>Biosolids</td>
<td>Sewage sludge that has been treated to reduce or eliminate health risks and improve beneficial characteristics. Biosolids are nutrient rich and may be suited to a range of beneficial uses in agriculture and other applications and are classified into Class A and Class B certification.</td>
</tr>
<tr>
<td>British thermal unit (Btu)</td>
<td>The standard measure of heat energy. It takes one Btu to raise the temperature of one pound of water by one degree Fahrenheit.</td>
</tr>
<tr>
<td>Carbon Dioxide (CO₂)</td>
<td>The main greenhouse gas caused by human activities; it also originates from natural sources like volcanic activity.</td>
</tr>
<tr>
<td>Chemical Oxygen Demand (COD)</td>
<td>Measures the quantity of dissolved organic pollutants than can be removed in chemical oxidation, by adding strong acids. This measurement of the reactivity of the effluent indicates an ability to pollute. It is expressed in mg/l.</td>
</tr>
<tr>
<td>Combined Heat and Power (CHP) / Co-generation</td>
<td>The sequential or simultaneous generation of two different forms of useful energy -- electric and thermal -- from a single primary energy source in a single, integrated system. CHP systems usually consist of a prime mover, a generator, a heat recovery system, and electrical interconnections configured into an integrated whole.</td>
</tr>
<tr>
<td>Composting</td>
<td>A process in which solid organic materials are broken down by micro-organisms in the presence of oxygen. High temperatures generated during this process kill harmful micro-organisms and a stabilized organic material soil-like ready for horticultural or agricultural use rich product is the end result.</td>
</tr>
<tr>
<td>Cubic feet per minute (cfm)</td>
<td>A measure of the volume of a substance flowing through air within a fixed period of time.</td>
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<tr>
<td>Compressed Natural Gas (CNG)</td>
<td>A fossil fuel substitute for gasoline, diesel, or propane/LPG. Although its combustion does produce greenhouse gases, it is a more environmentally clean alternative to those fuels, and it is much safer than other fuels in the event of a spill (natural gas is lighter than air, and disperses quickly when released).</td>
</tr>
<tr>
<td>Digestate</td>
<td>The solid and liquid material that remains after the organic material has been completely digested in the anaerobic digester.</td>
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<tr>
<td>Distributed Generation</td>
<td>It involves small amounts of generation located on a utility’s distribution system for the</td>
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<td>Term</td>
<td>Definition</td>
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<tr>
<td>Distribution System</td>
<td>The substations, transformers and lines that convey electricity from high-power transmission lines to ultimate consumers. May need upgrade to support power export.</td>
</tr>
<tr>
<td>Effluent</td>
<td>The discharge of a pollutant from a process in a liquid form, usually containing residues from that process and often from a pipe into a stream or river.</td>
</tr>
<tr>
<td>Electrical Generation Capacity</td>
<td>The maximum technical full-load sustained output of an electricity generating facility; actual output is usually lower. Capacity is measured in watts, kilowatts, or megawatts.</td>
</tr>
<tr>
<td>Emission</td>
<td>The release or discharge of a substance into the environment; generally refers to the release of gases or particulates into the air.</td>
</tr>
<tr>
<td>End-Use Sectors</td>
<td>The residential, commercial, transportation and industrial sectors of the economy.</td>
</tr>
<tr>
<td>Energy Consumption</td>
<td>The amount of energy consumed in the form in which it is acquired by the user. The term excludes electrical generation and distribution losses.</td>
</tr>
<tr>
<td>Fats, Oils, and Grease (FOG)</td>
<td>Common byproducts of food processing operations. Limited proportions of FOG can increase biogas production in a digester.</td>
</tr>
<tr>
<td>Feedstock</td>
<td>The biodegradable material that is put into an anaerobic digester.</td>
</tr>
<tr>
<td>Fertilizer</td>
<td>A substance added to soil to make it more fertile. Contains primary nitrogen, phosphorus and potassium to help plants grow.</td>
</tr>
<tr>
<td>Gallons Per Day (GPD)</td>
<td>A rate of water, wastewater or other flow, used most often in flow hydraulics calculations.</td>
</tr>
<tr>
<td>Gasoline Gallon Equivalent (GGE)</td>
<td>A unit to compare compressed natural gas fuel to the more widespread gasoline equivalent.</td>
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<tr>
<td>Generator</td>
<td>A device for converting mechanical energy to electrical energy.</td>
</tr>
<tr>
<td>Global Warming Potential (GWP)</td>
<td>A measure of how much a given amount of greenhouse gas is estimated to contribute to global warming, relative to the same amount of carbon dioxide.</td>
</tr>
<tr>
<td>Greenhouse Gas (GHG)</td>
<td>A gas in an atmosphere that absorbs and emits radiation within the thermal infrared range. This process is the fundamental cause of the greenhouse effect. The primary greenhouse gases in the Earth’s atmosphere are water vapor, carbon dioxide, methane, nitrous oxide, and ozone.</td>
</tr>
<tr>
<td>Groundwater</td>
<td>Water occurring in the subsurface zone where all spaces are filled with water under pressure greater than that of the atmosphere.</td>
</tr>
<tr>
<td>Hydrogen (H2)</td>
<td>The lightest of all gases, the element (hydrogen) occurs chiefly in combination with oxygen in water. It also exists in acids, bases, alcohols, petroleum, and other hydrocarbons.</td>
</tr>
<tr>
<td>Hydrogen Sulfide (H2S)</td>
<td>A toxic, colorless gas that has an offensive odor of rotten eggs and is soluble in water and alcohol; freezes at −85.5°C and boils at −60.7°C. Hydrogen sulfide is a dangerous fire and explosion hazard, and a strong irritant. It is used as a reagent and as a source of hydrogen and sulfur.</td>
</tr>
<tr>
<td>Hydraulic Retention Time (HRT)</td>
<td>A measure of the average length of time that a soluble compound remains in a constructed bioreactor. HRT is the volume of the aeration tank divided by the influent flowrate, where using SI Units Volume is in [m³] and Influent flowrate is in [m³/h]. HRT is usually expressed in hours (or sometimes days).</td>
</tr>
<tr>
<td>Installed Capacity</td>
<td>The total capacity of electrical generation devices in a power station or system.</td>
</tr>
<tr>
<td>Inorganic Fertilizer</td>
<td>Mined or synthesized chemical fertilizers.</td>
</tr>
<tr>
<td>Kilogram (kg)</td>
<td>The kilogram is the basic unit of mass.</td>
</tr>
<tr>
<td>Kilowatt (kW)</td>
<td>An instantaneous measure of power equal to 1,000 watts. It can be used to measure the capacity of a generator or the demand by an appliance.</td>
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<tr>
<td>Kilowatt-hour (kWh)</td>
<td>A unit of energy that represents one kilowatt of power generated or consumed for one hour. The most commonly-used unit of measure telling the amount of electricity consumed over time.</td>
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<tr>
<td>Landfill</td>
<td>An engineered area where waste is placed into the land. Landfills usually have liner systems and other safeguards to prevent groundwater contamination.</td>
</tr>
<tr>
<td>Lignin</td>
<td>A complex chemical compound, integral part of the secondary cell walls of plants (mostly woody) and some algae, crucial in conducting water in plant stems, significant role in the...</td>
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<tr>
<td>Term</td>
<td>Definition</td>
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<tr>
<td>Carbon cycle</td>
<td>Slowly decomposes (cannot be broken down anaerobically), becomes humus as it decomposes resulting in increased photosynthetic productivity of plant communities.</td>
</tr>
<tr>
<td>Liter (L)</td>
<td>A non-SI metric system unit of volume equal to 1 cubic decimeter, 1,000 cubic centimeters or 1/1,000 cubic meter.</td>
</tr>
<tr>
<td>Life Cycle Assessment (LCA)</td>
<td>A technique to assess environmental impacts associated with all the stages of a product’s life from cradle-to-grave (i.e., from raw material extraction through materials processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling).</td>
</tr>
<tr>
<td>Macro-nutrients</td>
<td>((\text{NPK} - \text{nitrogen, phosphorus and potassium})) Essential elements used by plants in relatively large amounts for plant growth are called macronutrients. The major macronutrients are nitrogen (N), phosphorus (P), and potassium (K). Calcium (Ca), magnesium (Mg), and sulfur (S).</td>
</tr>
<tr>
<td>Megawatt (MW)</td>
<td>The watt is a derived unit of power in the International System of Units. The unit, defined as one joule per second, measures the rate of energy conversion or transfer.</td>
</tr>
<tr>
<td>Megawatt Hours (MWh)</td>
<td>The basic unit of electricity equal to one megawatt of power steadily supplied to or taken from an electric circuit for one hour.</td>
</tr>
<tr>
<td>Methane (CH(_4))</td>
<td>A flammable, explosive, colorless, odorless, tasteless gas that is slightly soluble in water and soluble in alcohol and ether; boils at (-161.6^\circ\text{C}) and freezes at (-182.5^\circ\text{C}). It is formed naturally in marshes and swamps from decaying organic matter or in anaerobic digesters. Methane is a major constituent (up to 97%) of natural gas, and is used as a source of petrochemicals and as a fuel. It is a Greenhouse Gas 20 times more potent than CO(_2).</td>
</tr>
<tr>
<td>Mesophilic Bacteria</td>
<td>Bacteria that operates in temperatures around 100°F.</td>
</tr>
<tr>
<td>Micro-nutrients</td>
<td>Micronutrients are those elements essential for plant growth which are needed in only very small (micro) quantities. The micronutrients are boron (B), copper (Cu), iron (Fe), chloride (Cl), manganese (Mn), molybdenum (Mo) and zinc (Zn).</td>
</tr>
<tr>
<td>Microturbine</td>
<td>Small combustion turbine with an output of 25 to 500 kW. Microturbines are composed of a compressor, combustor, turbine, alternator, recuperator, and generator.</td>
</tr>
<tr>
<td>Municipal Solid Waste (MSW)</td>
<td>MSW includes all of the solid wastes that are generated from residential sources, commercial and business establishments, institutional facilities, construction and demolition activities, municipal services, and treatment plant sites. Hazardous wastes are generally not considered MSW.</td>
</tr>
<tr>
<td>National Pollutant Discharge Elimination System (NPDES)</td>
<td>A provision of the Clean Water Act that prohibits discharge of pollutants into waters of the United States unless a special permit is issued by EPA, a state, or (where delegated) a tribal government on an Indian reservation.</td>
</tr>
<tr>
<td>Net Generation</td>
<td>Gross generation minus the energy consumed at the generating station for its use.</td>
</tr>
<tr>
<td>Nitrogen (N(_2))</td>
<td>A colorless, tasteless, odorless gas that is the most abundant constituent of dry air. It comprises 78.09%.</td>
</tr>
<tr>
<td>Nitrate (NO(_3))</td>
<td>An inorganic form of nitrogen. Formed from the oxidation of ammonia by aerobic bacteria; present in fertilizer; and the preferred form of nitrogen in discharges to rivers.</td>
</tr>
<tr>
<td>NOx</td>
<td>Oxides of nitrogen (NOX) are a family of reactive gaseous compounds that contribute to air pollution in both urban and rural environments. NOx emissions are produced during the combustion of fuels at high temperatures.</td>
</tr>
<tr>
<td>Nutrient Management</td>
<td>Identifying how the major plant nutrients (NPK) are to be annually managed for expected crop production and for the protection of water quality. The goal of farm nutrient management planning is to maximize crop yields, while minimizing environmental impact.</td>
</tr>
<tr>
<td>Operation and Maintenance (O&amp;M) Cost</td>
<td>Operating expenses are associated with operating a facility i.e. supervising and engineering expenses while maintenance expenses are labor, materials, and other direct and indirect expenses incurred for preserving the operating efficiency or physical condition of utility plants that are used for power production, transmission, and distribution of energy.</td>
</tr>
<tr>
<td>Organic Material</td>
<td>Matter that has come from a once-living organism; is capable of decay, or is the product of decay; or is composed of organic compounds. Material which comes from animal or plant sources.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition/Description</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Organic Loading Rate (OLR)</strong></td>
<td>The application of soluble and particulate organic matter. It is typically expressed on an area basis as pounds of BOD5 per unit area per unit time. (e.g. lb/ft²/day).</td>
</tr>
<tr>
<td><strong>Organic Fraction of Municipal Solid Waste (OFMSW)</strong></td>
<td>The biogenic fraction of MSW. OFMSW can be removed from the waste stream at the source (source-separation), or downstream by mechanical separation and/or picking lines.</td>
</tr>
<tr>
<td><strong>Parts Per Million (ppm)</strong></td>
<td>In science and engineering, the parts-per notation is a set of pseudo units to describe small values of miscellaneous dimensionless quantities, e.g. mole fraction or mass fraction. Since these fractions are quantity-per-quantity measures, they are pure numbers with no associated units of measurement.</td>
</tr>
<tr>
<td><strong>Pasteurization</strong></td>
<td>A process of heating a substance to a specific temperature for a predefined length of time and then immediately cooling it after it is removed from the heat to partially sterilize destroying harmful microorganisms.</td>
</tr>
<tr>
<td><strong>Pathogen</strong></td>
<td>A bacterium, virus, or other microorganism that can cause disease.</td>
</tr>
<tr>
<td><strong>Pelletization</strong></td>
<td>A process where compressing or molding a material into the shape of a pellet.</td>
</tr>
<tr>
<td><strong>pH</strong></td>
<td>In chemistry, pH is a measure of the activity of the (solvated) hydrogen ion. Solutions with a pH less than 7 are said to be acidic and solutions with a pH greater than 7 are basic or alkaline.</td>
</tr>
<tr>
<td><strong>Power Purchase Agreement (PPA)</strong></td>
<td>Long-term agreements between an energy provider and a customer to purchase on-going power at rates with pre-determined annual increases.</td>
</tr>
<tr>
<td><strong>Pound (Lb)</strong></td>
<td>16 ounces = 0.45 kilograms.</td>
</tr>
<tr>
<td><strong>Primary Sludge</strong></td>
<td>The solids which settle out of the wastewater in the sedimentation tanks just after the wastewater passes through the grit chambers. The settled material represents 40-60% of the Suspended Solids that exist in the wastewater. This represents 25-35% of the BOD in the wastewater.</td>
</tr>
<tr>
<td><strong>Pre-treatment</strong></td>
<td>In reference to anaerobic digestion feedstock, pre-treatment can refer to any process used to treat the raw substrates prior to being added to the digester. This can include de-packaging, separating, grinding, slurrying, biological treatment, heating, and others</td>
</tr>
<tr>
<td><strong>Programmable Logic Controller (PLC)</strong></td>
<td>An industrial computer control system that continuously monitors the state of input devices and makes decisions based upon a custom program to control the state of output devices.</td>
</tr>
<tr>
<td><strong>Renewable Energy Credit (REC)</strong></td>
<td>The environmental attributes of electricity generated from renewable sources that are tracked or sold separately from the electricity itself.</td>
</tr>
<tr>
<td><strong>Rate of Return</strong></td>
<td>The annual return on an investment, expressed as a percentage of the total amount invested.</td>
</tr>
<tr>
<td><strong>Reciprocating Engine</strong></td>
<td>Also often known as a piston engine, is a heat engine that uses one or more reciprocating pistons to convert pressure into a rotating motion.</td>
</tr>
<tr>
<td><strong>Retention Time (RT)</strong></td>
<td>The time inside the digester. Varies with the amount and type of feed material, the configuration of the digestion system, and whether it be one-stage or two-stage (usually between 15 and 40 days)</td>
</tr>
<tr>
<td><strong>Supervisory Control and Data Acquisition (SCADA)</strong></td>
<td>A system for monitoring and controlling for production processes, and managing related data. Typically, a SCADA system is connected to PLCs, which are in turn connected to sensors and production machinery.</td>
</tr>
<tr>
<td><strong>Suspended Solids</strong></td>
<td>They are the solids which can be removed from the wastewater by physical or mechanical means, such as sedimentation or filtration.</td>
</tr>
<tr>
<td><strong>Separated Liquid Digestate</strong></td>
<td>The separated liquid portion of the digestate. Typically around 3% Solids.</td>
</tr>
<tr>
<td><strong>Separated Solid Digestate</strong></td>
<td>The separated solid portion of the digestate. Typically around 20% Solids.</td>
</tr>
<tr>
<td><strong>Source Separated Organics (SSO’s)</strong></td>
<td>Compostable or digestible materials that are segregated from the point of generation and collected separately from waste materials, to avoid any blending or contamination from the waste materials.</td>
</tr>
<tr>
<td><strong>Solids</strong></td>
<td>A measurement of the concentration of particulate solids that can dissolve or suspend in wastewater (includes TS, TSS, TDS, TVS, TFS)</td>
</tr>
<tr>
<td><strong>Standard Cubic Feet (scf)</strong></td>
<td>For gas volumes assume -32°F and 15.97 psi.</td>
</tr>
<tr>
<td><strong>Standard Cubic Feet per Hour (SCFH)</strong></td>
<td>The volumetric flow rate of a gas corrected to “standardized” conditions of temperature and pressure, making it the equivalent of the mass flow rate of the gas.</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Siloxane</strong></td>
<td>Commonly found in household waste and wastewater and are any of a class of organic or inorganic chemical compounds of silicon, oxygen, and usually carbon and hydrogen. Can contaminate the biogas.</td>
</tr>
<tr>
<td><strong>Sludge</strong></td>
<td>A solid, semi-solid or liquid residue generated during the treatment of domestic sewage.</td>
</tr>
<tr>
<td><strong>Secondary Sludge</strong></td>
<td>Is generated when the overflow from the settling tanks goes into the aeration chambers and the aerobic bacteria convert the dissolved organics into carbon dioxide, water and solids.</td>
</tr>
<tr>
<td><strong>Soil Conditioner</strong></td>
<td>A substance used to improve the physical (e.g. soil structure) or chemical (e.g. pH) properties of soil.</td>
</tr>
<tr>
<td><strong>Soil Profile</strong></td>
<td>A cross section of the soil from the surface down to and including the parent material.</td>
</tr>
<tr>
<td><strong>Stabilization</strong></td>
<td>The process used to reduce harmful bacteria and odors in biosolids, digestate, and/or compost.</td>
</tr>
<tr>
<td><strong>Solids Retention Time (SRT)</strong></td>
<td>The average length of time solid material remains in a reactor.</td>
</tr>
<tr>
<td><strong>Thermophilic Bacteria</strong></td>
<td>Bacteria that operate in temperatures above 122°F.</td>
</tr>
<tr>
<td><strong>Total Suspended Solids (TSS)</strong></td>
<td>The sum of suspended solids and dissolved solids (including organic and inorganic). Tested as a water quality measurement and is listed as a conventional pollutant by the Clean Water Act. Expressed as mg/l</td>
</tr>
<tr>
<td><strong>Tons Per Year (tpy)</strong></td>
<td>A typical unit to quantify the amount of organic waste</td>
</tr>
<tr>
<td><strong>Total Solids (TS)</strong></td>
<td>The amount of solid material (or dry matter) remaining after removing moisture from a sample. The total solids are composed of two components, volatile solids and fixed solids. Moisture content + TS = 100%;</td>
</tr>
<tr>
<td><strong>Total Dissolved Solids (TDS)</strong></td>
<td>The total amount in milligrams of solid material dissolved in one liter of water (mg/l).</td>
</tr>
<tr>
<td><strong>Total Volatile Solids (TVS)</strong></td>
<td>Organic compounds of animal or plant origin. The amount of combustible material in a sample. VS is used as an indicator or proxy for the biodegradability of a material.</td>
</tr>
<tr>
<td><strong>Total Fixed Solids (TFS)</strong></td>
<td>Items in the waste stream such as sand, gravel, and salt</td>
</tr>
<tr>
<td><strong>Transmission</strong></td>
<td>Movement of bulk energy sources (electricity) from the generation facility (power plant) to a distribution facility.</td>
</tr>
<tr>
<td><strong>Transmission and Distribution (T&amp;D) System</strong></td>
<td>An interconnected group of electric transmission lines and associated equipment for the movement or transfer or electric energy in bulk between points of supply and points at which it is transformed for delivery to the ultimate customers.</td>
</tr>
<tr>
<td><strong>Total Organic Carbon (TOC)</strong></td>
<td>The amount of carbon bound in an organic compound and is often used as a non-specific indicator of water quality.</td>
</tr>
<tr>
<td><strong>Utility Distribution Companies (UDCs)</strong></td>
<td>The entities which will continue to provide regulated services for the distribution of electricity to customers and serve customers who do not choose direct access.</td>
</tr>
<tr>
<td><strong>Volatile Solids (VS)</strong></td>
<td>The amount of combustible material in a sample (the remainder is ash). The value is usually reported as a percentage of the TS, but may occasionally be given as a fraction of the wet weight. VS are used as an indicator or proxy for the biodegradability of a material, though recalcitrant biomass (i.e., lignin) which is part of the VS is less digestible.</td>
</tr>
<tr>
<td><strong>Volatile Suspended Solids (VSS)</strong></td>
<td>That fraction of suspended solids, including organic matter and volatile inorganic salts, which will ignite and burn when placed in an electric muffle furnace at 550 °C for 15 minutes.</td>
</tr>
<tr>
<td><strong>Volatile Organic Compound (VOC)</strong></td>
<td>Organic chemicals that have a high vapor pressure at ordinary, room-temperature conditions. Their high vapor pressure results from a low boiling point, which causes large numbers of molecules to evaporate or sublime from the liquid or solid form of the compound and enter the surrounding air. VOCs are numerous, varied, and ubiquitous. They include both human-made and naturally occurring chemical compounds. Most scents or odors are of VOCs. VOCs play an important role in communication between plants</td>
</tr>
<tr>
<td><strong>Volatile Fatty Acid (VFA)</strong></td>
<td>Fatty acids with a carbon chain of six carbons or fewer. They are now usually referred to as short-chain fatty acids (SCFA).</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>--------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Vector Attraction</strong></td>
<td>The characteristics of biosolids that attracts rodents, flies, mosquitoes or other organisms capable of transporting disease.</td>
</tr>
<tr>
<td><strong>Wastewater Treatment Facility (WWTF) / Water Pollution Control Plant (WPCP)</strong></td>
<td>A processing facility that treats sewage and in the process produces biosolids and treated water or effluent (which can be treated further to use as recycled water) and minor residuals (screenings and grit).</td>
</tr>
<tr>
<td><strong>Waste Activated Sludge (WAS)</strong></td>
<td>Solids removed from the activated sludge process to prevent an excessive build up in the system.</td>
</tr>
<tr>
<td><strong>Watt (W)</strong></td>
<td>A standard unit of measure (SI System) for the rate at which energy is consumed by equipment or the rate at which energy moves from one location to another. It is also the standard unit of measure for electrical power.</td>
</tr>
<tr>
<td><strong>Watt-Hour (Wh)</strong></td>
<td>A measure of electrical energy equivalent to a power consumption of one watt for one hour. A standard unit of measure (SI system) for the amount of energy that is consumed by equipment, the amount of embodied energy, or the amount of energy moved from one location to another. It is also the standard unit of measure for electrical use. One watt-hour is equal to 3.413 Btu.</td>
</tr>
</tbody>
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Organics to Energy: Anaerobic Digestion

I. PROJECT OVERVIEW & COMMUNITY RESPONSE

I-1 Intent of Feasibility Analysis

The goal of this study is to assess the feasibility of establishing an anaerobic digester at the Greenfield Transfer Station paired with either a compressed natural gas (CNG) facility or a combined heat and power (CHP) facility. The system has the potential to provide a long-term management solution to the disposal of wastewater treatment sludge and regional generated organic wastes in an economically sustainable and environmentally responsible way. Anaerobic digestion technology also has the ability to serve as a renewable energy generator and to create an organics recycling infrastructure to support the region with regulation compliance.

This feasibility study is funded through the Massachusetts Clean Energy Center’s (MassCEC) Commonwealth Organics-to-Energy Program, which provides funding to educate stakeholders about organics-to-energy technologies, help communities and businesses evaluate organics-to-energy projects, and support construction of facilities. The main objectives of the MassCEC Organics-to-Energy Program include:

- Address public needs regarding the evaluation of, or planning for organics-to-energy projects at the local level
- Expand knowledge about organics-to-energy technologies
- Divert organic waste from landfills and incinerators and create economical and environmentally sound disposal methods for organic waste
- Increase clean energy capacity in Massachusetts
- Produce a useful end product such as fertilizer and/or soil amendments
- Create jobs and spur economic activity in Massachusetts
- Address the Massachusetts Department of Environmental Protection (MassDEP) organic waste ban set to go into effect October 1, 2014, which will ban the disposal of commercial/industrial food wastes into landfills.

I-2 Feasibility Study Drivers

Based upon discussions with town personnel, including a meeting with the Mayor of Greenfield, William Martin, on January 16, 2014, Greenfield has cited the following reasons as drivers for pursuing the implementation of anaerobic digestion. These drivers include:

1. Reduction of Operational Costs at Greenfield Water Pollution Control Plant (WPCP) – The town spends nearly $200,000 annually to dispose of sludge waste, with costs projected to increase over the upcoming years; therefore lower cost, long-term solutions are of interest to Greenfield.

2. Reduction of Transportation Costs – The town spends $324,385 on municipal fleet fuel costs, therefore renewable, lower-cost, and less volatile fuel (through the generation of bioCNG) is of interest in Greenfield.

3. Compliance with Upcoming Regulations – The MassDEP has promulgated an organic waste ban set to go into effect in October 1, 2014, which will prohibit generators of one or more tons of organic matter per week from disposing of that material at Massachusetts Transfer Stations, landfills, or incinerators. By offering a local or regional option for organic waste disposal, Greenfield is setting the foundation for
affected entities to manage adherence to these regulation. Please refer to Appendix A for the press release from Governor Patrick with additional information.

4. **Continuation of Current Transfer Station Initiatives** – Greenfield has recently begun offering municipal organics drop-off at the Transfer Station; investing in anaerobic digestion at this location is a natural progression and may provide an additional step towards improving sustainability and effective management of waste streams within Greenfield.

I-3 Anaerobic Digestion Overview

Anaerobic digestion (AD) is a naturally occurring process by which microorganisms and anaerobic bacteria break down or “digest” biodegradable material in the absence of oxygen and release gases as a byproduct of the process.

In an organics to energy anaerobic digestion system, the conversion process is harnessed within airtight vessels where the methane released is captured and used beneficially. The carbon in organic compounds is transformed into gaseous carbons and released primarily as methane gas (CH₄), as well as carbon dioxide and traces of other 'contaminant' gases. The methane can be utilized as a source of renewable energy in a generator that produces electricity and heat, for heat in a boiler, as a vehicle fuel, or injected into the natural gas pipelines.

AD reduces the total amount of volatile organic compounds (VOCs) in organic food waste and wastewater sludge. During the anaerobic digestion process, anywhere from 50 - 90% of the digestible solids are converted into biogas. This number varies given the substrate type – such as wastewater sludge, food waste, or fats, oils, and grease (FOG) – that is fed into the digester. The leftover organic material that did not break down through the anaerobic digestion process is called digestate, a nutrient rich soil amendment and fertilizer. When sludge is used as a feedstock, further processing, such as heat-drying or composting, is generally needed to achieve regulatory standards for beneficial digestate use.

The process of anaerobic co-digestion of food waste and sludge can be divided into four basic stages:

1. **Feedstock Preparation**: The substrate fed into the digester can vary widely and may necessitate pretreatment such as screening, grinding, shredding, or slurring. The most sought after feedstock is a pumpable, high strength feedstock that is free of contamination (such as organic waste from a food manufacturing plant with high oil content). As a broader range of feedstock sources and feedstock types are acquired, impurities such as packaging, silverware, and plastics must be considered in relation to additional processing requirements and equipment.

2. **Organic Digestion and Methane Generation**: Following feedstock preparation, the sludge and the homogenous slurry of food waste are fed to the digester where anaerobic bacteria break down the organic matter. This results in the release of a combustible biogas product, composed primarily of methane (50%-60%) and carbon dioxide (~25%).

3. **Gas Recovery and Energy Generation**: The biogas released from the digestion process may also contain small amounts of contaminants including siloxanes, hydrogen sulfide, and water. The reduction of these impurities in the biogas prior to combustion is essential in reducing equipment corrosion, lowering maintenance requirements, and increasing equipment efficiency. Following biogas capture and cleaning, the biogas is either sent to an engine where it is combusted for electrical generation and heat recovery or compressed and used in CNG vehicles.

4. **Digestate Recovery and Management**: Digestate is the material that remains after the organic material has been digested, and is typically separated into solid and liquid factions, so as to better utilize or dispose of. The separated solid digestate is often aerobically composted to break down the lignaceous material, and if the end product meets EPA and MassDEP regulations, it can be used as a soil amendment and fertilizer. The separated liquid digestate can be recycled back to digester processes for dilution or
to the head of the wastewater treatment plant. The organic components of the feedstock are often high in nutrients that are crucial to plant, animal, and bacteria life. Although, it should be noted the acceptable application of digestate is typically dependent on the substrate fed into the digester and post-processing techniques used to ensure regulation compliance.

The biochemical pathway of anaerobic digestion is shown in Figure I-1 and each stage of the process is described with their associated chemical formulas. This information is provided so that municipal stakeholders and community members can better grasp the basics of the AD process and, therefore, allow for more informed decision-making.

**Figure I-1: Biochemical Pathway of the Anaerobic Digestion Process**

1. **Hydrolysis** is the first stage of anaerobic digestion, where the transformation of particulate organic matter (proteins, carbohydrates, fats) to solubilized, smaller organic molecules (amino acids, monosaccharides and fatty acids) occurs so that the molecules can pass through the anaerobic bacteria cell membrane. Large polymers broken down by enzymes are depicted in the equation below.  

\[
C_6H_{10}O_4 + 2H_2O \rightarrow C_6H_{12}O_6 + 2H_2 
\]

2. **Acidogenesis** is a fermentative reaction, in which acidogenic bacteria convert the fatty acids into shorter chain molecules like ethanol, propionic acid, butyric acid, and acetic acid. One of the fermentative reactions (conversion of glucose to propionate and water) is shown in the equation below. It is the bacterial fermentation that produces carbon dioxide, volatile fatty acids, hydrogen, and organic acids.

\[
C_6H_{12}O_6 + 2H_2 \leftrightarrow 2CH_3CH_2OOH + 2H_2O
\]

3. **Acetogenesis** takes the intermediary degradative products and transforms them into the precursors for methanogenesis, including hydrogen, carbon dioxide, and acetic acid. The equation below demonstrates the conversion of propionate to acetate. It is the further breakdown of volatile acids produces acetate, carbon dioxide, and hydrogen.

\[
CH_3CH_2COO^- + 3H_2O \leftrightarrow CH_3COO^- + H^+ + HCO_3^- + 3H_2
\]
4. **Methanogenesis**, the fourth and last step, also involves multiple pathways to creating methane and carbon dioxide, although the most common reaction is the cleavage of acetic acid to form methane and carbon dioxide, which is shown in the equation below. The intermediate products (acetate, formaldehyde, hydrogen and carbon) of the preceding stages are consumed by anaerobic bacteria and converted into methane, carbon dioxide, and water.

\[ \text{CH}_3\text{COOH} \rightarrow \text{CH}_4 + \text{CO}_2 \]

**I-4 Benefits for the Town of Greenfield**

Anaerobic digestion can impart numerous benefits to the Town of Greenfield related to economic, environmental, and societal impacts. Below are the potential economic impacts associated with the addition of an anaerobic digester to the Greenfield Transfer Station:

- **Reduced Disposal Costs for the WPCP**: Greenfield is currently paying approximately $200,000 per year to dispose of its sludge and the addition of an anaerobic digester can significantly decrease disposal costs by decreasing transportation distance and eliminating tipping fees (if town owned). Sludge incinerators and landfills are becoming an unsustainable approach to waste management. Incineration and disposal rates, if the fuel costs required to operate the transport trucks, have been rising consistently. As incinerators go offline and landfills fill up, anaerobic digestion allows for Greenfield to manage their WPCP waste stream locally, rather than finding alternative incinerators and landfills, which are often hundreds of miles away. Municipal wastewater digesters typically have sludge volume reductions between 45-50%\(^1\), and with advanced digester technologies, such as those investigated in this report, up to 80% reduction can be achieved.

- **Lower Tipping Expenses for Department of Public Works**: Separating digestible material from the waste stream for separate collection (Source Separated Organics - SSO's) will lessen the overall solid waste volume needing disposal. Consequently, less tonnage is going to a landfill or an incinerator, in turn lowering tipping fee expenses allocated to the generators and haulers (both private and public sectors).

- **Potential Revenue Streams for Town of Greenfield**: The proposed anaerobic digestion system has the potential to generate multiple revenue streams for the Town of Greenfield. These include: tipping fees from accepting organic waste from local generators; upgrading biogas to produce compressed natural gas (CNG) for vehicles; and creating a marketable byproduct from the digestate that can be utilized as soil amendment or fertilizer.

- **Increased Local Employment**: Construction and operation of the system will generate new jobs by localizing waste management and energy production.

The most significant environmental benefits arise from redirecting organic waste from landfills and repurposing it as a renewable energy. This leads to a decrease in methane emissions into atmosphere and decreased consumption of non-renewable fossil fuels.

- **Reduced Emission from Transportation**: The sludge from the Greenfield WPCP is currently transported off-site to Montague WWTF to be thickened, after which it is landfilled in Vermont or sent to Upper Blackstone Water Pollution Abatement District in Millbury, MA. In comparison, a local waste management option will reduce emissions associated with the transport of food waste and sludge to non-local disposal sites.

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\(^{1}\) The International Joint Commission has shown that approximately half of the prescription drugs and other newly emerging contaminants in sewage are removed by typical treatment plant processes; the EPA is currently conducting a survey of the 50 largest U.S. municipal wastewater treatment plants to analyze the concentrations of 48 high-priority active pharmaceutical ingredients.
Organics to Energy: Anaerobic Digestion

- **Diversion of Organic Food Waste from Landfills:** The capacity of Massachusetts landfills are continually decreasing, with an expected drop from 2.1 million tons this year (2014) to approximately 600,000 tons/year by 2020. Massachusetts produces nearly 1.4 million tons of organic waste every year, so diversion is essential. When organic waste is landfilled and buried under solid waste with no access to oxygen, it will undergo anaerobic digestion and release a considerable amount of methane (a greenhouse gas with 23 times the global warming potential of CO₂). When organic waste is diverted to an anaerobic digester, the methane released from the breakdown of organic material is instead captured for use as an energy source, decreasing methane emissions into the atmosphere.

- **Diversion of Waste from Incineration:** There are concerns about sludge incineration because of emissions, high costs, and the need for additional fuel to operate the incinerator. An anaerobic digester will lessen the need for incineration and disposal of the sludge from the Greenfield WPCP by reducing the volume of sludge that must be disposed of. Approximately 80% of the sludge will be converted to usable methane and digestate.

- **Increased Community Sustainability:** The Greenfield community can take pride in the fact that they are significantly reducing their organic waste stream and their dependence on imported fossil fuels through the use of anaerobic digestion technology. Municipal commitment to environmental sustainability can often contribute to local economic and environmental resiliency among the businesses and residents.

1-5 Greenfield Community Engagement

A. **Municipal Environmental Initiatives**

Greenfield is located in the northern Pioneer Valley at the intersection of Interstate 91 and the Mohawk Trail (Route 2) and is a hub of regional commerce and culture, and is home to 18,168 residents. Greenfield has been very active in pursuing progressive, environmentally sustainable, and economically feasible goals. Notably, Greenfield was designated a Green Community on May 25, 2010. A grant of $202,066 was allocated to fund the buy-down of an energy management services contract for municipal buildings, a community energy efficiency program, a feasibility study on municipal electric load aggregation, and an energy coordinator staffing position. A Competitive grant of $40,000 was allocated to fund eight residents to receive up to $5,000 toward energy efficiency measures in conjunction with the municipality’s Community Development Block Grant Rehab Program for low to moderate income residents. Additionally, Greenfield has received a grant through MassCEC Community Energy Strategies Program to explore long term planning for municipal energy and sustainability efforts.

B. **Anaerobic Digestion Community Engagement**

As anaerobic digestion is generally an unknown technology for many people, community outreach and education play a critical role in project success. It is important to identify and include local environmental groups in efforts for community inclusion and education, as well as outreach to the community directly, as they can be influential advocates. Listed below are prominent local environmental groups that may be vital partners to ensure the community is properly educated on the project:

- **The Concerned Citizens of Franklin County** was created in response and concern to the proposed 5MW Energy biomass power plant to be located in Greenfield, MA. This group successfully drafted a biomass and waste-to-energy moratorium that states any facility that produces thermal energy, electrical energy, or combined heat and power from solid waste (all facilities) or biomass (capacity of more than 1 million BTUs per hour) relying on combustion or pyrolysis will be temporarily prohibited until the moratorium end date of September 15, 2014, and is now a proposed biomass zoning ordinance.

- **The Sustainable Advisory Committee** is an eight member committee comprised of Town staff and Mayor-appointed citizens to support Greenfield’s goals to reduce energy and promote community wide sustainability efforts.
• Greenfield received a MassCEC Clean Energy Strategies Program Grant along with Montague, Shelburne, and Buckland, with Franklin Regional Council of Governments as the lead to define goals for the future of renewable energy in the area. Their hope is to access grant funds to implement projects to help reduce energy use and to establish clean energy sources.

• The Greening Greenfield Campaign is composed of a group of concerned citizens working with residents, businesses, and the Greenfield town government. Their mission is to use the concept of "greening" as the economic and inspirational guiding force in building a more sustainable Greenfield, so that current and future generations can sustain and enjoy life in this beautiful, abundant valley.

At a public community meeting, BEAM Engineering, in partnership with the Town of Greenfield, held a presentation on anaerobic digestion (Press Release: http://gctv.org/news/2013/october/wednesday/learn-about-anaerobic-digestion-greenfield-thursday). All interested community stakeholders were invited to learn about the technology and to discuss any impacts the project may have on Greenfield. A recording of the presentation, including the in-depth public question and answer discussion held afterwards, can be found here: http://gctv.org/videos/greenfield-energy-sustainability-anaerobic-digesters-presentation.

Residents attending the forum expressed:
• A preference that the system only accept organic waste from the Greenfield WPCP and not from surrounding towns
• An aversion to using digestate for food-based land application because of the unknown presence of pharmaceuticals in the digestate
• Understand impacts on local air quality, including levels of carbon dioxide (CO₂), nitrogen oxide (NOₓ), volatile organic compounds (VOCs), and fine particulate matter
• Quantify the volume of waste that will be diverted from landfills
• Quantify the amount of gallons equivalent per year of bioCNG that will be generated and if it will be made available for sale to public
• Understand exactly how benefits and costs related to the system would be accrued, including the economic impacts carried by taxpayers or private third-party entities
• Understand the project's impacts on the surrounding area in regards to traffic, noise, odor, and regional emissions

The questions and concerns expressed by the local residents and community groups have been taken into consideration for the development of the recommended design scenario for this project. Support has been shown by the Greenfield community and prominent environmental groups, specifically through the drafting of the proposed biomass zoning ordinance. Clear language excludes 'anaerobic digestion' from the ordinance and construction restrictions of biomass facilities, as to not limit future opportunities for the development of an AD facility within the town.
II. BASELINE PROJECT AND MARKET CONDITIONS

**Key Points:** Primary project conditions consist of the Greenfield Transfer Station, Greenfield Water Pollution Control Plant, and the available organics feedstock substrates within and surrounding the Town of Greenfield. Important baseline project and market conditions include:

- Three (3) acres of land is available for the anaerobic digestion system at the Transfer Station. The water pollution control plant (WPCP) has a high flood risk; therefore it is not a good location to site the anaerobic digestion system.
- The Transfer Station is permitted to accept municipal solid waste, recycling, leaves, grass clippings, landscape refuse, and municipal food waste.
- Sludge disposal costs were $187,158 in 2012 and forecasted to exceed $200,000 in 2014.
- The WPCP generates 7,796 tons of sludge waste annually; regional food waste generators will provide an estimated 7,108 tons annually as feedstock; 1-2 trucks per day traffic increase at the Transfer Station due to feedstock for digester.
- An organics diversion program was recently implemented at the Transfer Station where residents can drop off their food waste free of charge; this may provide additional organic feedstock to the digester; the volume of the feedstock and the processing needed prior to integration into the digester are yet to be determined as the municipal collection program is new.
- It is not likely Greenfield will have a significant amount of direct competition for feedstock resource with nearby facilities.
- Municipal vehicle costs for Greenfield exceed $324,385 annually; major municipal departments include the DPW-Solid Waste ($63,175/year), School Sped ($58,082/year), and Police Department ($53,788/year).
- There are no CNG facilities located in or near Greenfield, though given the location at the juncture of Route 2 and I-91, there is strong stakeholder support to install a bioCNG fueling station at the Transfer Station, including support by the Massachusetts Clean Cities Coalition.

II-1 Greenfield Transfer Station

The Solid Waste and Recycling Division of the Department of Public Works operates the Transfer Station, as well as performs curbside rubbish and recycling collections, and daily transports of rubbish and recyclable materials to their disposal/processing centers in Springfield. The Transfer Station provides a drop-off location for residents to properly dispose of items not collected curbside such as food waste, computers, mattresses, demolition material, brush and hazardous wastes such as paint and waste oil.

A. Location

The Greenfield Transfer Station is located at 86 Cumberland Road in Greenfield, Massachusetts. The proposed construction site is an area of roughly 3 acres providing ample room for the anaerobic digestion facility to be built. Trucks carrying feedstock will enter and exit via the existing ingress and egress pathways at the Transfer Station. The following photographs exhibit the proposed site, available space, general conditions, and the proposed ingress and egress, including:

- Aerial View of Greenfield Transfer Station with Dimensions
- Approximate distance of proposed AD facility to closest neighbors
- Proposed Site Facing Northwest Towards Entrance
- Proposed Site Facing East
Figure II-1: Aerial View of Greenfield Transfer Station with Dimensions (Approximately 3 acres)

Figure II-2: Approximate Distance From Transfer Station to Closest Neighbors (shown below in feet).
Figure II-3: Proposed Site Facing Northwest Towards Entrance

Figure II-4: Proposed Site Facing East
B. Zoning

The Transfer Station is zoned as a solid waste facility within a Rural Residential (RC) zone. Abutting properties are zoned Rural Residential (RC), General Commercial (GC) and General Industry (GI) and include the capped landfill with a 2.0 MW newly installed solar array, a cemetery, forested area, and Sheldon Brook to the south. See zoning map in Figure II-5 below. The existing zoning parameters and available space owned by the Town allow an anaerobic digestion facility to be feasible at this site.

**Figure II-5: Greenfield Water Pollution Control Plant and Transfer Station Zoning**

C. Site Assignment & Existing On-Site Organic Waste Acceptance

The proposed site of the anaerobic digester in Greenfield at 86 Cumberland Road has two permits. One permit is for landfill operations, which has since been capped in 1999 (permit shown in Appendix B), and the second is for the parcel of land that was designated for Transfer Station operations to handle residential solid waste and recycling (permit shown in Appendix C).

The material applicable to an anaerobic digester would be the town's grass clippings (currently dropped off at Transfer Station for composting), and the organic fraction of municipal, local business, and institutional generators. The addition of brown wastes such as leaves and woody material should be avoided because of their inability to breakdown through anaerobic processes, although are good amendments to the aerobic composting process. Estimated current material volume quantities per year are:
- Residential Food Waste (Program newly launched, volume data not yet available)
- Grass - 31 tons/yr (3 CY/ton)
- Leaves - 440 tons/yr (5 CY/ton)
- Brush - 120 tons/yr (4 CY/ton)

Site Assignment Regulations for Solid Waste Facilities (310 CMR 16.00) set forth by the MassDEP are required for anaerobic digestion facilities in Massachusetts. The purpose of the site assignment process is to determine if a parcel of land is suitable to use as a site for a solid waste management facility including combustion facilities, and recycling, composting and conversion operations. The local board of health grants site assignments following MassDEP review of the site assignment application.2 The DEP Solid Waste Section Chief in the Western Region has been notified of the proposed approach for the Greenfield project.

The Board of Health final permit for the Transfer Station is in accordance with the provisions of Massachusetts General Laws, Chapter 111, Sections 150A and 150A 1/2 and the regulations promulgated thereunder, 310 CMR 16.00. The Board of Health reviewed the site suitability criteria listed in 310 CMR 16.40 as well as DEP’s site suitability report in order to make its determination. Suitability criteria includes, but is not limited to, buffers to protect drinking water supply; minimum distances from residences, institutions, facilities, farmland, and other sensitive receptors; protect public health and safety; address concerns over traffic, rare and endangered species, air quality, agricultural lands, Areas of Critical Environmental Concern, and potential nuisances; and that the size of the proposed site would be sufficient to properly operate and maintain the proposed facility.

The sludge from the Greenfield WPCP was disposed of at the Greenfield Sanitary Landfill up until the final landfill permit was determined by the MassDEP on November 21, 1994 in response to Greenfield’s application for BWP SW 09 (Bureau of Waste Prevention Solid Waste Management 09). The Final Permit states that as of January 1, 1996 the Greenfield Sanitary Landfill could no longer accept sludge from the Greenfield WPCP and would need to develop an alternate method for the management of the sludge and enter into contracts or agreements necessary to achieve this end. This was determined feasible because existing sludge composting facilities were available and accessible to the region. The MassDEP included this condition into the permit in order to achieve compliance with 310 CMR 19.061(6)(d)(2) Requirements for Sewage Treatment and Water Treatment Sludges which states, in part:

"Sewage treatment sludges may be accepted at a solid waste landfill only after land application and composting options have been investigated by the applicant or by the generator of such sludge and determined by the Department not to be feasible, provided that said investigation of options may be deferred for a reasonable time upon a determination by the Department that adverse impacts may occur as a result delaying disposal of sludge."

D. Traffic Flow

Feedstock deliveries of food waste and sludge to the anaerobic digester will only slightly increase local truck traffic by 1-2 trucks daily. There are three route options from the Mohawk Trail (Route 2) and I-91 rotary exit to the Greenfield Transfer Station averaging a distance of only 2 miles. The zoning map (Figure II-5) shows that this short route goes through General Commercial and Urban Residential areas. In addition, there is potential that the construction of the AD facility could intermittently and temporarily increase traffic congestion, traffic safety, and emergency vehicle access, as well as potentially create safety hazards due to road wear and accidental spills.

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2 http://www.mass.gov/eea/agencies/massdep/service/approvals/bwp-sw-01-38.html
There is existing infrastructure and precedence for managing truck flow at the Greenfield Transfer Station, as current operations include hauling solid waste to and from the Transfer Station daily, and historically there have not been any complaints. See Figure II-6 below for feedstock delivery flow. The estimated feedstock to be delivered to the digester is 7,601 tons/year (20 tons/day) and data from the WPCP states that the facility currently averages 32,000 gallons per week (4 trucks) of sludge disposal. The combination of regional organic waste and Greenfield WPCP sludge would result in the addition of 1-2 trucks daily. This will have minimal impact on traffic; therefore, it is assumed that a traffic study will not need to be completed for the project.

In order to avoid disturbance and comply with requirements, coordination with local agencies and government departments, state agencies, utility districts, and MassDOT regarding construction and operation is recommended. Strategies to be considered include haul routes minimizing truck traffic on local roadways, schedule truck trips outside of peak morning and evening commute hours, and survey and document pre-construction roadway conditions and identify any damage to roadway from construction. In addition, a spill prevention plan should be developed prior to initiation of project operations, which includes a requirement that each truck driver know how to carry out the emergency measures if an accidental spill were to occur, therefore reducing roadway hazards.

**Figure II-6: Feedstock Delivery Flow to Transfer Station from Junction of Route 2 Mohawk Trail Highway, Interstate 91, and the Greenfield Wastewater Treatment Plant**
E. Energy Costs

Western Massachusetts Electric Co. (WMECo) provides the Transfer Stations with its electrical service. The station consumes an average of 80,000 kWh of electricity per month, which costs $11,500 annually. Heat for the facility is provided by waste oil and natural gas. Costs for heating are less than $1,000 per year.

F. Flooding and Watersheds

According to the FEMA National Flood Hazard GIS mapping tool, the Greenfield Transfer Station is not in a flood zone. Given these conditions and that the Transfer Station is over 200 feet above sea level, well above the flood plain, there is little concern for flooding at the location. See Figure II-7 below for flood hazard zoning for the region. The Special Flood Hazard Area Town of Greenfield, MA can be found at: http://www.townofgreenfield.org/Pages/GreenfieldMA_Planning/SFHAMap.pdf.

Figure II-7: FEMA National Flood Hazard (GIS Mapping Tool)\(^3\)

The Greenfield Transfer Station resides in the Connecticut River Watershed, shown in Figure II-8, and must be taken into consideration with permitting issues that may arise. According to the Massachusetts Department of Energy and Environmental Affairs, the Connecticut River and its tributaries constitute the largest river basin in New England. From its origin in the Connecticut Lakes Region near the Canadian border, the 410-mile Connecticut River flows southward to form the boundary between New Hampshire and Vermont. It then flows

\(^3\) http://maps.massgis.state.ma.us/map
through Massachusetts and Connecticut to the Long Island Sound. The Connecticut River traverses approximately 67 river miles and drains approximately 2,726 square miles within Massachusetts. In Massachusetts it is bordered by the Deerfield River Basin to the northwest, the Westfield River Basin to the southwest, the Millers River Basin to the northeast and by the Chicopee River Basin to the southeast.

**Figure II-8: Connecticut River Watershed**

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**II-2 Greenfield Water Pollution Control Plant**

The Town of Greenfield Water Pollution Control Plant (WPCP) is a publicly owned treatment works (POTW) located at 384 Deerfield Street, Greenfield, MA. The WPCP is located in a General Commercial (GC) zoning, with abutting properties being an auto recycling yard and a county run bus garage.
The facility was designed to withstand 100 year flood levels of 140 feet above sea level. Serious flooding of the WPCP occurred in August of 2011 with Tropical Storm Irene. A marker to monitor flood level and documentation of the Tropical Storm Irene flood levels are shown in Figure II-10. Water levels reached 142.5 feet above sea level causing flooding in the basement and over 30 inches of flood water on the main floor of the building. These flooding issues are the motivation for siting the proposed anaerobic digester at the Greenfield Transfer Station at 86 Cumberland Road rather than at the WPCP.
A. Process and Equipment
The Water Pollution Control Plant serves as a source of feedstock for the proposed digestion plant. The processes include:

1. Pretreatment System: The first piece of equipment is a bar screen that continually rotates through the flow as it enters the channel to remove large debris that could clog pipes and pumps further down in the process. The material is collected daily, drained and sent out for incineration. The grit chamber is a long narrow tank designed to slow down the flow of the wastewater by creating a cyclone effect with the introduction of air causing the heavier particles to spin out and fall to the bottom of the chamber. Wastewater contains a great deal of these heavy inorganic material such as sand, small stones, coffee grounds, grit, etc. and the removal of this matter from the wastewater is necessary to prevent abrasive action on mechanical equipment such as pumps. The removal of grit is particularly important in combined sewer systems, such as Greenfield, which carry a good deal of silt, sand, and gravel that wash off streets or land.

2. Primary Treatment System: Primary treatment is the physical process of settling heavy solids in the wastewater to the bottom of four underground settling tanks. These settled solids (primary sludge) are collected in the tanks by a system of rake arms, where they are then pumped to the sludge thickening tank. Oil, grease, and plastic material, which float to the top of the tanks, are then skimmed off in the primary tank. The remaining liquid (primary effluent) contains less than 0.5 mg/l of suspended solids and needs to be treated further to lower the soluble BOD.

3. Secondary Treatment: This is a biological process followed by a physical process, which greatly reduces the oxygen demand, thereby diminishing the harmful effect that the wastewater would have upon the Deerfield River. Secondary treatment includes two ten-foot bed trickling filters that are large biological reactors, which basically acts as a sped up version of nature's own water purification process. The primary effluent is distributed evenly over the surface of the media by rotating distributors, and as it flows downward and causes a layer of microbial slime (biofilm - algae, fungi, bacteria, protozoa and worms) to grow, covering the bed of media. Aerobic conditions are maintained by splashing, diffusion, and either by forced air flowing through the bed or natural convection of air if the filter medium is porous. As the primary effluent passes through the filter, this microbial growth retains much of the suspended and dissolved matter. The two final clarifiers remove the settleable solids. The solids that settle at the bottom are mechanically collected from the bottom of the tanks and transferred to the sludge
thickening tank. Before the effluent is discharge it is passed through the chlorine contact chamber, where the liquid sodium hypochlorite is added to the wastewater. Analyzers continually monitor the chlorine residual in the effluent and adjust chemical dosage rates accordingly.

**Figure II-11: Process Flow of Wastewater Treatment Facility**

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**B. Capacity and Sludge Characteristics**

The plant is currently permitted to a flow of 4.6 MGD, and in 2011 had a monthly average flow of 4.1 MGD. Designed for a TSS 5,200 lbs/day, and BOD 8,200 lbs/day. The Sewer/Drainage/Wastewater Treatment Division is responsible for the operation and maintenance of 70.25 miles of sewer mains, 4,632 sewer services and catch basins throughout the 120 miles of roadway in Greenfield. Gravity transports the flow to the WPCP where the effluent is treated to a Class B water quality standard and pumped and discharged through a long outfall to the Deerfield River, while the sludge is thickened and hauled off-site. In the proposed project, the sludge from the thickening tank will instead be transported to the AD facility in place of current disposal by off-site incineration. The town does not currently own any trucks that are capable of transport sludge; therefore the town would need to outsource the trucking of the sludge. Zoning is Industrial, with abutting properties being an auto recycling yard and a county run bus garage.

Influent consists of 99+% water, with the remaining components being dissolved and suspended solids, oils, greases, and other compounds. Effluent Discharge limits per NPDES permit: BOD\(^4\) average monthly of 28mg/l and a weekly average of 42mg/l, TSS\(^4\) average monthly of 28mg/l and a weekly average of
42mg/l, pH between 6.5 and 8.3. The Greenfield Water Pollution Control Plant NPDES permit can be found in Appendix D.

### Table II-1: Greenfield WPCP Monthly Averages and Annual Summaries for 2010 and 2011

<table>
<thead>
<tr>
<th>Design: TSS 5200 lbs./day, BOD 8200 lbs./day, Q = 3.4 MGD/4.6 MGD</th>
<th>2010</th>
<th>2011</th>
<th>Average</th>
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<td><strong>Total Suspended Solids - TSS (mg/L)</strong></td>
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</tr>
<tr>
<td><strong>Copper (ug/l)</strong></td>
<td>COPPER ug/l</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Nitrogen (mg/l)</strong></td>
<td>EFF - TKN mg/l</td>
<td>3.12</td>
<td>2.8</td>
</tr>
<tr>
<td><strong>Nitrate (mg/l)</strong></td>
<td>EFF - NITRATE mg/l</td>
<td>13.97</td>
<td>9.74</td>
</tr>
<tr>
<td><strong>Nitrite (mg/l)</strong></td>
<td>EFF - NITRITE mg/l</td>
<td>0.12</td>
<td>0.2</td>
</tr>
<tr>
<td><strong>Phosphorous (mg/l)</strong></td>
<td>EFF-PHOSPHOROUS mg/l</td>
<td>2.68</td>
<td>1.44</td>
</tr>
</tbody>
</table>
C. Sludge Disposal & Energy Costs
The current disposal, electric, and heating costs are discussed below.

- **Sludge Disposal Costs:** According to the Town of Greenfield’s Summary of Annual Sludge Disposal Costs, in 2012 Sludge Disposal from the Greenfield WPCP to the Fitchburg Incinerator (which has since closed) totaled 1,777,000 gallons and 361 dry tons transported, with a total annual disposal cost of $187,158. Three to four times per week, depending on the quantity, the sludge is pumped into a tanker and transported to incinerators or landfills. Approximately 32,000 gallons of sludge are trucked out weekly.

### Table II-2: Greenfield Sludge Disposal Cost from 1997 to 2012

<table>
<thead>
<tr>
<th>FY</th>
<th>Contractor</th>
<th>Disposal Site</th>
<th>Gallons</th>
<th>Dry Tons</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997</td>
<td>WSE</td>
<td>Fitchburg</td>
<td>1,962,000</td>
<td>397</td>
<td>$155,428</td>
</tr>
<tr>
<td>1998</td>
<td>WSE</td>
<td>Fitchburg</td>
<td>1,988,000</td>
<td>393</td>
<td>$155,042</td>
</tr>
<tr>
<td>1999</td>
<td>WSE</td>
<td>Fitchburg</td>
<td>1,880,500</td>
<td>379</td>
<td>$148,573</td>
</tr>
<tr>
<td>2000</td>
<td>WSE</td>
<td>Fitchburg</td>
<td>1,962,000</td>
<td>399</td>
<td>$185,165</td>
</tr>
<tr>
<td>2001</td>
<td>WSE</td>
<td>Fitchburg</td>
<td>2,043,000</td>
<td>384</td>
<td>$183,682</td>
</tr>
<tr>
<td>2002</td>
<td>WSE</td>
<td>Fitchburg</td>
<td>1,878,500</td>
<td>396</td>
<td>$181,339</td>
</tr>
<tr>
<td>2003</td>
<td>McNamara</td>
<td>Springfield</td>
<td>2,033,500</td>
<td>428</td>
<td>$155,109</td>
</tr>
<tr>
<td>2004</td>
<td>McNamara</td>
<td>Springfield</td>
<td>2,000,000</td>
<td>365</td>
<td>$138,790</td>
</tr>
<tr>
<td>2005</td>
<td>Casella</td>
<td>Fitchburg</td>
<td>2,050,000</td>
<td>400</td>
<td>$179,855</td>
</tr>
<tr>
<td>2006</td>
<td>Casella</td>
<td>Fitchburg</td>
<td>2,050,000</td>
<td>400</td>
<td>$182,315</td>
</tr>
<tr>
<td>2007</td>
<td>Wall Truck.</td>
<td>Fitchburg</td>
<td>1,933,500</td>
<td>395</td>
<td>$179,335</td>
</tr>
<tr>
<td>2008</td>
<td>Wall Truck.</td>
<td>Fitchburg</td>
<td>1,732,450</td>
<td>404</td>
<td>$186,181</td>
</tr>
<tr>
<td>2009</td>
<td>Wall Truck.</td>
<td>Fitchburg</td>
<td>1,838,000</td>
<td>382</td>
<td>$175,382</td>
</tr>
<tr>
<td>2010</td>
<td>Wall Truck.</td>
<td>Fitchburg</td>
<td>1,764,000</td>
<td>382</td>
<td>$177,487</td>
</tr>
<tr>
<td>2011</td>
<td>Wall Truck.</td>
<td>Fitchburg</td>
<td>1,763,000</td>
<td>361</td>
<td>$175,861</td>
</tr>
<tr>
<td>2012</td>
<td>Wall Truck.</td>
<td>Fitchburg</td>
<td>1,777,000</td>
<td>391</td>
<td>$187,158</td>
</tr>
</tbody>
</table>
**Electrical Costs:** The electric utility provider is Western Mass Electric. Monthly electric energy usage is shown below, which shows a fairly even electric usage level throughout the year. Annual peak demand is 236 kW, with an average monthly demand of 161 kW. The plant consumes 956,544 kWh annually, with an average of approximately 70,000 to 80,000 kWh used monthly. Electric service costs are approximately $128,949 annually.

<table>
<thead>
<tr>
<th>Read Date</th>
<th>Billed Demand</th>
<th>Usage</th>
<th>Number of Days</th>
<th>Usage per day</th>
<th>Charge</th>
<th>Average Temperature</th>
<th>$/kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>6/17/2013</td>
<td>209.5</td>
<td>47528</td>
<td>17</td>
<td>2795.74</td>
<td>$6,409.70</td>
<td>63.2</td>
<td>$0.13</td>
</tr>
<tr>
<td>5/31/2013</td>
<td>209.5</td>
<td>41944</td>
<td>15</td>
<td>2796.29</td>
<td>$5,933.76</td>
<td>60.1</td>
<td>$0.14</td>
</tr>
<tr>
<td>5/16/2013</td>
<td>163</td>
<td>81024</td>
<td>29</td>
<td>2793.93</td>
<td>$11,118.42</td>
<td>52.4</td>
<td>$0.14</td>
</tr>
<tr>
<td>4/17/2013</td>
<td>163</td>
<td>93696</td>
<td>33</td>
<td>2839.27</td>
<td>$12,532.64</td>
<td>37.8</td>
<td>$0.13</td>
</tr>
<tr>
<td>3/15/2013</td>
<td>159.5</td>
<td>64512</td>
<td>24</td>
<td>2688</td>
<td>$8,824.57</td>
<td>33.2</td>
<td>$0.14</td>
</tr>
<tr>
<td>2/19/2013</td>
<td>154.5</td>
<td>98688</td>
<td>34</td>
<td>2902.59</td>
<td>$12,781.75</td>
<td>23</td>
<td>$0.13</td>
</tr>
<tr>
<td>1/16/2013</td>
<td>171.5</td>
<td>40956</td>
<td>16</td>
<td>2559.75</td>
<td>$5,627.59</td>
<td>27.9</td>
<td>$0.14</td>
</tr>
<tr>
<td>12/31/2012</td>
<td>171.5</td>
<td>43524</td>
<td>17</td>
<td>2560.24</td>
<td>$5,818.57</td>
<td>30</td>
<td>$0.13</td>
</tr>
<tr>
<td>12/14/2012</td>
<td>144</td>
<td>74112</td>
<td>30</td>
<td>2470.4</td>
<td>$9,827.54</td>
<td>34.8</td>
<td>$0.13</td>
</tr>
<tr>
<td>11/14/2012</td>
<td>167.5</td>
<td>76800</td>
<td>29</td>
<td>2648.28</td>
<td>$10,407.09</td>
<td>46</td>
<td>$0.14</td>
</tr>
<tr>
<td>10/16/2012</td>
<td>236.5</td>
<td>38981</td>
<td>16</td>
<td>2436.31</td>
<td>$5,835.37</td>
<td>52.3</td>
<td>$0.15</td>
</tr>
<tr>
<td>9/30/2012</td>
<td>236.5</td>
<td>31675</td>
<td>13</td>
<td>2436.54</td>
<td>$4,742.74</td>
<td>55.8</td>
<td>$0.15</td>
</tr>
<tr>
<td>9/17/2012</td>
<td>139</td>
<td>77952</td>
<td>32</td>
<td>2436</td>
<td>$10,187.03</td>
<td>66.4</td>
<td>$0.13</td>
</tr>
<tr>
<td>8/16/2012</td>
<td>128.5</td>
<td>69504</td>
<td>30</td>
<td>2316.8</td>
<td>$9,137.20</td>
<td>73</td>
<td>$0.13</td>
</tr>
<tr>
<td>7/17/2012</td>
<td>133</td>
<td>75648</td>
<td>32</td>
<td>2364</td>
<td>$9,765.31</td>
<td>71.6</td>
<td>$0.13</td>
</tr>
<tr>
<td>6/15/2012</td>
<td>140</td>
<td>69504</td>
<td>30</td>
<td>2316.8</td>
<td>$9,086.94</td>
<td>64.4</td>
<td>$0.13</td>
</tr>
<tr>
<td>5/16/2012</td>
<td>128</td>
<td>67200</td>
<td>29</td>
<td>2317.24</td>
<td>$8,659.25</td>
<td>53.6</td>
<td>$0.13</td>
</tr>
<tr>
<td>4/17/2012</td>
<td>130.5</td>
<td>66816</td>
<td>32</td>
<td>2088</td>
<td>$8,649.10</td>
<td>47.5</td>
<td>$0.13</td>
</tr>
<tr>
<td>3/16/2012</td>
<td>112</td>
<td>54912</td>
<td>30</td>
<td>1830.4</td>
<td>$7,163.66</td>
<td>35.5</td>
<td>$0.13</td>
</tr>
<tr>
<td>2/15/2012</td>
<td>153</td>
<td>57984</td>
<td>29</td>
<td>1999.45</td>
<td>$8,025.82</td>
<td>29.5</td>
<td>$0.14</td>
</tr>
<tr>
<td>1/17/2012</td>
<td>147.5</td>
<td>34226</td>
<td>17</td>
<td>2013.28</td>
<td>$4,587.35</td>
<td>27.6</td>
<td>$0.13</td>
</tr>
<tr>
<td>12/31/2011</td>
<td>147.5</td>
<td>32206</td>
<td>16</td>
<td>2012.89</td>
<td>$4,334.70</td>
<td>31.5</td>
<td>$0.13</td>
</tr>
</tbody>
</table>
Figure II-12: Monthly Electric Energy Usage

Figure II-13: Peak Monthly Electric Demand Increases in the Summer Months
Oil is used to provide space heating and domestic hot water heating for the facility. Two Buderus boilers were recently installed; these boilers are shown in Figure II-14 below.

**Figure II-14: Buderus Oil-Fired Boilers**

**II-3 Greenfield Vehicle Fleet**

Greenfield vehicle fleet totals for Fiscal Year 2013 were 47,416 gallons of diesel and 53,081 gallons of gasoline equaling an annual total cost of $324,386. The table below shows costs associated with gas and diesel used in both light and heavy duty vehicles for the various Greenfield vehicle accounts. It also demonstrates that only a few town vehicles make up the majority of diesel and gas usage, such as DPW-Solid Waste $63,175/year, School Sped $58,082/year, and Police Department $53,788/year.

**Table II-4: Greenfield Fuel Usage FY2013**

<table>
<thead>
<tr>
<th>Vehicle Accounts</th>
<th>Diesel (gal)</th>
<th>Gas (gal)</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assessor</td>
<td>--</td>
<td>123.40</td>
<td>401.19</td>
</tr>
<tr>
<td>Bldg Inspector</td>
<td>--</td>
<td>237.00</td>
<td>773.85</td>
</tr>
<tr>
<td>DPW-EN</td>
<td>--</td>
<td>933.00</td>
<td>3,042.11</td>
</tr>
<tr>
<td>DPW-HW</td>
<td>9785.93</td>
<td>2267.70</td>
<td>38,433.19</td>
</tr>
<tr>
<td>DPW-PK</td>
<td>3843.10</td>
<td>2664.40</td>
<td>21,112.90</td>
</tr>
<tr>
<td>DPW-SW</td>
<td>17805.39</td>
<td>1776.10</td>
<td>63,175.39</td>
</tr>
<tr>
<td>DPW-TR</td>
<td>12.24</td>
<td>1119.20</td>
<td>3,661.40</td>
</tr>
<tr>
<td>DPW-VM</td>
<td>75.34</td>
<td>826.00</td>
<td>2,891.07</td>
</tr>
<tr>
<td>DPW-SF</td>
<td>6426.76</td>
<td>1560.00</td>
<td>25,722.64</td>
</tr>
<tr>
<td>DPW-WF</td>
<td>1602.30</td>
<td>4067.70</td>
<td>18,270.97</td>
</tr>
</tbody>
</table>
The Town of Greenfield has 2 garbage trucks for weekly curbside collection of solid waste and 2 recycling trucks for bi-weekly collection of recyclables.

Figure II-15: Greenfield Transfer Station Vehicles

<table>
<thead>
<tr>
<th>Department</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health Department</td>
<td>--</td>
<td>392.10</td>
<td>1,274.01</td>
</tr>
<tr>
<td>School - Main</td>
<td>--</td>
<td>967.60</td>
<td>3,114.93</td>
</tr>
<tr>
<td>School - SPED</td>
<td>1535.45</td>
<td>16439.40</td>
<td>58,082.35</td>
</tr>
<tr>
<td>School - Food</td>
<td>--</td>
<td>671.00</td>
<td>2,163.64</td>
</tr>
<tr>
<td>School - High School</td>
<td>1142.20</td>
<td>--</td>
<td>3,662.86</td>
</tr>
<tr>
<td>Police Department</td>
<td>--</td>
<td>16572.20</td>
<td>53,788.34</td>
</tr>
<tr>
<td>Fire Department</td>
<td>4567.84</td>
<td>2013.70</td>
<td>21,319.04</td>
</tr>
<tr>
<td>Central Maintenance</td>
<td>620.00</td>
<td>246.00</td>
<td>2,833.63</td>
</tr>
<tr>
<td>Recreation Department</td>
<td>--</td>
<td>204.60</td>
<td>662.42</td>
</tr>
<tr>
<td>Totals</td>
<td>47,416.55</td>
<td>53,081.10</td>
<td>$324,385.93</td>
</tr>
</tbody>
</table>

II-4 Existing Market Conditions of Anaerobic Digestion in Massachusetts

A. Distribution of AD Facilities in Massachusetts

There are currently six AD facilities in operation at Wastewater Treatment Facilities across Massachusetts for sludge only, shown in Table II-5 below. This number is expected to grow, and may have increased since the writing of this report. Current conditions and projects are updated by the MassDEP and can be found at the following website: http://www.mass.gov/eea/agencies/massdep/climate-energy/energy/anaerobic-digestion/
Table II-5: Wastewater Treatment Facilities in Massachusetts with Anaerobic Digestion of Sludge-only

<table>
<thead>
<tr>
<th>Facility Name</th>
<th>Flow (MGD)</th>
<th>Biogas Use</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>MWRA Deer Island</td>
<td>360</td>
<td>Heat &amp; Electricity (steam turbine)</td>
<td>~20 years</td>
</tr>
<tr>
<td>Pittsfield</td>
<td>13</td>
<td>Heat &amp; Electricity (New CHP)</td>
<td>Built in 1963; Recent rehab</td>
</tr>
<tr>
<td>Rockland</td>
<td>2.5</td>
<td>Heat. Flare any excess</td>
<td>~20 years</td>
</tr>
<tr>
<td>Greater Lawrence Sanitary District</td>
<td>30</td>
<td>Process Heat to pelletize biosolids.</td>
<td>Tanks installed 2002</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Flare any excess</td>
<td></td>
</tr>
<tr>
<td>MWRA Clinton</td>
<td>2 to 4</td>
<td>Heat. Flare any excess</td>
<td>~20 years</td>
</tr>
<tr>
<td>Fairhaven</td>
<td>2.7</td>
<td>Heat &amp; Electricity</td>
<td>New (2010-11)</td>
</tr>
</tbody>
</table>

Figure II-16 below shows the location of the above mentioned wastewater treatment plants with sludge only anaerobic digestion (blue pins), and the location of wastewater treatment plants currently under consideration for anaerobic digestion of both sludge and food waste. In evaluating the region’s landscape for potential anaerobic digestion systems, it is not likely Greenfield will have a significant amount of direct competition for feedstock resource with nearby facilities.

Figure II-16: Wastewater Treatment Facilities in Massachusetts with Anaerobic Digestion Implemented or Currently Under Consideration

The market for anaerobic digestion varies state to state, and with the MassDEP commercial organic waste ban on the largest organic generators across the Commonwealth (>1 ton/week) and the support for AD implementation, Massachusetts is leading the country in creating an organic waste market. Regulation changes have been prompted by landfills increasingly reaching their limits, greenhouse gas emissions escalating...
climate change, and disposal costs rising annually, and have opened the market for sustainable waste management solutions. Feasible anaerobic digestion projects will be dependant on location, return on investment, technology, local energy markets, feedstock quality and acquisition, local tipping fee rates (cost to dispose of material in landfills), rules and regulations, and incentives.\textsuperscript{4} Figure II-17 below displays the 2010 biogas market in the United States as well as the potential, illustrating that only approximately 200 systems have been built of the 8,200 potential. As shown, the potential is large and as regulations begin to support it’s growth, this potential will likely be realized.

\textbf{Figure II-17: United States Current and Potential Biogas Market Status (Source: AgStar, 2010)}

B. Compressed Natural Gas Vehicles

Compressed Natural Gas, as an alternative fuel to gas and diesel, is a growing market throughout Massachusetts, with support from the Massachusetts Clean Cities Coalition, a nationwide program sponsored by the U.S. Department of Energy (DOE) that focuses on promoting the adoption of alternative fuel vehicles and the development of infrastructure necessary. CNG infrastructure exists mainly in eastern Massachusetts, though numerous potential CNG customers exist in western Massachusetts (shown in Appendix E). Additionally, many car manufacturers have CNG options commercially available, vehicles ranging from small sedans to heavy duty utility vehicles such as refuse trucks.

Natural gas powered vehicles are proven and reliable. Improving technology and performance of natural gas engines has led to not only meeting, but exceeding EPA emissions requirements ahead of schedule. Currently, there are 110,000 natural gas vehicles operating on U.S. roads, including more than 11,000 transit buses, nearly 4,000 refuse trucks (California leading the way), more than 3,000 school buses, 15-17,000 medium duty vehicles (airport shuttles and a wide variety of work applications), and more than 30,000 light duty vehicles in federal, state, local government and private fleets. They are also quieter with an 80-90% lower decibel level than comparable diesels.\textsuperscript{5}

\textsuperscript{4} Renewable Waste Intelligence, Business Analysis of Anaerobic Digestion in the USA, March 2013

\textsuperscript{5} Natural Gas Vehicles For America, Retrieved From: http://www.ngvc.org/forfleets/index.html
The mileage is comparable between vehicles that have a CNG conversion kit, a new CNG vehicle, or a regular gasoline/diesel vehicle. Savings are seen in the comparatively low price of CNG, and the clean burning qualities. CNG vehicles are suggested for fleets that won’t travel far and can be fueled centrally, primarily because there isn’t an established infrastructure for fueling stations. Since the mileage of CNG, gasoline, and diesel is similar, it is assumed that existing Greenfield town vehicles that are converted to CNG would be able to keep existing transportation routes.

**Existing Natural Gas Fueling Stations in Massachusetts:** Existing natural gas fueling stations in Massachusetts are listed below and shown on a map in the following Figure II-18. The map shows that there is infrastructure in eastern Massachusetts, and Greenfield that may be able to serve as a key role in the expansion of CNG fueling station throughout New England. The Transfer Station is less than two miles off of exit 26 off of I-91 and the CNG station would be located at the facility at 86 Cumberland Rd.

Existing CNG fueling stations in Massachusetts:

- 81 N. Access Rd., East Boston, MA 02128
- 14 Rover St., Everett, MA 02149
- Rt. 128 N, Lexington, MA 02421
- 44 Harding St., Middleboro, MA 02346
- Rt. 128 S (Service Area), Newton, MA 02459
- 127 Whites Path, South Yarmouth, MA 02664
- 164 Pond St., Stoneham, MA 02180
- 20 Main St., Tewksbury, MA 01876
- 533 High Plain St., Walpole, MA 02081

**Figure II-18: Location of Natural Gas Fueling Stations in Massachusetts**

![Map of Natural Gas Fueling Stations in Massachusetts]

Adding CNG in Greenfield would support CNG infrastructure, providing a corridor from the Boston to the West, at the junction of Route 2 and Highway 91.

**Compressed Natural Gas Fleets in Massachusetts:** Below is a list of major fleets in Massachusetts that operate on CNG (compiled by the Massachusetts Clean Cities Coalition). Although these fleets are primarily in the metro Boston area, the proposed CNG fueling station in Greenfield can provide a necessary fueling station to assist in CNG infrastructure expansion throughout the state.
Massachusetts Bay Transport Authority (MBTA)
- 362 CNG buses
- Three (3) private-fueling stations

Massachusetts Port Authority (MassPort)
- 18 CNG buses
- Fueling at a full public-access CNG station

Lowell Regional Transit Authority (LRTA)
- 6 CNG buses
- Fueling at a full public-access CNG station

Courtyard by Marriott
- 5 CNG buses
- Fueling at a full public access CNG station

Steamship Authority (SSA)
- 10 CNG buses
- Fueling at both private and public access CNG stations

PreFlight Parking: 111 Eastern Ave, Chelsea, MA 02150
- 10 CNG shuttle buses
- Fueling at a full public access CNG station

NSTAR
- 15 CNG vans and sedans
- Fueling at public-access CNG stations

Massachusetts Department of Transportation (MassDOT)
- 200+ CNG vans, sedans, and pick-up trucks
- Fueling at public access CNG stations

Town of Middleborough
- 5 CNG vans, sedans, and pick-up trucks

Waste Management
- 10 CNG refuse trucks
- Fueling at a full public access CNG station

ABC Waste Services
- 10 CNG refuse trucks
- Fueling at public access CNG stations

There are two options when transitioning an existing diesel and gas fueled fleet of vehicles with compressed natural gas vehicles. Existing vehicles can be converted to use CNG fuel, or manufactured CNG vehicles can be purchased. When a vehicle is converted to run on compressed natural gas, the original diesel/gas system is typically left in place, giving the vehicles the ability to operate on regular gasoline/diesel. This creates a bi-fuel vehicle, where the fuel and CNG are not mixed, but rather the vehicle can run on either. This is very common with after-market conversions since most people don't want to give up the ability to use gasoline. Dedicated single-fuel vehicles run on only CNG and this is most commonly seen in new CNG vehicles.

Available CNG Manufactures and Models: Compressed natural gas vehicles are available across nearly all market segments, including consumer cars, fleet vehicles, and heavy duty work trucks. More common models and vehicle types are discussed below.

Consumer Cars:
Honda Civic Natural Gas: Sold to fleets and individuals throughout the U.S. since 1998. Honda Civic's Natural Gas is now available at Honda dealerships in 38 states.

Chevrolet Silverado 2500 and GMC Sierra 2500 HD: General Motors introduced two CNG-powered pickups in its 2013 line. The Chevrolet Silverado and GMC Sierra 2500 HD were available for order in spring 2012, with a 6.0-liter V-8 engine that can run on CNG or gasoline. Computer control systems automatically switch between the fuels. The trucks can be ordered through any dealer, and will be delivered directly to customers by GM's Tier One supplier.

Dodge Ram 2500 CNG: One of the first mass-produced CNG pickups in the U.S., the Dodge Ram 2500 CNG features an 18.2 gasoline gallon equivalent (GGE) tank with an estimated range of 255 miles. It also has an eight-gallon gasoline tank.

Ford F250 and F350: Alternative fuel. Ford's F250 and F350 Super Duty trucks with optional bi-fuel CNG conversions performed by many Ford-supported qualified vehicle modifiers (QVMs). They can be sold and serviced by authorized Ford dealers. Using rigorous OEM testing for safety and durability, they meet EPA 2012 standards.

GM Cargo Vans: GM offers full warranties along with the option to buy a new Chevrolet Express or GMC Savana cargo van. Introduced in the 2011 model year, the vans feature CNG fuel systems made and installed by Productive Concepts.

Fleet Vehicles & Medium Duty Vehicles:

Vans and Shuttles: The use of natural gas-powered vans and shuttles is increasing in U.S. airports. Current applications are available for almost all models of domestic light- and medium-duty vans and shuttles.

Heavy Duty Vehicles: With the same power as gasoline or diesel fuel, CNG can be used in transit buses, semi-trucks, school buses, waste disposal trucks and delivery vehicles to save money on fuel costs and reduce emissions.

Transit Buses: Currently, one of every five new transit buses in America is fueled by natural gas. As more American businesses become aware of the many benefits of using natural gas in its transit fleets, this number will certainly improve. Major manufacturers already produce natural gas-powered transit buses and can scale up even further with increased demand.

School Buses: A natural gas-powered school bus can displace 1,400 gallons of diesel fuel per year. CNG buses emit far fewer pollutants, such as soot (PM) and nitrogen dioxide (NOx), than older diesel engine buses (model 2006 and earlier) and significantly less NOx emissions than new diesel engine buses.\(^6\) Currently, there are more than 2,500 CNG buses in school districts across the country.

Heavy-Duty Transportation Sector:

Semi-trucks: Major manufacturers such as Kenworth and Sterling offer natural gas-powered trucks today and other manufacturers are planning to follow their lead. Using mostly liquefied natural gas (LNG), these massive vehicles operate with the same horsepower and performance as their diesel counterparts.

Refuse Vehicles: CNG vehicles are being used in many fleet applications: airports, delivery services, long-haul trucks, parks, police and traffic enforcement, refuse haulers, buses (school, shuttle and transit) and taxis. Like school buses, there are several factors that make fleet vehicles a great fit for CNG. They are typically high mileage vehicles, so the fuel savings from CNG vs. gasoline is substantial over the life of a vehicle. Plus, the central location of fleets indicates that they can locate near refueling stations or house their own facility.\(^7\)

CNG Vehicle Conversion Costs: Natural gas vehicle conversion costs vary across the board depending on fuel tank capacity, sizing, gas/diesel, and materials. For trucks (such as Ford F150's) costs are estimated to


\(^7\) CNG Now!, Fleets, Retrieved From: http://www.cngnow.com/vehicles/fleets/Pages/information.aspx
run between $7,500 and $9,500 for CNG conversion. Natural gas vehicle maintenance costs are equal to or less than gasoline or diesel, NGVs’ already favorable lifecycle cost advantages improve with federal and/or state tax credits.8

Materials that generally come with an example conversion kits are listed below:

- 6mm high pressure seamless stainless steel hose for connecting the cylinder tank to the regulator
- Rubber hoses, brackets, screws, and vacuum "T"s and clamps
- CNG Manometer (in-line gas pressure gauge)
- Gasoline Injector Cut-off Electrical Harness (stops the gasoline when CNG is running)
- Low Pressure CNG Fuel Filters (2 with V8 kit)
- Windows PC Cables and Software for Fuel Calibration ($159 one-time fee)
- P36 Refuel Valve 3600psi (where you pump the CNG into) Additional $60

C. Digestate Market

There is potential to generate revenue from the sale of the digestate produced from the co-digestion of wastewater treatment sludge and food waste. Although it has not been commonplace in the U.S market up to now, the changing regulations support the diversion of food waste and anaerobic digestion projects, as well as a promising market for the beneficial use of the digestate - which is necessary for a successful business structure. Supporting efforts for the beneficial use of biosolids is the Northeast Biosolids & Residuals Association (NEBRA), non-profit organization that promotes the use of biosolids and other residuals as fertilizers, soil amendments, and sources of energy. It is important that there is an investment in product and market development because without determining the markets and having a reliable digestate outlet plan and process in place, unforeseen costs can be incurred.

The quality of the digestate is largely based on the type and quality of organic material fed to the digester. Characteristics of digestate quality include the level of pathogen reduction, vector attraction reduction, concentrations of contaminants, concentrations of available nutrients, as well as its physical properties including appearance, odor, and moisture content. Utilization will depend on adherence to state and federal biosolid classifications.

As an example, a well-known product called Milorganite, is a sludge-based fertilizer produced at the Milwaukie based Jones Island Wastewater Treatment Plant. The final product is derived from anaerobically digested sludge that has been heat-dried and formed into small granules. This is an important success story to demonstrate that it is possible to market a sludge-based product and overcome social stigmas. Currently Milorganite is sold for approximately $13.00 per 36 lb bag, which will fertilize an area of about 2,500 ft².

The beneficial use of biosolid digestate is still in the early stages in the United States, therefore, as a reference, the expected digestate value has been compared to manure based operations which have the most readily available cost analysis data. In manure based anaerobic digestion, much of the material is used on-site for crop fertilizer and bedding, but when the separated solid digestate is marketed as a lightweight compost (used in place of peat or bark) and is sold for between $6 to $16/cubic yard.9 The actual revenue on digestate will vary based on quality, nutrient profile, and marketing.

Potential Digestate Applications: It is important to achieve a beneficial use for the digestate rather than disposal, to ensure an economically successful project for the Town of Greenfield. In addition to economic viability, the local creation of a nutrient rich land applicable product reduces the need for chemical fertilizers, which can be highly taxing on the environment and energy intensive to produce and transport.

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8 http://www.ngvc.org/forfleets/index.html
Options for digestate use include internal operations by the Town of Greenfield in composting, Brownfield reclamation projects, and use on municipal property, or sold to a single source purchaser. In addition, the separated solids can be repurposed, marketed and sold as bagged compost, bioplastics, low grade building materials, or egg cartons/fiber plant pots, although this often requires additional infrastructure resulting in additional costs, so is less common and not recommended for Greenfield.

**Internal Greenfield Digestate Utilization:** It is proposed that Greenfield add a composting facility following anaerobic digestion operations to manage the separated solid digestate, ensuring a high-quality product, free of pathogens, bacteria, and physical contaminants. The goal is to off-set costs of the town through beneficially utilizing the composted digestate to fertilize and enhance the soil structure of municipally owned lawns and fields, and well as Brownfield reclamation projects.

Brownfield reclamation and land revitalization projects are an excellent application for digestate. A Brownfield site is land previously used for industrial purposes or other potentially polluting operations, and is now contaminated with high concentrations of hazardous waste or pollution, making it unusable. Reclamation of a Brownfield Site can be both environmentally and economically beneficial. One method utilized to remediate Brownfield sites is to dig up and dispose of the contaminated soil and replace with non-contaminated soil. The composted digestate can be used to backfill this type of reclamation process.

Supporting this type of endeavor are incentives and cost-saving opportunities through programs such as the Brownfield Redevelopment Fund, created in 1998 to encourage the reuse of Brownfield sites in economically distressed areas. According to the MassDEP, Greenfield alone has almost 200 Brownfield sites shown in Figure II-19 below.\(^\text{10}\)

EPA Brownfield and Land Revitalization programs can benefit local communities in many ways. The EPA states that benefits are:

- Projects leveraged $17.79 per EPA dollar expended
- Leveraged 90,363 jobs nationwide
- Can increase residential property values 5.1% - 12.8% near Brownfield sites when cleanup is completed
- Promotes area-wide planning

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\(^{10}\) MassDEP, Waste Site/Reportable Releases Look Up, Retrieved From: http://public.dep.state.ma.us/SearchableSites2/Search.aspx
Single Source Purchaser of Digestate: In siting an anaerobic digester at the Greenfield Transfer Station, an arrangement with a local off-taker with existing composting infrastructure is also a favorable application. A single source purchase or trade is simple, streamlined, and secure; the Town of Greenfield will not have to pay disposal fees, increasing return on investment. The Town of Greenfield will not have to find use or spend money on marketing and selling of products; in addition, transportation costs would be minimal because it is going to a local facility adjacent to the digester. Digestate can be a beneficial additive to existing composting facility. A partnership between Greenfield and a local composting facility to integrate digestate into operations will depend on the quality of the digestate and compost end-product, which includes physical appearance, contaminants, and the nutrient profile.

Digestate Disposal Costs: In order for the project to be successful, the project developer must define an off-taker for the digestate, whether it be the municipality itself or a third party, to utilize the separated solid digestate beneficially rather than disposed of. The financial model used in this analysis assumes a slightly positive value for the separated solid digestate at $5.00 per ton ($3.35 per cubic yard), which was determined by considering a very conservative rate for comparable products, such as Milorganite or manure based digestate. It is assumed the separated solid digestate will be composted to create a product that meets all state and federal biosolid regulations and will be suitable for land application. In comparison, local Greenfield farms sell compost at an average of $42.00 a cubic yard. If disposed of, it will cost approximately $200,000 each year to landfill or incinerate the estimated 2,117 tons of separated solid digestate created annually.

II-5 Regional Organics Availability and Bio-Methane Potential (BMP)
In addition to the sludge from the Greenfield WPCP, which will serve as the primary stabilizing feedstock to the anaerobic digester, food waste will be incorporated to increase methane production. The sectors included in the assessment of available organics are entities required through the MassDEP waste ban to divert organic
waste from landfills and incineration, such as supermarkets, correctional facilities, restaurants, or food processing plants. Greenfield residential food waste and grass clippings will also be included. It is important to be conservative with availability estimates as there is the potential that organics may become a commodity rather than a waste stream over the long-term. Greenfield has a unique opportunity, as it is at the junction of two major roadways, Route 2 and Interstate 91, and can provide an opportunity for Greenfield to readily accept available organic waste that is transported through the region.

A. Category of Feedstock Generators

As mentioned, the MassDEP has promulgated a commercial organics waste ban, prohibiting organic generators that produce more than 1 ton of organic waste per week from disposing of it at landfills or incineration. This ban suggests that there is much potential for food waste incorporation in the digestion process. Feedstock substrate partners typically include: industrial food processing byproducts, supermarket food waste, large restaurant/cafeteria food waste (such as nursing homes and schools), and commercial waste haulers. The process to acquire a feedstock contract generally includes:

- Outreach and engagement to the producers
- Discussion of the upcoming DEP organics ban
- Review of existing obligations by organics producers
- Review of procedures and process enhancements to facilitate separation of organics
- Coordination and signing of contract structure, including volume or weight costs, frequency of shipping, and contingency planning
- Implementation, including a tracking and data collection system
- Ongoing Billing

Table II-6 below briefly describes the major benefits and risks with each food waste generator.

<table>
<thead>
<tr>
<th>Feedstock</th>
<th>Benefits</th>
<th>Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food processing byproducts (Industrial Sector)</td>
<td>Consistent, predictable stream fed to digester; high tipping costs that would make a new contract worth pursuing; low chance of contamination</td>
<td>Might already be locked into long-term contracts for waste disposal</td>
</tr>
<tr>
<td>Supermarkets</td>
<td>Consistent stream of food waste (although perhaps less formal information on its composition)</td>
<td>Mild risk of contamination (e.g. gloves); potentially have long-term contracts for food waste disposal</td>
</tr>
<tr>
<td>Restaurants</td>
<td>Potentially consistent stream of food waste, although often in less volume than supermarkets</td>
<td>A lot of coordination for relatively less feedstock; High risk of contamination (utensils, etc.); need for education of staff to promise contaminant-free feedstock</td>
</tr>
</tbody>
</table>
B. Quantifying Methane Production Given Regional Organics Feedstock

The Draper/Lennon, Inc report *Identification, Characterization, and Mapping of Food Waste and Food Waste Generators in Massachusetts* has identified large generators of food waste in Massachusetts, such as food processors, wholesalers, grocery stores, institutions, and large restaurants. Included are estimated food waste generation and mapped generator locations to facilitate planning of programs and facilities for capturing source separated organic materials for composting or other diversions, including the ability to process the feedstock items listed below. See 'Appendix F: Greenfield and Franklin County Organics Generators' for a listing of major organics generators located within Greenfield.

This study was used as the original data source for the MassDEP food generators data base and reference tool, and was updated in summer 2011 by the U.S. Environmental Protection Agency Region 1 office. The study goal to define food waste generation in Massachusetts was completed, and a comprehensive database of food waste generators in Massachusetts across a variety of generator types was produced. A set of Geographic Information System (GIS) tools that allow the state to use GIS technology to map food waste generators by category, size, waste types, waste quantities, and other variables, was provided in order to facilitate development of composting or organics diversion infrastructure on a statewide or local basis.11

Determining the feedstock capacity for an individual project is dependent on a number of factors, including regional availability, volume, bio-methane potential of acquired feedstock, and composition.

### Table II-7: Feedstock Source, Mix, and Percent Solids

<table>
<thead>
<tr>
<th>Source</th>
<th>Mix</th>
<th>Percent Solids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Pollution Control Plant (WPCP)</td>
<td>100% Sludge</td>
<td>3-5%</td>
</tr>
<tr>
<td>Yard Waste (Grass Clippings)</td>
<td>100% Green Waste</td>
<td>15-25%</td>
</tr>
<tr>
<td>Supermarket</td>
<td>95% Food Waste, 5% FOG</td>
<td>15-25%</td>
</tr>
<tr>
<td>Restaurant</td>
<td>85% Food Waste, 15% FOG</td>
<td>15-25%</td>
</tr>
<tr>
<td>Colleges/Institutions</td>
<td>90% Food Waste, 10% FOG</td>
<td>15-25%</td>
</tr>
<tr>
<td>Food and Beverage Manufacturers</td>
<td>75% Food Waste, 25% FOG</td>
<td>10%</td>
</tr>
<tr>
<td>Organic Fraction of Municipal Solid Waste (OFMSW)</td>
<td>95% Food Waste, 5% FOG</td>
<td>15-25%</td>
</tr>
</tbody>
</table>

C. Recipe Considerations

When managing multiple sources and types of feedstock, care must be given to develop the proper recipe within the digester. Factors in determining the most advantageous recipe include bio-methane potential, percent solids, and potential to upset process. The correct recipe can decrease operational issues and limit chemical additives, as well as encourage high efficiency and thus a high yield of methane. Additionally, a consistent loading rate of the determined recipe is important, as overfeeding or underfeeding the bacteria can cause spikes and crashes which can decrease bacteria colony size and negatively impact equipment.

Evaluating the strength of each feedstock type is important to attain even methane production, because not all waste has an equal bio-methane potential. Wastewater sludge, while offering stability to the process, is a material that has already been digested and yields relatively little energy (methane). To produce enough energy for an economically feasible system, the addition of higher methane yielding substrates to produce larger amounts of biogas is necessary. For complete mix AD systems, the feedstock recipe needs to be

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11 Draper/Lennon, Inc, Identification, Characterization, and Mapping of Food Waste and Food Waste Generators in Massachusetts, MassDEP, September 2002
12 Oregon Department of Environmental Quality, Grasscycling, Retrieved From: http://www.deq.state.or.us/1q/sw/twopercen/grasscycling.htm
slurried into an 8-12% solids mixture. If dilution of the feedstock slurry is necessary, the separated liquid digestate can be piped into the hydrolysis tank to meet the desired solids content.

D. Wastewater Sludge as Digester Feedstock

Data from the Greenfield Water Pollution Control Plant for 2012 shows that a total of 1,777,000 gallons of sludge, 391 dry tons, was trucked out with an average of 148,083 gallons monthly at 5% Solids. The characteristics of WPCP sludge is discussed in greater detail in Section II-2-B.

E. Greenfield and Franklin County Organics Generators as Digester Feedstock

The MassDEP Organics Waste Ban will affect nearly 30 businesses and institutions throughout Greenfield which can serve as feedstock sources for the anaerobic digester. Based on data provided by the Massachusetts DEP, Greenfield alone generates almost 2,000 tons of food waste per year, while Franklin County generates 2,501 tons a year. A complete list of regional businesses affected by the upcoming MassDEP organic waste ban is shown in Appendix F.

Table II-8 below shows our calculation methodology relating to the availability of total volume from organics generators. Note that waste generation estimates are not available for food and beverage manufacturers/processors and distributors due to the variability in these sectors. Additionally, generation estimates may not be available for other facilities where data is missing.
Table II-8: Estimated Total Feedstock Availability and Methane Potential in Greenfield/Franklin County and Massachusetts

<table>
<thead>
<tr>
<th>Region:</th>
<th>Greenfield / Franklin County</th>
<th>Massachusetts</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Amount (tons/year)</td>
<td>Estimated Availability</td>
<td>Total (tons/year)</td>
</tr>
<tr>
<td>WPCP</td>
<td>7,796</td>
<td>100%</td>
<td>7,796</td>
</tr>
<tr>
<td>Total Sludge (tons/year)</td>
<td>7,796</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supermarkets</td>
<td>1,072</td>
<td>10%</td>
<td>107</td>
</tr>
<tr>
<td>Restaurants</td>
<td>612</td>
<td>10%</td>
<td>61</td>
</tr>
<tr>
<td>Institutional</td>
<td>200</td>
<td>10%</td>
<td>20</td>
</tr>
<tr>
<td>Food and Beverage Manufactures</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Curbside Pickup</td>
<td>1,962</td>
<td>25%*</td>
<td>490</td>
</tr>
<tr>
<td>Green Yard Waste</td>
<td>31</td>
<td>100%</td>
<td>31</td>
</tr>
<tr>
<td>Total Food Waste (tons/year)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL (tons/year)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

F. Municipal Organics Waste as Digester Feedstock - Transfer Station

Greenfield has recently implemented an organics diversion program at the Transfer Station where residents can drop off their food waste free of charge, and according to Greenfield, the new initiative has been embraced by Greenfield residents. Greenfield was also a recipient of a MassDEP Sustainable Material Recovery Program Grant that supports the diversion of food waste throughout Greenfield schools and advances municipal residential curbside collection.

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13 In line with DEP estimations, industrial producers have been excluded from this analysis in order to be conservative.

14 Greenfield: Population 17,456; 4.4 pounds of waste generation per person per day; 14% is food scraps; 0.14(4.4x17,456) = 10,753 pounds per day. http://www.epa.gov/wastes/nonhaz/municipal/pubs/msw_2010_rev_factsheet.pdf
III. ANAEROBIC DIGESTION EQUIPMENT RESEARCH & ANALYSIS

Key Points: Commercially available technologies were explored to determine the optimum approach for the proposed anaerobic digestion project at the transfer station in Greenfield. Discussion, recommendations, and background reference information is found within this chapter. Based upon our analysis, the following components are recommended:

- Complete mix mesophilic anaerobic digester with mechanically and variable-angle mixers
- Hydrolysis and digestion tanks heated with integrated PEX tubing
- A tank mounted dual-membrane for biogas capture
- A compressed natural gas (bioCNG) fueling station for vehicle use is recommended due to the interest Greenfield has in reducing municipal vehicle operational costs; In the bioCNG system, the H₂S and Siloxanes present in the biogas will be scrubbed by the bioCNG gas cleaning and conditioning system
- Combined heat and power generation is not recommended due to low electrical and thermal energy consumption at the transfer station
- Injecting bio-methane into the natural gas pipeline is not recommended due to the low cost of natural gas on the wholesale energy market
- Solid digestate is recommended to be composted on-site and used in municipal applications, brownfield reclamation, or provided to a reseller; liquid digestate will be returned to the WPCP through the existing sewer system

III-1 Feedstock Selection, Receiving, and Storage

A successful feedstock management program must account for operational, sourcing, and processing considerations. Improper management can create unfavorable conditions that can negatively impact digester operations. It is recommended that a comprehensive feedstock management plan should consider the following:

- **Quantify Volume of Available Classifications of Organic Waste:** Determine the total amount of organic waste in the region and establish what is available and economically viable for use at the Greenfield anaerobic digester. This includes exploring establishments’ existing contracts (with waste haulers, composting facilities, or elsewhere), interest level on their behalf, the volume, and the degree of quality of organic waste the establishment would be supplying.
- **Evaluate Pre-processing and Sorting Programs:** Establish if any methods and procedures are in place for sorting out organic waste at the generator site, and if not, what type of sorting programs would need to be implemented. Both the level of sorting and separation processes, and transportation methods (tanker truck liquids, solids) will be determined depending on the type of the organic generation establishment (supermarket, industrial, restaurant).
- **Evaluate On-site Processing Needs:** Once the feedstock arrives at the digester site, on-site processing requirements will need to be determined (screening, de-packaging, slurrying, etc).
- **Designing Feedstock Recipe for Maximum Methane Production:** When the available feedstock is determined, a specific recipe can be resolved to maximize the highest consistent methane production and maintain optimal operating conditions in the digester.
- **Feedstock’s Ability to Create Beneficial Digestate:** The material that goes into the digester, although transformed and reduced, determines the structure and composition of the end product. Therefore, the
feedstock must be analyzed to determine appropriate uses or disposal methods. The most sustainable model for anaerobic digestion is using the digestate beneficially.

A. Feedstock Types and Energy Characteristics

When developing an anaerobic digestion project the organic feedstock acts as the ‘fuel’ for the system as it is converted into methane. Common organic feedstock generators include:

- Wastewater Treatment Facilities
- Municipal Green Waste (Grass Clippings)
- Supermarkets
- Restaurants
- Hospitals
- Nursing Homes
- Industrial Food Manufacturers
- Universities
- Municipal Solid Waste

Each feedstock has different characteristics associated with it. The table below depicts some of the varying characteristics including: total solids, total volatile solid, biogas yield, biomethane potential (BMP), unwanted substances, and frequent problems.
Table III-1: Characteristics of Sample Feedstocks

<table>
<thead>
<tr>
<th>Feedstock</th>
<th>Total Solids TS (%)</th>
<th>Volatile Solids (% of TS)</th>
<th>C:N Ratio</th>
<th>Biogas Yields (m³/kg VS)</th>
<th>BMP (% CH₄ Content)</th>
<th>Potential Unwanted Substances</th>
<th>Inhibiting Substances</th>
<th>Frequent Problems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Garden Wastes</td>
<td>60-70</td>
<td>90</td>
<td>100-150</td>
<td>0.20-0.50</td>
<td>NA</td>
<td>Soil, cellulosic components</td>
<td>Pesticides</td>
<td>Poor reduction of cellulosic material</td>
</tr>
<tr>
<td>Grass</td>
<td>20-25</td>
<td>90</td>
<td>12-25</td>
<td>0.55</td>
<td>NA</td>
<td>Grit</td>
<td>Pesticides</td>
<td>pH reduction</td>
</tr>
<tr>
<td>Fruit Wastes</td>
<td>15-20</td>
<td>75</td>
<td>35</td>
<td>0.25-0.50</td>
<td>NA</td>
<td>Non-degradable material, grit</td>
<td>Pesticides</td>
<td>pH reduction</td>
</tr>
<tr>
<td>Food Remains</td>
<td>10</td>
<td>80</td>
<td>NA</td>
<td>0.50-0.60</td>
<td>70-80</td>
<td>Bones, plastic material</td>
<td>Disinfectants</td>
<td>Sediments, mechanical problems</td>
</tr>
<tr>
<td>Cow Slurry</td>
<td>5-12</td>
<td>75-85</td>
<td>6-20</td>
<td>0.20-0.30</td>
<td>55-75</td>
<td>Bristles, soil, H₂O, NH₄, straw, wood</td>
<td>Antibiotics, disinfectants</td>
<td>Scum layers, poor biogas yield</td>
</tr>
<tr>
<td>Chicken Slurry</td>
<td>10-30</td>
<td>70-80</td>
<td>3-10</td>
<td>0.35-0.60</td>
<td>60-80</td>
<td>NH₄, grit, sand, feathers</td>
<td>Antibiotics, disinfectants</td>
<td>NH₄ inhibition, scum layers</td>
</tr>
<tr>
<td>Whey</td>
<td>1-5</td>
<td>80-95</td>
<td>NA</td>
<td>0.80-0.95</td>
<td>60-80</td>
<td>Transportation impurities</td>
<td>NA</td>
<td>pH reduction</td>
</tr>
</tbody>
</table>

B. Feedstock Receiving and Odor Control

Odor issues are very rare with anaerobic digestion systems. It occurs primarily in feedstock transportation, handling and storage, such as putrescent food waste leaking out of a delivery truck or a storage container that is not properly sealed or contained. These issues are easily eliminated by complying with proper protocols. To mitigate transportation odors the type of trailer/hauling truck to be used should be leak-proof and able to withstand the corrosive nature of some food waste. Additionally, feedstock receiving and handling will take place in a closed structure, limiting any potential for odor to escape. Furthermore, there is a large buffer zone between the proposed facility and the neighbor, see Figure II-2 for distance to adjacent neighbors. In addition, an Odor Management Plan (OMP) will be developed and implemented that incorporates odor reduction controls for digester operations and is consistent with local air district odor management requirements.

C. Pretreatment and Processing

The substrate fed into the digester can vary widely in size and material properties (pH, solids content, contaminants), and may necessitate a method of pretreatment to remove any impurities and to create a homogenous feed to digester. Treatments can be completed physically, chemically, or biologically.¹⁵ Feedstock processing methods are determined by the digester technology, available feedstock, solids content (i.e. whether it is a pumpable feedstock that can be directly connected with a hose, or higher solids that need to be slurried), where in the supply chain the waste comes from (i.e. pre-consumer waste that is free of contaminants, or post-consumer waste that is likely to have contaminants such as packages, utensils, etc), and other potential contaminants. General requirements for pre-processing feedstocks include sorting, material removal, and size reduction employing a combination of the following steps:

- **Sorting**: Mechanical or manual sorting out of organic waste from other recyclables and solid waste.
- **Material Removal**: Removing unwanted packaging and materials can be done manually or with a trommel (a large rotating drum with knives).
- **Size Reduction**: Commonly used methods to create slurry of the proper consistency include a chopper pump in the receiving tank or an in-line grinder prior to the pump. These pieces of equipment serve to:
  - Shred (slow speed, larger size output)
  - Grind (high speed, smaller size output)
  - Screening, small and large

**Figure III-2: Mixed Food Waste Pre-Processing Equipment - Trommel and Chopper Pump**

Other forms of treatment may include:
- **pH levels**: A neutral pH is necessary for an optimal anaerobic environment, so additions can be added to either raise pH with the addition of Lime, or lower it with acidic substances.
- **Removal of Toxic Materials** (Heavy metals, chlorinated compounds and detergents): Examples include copper ion adsorption.
- **Water Addition**: If necessary this can include, but is not limited to, the addition of separated out effluent from the digester, city water, and non-potable well water to the feedstock. Addition of water or effluent will be required when the feedstock slurry has a solids content that is too high and needs to be brought down to the 8-12% range.

**D. Feedstock Storage**

Feedstock storage is critical to ensure that enough resources are available to be fed to the system to produce consistent biogas production given the intermittent nature of the feedstock deliveries. Typically this is best achieved by having at least two receiving tanks – one of high energy (high bio-methane potential such as FOG) feedstock and low energy (low bio-methane potential such as sludge) feedstock. This allows for the recipe to be optimized and contents from the high-capacity tank to be slowly fed to the digester to ensure consistent biogas production. A regular feeding schedule is important because the overfeeding of high capacity feedstock can cause overproduction of methane causing an excess of biogas that would have to be flared, as well as causing a “spike and crash” of the bacteria living in the tank, which can depress production for days while the bacteria repopulates. Additionally, while low-energy feedstocks offer stability to the
system, overfeeding of low-energy substrate can result in underproduction of methane which decreases the available operational capacity for CNG, CHP, or other energy generating systems.

### III-2 Digester Technologies

The scope of anaerobic digesters can vary greatly depending on many factors, including but not limited to, loading rates, feedstock type and availability, budget, and space. The motivation, whether it is biological, technical, economical, or environmental, should also be identified prior to implementation. Proper design and application of technology is required to avoid common mistakes, such as tank foaming, pH spikes, wide variances in biogas production, and ensuring correct carbon-nitrogen ratio. Following feedstock preparation, the VWWTF sludge and the homogenous slurry of food waste is fed to the digester where anaerobic bacteria break down the organic matter, resulting in the release of a combustible biogas product, composed primarily of Methane (50%-60%) and Carbon Dioxide (~25%). The size of the digester tank is determined by retention time and organic loading rate. For a detailed parts list of an anaerobic digester, please refer to Appendix G: Anaerobic Digester Example Equipment List.'

#### A. Digester Types

The size and type of digester is dependent on feedstock volume, feedstock type, loading rate, and retention time. The most common types are complete mix, plug-flow, and covered lagoon. The type most applicable to the proposed AD facility at the Greenfield Transfer Station is a complete mix digester as it maximizes the quality and quantity of biogas production and is the most reliable configuration for this region.

**Complete Mix Digester (Recommended):** This type of system consists of an enclosed, heated tank, and a mechanical, hydraulic, or gas mixing system, where controls regulate volumes and maintain constant elevated temperatures in the mesophilic range (35°-40°C/95°-104°F) or thermophilic range (50°-60°C/122°-140°F). Complete mix digesters require low solid slurry, which can include sludge, cow manure, food waste, FOG, and industrial organic waste. To keep the solids content between 8-12%, dilution may be required and can be done with low solids WWTF effluent and non-potable wells. It has a shorter retention time typically between 20-35 days. Note that these types are suitable to take advantage of mixed substrates and therefore are recommended.

System Components typically include the following, with a schematic shown in the subsequent Figure III-3.

- Mix tank
- Digester tank with mixing, heating, and biogas recovery systems
- Effluent storage structure
- Biogas utilization system

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Plug Flow Digesters: These systems are generally long and narrow tanks made of reinforced concrete, steel or fiberglass with a rigid or flexible cover. It can be positioned either horizontally or vertically, with a constant volume of material added, forcing the material in the tank to move through and be digested. Basically, the material enters at one end and pushes older materials toward the opposite end. Plug-flow digesters do not have internal mixers and the breakdown of organic matter results in stratification along the length of the digester. The biogas produced is used to heat the digester and on-site operations, to power a CHP engine, or in CNG applications. Plug Flow Digesters are used typically at dairy operations where manure is scraped, collected, and fed to the digester. Retention time is typically 20-40 days, the tanks are insulated and heated, and the total solids content is approximately 11-14%. Note that these types are not suitable to take advantage of mixed substrates.19

Figure III-4: Plug Flow Digester Process Diagram

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19 Penn State College of Agricultural Sciences, Types of Anaerobic Digesters, Retrieved From: http://extension.psu.edu/natural-resources/energy/waste-to-energy/resources/biogas/types-of-anaerobic-digesters
B. Anaerobic Bacteria and Temperature Preferences

There are three main temperature ranges at which anaerobic digesters operate: Psychrophilic, Mesophilic, and Thermophilic. The temperature will dictate the type of bacteria that live and thrive in the oxygen free environment. Reaction rates generally increase at higher temperatures, which in turn lessen retention time, though may result in a more unstable environment.20

- **Mesophilic (Recommended):** Temperature range 35°C (95°F) and 40°C (104°F). This temperature is advantageous because it encompasses a wide diversity of bacteria that are robust and adaptable to environmental change resulting in a stable environment. In addition, the less stringent heating requirements (compared to thermophilic) are easier to maintain and require less energy to remain steady. The process only brings the biosolid digestate to a Class "B" standard (USEPA Title 40 Part 503 - restricted land application and public contact) and may need additional stabilizing to be beneficially used. A single stage mesophilic system typically has a retention period between 20 and 30 days to allow for full digestion of the organic feedstock. Furthermore, municipal wastewater systems can see a volatile solid reduction of approximately 50%, while advanced complete mix can reduce volatile solids by 80-90%.

- **Thermophilic:** Temperature ranges between 50°C (122°F) and 60°C (140°F). Benefits of the higher temperature include increased reaction rates resulting in shorter retention times (12-14 days), increased gas yields, easier removal of water from digestate, increased volatile solids reduction (VSR), and better pathogen kill resulting in a Class "A" biosolid (USEPA Title 40 Part 503) that can be used in land application widening the available options for use. On the other hand, thermophilic systems are less stable, require increased energy input (may not be viable depending on the amount of methane/electricity/heat produced), and require a more expensive technology and a higher degree of operation and monitoring.

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- **Psychrophilic**: Temperature ranges between 15°C (59°F) and 25°C (77°F). The low temperature makes for a very stable reaction process, which is easy to manage; however, the retention time is very long creating the need for large tanks. Given the municipal wastewater treatment facility’s economic and sizing constraints, this option is not applicable to this project.

- **Two-stage Thermophilic-Mesophilic**: A two-stage thermophilic-mesophilic digestion system can also be implemented, typically operating in a primary thermophilic stage of 1-3 days retention time in order to achieve disinfection, followed by the stable mesophilic conditions having a retention period of 10-15 days. This strategy is generally applied for larger systems, thus is not viable for the small sizing of this project.

**C. Heating and Insulation**

In order for the digestion tank to be kept at a constant elevated temperature necessary for the bacteria to thrive, the process tank must be heated. The level to which it is heated is dependent on the type of system - psychrophilic, mesophilic, and thermophilic. Heating is accomplished through three common methods, with the most successful being integrated PEX tubing and is therefore recommended for the Greenfield anaerobic digester.

- **Integrated PEX Tubing (Recommended)**: In order to transfer heat to the steel tank and maintain an elevated steady temperature, PEX tubing is wrapped around the steel tank, or more efficiently within the concrete walls of the tank, and hot water from CHP hot water supply or a boiler is circulated through the tubing bringing the temperature up and maintaining it. The tanks are then insulated and covered with metal siding. This is typically the best option as it allows for consistent and low-temperature heating.

- **Immersed Coils**: An external boiler or a CHP unit generates either hot water or steam, which is then circulated through coils that are immersed within the tank. This method is not recommended because it causes inconsistent heating across the tank. Additionally, over time, the coils will ‘bake’ feedstock onto the coils and reduce heat transfer ability.

- **External Heat Exchanger**: An external heat exchanger pulls slurry from the tank, runs it through an external heat exchanger, and then is returned to the tank, now warmer. The Greenfield digester is planning the co-digestion of food waste and sludge (estimated solids between 10% and 15%), and when 12% solids are pumped through a heat exchanger it can clog and be very abrasive, damaging equipment.

**D. Tank Cover and Biogas Storage**

The digester cover needs to be completely sealed to retain biogas and odors inside the vessel and support anaerobic activity. Options include a fixed structure that is used when sludge/substrate levels remain constant with only a small variation because it is a stationary design; a floating cover that allows variable sludge storage and is in contact with the substrates preventing scum blankers from forming; or the more commonly used application with a complete mix co-digestion system - the gasholder covers.

Dual-membrane gas-holders are not in contact with the substrate, but rather with the biogas being produced. A double air supported membrane has one fixed membrane and a second membrane that fluctuates with the production of biogas. The highest rated membrane materials used are polyvinyl chloride (PVC) geomembrane and high density polyethylene (HDPE) geomembrane - both synthetic materials that offer a barrier between the reaction inside the vessel and the outside environment. The HDPE geomembrane also offers excellent UV protection, thus providing long term operation before replacement.

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A steady biogas can be produced with the complete analysis of the substrate mixture, the AD plants loading rate capacity, and monitoring system. Because the biogas will not necessarily be used at exactly the same rate at which it is being produced, it must be stored. When deciding how big the storage tank/bladder should be, what it should be stored in, and how it should be stored, one must take into account many factors because there is no one definitive right answer across the board, as is all facets of constructing a digester. Parameters one must take into account include: volume changes, varying exterior temperatures, plant design and management, load, available feedstock, projected biogas output, biogas utilization (CHP, natural gas pipeline, boiler, or CNG quality), frequency, rate used, and costs of locally available building materials.

A successful design makes sure the tank/bladder is the appropriate size, compensating for biogas fluctuations. By leaving enough room for the gas to expand, it will avoid sludge being forced out of the overflow pipe or gas bubbles to be forced out of the storage tank’s water seal. As well as compensating for large biogas production, the storage tank should also be small enough that the tank is never so empty of biogas that the gas pressure drops below the threshold of acceptable pressure. Storage capacity should be equal to approximately one day’s gas production to account for fluctuations in methane generation. Biogas storage options include a stand-alone system or a tank-mounted membrane, which is recommended because it is a better utilization of the space and more common.

- **Tank-mounted membrane (Recommended):** Tank-mounted membrane is located on top of a digester system and involves an inner and outer membrane where the outer one is kept in a fixed position while the inner one moves freely like a balloon as it stores or releases biogas. The outer membrane acts as a protective layer preventing leaks while the inner membrane provides useful storage and is generally made out of PVC coated polyester fabrics and moves freely as it stores or releases biogas. Every gas holder will be designed specifically with storage capacity and structural requirements, such as managing snow load, wind load, and operating pressure.

- **Stand-alone systems:** Stand-alone systems use the same duel membrane as a tank-mounted gas holder, but act as a separate structure with a concrete foundation. There is also a bottom membrane which seals the gas storage to the foundation. The drawback of stand-alone systems is that they can require an area equal to the digester footprint.

**E. In-tank Mixing**

Mixing of the different feedstocks to create a homogenous substrate in the digester is very important as it ensures that the maximum number of bacteria will come in contact with the substrate, thus optimizing methane production. Mixing in the digester tank can be done mechanically, hydraulically or with a gas mixing system and is necessary to create a stable and homogeneous environment (physically, chemically, and biologically) through the reactor, which is especially important with high loading rates. Proper mixing in the reactor promotes contact between the feedstocks and bacteria, distributes organics and dilutes inhibitory substances within a digester, lessens temperature stratification, reduces grit settling, and keeps the formation of the surface scum layer under control. It has been shown that the smaller the particle, the more contact the volatile solids of the substrate has with the methane forming bacteria, therefore increasing biogas yields.

Electrical energy required for mixing is typically about 5-10% of the total energy generated by a combined heat and power system. In implementing a CNG system, this electricity is provided by the existing electric utility service. A major goal of digester companies is to determine the most cost-effective way to mix the substrate with the least amount of parasitic load. Listed below are three ways mixing is accomplished in the digestion tank. Mechanical mixing with variable propeller positioning is recommended for the Greenfield AD facility due its ability to handle the variety of substrates fed to digester and the total solids of 12%.

- **Mechanical Mixing (Recommended):** Mechanical mixing is the physical movement and agitation of liquid and requires the use of electrical power. Mechanical mixing is more suited for co-digestion because
of its robust nature, and is commonly achieved with a propeller.\textsuperscript{22} Propellers can be fixed within the digester, although the improved and recommended application is that they are able to move within the tank and be repositioned to a desired angle in order to optimize mixing and to decrease foaming.

**Figure III-6: Mechanical Mixing System**

- **Gas Mixing:** Gas driving the movement of liquid. Gas mixing recycles the biogas released through the AD process to bubble through the digester, thus mixing the contents. This process can be done in a few different ways - gas injectors installed throughout the tank extending from the roof throughout the reactor, and gas injectors being placed at the bottom of the tank, therefore avoiding the use of long lances. Jet aerators combine low pressure gas with the liquid in the reactor tank and the resulting mixture is pushed through a nozzle creating a high velocity plume which mixes the tank. Gas mixing has historically been very popular and appropriate in the municipal WWTF digester methods, but isn't suited for mixed substrates, as gas mixers are meant for 1-6% solids.\textsuperscript{23}

**Figure III-7: Gas Mixing System**

- **Hydraulic Mixing:** (Jet Mixer) Liquid driving the movement of liquid or pumped recirculation. This type of system requires a compressor to generate the pressurized jets; the compressor consumes electricity.

\textsuperscript{22} N. Massart et al, *Anaerobic Digestion - Improving Energy Efficiency with Mixing*, Pima County Regional Wastewater Reclamation Department, Tucson Arizona, Water Environment Federation, 2008

• **No Mixing/Stratification:** An example of a non-mix system would be a plug-and-flow system or landfill gas project where the waste, including the organic fraction, is simply placed into a contained environment. A non-mix tank would not be applicable to this type of project.  

**F. Operations & Maintenance**

Installation of an anaerobic digester may require one full time position for routine maintenance, depending on the size of the operation. Other maintenance activities may be required specific to the manufacturer and equipment provider, though common maintenance activities and frequency are listed below:

- **Sludge/Organic Waste Removal (every 1-2 years)** - An anaerobic digester system must be cleaned and removed of excess sludge and organic waste. In well-designed systems, this is performed automatically with very little downtime.
- **Pump Clearing (every 3-6 months)** - When pumping high solids content waste, it is important to ensure that pumps are cleared of debris regularly. Inorganic substances can clog pumps hindering operation of the digester.
- **Iron Packing Replacement (every 6-12 months)** - In CHP applications, it is important to remove the corrosive hydrogen sulfide compounds to avoid engine replacement. This can be done by passing the biogas through iron packing material. The iron packing should be replaced at least every 12 months.
- **Valve Leak Checks (every 6-12 months)** - To avoid safety hazards, it is recommended that the valves on the digestion system be checked for leaks one to two times a year. Improperly working valves should be replaced immediately.
- **Pipe Leak Checks (every 6-12 months)** - Pipes must be checked for leaks at least once per year. It is also important that no open flames are anywhere near inflow or outflow pipe lines.
- **Fittings Leak Checks (every 6-12 months)** - Any nonmetal fitting (i.e. ducted vents, plastic valves, rubber fittings) located on the gas or waste pipeline must be inspected.

**III-3 Biogas Generation**

**A. Optimizing Methane Production**

Methane production is the result of a complex series of naturally occurring biochemical reactions within the digester tank. A number of conditional factors relate to the level of methane production, with some basic criteria listed below. Since it is a naturally occurring process, when these conditions are met, the anaerobic digestion process is self-propagating.

- **Staging the Process:** The feedstock is loaded into a receiving tank, from there it is pumped to the hydrolysis tank per recipe parameters, and completes digestion in the anaerobic digestion tank. A separate stage for hydrolysis (3-5 days) is done to ensure the digestion process is started correctly.
- **Carbon to Nitrogen Ratio (C:N):** Anaerobic Digestion is basically a carbon conversion tool where the organic carbon of the sludge and food waste is converted into a gaseous inorganic carbon - methane and carbon dioxide, meaning that higher carbon to nitrogen ratio increase methane production. The ideal C:N ratio for AD is approximately 20:1 to 30:1, so care must be given to maintain this ratio. In smaller scale anaerobic digestion application such as with Greenfield, co-digestion of the sludge with materials that have higher carbon content is necessary to produce the amount of methane needed for to generate a reasonable return on investment for the system.

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24 Dr. Hara Papachristou, *The Art of Mixing, Anaerobic Digesters*, BHR Group, 2011
26 EPA AgStar, *Increasing Anaerobic Digestion Performance with Codigestion*, September 2012
• **pH Requirements**: Anaerobic digestion bacteria thrive in a neutral environmental and excessive stray in either direction to acidic or basic can cause serious operational problems and even the complete death and shutdown of a system. The necessary pH for anaerobic digestion ranges between 6.8 and 8.5 and varies slightly depending on which stage of the anaerobic digestion process is occurring.

• **Total Solids Content**: The total solids (TS) concentration of the feedstock affects the operational parameters of the anaerobic digestion process (pH, temperature) and effectiveness of the microorganisms in the decomposition process. Generally, a system is designed to be a wet or dry process depending on the total solids of the feedstock. A wet AD process is primarily water based with incoming substrates usually less than 15% solids, and dry systems, although still composed primarily of water, have a higher total solids content on average of 20% or higher. Higher solids require more energy input to move and process the feedstock (pumping, mixing, etc.) and will typically have a lower land requirement due to the lower volume of liquid incorporated. In turn, lower solid feedstocks have a larger land requirement, but require less energy input because it’s easier to pump and process a liquid material. Lower solids also promote increased mixing and circulation of materials encouraging contact between the bacteria and their food.

B. Non-Methane Biogas Components

The biogas created through the digestion process is primarily composed of methane and carbon dioxide, but can also contain varying amounts of other substances that may require removal prior to combustion in either a CHP engine or a CNG vehicle engine. The removal of these impurities is often essential to reducing equipment corrosion, lowering maintenance requirements, and increasing equipment efficiency. Typical contaminants include siloxanes, hydrogen sulfide, water, dirt particles, nitrogen, hydrogen, and oxygen.

• **Siloxanes**: Siloxanes are a silicone-based compound found typically in personal care products such as soap, cosmetics, deodorants, food additives, and shampoo, therefore, easily making their way through the sewer system and ultimately to wastewater treatment facilities. Removal of siloxanes is required before the biogas is sent to operate a CHP system or CNG vehicle because, when subjected to high combustion engine temperatures, siloxanes can glassify on equipment causing engine parts to prematurely wear out, adversely affect the life and effectiveness of catalytic converters, and leave abrasive siloxane deposits on pistons and cylinder heads reducing engine life drastically. They are mainly found in landfill gas and wastewater treatment plant biogas as they are related to human consumer products.

• **Hydrogen Sulfide (H₂S)**: The bacterial breakdown of organic material containing Sulfur creates H₂S in the biogas. It is a colorless gas with a familiar foul odor, most recognizable where anaerobic digestion occurs naturally such as swamps. Hydrogen sulfide can become problematic to the anaerobic digestion process if there is equipment failure where the odorous gas is released. Additionally, it can be corrosive to mechanical parts and gaskets when present with moisture, and release harmful emissions when combusted. The concentration of H₂S can vary greatly depending on the nature of the feedstock, but are typically reported between 1,000 - 3,000 ppm for H₂S in raw biogas. In terms of equipment tolerances, H₂S concentrations in biogas have to typically be reduced to between 200-500 ppm for combustion in a CHP system, and reduced to 4 ppm for applications that require natural gas equivalent standards such as CNG or injection into the grid. By decreasing hydrogen sulfides at or below 200 ppm CHP engines can extend their efficiency to be rebuilt every five years, rather than every 2 years when H₂S removal is at 1500 ppm.

• **Moisture/Water Vapor**: Biogas from anaerobic digestion is commonly saturated with water, and because most biogas utilization processes (combustion and grid injection) require dry gas, moisture removal is necessary. Problems occur when water vapor is present because when biogas is passing from high pressure to lower pressure the water vapor condenses into water or ice, which can result in corrosion,
clogging of the pressure regulator in the gas conveyance system, and it may reduce the energy value of the biogas.

- **Ammonia (NH₃):** Ammonia is a common and widely used product in fertilizers and household cleaners, and can also be a byproduct of the breakdown of organic waste. Ammonia in gaseous form is colorless with a characteristic pungent smell and is generated at very low levels of typically 1 ppm in biogas. A separate cleaning step is usually not necessary to remove ammonia because it is soluble in water and biogas upgrading methods that remove moisture will typically separate out the ammonia as well. It is important to remove ammonia because it can be corrosive on mechanical parts, and if ammonia is present in the combustible of the biogas it could lead to the formation of nitrogen oxides (NOₓ), an air pollutant.

- **Carbon Dioxide (CO₂):** Carbon dioxide is a natural part of the digestion process, thus is not necessary to remove in CHP applications and can simply pass through the burner or engine. When a higher percentage of methane is required for applications such as CNG or pipeline injection, the CO₂ is removed since it accounts for 25% of the volume of biogas.

- **Particulates:** Particulates are tiny pieces of solid or liquid matter, such as dust and oil particles, in the anaerobic digestion process. These particles can cause mechanical wear in gas engines and gas turbines.

### C. Gas Cleaning Methods

Biogas cleaning is important for two primary reasons; to increase heating value of biogas, and to meet quality requirements for gas burning or consuming appliances, such as a CNG vehicle engine or a combined heat and power engine.

In the case of BioCNG, which is recommended for Greenfield, the biogas cleaning and conditioning (removal of H₂S, siloxanes, and moisture) is inclusive of the BioCNG system. Please refer to 'Appendix H: Example Specification for BioCNG Biogas Cleaning System'. In other applications such as CHP, recommended cleaning methods include air injection systems, adding ferric chemicals to the feedstock, or an activated charcoal system. Additionally, moisture content needs to be reduced as much as possible. This is usually done by having condensate traps along the biogas piping as well as a gas cooler/condenser just before the biogas is fed to the CHP. The available gas cleaning technologies are discussed in further detail below. The cost for biogas scrubbing has come down considerably in recent years.²⁷

- **Cooling/Condensation:** This technology is implemented to remove water vapor. The biogas is cooled to the point of water vapor condensation and is collected in condensation traps. This method can also condense and collect other contaminant such as siloxanes and ammonia. This can be achieved through refrigeration compression/chiller facility, advanced refrigeration, and passive gas cooling. Cooling introduces no contaminants to the biogas or digestate. There is minimal waste discharged, where the condensate water can be discharged to the sewers, but is more likely to be recycled back into the digester. Spent refrigerant contaminated with another substance may constitute a hazardous waste and must be disposed of according.²⁸

- **Activated Carbon:** Activated carbon is an inexpensive, non-polar, well proven technology used for the removal of organic substances and non-polar adsorbates such as siloxanes, hydrogen sulfide (H₂S), carbon dioxide (CO₂), and halogenated hydrocarbons. This is the most widely used adsorbent because the pore size, distribution, and surface area can be tuned to the desired materials to be removed.²⁹ The biogas is led through vessels containing activated carbon filters where the unwanted substances are taken up and is usually used in combination with and subsequent to ventilation of air into the biogas (air injection). Activated carbon introduces no contaminants to the biogas or digestate. When the activated

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²⁸ Ed Wheless and Jeffrey Pierce, *Siloxanes in Landfill and Digester Gas Update*, 2004

²⁹ [http://www.cpeo.org/techtree/ttdescript/vapphas.htm](http://www.cpeo.org/techtree/ttdescript/vapphas.htm)
carbon beds are saturated, they will need regeneration or replacement. More commonly the filters are just disposed of in landfills, but can be regenerated although there are few regeneration facilities.

- **Adsorption**: Adsorption is a simple technology used to remove a broad range of contaminants including siloxanes, moisture/water vapor, carbon dioxide (CO2), and hydrogen sulfide. The raw biogas is directed through the medium, commonly silica gel or aluminum oxycarbide, and because the contaminants are smaller than the adsorbent’s pore size, they get trapped. Although it has a low capital cost, there are high costs associated with media procurement, maintenance costs, and disposal. No contaminants are introduced to the biogas or digestate through this process, but the adsorbent will eventually need to be replaced or regenerated by drying it at high temperature and high pressure.

- **Absorption**: Absorption is a common and economical process where contaminants are taken up by the volume of the material (Glycol or Hygroscopic Salts). The contaminants commonly removed include hydrogen sulfide, siloxanes, moisture/water vapor removal, and volatile organic compound (VOCs). This process introduces no contaminants to the biogas or digestate, and although the process is regenerative by drying the medium at high temperature, it will eventually have to be replaced. Hygroscopic salts will result in a non-hazardous solid waste stream.

- **Air Injection (Biological Fixation)**: This technology is used to convert H2S into elemental sulfur and water. This process introduces 2-6% air into the biogas in the headspace of the digester. It is critical that the introduction of the air be carefully controlled to avoid reducing the amount of biogas that is produced. With the injection of air, nitrogen is also introduced, which can potentially result in NOx emissions when combusted if not removed. There are no direct waste discharges.

- **Iron Chloride Dosing**: An iron chloride solution can be introduced to the feedstock mixing tank, converting the H2S to iron sulfate (Fe2(SO4)3) containing it in the feedstock. There are no direct waste charges, but the chloride ions that are introduced remain in the digestate where they do not cause any problems.

- **Water Scrubbing**: This technology is implemented to remove H2S as well as CO2. The process is done under high pressure where the biogas is passed through a counter flow of water and because carbon dioxide is soluble in water this process separates it from the biogas. No contaminants are introduced to the biogas or digestate and the scrubbing water is discharged. The main disadvantage of this process is that it requires a large volume of water that must be purified and recycled.

- **Polyethylene Glycol Scrubbing**: This technology is very similar to water scrubbing, but instead uses a scrubbing solution of polyethylene glycol. The benefits of using a scrubbing solution is that carbon dioxide and hydrogen sulfide are more soluble in the polyethylene glycol scrubbing solution than water, resulting in lower solvent demand and reduced pumping, making it more efficient for the contaminant removal from the biogas. Although, a disadvantage is it requires the regeneration of a large volume of polyethylene glycol.

- **Carbon Molecular Sieves/Pressure Swing Adsorption**: The carbon molecular sieve method uses differential adsorption characteristics to separate CH4 and CO2. This adsorption is carried out at high pressure. For this process to be successful, H2S should be removed before the adsorption process.

- **Mechanical Moisture Separators**: This technology separates the liquid that is condensed during cooling through mechanical devices such as a baffle or centrifugal action. Demister pads are employed to remove fine mist in the outlet, further enhancing the separation efficiency. Separated liquids are effectively drained by auto drain valve.

- **Iron Hydroxide or Oxide**: This process removes hydrogen sulfide by passing the biogas through a media composed of woodchips and iron oxide (or hydroxide), and the H2S reacts to form iron sulfide on the

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30 T.A. Seadi et al, Biogas Handbook, University of Southern Denmark Esbjerg, Lemvig Biogas, 2008
32 Alberta Agriculture and Rural Development, Biogas: Cleaning and Uses, Retrieved From: http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex12276
medium which can then be disposed of. No contaminants are introduced to the biogas or digestate and this process is often regenerative, but eventually the filter media will have to be replaced. Depending on filter media used, the spent media may constitute a hazardous waste and must be disposed of accordingly. The iron oxide media needs to be replaced periodically.

- **Mechanical Filters:** A simple and inexpensive process applied to remove particles. Filters are made of paper or fabric, and will need to be replaced at regular intervals as part of normal maintenance. No contaminants are introduced and the replaced filters will constitute a non-hazardous solid waste discharge.

### Table III-2: Biogas Cleaning Technologies

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<th>Method of Removal</th>
<th>Technology</th>
<th>Substance Removed</th>
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<td>Carbon Adsorption/Activated Carbon</td>
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<td>• Removal of Siloxanes</td>
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<td></td>
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<td>• Removal of Hydrogen Sulfide (H2S)</td>
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<td></td>
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<td>• Carbon Dioxide (CO2)</td>
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<td>• Halogenated Hydrocarbons</td>
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<td>Refrigeration</td>
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<td>• Ammonia (NH3)</td>
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<td>Silica Gel</td>
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</tr>
<tr>
<td>Mechanical Moisture Separators</td>
<td>--</td>
<td>• Moisture/Water Vapor Removal</td>
</tr>
<tr>
<td>Air Injection</td>
<td>--</td>
<td>• Removal of Hydrogen Sulfide (H2S)</td>
</tr>
<tr>
<td>Iron (Ferrous) Chloride Dosing</td>
<td>--</td>
<td>• Removal of Hydrogen Sulfide (H2S)</td>
</tr>
<tr>
<td>Water Scrubbing</td>
<td>--</td>
<td>• Removal of Hydrogen Sulfide (H2S)</td>
</tr>
<tr>
<td>Iron Hydroxide or Oxide</td>
<td>--</td>
<td>• Removal of Hydrogen Sulfide (H2S)</td>
</tr>
<tr>
<td>Sodium Hydroxide (NaOH)</td>
<td>--</td>
<td>• Removal of Hydrogen Sulfide (H2S)</td>
</tr>
<tr>
<td>Filtration</td>
<td>Mechanical Filter</td>
<td>• Particulates</td>
</tr>
</tbody>
</table>

### III-4 Energy Conversion Systems

The methane generated from the anaerobic digestion process is converted to more useful purposes. These purposes may include the generation of heat, the generation of electricity, or to provide a fuel for transportation. In the event that the methane cannot be use at any given moment, it will be ‘flared’, which is simply combusting to atmosphere.

#### A. Compressed Natural Gas (CNG) for Vehicles

The methane produced from the anaerobic digestion process can be cleaned, processed, and stored at high pressure (3,000 to 3,600 pounds per square inch) to be used as a fuel for vehicles called compressed natural gas. Under the Energy Policy Act of 1992 CNG is considered an alternative fuel and is desirable because of
the inherent clean-burning qualities, domestic availability, low cost, and high mileage. The best use is for a fleet of vehicles that operate within a limited area that can be centrally-fueled, and are available in a variety of natural gas vehicles (NGV) from light-duty sedans and vans to school buses, street sweepers and freightliner trucks. Typical NGV’s include municipal police enforcement, hotel and parking shuttles, taxis, food and beverage delivery, newspaper delivery, utilities, collection-recycling and transfer trucks.

When transitioning an existing diesel and gas fueled fleet of vehicles to compressed natural gas vehicles the existing vehicles can be fitted with a conversion kit to use CNG fuel in addition to gas or diesel, or existing vehicles can be replaced with vehicles manufactured specifically to operate on CNG.\textsuperscript{33}

\textbf{Figure III-8: Compressed Methane Fueling Station}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{compressed_methane_fueling_station.jpg}
\caption{Compressed Methane Fueling Station}
\end{figure}

The CNG fueling station maintenance technician is in charge of safety for station users and the general public, ensuring the highest station reliability possible, maintaining environmental and regulatory compliance, and managing operating costs. The station performance specifications are the basis of an effective operation and maintenance (O&M) program for any compressed natural gas (CNG) fueling station. It is essential that CNG fueling station maintenance technicians understand what performance levels are required of the equipment. There are typically seven areas of focus for a CNG station O&M technician must have.

- **Fuel delivery**: Fuel delivery specifications are usually expressed as a volume of fuel over a particular time period for example, in gasoline gallon equivalents (GGEs) per minute/per hose; or in vehicles per hour/per hose. In addition, specifications should ensure that vehicles are fueled to a nominal 3,600 psi at 70 degrees Fahrenheit.
- **Gas quality**: It is critical to ensure that vehicles fueling at the station perform optimally and are not damaged by failure of the fuel to meet specifications. Gas quality specifications may include those for lubrication oil content, water content, and odorant level.
- **Operations and maintenance**: A general specification may be established for the amount of time a station must be operational and available to deliver fuel to customers.
- **Service requirements**: Whether the CNG station is being maintained by in-house fleet operations personnel or a third party, a minimum specification for service expectations should be established and met.

• **Liquid and vapor fugitive emissions**: Properly working CNG stations should have no liquid (e.g., oil) or gas emissions except for the depressurization of the nozzle/receptacle combination when a vehicle is being fueled. In other words, nothing should be emitted into the environment from the station. The ideal specification would indicate that there are no liquid or vapor fugitive emissions coming from the station’s equipment.\(^\text{34}\)

### B. Combined Heat and Power (CHP) Systems

Combined Heat and Power (CHP), also known as cogeneration, is the sequential or simultaneous generation of two types of energy, electrical and useful thermal, from a single primary energy source. Traditional electrical power plants generally only convert about one third of the potential energy of the fuel into usable energy, with the rest of the energy being sent to atmosphere as heat. This excess heat is simply released into the atmosphere as a waste product, contributing to pollution and global warming, as well as being an energy loss for the power generators. Cogeneration provides an efficient solution, combining electrical and/or mechanical power and waste-heat recovery for heating, cooling or dehumidification. In AD applications, the heat is most typically used to heat the digestion tanks to the desired temperature and for heating buildings, greenhouses, and other nearby buildings. Exhaust emissions are the primary environmental concern with operating a combined heat and power system. The primary pollutants are oxides of nitrogen (NO\(_x\)), carbon monoxide (CO), and volatile organic compounds (VOCs – unburned, non-methane hydrocarbons). Other pollutants include sulfur oxides (SO\(_x\)) and particulate matter (PM).

- **Reciprocating Engines**: A reciprocating engine uses one or more reciprocating pistons to convert pressure into a rotating motion. Reciprocating engines are more applicable to anaerobic digester biogas projects because of their robust nature (start quickly, follow electric demand well, have good part-load efficiencies, highly reliable) and are more resistant to equipment failures and maintenance issues.\(^\text{35}\)

**Figure III-9: Biogas Reciprocating Engine**

- **Microturbines**: Microturbines are small combustion turbines with an output of 25 to 500 kW. The initial advantage is that they are compact with few moving parts, but those parts are susceptible to mechanical

\(^{34}\) A. Thompson, Why CNG Station Performance Specification Are Critical for Maintenance Technicians, Green Fleet, July 2013

breakdown from even the reduced amount of hydrogen sulfide and siloxanes present in the biogas. Also, although low cost and low emissions, they also suffer from low fuel-to-electricity efficiencies and reduced power output and efficiency with higher ambient temperatures.\textsuperscript{36} These reasons make microturbines less suitable for anaerobic digestion.

**Figure III-10: Packaged Microturbine Engine (Capstone)**

Maintenance for either reciprocating engines or microturbines can be done by in-house personnel or contracted out to manufacturers, distributors or dealers under service contracts. Full maintenance contracts (covering all recommended service) generally cost between 0.7 to 2.0 cents/kWh depending on engine size, speed and service. Many service contracts now include remote monitoring of engine performance and condition and allow for predictive maintenance. Service contract rates typically are all-inclusive, including the travel time of technicians on service calls.

Maintenance costs for the combined heat and power vary with type, speed, size and numbers of cylinders of an engine and typically include:

- Maintenance labor
- Pump and piping inspection
- Engine parts and materials such as oil filters, air filters, spark plugs, gaskets, valves, piston rings, electronic components, etc. and consumables such as oil
- Minor and major overhauls

According to Dresser-Rand, based upon their 400 systems currently in operation, a conservative estimate for annualized 2014 maintenance costs for a biogas CHP engine are $0.025/kWh, which is inclusive of scheduled maintenance, labor, and unexpected equipment replacement and is based on approximately 8,000 annual operating hours. This number may vary based upon manufacturer, model, and capacity.

\textsuperscript{36} N. Goldstein, Microturbines, Gas Engines Link Biogas to the Grid, BioCycle, September 2006, Vol.47, No.9, p.59
C. Space or Process Heating

The biogas can also be burned directly for space heating or digestate processing in a boiler or furnace. This is most common at small digesters where an engine and electric generation would not be economical, though space heating or water heating would be useful.

D. Natural Gas Pipeline Injection

When the biogas produced from anaerobic digestion is upgraded to natural gas pipeline quality standards (primarily methane), it can be sold and piped into the natural gas distribution system as a renewable energy. The biogas released from the AD process is generally between 50%-60% methane, 25% carbon dioxide, and small amounts of contaminants such as siloxanes, H2S, and water vapor. To achieve pipeline quality of 97% methane, additional biogas processing using is needed. Natural gas pipeline injection was not pursued for this project given the very low market price for natural gas on the wholesale market.

![Figure III-11: Natural Gas Pipeline](image)

Ill-5 Digestate Processing

Digestate is the nutrient rich byproduct of the anaerobic digestion process. After the organic matter has been completely digested, it settles to the bottom of the tank where it is then pumped out. It is a watery solution of 5%-10% solids and is often separated into liquids and solids to allow for optimal post treatment, use, or disposal. Digestate can be a valuable soil fertilizer because the organic material fed to the digester contains macro-nutrients (nitrogen, phosphorous, potassium) and micro-nutrients (manganese, boron, copper, iron, chlorine, molybdenum, zinc). Throughout the digestion process nutrients are not consumed or destroyed, but rather the nitrogen-containing compounds are converted to ammonium, which is more readily available for plant uptake.

A. Separated Liquid Digestate

The separated liquid portion of the digestate has had all or most of the solid material separated out, contains most of the dissolved solid, and typically has a total solid content of 3%. It is recommended that the liquid be sent back to the WPCP through the existing sewer system (discussed further in Section II-5-B). If it is determined that the concentration of phosphorous and nitrogen in the recycled effluent will affect current Greenfield WPCP National Pollution Discharge Elimination System (NPDES) permitting, a sequential batch
reactor (SBR) can be added at the anaerobic digestion facility. SBR systems are a common and inexpensive technology to treat the separated liquid digestate after the solid separator to further remove N and P.

**B. Separated Solid Digestate**

The separated solid digestate is a compost-like product that contains most of the suspended solids, fibrous undigested organic material (lignin and cellulose), microbial biomass, and nutrients, with a moisture content of 18% to 30%. The volume and the moisture content of the separated solids will vary depending on the substrate and the technology used. When the separated solid digestate meets state and federal standards, it can be land applied as a soil amendment to increase soil structure, water retention properties, and nutrient enhancement. With human waste as a feedstock, it is likely that further processing will be needed, which can include aerobically composting in windrows or piles, or high-temperature drying to produce granular fertilizers. These processes can assure full biological stabilization of the digestate by further minimizing the risk of volatilization of ammonia or leaching of nutrients from the separated digested fiber, reduce pathogens, and eliminate any additional methane emissions or potential odor from the digestate. Figure III-13 displays a composted digestate product free of contaminants.

**C. Solid-liquid Separation Technologies**

The dewatering process of the digestate is most commonly achieved mechanically or thermally (evaporation). For this project it is recommended that the separation of liquid and solid digestate is done mechanically with a FAN Solid/Liquid Separator, see Figure III-12 below. Thermal heating would be applicable in AD paired with CHP, where waste heat from the engine could be used to process digestate, though this is not the case of Greenfield. A FAN Solid/Liquid Separator can treat roughly 20 cubic yards per hour at 6-8% solids to reach 25% solids for a composting facility. Please refer to Appendix I: Example FAN Separator Features and Specifications for additional details.

**Figure III-12: FAN Solid Separator**

**D. Composting the Separated Solid Digestate**

Composting the solid digestate transforms the nutrients to a more soluble form making them more readily available for plant use, therefore enhancing its effectiveness and its market value. Additionally, present elements such as lignin and ammonia can both be transformed through this process. Lignin, which cannot be broken down by the anaerobic microorganisms, can be broken down by aerobic microorganisms such as fungi.
Also, through composting, ammonia will be oxidized into nitrates, improving the fertility of the material and making it more suitable for land application. A stable compost is no longer undergoing rapid decomposition, has readily available nutrients for soil and plant uptake, and has no qualities that will inhibit plant growth. Indicators used to determine stability include temperature, respiration rate, length of compost processing, carbon to nitrogen ratio, and visual/olfactory inspection.\textsuperscript{37}

Additionally, composting is an effective way to reduce pathogens and meet state and federal regulatory requirements. To meet the standard of a “Process to Further Remove Pathogens” (PFRP), composting digestate piles must maintain a temperature of 131\textdegree Fahrenheit for at least 15 days, and must be turned at least 5 times in the 15 days. The temperature should be checked daily and if it shows that the temperature is decreasing the pile must be turned again. Turning frequently maintains proper oxygen and moisture levels, and to ensure the entire amount of material is heated properly to destroy pathogens and weed seed.

It is recommended that Greenfield compost the separated solid digestate on-site in windrow piles, an active treatment process. This would entail a concrete slab with a metal building to contain the digestate and protect the piles from the elements such as snow, rain, and vector problems. In addition, a bunker silo to store the carbon source and aeration amendments, which provide the structure portion of the compost, would be necessary. These amendments can include landscape waste, bark chunks, leaves, straw, and/or saw dust, some of which is already brought to the Transfer Station. Typical operational parameters are rows of 10 ft wide 7 ft high and a 50 horsepower tractor turner.

Composting operations require a large area, and given the available space at the Transfer Station, should not present any issues. In addition, compost is a seasonal product so it is assumed that storage will be made available throughout the winter months, if needed.

\textbf{Figure III-13: Composted Digestate}

\footnote{\url{http://www.calrecycle.ca.gov/organics/products/quality/Needs.htm}}
III-6 Remote System Monitoring

The monitoring and control of an AD system is essential because anaerobic digestion is an innately complex combination of bio-chemical and physical-chemical processes. Driving the system are anaerobic bacteria and microbial populations that require specific parameters in order to operate and maximize energy output. Monitoring and control of the operational parameters will optimize performance, decrease residence time, increase methane recovery, and prevent failure.

The monitoring system is remotely accessible through internet enabled computers and personal devices, and can be configured to send "alerts" regarding production and operational conditions. The centralized system that will monitor and control the entire AD facility is a Supervisory Control and Data Acquisition (SCADA) system. Typically, a SCADA system is connected to Programmable Logic Controllers (PLCs), which are in turn connected to sensors and production machinery. The SCADA system monitors overall performance and allows the operational set-points and alarms, while the PLC performs the control actions to adhere to set operational parameters.

Figure III-14: Typical Monitoring Systems Screenshot

Sensors can measure a number of system conditions (identified below) and typically use a standard 4-20 mA signal which is relayed to the controller which interprets the data and configures it for the graphical display (as in the example shown above). For a more complete list of monitoring points, please refer to 'Appendix J: Example Monitoring Points List'. Typical operational, biological and physical parameters to monitor may include:

- **Temperature**: Mesophilic bacteria operate at temperatures near 102°F, Thermophilic bacteria operates at temperatures near 135°F.
- **pH**: A simple test that is widely used to determine proper environmental conditions that the bacteria require to survive. The pH should be in the range of 6.8 to 7.5.

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39 R. Labatut, Monitoring to Optimize Performance and Prevent Failure of Anaerobic Digestion Systems, 2012

40 R. Moletta, Anaerobic Digestion Monitoring and Control, Laboratoire de Biotechnologie de l’Environnement
• **Organic Loading Rate (OLR):** The amount of organic matter loaded per day. If the system is overloaded then acidification of the system can occur and kill the microbial population and if the system is under-loaded it could work under capacity.

• **Hydraulic Retention Time (HRT):** The measurement of the average length of time that a soluble compound remains in the reactor.

While uncommon, potential operational issues can be more effectively managed with the implementation of an effective monitoring program. The issues that can be avoided may include:

• **Biogas Production Fluctuations:** The system has potential to over produce or under produce bio-methane and is generally caused by fluctuations in the organic loading rate (OLR). An established recipe and scheduled feeding times, in addition to multiple tanks for high-strength and low-strength feedstocks to be fed to the digester, will maintain digester gas production and lessen the potential of biogas fluctuations.

• **pH Spikes:** Lower pH (i.e., more acidic) conditions inhibit biogas production because methanogens are sensitive to acid content and the bacteria cannot survive. Most food waste feedstocks tend to decompose quickly decreasing the pH of the digester, so the overloading of organic feed is what generally causes pH spikes. The addition of a buffer such as sodium bicarbonate or lime, to the digester may be needed to balance the initial high acidity caused by decomposing food waste.

• **Foaming:** All anaerobic digesters will foam to some extent, but excessive foam will be problematic. The chief cause of excessive foaming is inconsistent feed to the digester, but may also be effected by the sludge quantity and loading rate, a high ratio of waste activated sludge (WAS), inadequate mixing, inconsistent or high volatile fatty acids (VFA’s), low influent solids concentration, Nocardia and Microthrix Parvecella, excessive filamentous bacteria, extreme amounts of oils and grease, and/or the type of substrates fed into the digester. Foaming can upset the anaerobic digestion biological process as well as adversely impact operations and equipment through overflow, such as clogging of gas piping. Mitigation methods for foaming management begin with establishing a properly defined feedstock recipe and loading rate. Additionally, monitoring and control to maintain optimal operational parameters and a consistent feed can lower the risk of foaming. The addition of equipment to mitigate foaming issues is often costly, so it is suggested to consider operational management prior to investment.

• **Burping:** When gas pressure builds within the tank the gas seeks to escape and can cause burping. When this happens it can create a leak or possibly rupture the gas membrane enclosure which can negatively impact operations. Burping can be avoided through mechanical means (i.e. mixing) and proper feedstock recipe management, through secondary measures that include chemical agents, such as Tramfloc, Fibrochem, and chlorine, which can reduce the volume of undesired gas buildup when they are added to the substrate. Levels of chemical additions, if necessary, will be determined in the design phase once the final feedstock recipe and digester configuration is determined.

• **Struvite:** The anaerobic digestion process releases ammonium and phosphate from waste material, creating struvite, or magnesium ammonium phosphate (MgNH₄PO₄), which accumulates in scale deposits on equipment. Struvite can cause maintenance problems by clogging pipes, valves, and heat exchangers with a hard white residue, and once the dense scaling deposits have formed, they are difficult to remove. Therefore it is best to reduce the potential of initial struvite forming through feeding ferric chloride or ferrous chloride to digester feed lines. Acid washing is an effective cleaning method but is time consuming, costly, and can be a safety issue.

• **Equipment Corrosion:** Corrosion can occur in the digestion equipment, biogas piping, CHP engines, and CNG engines. As the percent solids of the feedstock increase (8-12% in a complete mix digester) AD process equipment can corrode. Equipment corrosion and failure is primarily an issue with the biogas processing equipment. Biogas will be cleaned prior to combustion to lessen the occurrence of any equipment corrosion.
**Nutrient Loading:** Phosphorus and Nitrogen removal from wastewater effluent is important for preventing nutrient loading and eutrophication of lakes, inland seas, and other natural waters. Municipal wastewater co-digested with food waste can result in high phosphate and nitrogen concentrations in the digestate effluent (both liquid and solid). It is assumed that the liquid digestate will go back to the head of the WPCP and the solid digestate will be composted on-site. Prior to determination of use or disposal, phosphorus and nitrogen levels will need to be considered.

**Noise from Combined Heat and Power Engine:** Though not applicable to this project, the noise generated from the engine must comply with regulatory zoning requirements. It is typically housed in its own structure which can feature noise-muffling insulation, if necessary.

**Operational Odors:** Anaerobic digestion is a waste-stabilization method, designed to reduce the total amount of volatile organic compounds (VOCs) in a particular substrate, thus reducing odor causing compounds. Odors from anaerobic digesters, while uncommon, can occur if the digestion process is mismanaged. Anaerobic bacteria that thrive in the digester use the dissolved sulfate ion ($SO_4^{2-}$) as an oxygen source, creating dihydrogen sulfide ($H_2S$) as a byproduct, which is odorous and corrosive. Leaks in the gas storage membrane could potentially cause strong odors.
IV. DESIGN SCENARIO ANALYSIS & RECOMMENDED CONFIGURATION

**Key Points:** In order to effectively determine the optimal project for Greenfield, diverse configurations were analyzed given the project's baseline conditions and the findings related to the anaerobic digestion equipment research. The analysis findings and recommendations include:

- Six options were selected to represent a variety of configurations and were investigated in detail given the location, energy, feedstock, and operational conditions specific to this project. The scenarios were selected to provide diverse options so that Greenfield could best determine their needs relative to the optimal project approach.
- It is recommended that Greenfield pursue an anaerobic digestion system at the Transfer Station, where the bio-methane generated is used to establish a CNG fueling station for municipal, private, and public use. The system will co-digest organic food waste (7,601 tons/year) and wastewater sludge from the WPCP (7,796 tons/year).
- The system will consist of two (2) receiving tanks, each at 25,000 gallons; there will be a ‘high’ strength and ‘low’ strength tank to facilitate optimal recipe management and methane production within the digester. Feedstock will be pumped from the receiving tank to the hydrolyzer tank (52,000 gallons), and then to the digester tank (265,000 gallons). The digestion process will generate 1,097,664 m³ of methane annually.
- The CNG vehicle fueling station will generate 775 gallons gasoline equivalent of fuel daily.

**IV-1 Configurations Analyzed for Greenfield**

**A. Scenario Configurations**

Six design options using various technologies discussed in Section III and feedstock conditions discussed in Section II were investigated in the feasibility study. The scenarios are discussed below, and were selected in order to present the full breadth of options to the Town of Greenfield.

- Scenarios that include food waste as a feedstock (A, C, E, and F) assume the same feedstock reception area. An enclosure for feedstock operations including receiving, handling, and pre-processing to remove physical contaminants and slurry if needed. There will be two separate 25,000 gallon receiving tanks - one for high strength (high biomethane potential) organic waste and one for low strength (low biomethane potential) organic waste, as to regulate and maintain recipe parameters and proper biogas production. Both receiving tanks will be equipped with direct hose connection for pumpable liquids, and a flip top lid tank for high solid organic waste.
- Scenario B and D both explored wastewater sludge only as a feedstock. In these two scenarios there will be one direct hose for the sludge to be pumped to the anaerobic digester tank only, omitting the need for a receiving tank and hydrolyzer tank.
- Sizing of the anaerobic digestion tank is dependent on the amount of feedstock acquisition to the facility. All scenarios assume 100% of the sludge from the Greenfield WPCP, and varying amounts of regional source separated organics (SSOs).
- All scenarios assume the biogas is captured and cleaned to varying degrees dependent on the application of CHP or CNG. Compressed natural gas will need to be cleaned to natural gas pipeline quality standards, while CHP can operate with a higher percentage of CO₂ in the biogas.
- All scenarios assume a conservative beneficial value of the solid digestate at $5.00 per ton.
### Table IV-1: Investigated Design Options

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>Feedstock</th>
<th>AD System Size</th>
<th>Biogas Use</th>
<th>Digestate Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scenario A</td>
<td>• 100% of WPCP sludge • 7,601 tons/year food waste</td>
<td>• (2) 25,000 gal Receiving Tanks • 52,000 gal Hydrolyzer Tank • 265,000 gal AD Tank</td>
<td>300 kW combined heat and power system</td>
<td>Composted/beneficially used</td>
</tr>
<tr>
<td>Scenario B</td>
<td>• 100% of WPCP sludge • No food waste</td>
<td>• 180,000 gal AD Tank</td>
<td>10 kW combined heat and power system</td>
<td>Composted/beneficially used</td>
</tr>
<tr>
<td>Scenario C</td>
<td>• 100% of WPCP sludge • 7,601 tons/year food waste</td>
<td>• (2) 25,000 gal Receiving Tanks • 52,000 gal Hydrolyzer Tank • 265,000 gal AD Tank</td>
<td>100 SCFH biogas compressed natural gas station used for natural gas vehicles</td>
<td>Composted/beneficially used</td>
</tr>
<tr>
<td>Scenario D</td>
<td>• 100% of WPCP sludge • No food waste</td>
<td>• 180,000 gal AD Tank</td>
<td>50 SCFH biogas compressed natural gas station used for natural gas vehicles</td>
<td>Composted/beneficially used</td>
</tr>
<tr>
<td>Scenario E</td>
<td>• 100% of WPCP sludge • 87,000 tons/year food waste</td>
<td>• (2) 25,000 gal Receiving Tanks • 52,000 gal Hydrolyzer Tank • 2,650,000 gal AD Tank</td>
<td>3,000 kW combined heat and power system and a 100 SCFH biogas compressed natural gas station used for natural gas vehicles</td>
<td>Composted/beneficially used</td>
</tr>
<tr>
<td>Scenario F</td>
<td>• 100% of WPCP sludge • 11,000 tons/year food waste</td>
<td>• (2) 25,000 gal Receiving Tanks • 52,000 gal Hydrolyzer Tank • 285,000 gal AD Tank</td>
<td>300 kW combined heat and power system and a 50 SCFH biogas compressed natural gas station used for natural gas vehicles</td>
<td>Composted/beneficially used</td>
</tr>
</tbody>
</table>

### B. Technical Model Assumptions, Inputs, and Production

The expected outputs of the system were modeled using a platform developed to analyze anaerobic digestion operational parameters. This model uses technical input from various manufacturers and equipment providers, as well as market and industry standards. Assumptions and constants used in the model are shown in Table IV-2.
### Table IV-2: Sizing and Loading Assumptions and Constants

<table>
<thead>
<tr>
<th>ITEM</th>
<th>ASSUPTION</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat Loading for Digester</td>
<td>0.000034</td>
<td>therms per hour per gallon</td>
</tr>
<tr>
<td>Digester sizing safety factor</td>
<td>0.150</td>
<td></td>
</tr>
<tr>
<td>Methane Production, Sludge, 5-6%</td>
<td>16.000</td>
<td>m3 per ton</td>
</tr>
<tr>
<td>Methane Production, SSO</td>
<td>128.000</td>
<td>m3 per ton</td>
</tr>
<tr>
<td>Conversion rate</td>
<td>2.776</td>
<td>m3 per therm</td>
</tr>
<tr>
<td>Biogas to Natural Gas</td>
<td>0.650</td>
<td>percent biogas</td>
</tr>
<tr>
<td>Consumption Rate of Engine</td>
<td>0.124</td>
<td>therms per kWh</td>
</tr>
<tr>
<td>System Operating Hours</td>
<td>8,332</td>
<td>hours per year</td>
</tr>
<tr>
<td>Rate of Thermal Energy Production</td>
<td>0.059</td>
<td>Therm per kW rating</td>
</tr>
<tr>
<td>Heating Hours</td>
<td>5,694</td>
<td>per year</td>
</tr>
<tr>
<td>% Volume Reduction from AD</td>
<td>80%</td>
<td></td>
</tr>
<tr>
<td>Therms per GGE</td>
<td>1.200</td>
<td></td>
</tr>
<tr>
<td>Average weight</td>
<td>8.330</td>
<td>lbs per gallon</td>
</tr>
<tr>
<td>Conversion factor</td>
<td>2,000</td>
<td>lbs per ton</td>
</tr>
<tr>
<td>Percent Digestate</td>
<td>55.0%</td>
<td></td>
</tr>
<tr>
<td>Percent Solid, post-separation</td>
<td>25.0%</td>
<td></td>
</tr>
<tr>
<td>Parasitic Losses, Electric</td>
<td>12.0%</td>
<td></td>
</tr>
</tbody>
</table>

### Table IV-3: Anaerobic Digestion Equipment Sizing, Feedstock Quantities, and Methane Production *(Option C Recommended)*

<table>
<thead>
<tr>
<th>Component</th>
<th>Option A:</th>
<th>Option B:</th>
<th>Option C:</th>
<th>Option D:</th>
<th>Option E:</th>
<th>Option F:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sludge &amp; Food Waste, CHP</td>
<td>Sludge &amp; Food Waste, CNG</td>
<td>Sludge, CNG</td>
<td>Food-only, CHP, CNG</td>
<td>Sludge &amp; Food Waste, CNG &amp; CHP</td>
<td></td>
</tr>
<tr>
<td>CNG Gallons Equivalent (GGE/day)</td>
<td>0</td>
<td>0</td>
<td>775</td>
<td>30</td>
<td>775</td>
<td>400</td>
</tr>
<tr>
<td>Sludge Processed, tons annually, 3-5% solids</td>
<td>7,796</td>
<td>7,796</td>
<td>7,796</td>
<td>7,796</td>
<td>0</td>
<td>7,796</td>
</tr>
<tr>
<td>Food Waste Processed, Tons Annually</td>
<td>7,601</td>
<td>0</td>
<td>7,601</td>
<td>0</td>
<td>87,000</td>
<td>11,000</td>
</tr>
<tr>
<td>Methane Production, m³ Annually</td>
<td>1,097,664</td>
<td>124,736</td>
<td>1,097,664</td>
<td>124,736</td>
<td>11,136,000</td>
<td>1,532,736</td>
</tr>
<tr>
<td>Methane Production, Therms Annually</td>
<td>395,412</td>
<td>44,934</td>
<td>395,412</td>
<td>44,934</td>
<td>4,011,527</td>
<td>552,138</td>
</tr>
<tr>
<td>Methane Used to Heat Digester</td>
<td>61,886</td>
<td>35,140</td>
<td>61,886</td>
<td>35,140</td>
<td>527,492</td>
<td>65,790</td>
</tr>
<tr>
<td>Methane Combusted by CHP Engine (therms/year)</td>
<td>308,951</td>
<td>10,298</td>
<td>308,951</td>
<td>10,298</td>
<td>3,089,506</td>
<td>308,951</td>
</tr>
<tr>
<td>Methane Dispensed at CNG Fueling Station (therms/year)</td>
<td>339,450</td>
<td>13,140</td>
<td>339,450</td>
<td>13,140</td>
<td>339,450</td>
<td>175,200</td>
</tr>
</tbody>
</table>
IV-2 Recommended Equipment Configuration

Through in-depth scenario analyses and discussions between BEAM, Greenfield personnel, and additional public and private stakeholders, it has been determined that Option C, the co-digestion of sludge and organic waste coupled with CNG, will have the highest yielding opportunities for the town given their long-term goals.

A. Digestion of WPCP Sludge and Source Separated Organics

In the recommended scenario for Greenfield, the WPCP sludge and source separated organics (SSOs) are received at the anaerobic digestion facility located at the Transfer Station. There are two 25,000 gallon capacity receiving tanks - a high strength for waste with high bio-methane potential and a low strength for waste with a low bio-methane potential. Annually, 1.8 million gallons of sludge, at 3-5% solids is piped directly to the low strength feedstock storage tank and 7,601 tons of SSOs are brought to the facility waste reception area where they are processed further if necessary, or piped to the appropriate feedstock storage tank. The SSOs needing further processing are sorted, where the solid waste and recyclables are mechanically separated out through a trommel or manually removed and recycled or disposed of. The organic waste is then sent through a chopper pump to create a homogenous slurry that is piped to the storage tank.

B. Digester Tank and Methane Capture Configuration

Once the feedstock is processed, in keeping with the recipe parameters, the appropriate amounts of low and high strength slurries are piped to the 52,000 gallon hydrolyzer tank. The hydrolyzer tank is where the anaerobic digestion process begins and has a retention time of 3 to 5 days before being piped to the 265,000 gallon mesophilic anaerobic digestion tank. In the AD tank, the bacteria continue to break down the organic material for approximately 30 days, producing biogas which is captured in a membrane on top of the tank.

C. Gas Recovery and Generation of Compressed Natural Gas (CNG) for Vehicle Use

The captured biogas is cleaned to remove hydrogen sulfide, siloxanes, water, and carbon dioxide to ensure standards compatible with compressed natural gas guidelines and processes (>95% methane). The methane production is expected to be 11,097,664 m$^3$ annually (395,412 therms annually). The cleaned biomethane is then compressed and stored at a CNG fueling station located at the Transfer Station and is made available for CNG vehicles. The recommended CNG vehicle bay is to be sized at 100 standard cubic feet per minute (scfm) capacity, and produce 775 CNG gasoline gallon equivalent (GGE)/day.

D. Digestate Recovery and Management

After the organic material is completely digested, it settles to the bottom of the tank where it is removed and processed. The digestate is separated into solid and liquid factions with a FAN solid separator that can treat roughly 20 cubic yards of digestate per hour at 6-8% solids, to reach a product of 25% solids and a 3% solids liquid effluent. It is assumed that the solid digestate will be composted to create a product compliant with state and federal regulations, while the liquid digestate is either recycled back to the hydrolyzer tank if dilution is necessary, or sent through the leachate line below the Transfer Station directly back to the head of the WPCP.
V. OWNERSHIP STRUCTURE AND FINANCIAL ANALYSIS

**Key Points:** Installation of an anaerobic digestion plant is a capital intensive project. Therefore, it is important to understand the conditions and risks associated with the investment, along with the sensitivities related to operational costs and future revenue streams and costs. In discussions with Greenfield, the following items were established relating to ownership and contract structures:

- Greenfield has an interest in operating the anaerobic digestion side of the proposed system, though it would like the CNG station to be operated by a specialty contractor under a turn-key construction.
- Greenfield is open to various ownership structures with considerations including available public vs. private financial grants and tax implications.
- In order to reduce project risk during the financing period, it is recommended that the contract rates for feedstock, off-takers, and operational costs align with the period of financing (i.e. 12 years) where possible.
- Potential long term off-takers for the bioCNG have been determined and include vehicles owned by the Town of Greenfield and a regional waste hauler which has expressed interest in converting their heavy-trucking fleet to CNG.
- Annual benefits are estimated to be $1,066,175/year. This value is largely driven by the sale of CNG as vehicle fuel, renewable fuel standard credits, and a reduction in the disposal cost of sludge at the WPCP.
- Capital costs for the system are estimated to be $4,048,000. These costs are largely driven by the anaerobic digestion system ($2,120,000), the compressed natural gas fueling station ($1,300,000), dewatering ($100,000), composting ($100,000), and project contingencies ($428,000).
- To support construction of the recommended system, grants through programs such as MassCEC Organics to Energy Program are estimated to provide $400,000 towards construction costs.
- Annual operating costs are estimated to be $434,358. These costs are largely driven by operating costs of the anaerobic digestion system ($202,400/year) and the bioCNG fueling station ($231,958/year). The costs for the bioCNG fueling station are inclusive of bio-gas cleaning.
- The value of high-energy organic food waste as a feedstock is expected to increase as digesters are built in the region; for this reason, the average tipping cost fee for accepting organic food waste over the financing period (estimated at a maximum of 12 years) is conservatively estimated as no revenue (compared to current average $78.50/ton cost in Massachusetts). Accepting ‘tipping fee’ revenue for accepting regional food waste at the digester could generate an additional revenue stream and should be pursued by the project development team.
- Determining a viable off-taker for the composted solid digestate is critical to the viability of the project; our financial model assumed a modest value of $5.00/ton. The Town or development team should define a clear, long-term use for the solid digestate.

V-1 Ownership and Contract Structures

When choosing to move forward with an infrastructure project such as the installation of an anaerobic digester it is important to evaluate ownership and operational structures. Ownership of the project can impact risks, costs, revenues, and benefits, including tax benefits, which can impact financing considerations and ultimately the feasibility of a project. Three common scenarios are listed below:

1. **Municipal Owned and Operated** - In this scenario the system is owned and operated by the municipality. All costs, revenues, and risks (outside of equipment and labor warranties) associated with the project accrue back to the municipality. For public entities that do not have a tax basis this typically means that tax benefits typically do not accrue to the project investment.
2. **Municipally Owner and Third Party Operated** - In this scenario the system is owned by the municipality, and operated by an outside party. All costs are typically absorbed by the municipality, with revenues and risks (outside of equipment and labor warranties) associated with the project shared between the operator and the municipality. For public entities that do not have a tax basis this typically means that tax benefits typically do not accrue to the project investment.

3. **Third Party Owned and Operated** - In this scenario the system is owned and operated by a third party, typically the installing contractor and designers. Cost, the majority of revenues, and risks associated with the project typically accrue back to the third party owner. As private entities with a tax basis, this typically means that tax benefits typically accrue to the project investment.

## V-2 Financing

When evaluating the various financial configurations to facilitate project construction, identifying key stakeholders is required. These stakeholders include the borrower, lender, underwriter, issuer, off-taker, and equity stakeholders. Not all stakeholders will necessarily apply to every project, as different ownership structures exist.

It is recommended that the following stakeholders be evaluated for their role in the project:

- **Borrower:** The borrower is defined as the group who requires capital in order to construct the project. The borrower can be a private entity or a public entity.
  - Private Entities (sometimes referred to as “developers” as they are often the party that organizes, funds, or originates early-stage development of projects) typically include:
    - Public companies, including investor-owned utilities
    - Privately-held companies
    - Limited liability companies
    - Limited partnerships
    - 501(c)(3) corporations, including private educational institutions, cultural institutions, health care corporations.
  - Government Entities typically include:
    - States
    - State departments and agencies
    - Cities or counties
    - Public educational institutions
    - Native American Tribes

- **Lender:** The lender is the entity which provides capital to the project developer or owner. The lender typically receives a fixed return on their investment over the term of the loan. Lenders typically include:
  - Credit enhancer institution (e.g., letter-of-credit bank)
  - Federal, state, or local government entity that underwrites renewable energy projects
  - Bond purchaser in a private placement (the “bondholders”)

- **Underwriter:** In a publicly offered capital markets debt transaction, the underwriter is typically an investment banking firm or the capital markets group of a bank. The institution typically underwrites debt by purchasing the debt from the borrower and reselling it to investors, and can also assist in other forms of financing, such as equity or subordinate debt.

- **Issuer:** For tax-exempt bonds and municipal tax credit bonds, the issuer is generally the state or local government entity. If the project is owned by the state or government entity, then it can be both issuer and borrower. If the project is held by a private party, then this party is considered the borrower of the debt proceeds issued by the state or government entity, but the issuing government entity is not looked upon to
repay the debt, and is considered a pass-through entity for the purpose of issuing tax-exempt bonds on behalf of the borrower.

- **Off-taker**: The contracting entity that purchases the energy produced from the facility, which can be a public or private utility or large end-user of the energy.

- **Equity**: Equity financing may be corporate stock or subsidiary company/limited partnership to receive cash distributions or related tax benefits from the project.

Typically, there are two main types of financing for biogas projects: traditional loan financing and project financing. In traditional loan financing, the credit history of the operator is a critical determining factor, as is the physical assets of the operating plant. Project financing is related to the project considerations itself and is discussed in more detail below. Additionally, tax equity and off-balance sheet financing may factor into the project as additional strategies to provide the capital to construct the project.

**Project Finance**: In project finance, the operating plant itself is considered the legal entity and several stakeholders, lenders, and operators may be involved. Typically, the borrower is set up as a special purpose entity that is “bankruptcy remote” from its parents, meaning that it would not be consolidated into any bankruptcy of the parent entity. This way, only the credit of the project is considered rather than the credit of the borrowing parties or parent entities. Cash-flow projection is the key determining factor for project financing, owing to the predictable, annuity-like conditions of the financial model. Other decision factors include:

- Technology of the project
- Contracts for electricity and heat sale
- Feedstock availability and reliability
- Legislation and insurance
- Qualification of the operator and related parties

Typically, project finance projects have an equity investment component of 20-30 percent of the project’s total capital cost. In such a structure, costs and benefits are shared between the consortium investors. Cash equity may be in the form of stock or limited liability company interests and may be sourced from:

- Private equity funds, which typically price their deals on a pre-tax basis (i.e. without taking the tax benefits into consideration); or,
- Strategic investors with other kinds of participation in the project, such as equipment suppliers, contractors, or operators.

For the remaining capital, the lender’s primary security for the financing is a mortgage or lien on the asset itself and project revenues. Typical steps for a project finance transaction are:

- The project sponsor (the parent entity or developer) forms a special purpose vehicle (the project company), which will construct, own, and operate the project. The project company takes on the role of the borrower. The project sponsor, as a shareholder of the project company, is generally not liable for the obligations of the project company, unless it contractually agrees to do so.
- The project company obtains control of the facility by entering into a long-term lease, or purchase, of the site.
- The project company enters into construction contracts to procure equipment for, construction, and installation of the plant.
- The project company enters into an off-take agreement or power purchase agreement (“PPA”) to sell its output electricity to a creditworthy third party (utility or commercial customer), and a feedstock supply agreement to acquire the necessary fuel/ingredients.
Project companies typically do not have their own employees, so they enter into an operations and maintenance agreement ("O&M agreement") often with affiliates of the project sponsor or related third parties, to provide for necessary services to be performed for the project company.

The project company enters into a credit agreement with one or more lenders.

Additional equity investors may be admitted to the project company to provide equity funding.

**Tax Equity:** Tax equity is similar to cash equity in that the tax equity investor will contribute cash for the project, but receives primarily tax benefits instead of cash distributions. Typically, the tax investor invests in a portion of the total equity required, but is allocated nearly 100% of the tax benefits of the project, along with some level of cash distribution. Tax equity investors are typically large companies with significant and predictable taxable income, such as financial institutions or utility companies. Since these investors rate returns on an “after-tax” basis (i.e. counting benefits to include tax savings from the tax benefits), less cash is required to meet targeted returns, therefore leaving more cash to be distributed to cash equity investors. Once a tax equity investor has obtained all the tax benefits and achieved its target return (anywhere from 5 to 15 years), its remaining interest in the project is reduced and can be purchased by the other investors/partners for fair market value.

### V-3 Key Sensitivities

When undertaking a capital intensive project it is important to understand the conditions and risks associated with that investment. The general trends and expectations over the operational life and especially the payback period of the system will be investigated.

In undertaking a municipal project at this scale, there is a need to fully understand financial and risk allocations that could occur throughout the construction, permitting, and operating process. If the project does move to the bid solicitation phase, the Town or Owner’s Agent should assess the contractual relationship relating to the items discussed below.

**Potential Construction and Execution Considerations:**

- Cost over-runs
- Credentials of contractors and related parties
- Performance guarantees
- Maintenance and adjustment capex (as well as replacement capex)
- Scalability
- Facility terms and conditions
- Covenants

**Potential Supply Considerations:**

- Feedstock availability, diversity, substitutability
- Supplier/vendor bargaining power

**Potential Output Considerations:**

- Power purchase agreements (prices and contract length)
- Excess production (ability to capture excess output at efficient incremental cost)
- Renewable Energy and Carbon Credits (regulatory and pricing changes)
- Consistency in gas quality
- Inability to sell or dispose of digestate in an economical fashion

**Potential Economic Considerations:**
• Rigidity of business model (sensitivity to changes in regulatory, business, supplier, or competitor environment)
• Change in pricing of alternative/competing fuels/power
• Payback period (competitive ROI) compared to alternative investments

Potential Financial Considerations:
• Security against default (land and assets, supporting guarantees)
• Interest rate protection
• Assurance of supporting national/local supporting schemes (feed-in tariffs or net metering, green certificates)

V-4 Assumptions and Inputs
Anaerobic digestion systems have many factors that relate to production capacity and system economics. The following table summarizes the financial and operational assumptions and inputs used in the analysis. All scenarios assume that potentially variable cost items (such as feedstock, value of energy products, disposal costs, etc.) were negotiated and contracted at fixed rates, thus have a known figure throughout the financing period.

<table>
<thead>
<tr>
<th>ITEM</th>
<th>ASSUPTION</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>O&amp;M AD system A</td>
<td>2.5%</td>
<td>Capital Costs</td>
</tr>
<tr>
<td>O&amp;M CHP</td>
<td>0.025</td>
<td>per kWh</td>
</tr>
<tr>
<td>O&amp;M CNG - 50 SCFM</td>
<td>$1.060</td>
<td>per GGE</td>
</tr>
<tr>
<td>O&amp;M CNG - 100 SCFM</td>
<td>$0.820</td>
<td>per GGE</td>
</tr>
<tr>
<td>Electric Energy</td>
<td>$0.130</td>
<td>kWh (combined with demand)</td>
</tr>
<tr>
<td>Thermal Energy</td>
<td>$3.310</td>
<td>per gallon (conservative estimate oil rates)</td>
</tr>
<tr>
<td>GGE Cost</td>
<td>$3.500</td>
<td>gallon (average gasoline rate)</td>
</tr>
<tr>
<td>Separated Liquids</td>
<td>$0.00</td>
<td>cost per gallon of liquid disposed (returned WCPC through existing sewer system)</td>
</tr>
<tr>
<td>Separated Solids</td>
<td>$5.000</td>
<td>per ton revenue or value (i.e. as soil amendment or in brownfield)</td>
</tr>
<tr>
<td>Sludge Disposal</td>
<td>$0.064</td>
<td>Gallon</td>
</tr>
<tr>
<td>REC Class I Value</td>
<td>$0.061</td>
<td>per kWh</td>
</tr>
<tr>
<td>Estimated Receiving Tipping Fees</td>
<td>$10.000</td>
<td>per ton</td>
</tr>
<tr>
<td>Days of Fleet Fueling</td>
<td>260</td>
<td>days per year</td>
</tr>
<tr>
<td>Renewable Fuel Credit</td>
<td>$1.250</td>
<td>per GGE</td>
</tr>
</tbody>
</table>
V-5 Revenue and Savings Benefits

The installation of an anaerobic digester is costly, though has relatively low operational costs as the energy feedstock is taken from what is now a revenue producing waste stream. In lieu of additions to the town budget, there are other options including 3rd party ownership and operation that would require no capital expenses. This option would essentially be a lease that is paid back with the energy savings, energy sales and by-product sales from the anaerobic digester system. The costs associated with the scenarios analyzed are indicative of ‘turnkey’ system which is inclusive of all equipment, installation, and permitting costs.

Saving and Revenue Sources:
- Sludge Disposal
- Electric Energy
- Thermal Energy
- CNG Fuel
- Digestate
- REC, Class I
- Renewable Fuel Standards Credit

Revenue for the options investigated range from $115,200 to $4,968,328 annually and is shown in the table below, with the recommended Option C generating $1,066,175 million in savings annually. The following Table V-2 reviews the economic inputs to the project, including capital costs, operational costs, energy costs, and revenues sources.

Table V-2: Design Scenario System Economics

<table>
<thead>
<tr>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Benefits ($)</td>
<td>$526,554</td>
<td>$115,200</td>
<td>$1,066,175</td>
<td>$128,570</td>
<td>$4,968,328</td>
<td>$1,024,248</td>
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<tr>
<td>Sludge Disposal</td>
<td>$95,836</td>
<td>$95,836</td>
<td>$95,836</td>
<td>$95,836</td>
<td>$0</td>
<td>$95,836</td>
</tr>
<tr>
<td>Electric Energy</td>
<td>$285,954</td>
<td>$9,532</td>
<td>$0</td>
<td>$0</td>
<td>$2,859,542</td>
<td>$285,954</td>
</tr>
<tr>
<td>Thermal Energy</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>CNG Fuel</td>
<td>$0</td>
<td>$0</td>
<td>$707,188</td>
<td>$27,375</td>
<td>$707,188</td>
<td>$365,000</td>
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<tr>
<td>Digestate</td>
<td>$10,585</td>
<td>$5,360</td>
<td>$10,585</td>
<td>$5,360</td>
<td>$59,813</td>
<td>$12,922</td>
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<tr>
<td>REC, Class I</td>
<td>$134,179</td>
<td>$4,473</td>
<td>$0</td>
<td>$0</td>
<td>$1,341,785</td>
<td>$134,179</td>
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<tr>
<td>Renewable Fuel Standards Credit</td>
<td>$0</td>
<td>$0</td>
<td>$252,567</td>
<td>$9,777</td>
<td>$252,567</td>
<td>$130,357</td>
</tr>
</tbody>
</table>
V-6 Capital and Operating Costs

Construction costs consist of equipment cost plus installation labor and materials (including site work), engineering, project management (including permitting, licensing, insurance, commissioning and startup), and financial carrying costs during the 6 to 18 month construction period.

A. Capital Costs

System capital expenditures are shown in Table V-3 below. The costs shown in the table are reflective of a ‘turnkey’ system. Additional costs may be required. For example, a sequencing batch reactor may be required if expected N and P levels exceed the allowable range. An SBR system with the ability to treat 4,109 GPD of separated liquid would cost approximately $50,000. Installation costs for the scenarios investigated range from $1.6 million to $18.9 million depending on the configuration. Operational costs range from $86,013 to $1,798,510 per year.

<table>
<thead>
<tr>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital Costs: Anaerobic Digester</td>
<td>$2,120,000</td>
<td>$1,440,000</td>
<td>$2,120,000</td>
<td>$1,440,000</td>
<td>$10,600,000</td>
<td>$2,280,000</td>
</tr>
<tr>
<td>Capital Costs: CHP System</td>
<td>$720,000</td>
<td>$24,000</td>
<td>$0</td>
<td>$0</td>
<td>$4,500,000</td>
<td>$720,000</td>
</tr>
<tr>
<td>Capital Costs: CNG System</td>
<td>$0</td>
<td>$0</td>
<td>$1,300,000</td>
<td>$900,000</td>
<td>$1,300,000</td>
<td>$1,300,000</td>
</tr>
<tr>
<td>Capital Costs: Dewatering</td>
<td>$100,000</td>
<td>$0</td>
<td>$100,000</td>
<td>$0</td>
<td>$100,000</td>
<td>$100,000</td>
</tr>
<tr>
<td>Composting</td>
<td>$100,000</td>
<td>$100,000</td>
<td>$100,000</td>
<td>$100,000</td>
<td>$100,000</td>
<td>$100,000</td>
</tr>
<tr>
<td>Contingency</td>
<td>$341,000</td>
<td>$119,600</td>
<td>$428,000</td>
<td>$251,000</td>
<td>$2,375,000</td>
<td>$560,000</td>
</tr>
<tr>
<td>Capital Costs: Total</td>
<td>$3,381,000</td>
<td>$1,683,600</td>
<td>$4,048,000</td>
<td>$2,691,000</td>
<td>$18,975,000</td>
<td>$5,060,000</td>
</tr>
</tbody>
</table>

B. Operating Costs

On a daily basis facility staff should check alerts, monitor methane production, and verify any changes to upcoming feedstock shipments. These costs are included in the analysis and approximate daily operational costs for the various options are shown. These numbers reflect staffing, materials, maintenance, and scheduled overhauls. Costs for the CNG system are comparatively higher as they are inclusive of biogas cleaning and compression processes.
## Table V-4: Operational Costs for Design Scenarios

<table>
<thead>
<tr>
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<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Operational Costs ($/year):</td>
<td>$169,050</td>
<td>$84,180</td>
<td>$202,400</td>
<td>$134,550</td>
<td>$948,750</td>
<td>$253,000</td>
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<tr>
<td>Anaerobic Digester</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operational Costs ($/year):</td>
<td>$54,991</td>
<td>$1,833</td>
<td>$0</td>
<td>$0</td>
<td>$549,912</td>
<td>$54,991</td>
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<td>CHP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operational Costs ($/year):</td>
<td>$0</td>
<td>$0</td>
<td>$231,958</td>
<td>$11,607</td>
<td>$299,848</td>
<td>$119,720</td>
</tr>
<tr>
<td>CNG</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operational Costs ($/year):</td>
<td>$224,041</td>
<td>$86,013</td>
<td>$434,358</td>
<td>$146,157</td>
<td>$1,798,510</td>
<td>$427,711</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Approximate Daily Operating</td>
<td>$613.81</td>
<td>$235.65</td>
<td>$1,190.02</td>
<td>$400.43</td>
<td>$4,927.42</td>
<td>$1,171.81</td>
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<tr>
<td>Costs</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

### V-7 Potential Grants and Incentives

In recent years, anaerobic digestion has been reemerging as an alternative disposal method to landfills and as a source of renewable energy. Supporting the technology are many grants and financing options on the Federal, State, and Municipal level to support the deployment of anaerobic digestion. A summary of these grants has been compiled and is shown below.

**Massachusetts Clean Energy Center - Commonwealth Organics-to-Energy Program**

The goal of this grant is to increase the diversion of organic waste (food waste, wastewater treatment sludge, animal manure, and yard waste) from landfills and incineration and convert it to electricity, heat, or other usable fuels, while producing a valuable compost/fertilizer end product. Additional information can be found at: [www.masscec.com](http://www.masscec.com).

- **Technical Support:** This solicitation is available to the public sector only and offers up to $60,000 with a 5% grantee cost share (can be met with cash or a grant from another entity).
- **Construction:** This solicitation is available to commercial, industrial, institutional or public entities and offers up to $400,000 for construction grants and up to $200,000 for the Pilot Grant.

**Massachusetts Department of Environmental Protection (MassDEP)**

The MassDEP provides a variety of potential support programs, including:

- The **Sustainable Materials Recovery Program (SMRP)** provides technical and financial assistance to public and private entities involved in the collection, processing, composting and recovery of organic materials.
Grant funding requests are at minimum of $10,000 and a maximum of $500,000. Additional information can be found at: http://www.mass.gov/eea/agencies/massdep/recycle/grants/smrp-grants.html

- Recycling Loan Fund (RLF) is a flexible lending program for working capital, refinancing and real estate acquisition, purchasing of machinery and equipment and acquisition financing with reduced interest rates for projects involved in the collection and processing of organic material.

- State Revolving Loan Funds for Clean Water (CWSRF) provides low-cost funding, via 2% interest loans, to assist municipalities in complying with federal and state water quality requirements. Financial assistance is available for planning and construction of projects which may include anaerobic digestion systems at wastewater treatment plants. Additional information can be found at: http://water.epa.gov/grants_funding/cwsrf/cwsrf_index.cfm

Renewable Energy Certificates/Alternative Energy Certificates

- Renewable Energy Certificates/Alternative Energy Certificates (RECs/AECs) represent the environmental attributes of the power produced from renewable energy projects and are sold separate from commodity electricity. Additional information can be found at: http://www.epa.gov/greenpower/documents/gpp_basics-recs.pdf

Qualified Energy Conservation Bonds (QECBs)

- Qualified Energy Conservation Bonds (QECBs) are a public financing tool for low cost rates to fund energy conservation projects. Additional information can be found at: http://www1.eere.energy.gov/wip/solutioncenter/qecb.html

WMECO Combined Heat and Power Incentives

- WMECO offers grants to support combined heat and power deployment. Though the grant level is $750 per kW and can cover up to 50% of the system cost. More information can be found here: http://www.wmeco.com/residential/understandbill/ratesrules/distribgenrequirements.aspx
VI. REGULATORY, PERMITS, AND APPROVALS

Key Points: The process of permitting an anaerobic digester biogas to energy project may take anywhere from 4 to 12 months in Massachusetts, though could potentially take longer. Regulations are evolving and therefore the respective agencies should be consulted at time of project development.

- The Town of Greenfield Guide to Development Permits outlines a chronological step-by-step explanation of the permit process and is included in this report. Next steps include submitting a site plan design and convening a Staff Technical Review Group meeting to review the project with representatives from the following entities: Planning & Development, Engineering from DPW, Fire Department, Licensing Commission, Health Department, and Building & Inspecting Department.

- Modifications to the existing WPCP Treatment Work Plan Approval (BRP WP 68) will be required to define that the anaerobic digestion system will serve as the primary sludge disposal method, and the current primary disposal method should be included as a backup.

- The proposed AD facility will accept solid food waste, pumpable food waste (FOG, food and beverage manufacturers/processors), as well as sewage sludge from the WPCP. Given that the final permit for the Greenfield Sanitary Landfill states that sludge from the Greenfield WPCP is no longer accepted at the landfill, modification will be required to the existing site assignment and is also likely to trigger a Permit for Recycling, Composting or Conversion (16.05).

- The proposed anaerobic digester facility is well under the authorized daily tonnage accepted of 99 tons/day; current levels are 22 tons/day and the AD system will add an estimated 42 tons/day.

- The post-digestion disposal of the effluent from the system will be returned to the WPCP through an existing line from the transfer station through the sewer system. The additional wastewater allocation requirement due to the liquid digestate being returned to the WPCP has been verbally approved by the town. The separated solid digestate will be composted on-site to meet state and federal requirements for land use. These disposal methods avoid the necessity of a NPDES for the digester system.

- Biosolids refer to sewage sludge that has been treated to meet federal and state standards. As sludge will serve as a primary feedstock in the digester, the digestate is considered a biosolid. Both state and federal standards apply for pathogen and contaminant reduction and restrictions of use. The EPA standards regulate the digestate to Class A and Class B, while the MassDEP classifies to Type I, II, II.

- MEPA review is required only when the project is seeking State Financial Assistance or requires a Permit from a State Agency and exceeds a MEPA review threshold that is related to the subject matter of the State Permit. The first threshold test would be to determine if the project will be accepting state financial assistance. If not, no MEPA review is required. If financial assistance is sought, the final system configuration would have to be reviewed according to each of the threshold. If the project accepts state financial assistance and triggers a threshold review item (Appendix I), a MEPA review is required.

- The BioCNG facility is a 'turnkey installation' where the responsibility to adhere to National Fire Protection Association regulations and the Massachusetts Board of Fire Prevention Regulations covering Compressed Natural Gas Containers and Systems lies with the developer.

In biogas projects, obtaining the required environmental, siting, and applicable permits is essential to ensure a successful project development process. Permit conditions may affect project design, so it should be noted that no construction or operation should begin until all permits are in place and will be the responsibility of the
Permitting costs can range greatly, though typically fall between 1 – 3% of total project costs. For the options outlined in this feasibility study the estimated costs would range from $50,000 up to $200,000. Table V-1 below is excerpted from the Town of Greenfield Guide to Development Permits and outlines a chronological step-by-step explanation of the permit process. The entire document can be found in Appendix K.

<table>
<thead>
<tr>
<th>Step</th>
<th>Associated Organizations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Contact the Permits Manager to schedule a preliminary consultation.</td>
<td>☐ Identify local, state and federal permits that will be required.</td>
</tr>
<tr>
<td></td>
<td>☐ If appropriate, meet with the Staff Technical Review Group to discuss details of the project.</td>
</tr>
<tr>
<td></td>
<td>☐ Permits Manager will assist with the filing of applications.</td>
</tr>
<tr>
<td>2. Submit conservation permits to the Conservation Agent and zoning and subdivision applications to the Permits Manager for determination of completeness prior to submission to the Town Clerk for certification.</td>
<td>☐ Completed application form.</td>
</tr>
<tr>
<td></td>
<td>☐ Appropriate filing fee.</td>
</tr>
<tr>
<td></td>
<td>☐ Appropriate number of copies of all plans and supporting documentation.</td>
</tr>
<tr>
<td>3. Attend public hearing or administrative review to present the proposed project</td>
<td>☐ Inspector of Buildings</td>
</tr>
<tr>
<td></td>
<td>☐ Conservation Commission</td>
</tr>
<tr>
<td></td>
<td>☐ Planning Board</td>
</tr>
<tr>
<td></td>
<td>☐ Zoning Board of Appeals</td>
</tr>
<tr>
<td>4. A decision is made by the Conservation Commission, Planning Board, Zoning Board of Appeals and Inspector of Buildings on zoning, wetland, subdivision, and building permits.</td>
<td></td>
</tr>
<tr>
<td>5. If necessary, record permits at the Registry of Deeds after the specified appeal period. Required for:</td>
<td>☐ Special Permits and Variances</td>
</tr>
<tr>
<td></td>
<td>☐ ANR’s and Definitive Subdivision Plans</td>
</tr>
<tr>
<td></td>
<td>☐ Orders of Conditions</td>
</tr>
<tr>
<td>6. Apply for all other development related permits, approvals and licenses. Including:</td>
<td>☐ Department of Public Works</td>
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<tr>
<td></td>
<td>☐ Board of Health</td>
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<tr>
<td></td>
<td>☐ Fire Department</td>
</tr>
<tr>
<td></td>
<td>☐ Board of License Commissioners</td>
</tr>
<tr>
<td></td>
<td>☐ State &amp; Federal</td>
</tr>
<tr>
<td>7. Upon receiving all necessary permits, approvals and licenses, apply to the Building Inspector for a Building Permit. Building permit applications are not deemed complete unless they include building plans, a plot plan, and copies of permits.</td>
<td></td>
</tr>
<tr>
<td>8. Schedule the required inspections</td>
<td>☐ Electric</td>
</tr>
</tbody>
</table>

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41 EPA AgStar Handbook, A Manual For Developing Biogas Systems at Commercial Farms in the United States, Chapter 8: Permitting and Other Regulatory Issues, February 2004
VI-1 Anaerobic Digester Plant at Transfer Station

A. Transfer Station Site Assignment Compliance

All anaerobic digestion facilities in Massachusetts are required to follow siting approval requirements set by the Massachusetts Department of Environmental Protection for solid waste facilities, including landfills, combustion facilities, and recycling, composting and conversion operations, through Site Assignment Regulations for Solid Waste Facilities (310 CMR 16.00). The DEP Solid Waste Section Chief in the Western Region has been notified of the proposed approach for the Greenfield project.

Since the proposed AD facility will accept solid food waste, pumpable food waste (FOG, food and beverage manufacturers/processors), as well as sewage sludge from the WPCP, modification will be required to the existing site assignment and also likely trigger a Permit for Recycling, Composting or Conversion (16.05) that authorizes the acceptance of high solid feedstock delivered through a dump truck and liquid feedstock delivered through a pump truck. 42

Also, given that the final permit for the Greenfield Sanitary Landfill (which has since been capped), states that sludge from the Greenfield WPCP is no longer accepted at the landfill, it is likely that to move forward to construction, Greenfield will need to go through the traditional permitting process route which includes:

1. MEPA (Solid Waste Section Chief indicates that this is unlikely to pose an issue, but it is important to provide an opportunity for MEPA review);
2. Authorization to construct permit; and,
3. Authorization to operate permit.

In addition, the proposed anaerobic digester scenario is to accept approximately 42 tons of organic waste and sludge per day, which is well under the landfill permit that states the daily tonnage acceptance of up to ninety-nine (99) tons per day (the maximum allowable without prior MEPA certification).

B. Air Quality Permitting

As a facility that will create and utilize biogas, a filing will have to be made to the Massachusetts Department of Environmental Protection pursuant to Air Pollution Control Regulations (310 CMR 7.02). 43 As stated in the regulations, it "...provides procedures and standards for the issuance of approvals in the Commonwealth of

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43 MassDEP, 310 CMR 16.00: Regulations For Solid Waste Management Facility Site Assignment and Recycling, Composting, and Conversion Permits, Final Regulations
Massachusetts, and establishes emission limitations and/or restrictions for a facility or emission unit." The MassDEP may also require the submittal of a Comprehensive Approval Plan (CPA). Before approving the CPA, MassDEP must determine the best available air pollution control technology (BACT) for the proposal. MassDEP will not approve the construction and operation of a new or modified facility if its emissions will cause or contribute to an exceedance of National Ambient Air Quality Standards (NAAQS).

The EPA has established that the MassDEP Plan Approval and Emissions Limitations Regulation (310 CMR 7.02) meets Clean Air Act requirements and ensures that emissions will not cause a condition of air pollution (i.e. create a nuisance). Therefore, adherence to 310 CMR 7.02 will meet or exceed EPA standards.

C. Municipal Development Approval Process
To determine specific local permitting in Greenfield a conceptual site plan must to be submitted a Staff Technical Review Group meeting is convened to discuss the project. The following departments typically attend this meeting:

- Planning & Development to include the Conservation Agent
- Engineering from DPW
- Fire Department
- Licensing Commission
- Health Department
- Building & Inspecting Department

Following this meeting a formal proposal for the project is generated.
Figure VI-1: Greenfield Municipal Project Approval Process
VI-2 Water Pollution Control Plant

A. National Pollutant Discharge Elimination System Permit

The Greenfield WPCP has an existing National Pollutant Discharge Elimination System (NPDES) permit program, which controls water pollution by regulating discharge pollutants into the Deerfield River. For this project, the separated liquid will be piped directly to the WPCP through a leachate line under the east corner of the Transfer Station that goes directly to the Greenfield water pollution control plant. If nitrogen and phosphorous levels exceed allowable levels, a sequential batch reactor (SBR) can be installed prior to the liquid digestate being circulated back to the WPCP. In re-circulating the liquid digestate to the head of the WPCP plant, the AD facility may be considered an industrial discharger (depending on ownership structure) and therefore potentially subject to compliance with Pretreatment Regulations in accordance with 40 CFR 403. These regulations establish, "...responsibilities of Federal, State, and local government, industry and the public to implement Pretreatment Standards to control pollutants from the industrial users which may pass through or interfere with POTW treatment processes or which may contaminate sewage sludge."

Although the Greenfield Water Pollution Control Plant no longer has an industrial pretreatment program in place, Federal regulations under 40 CFR §403.5(d) give the POTW the authority to enforce its local limits to ensure they are still operating within the NPDES permit. Through preliminary review and discussion with the WPCP Superintendent about the impacts of returning the liquid digestate to the head of the WPCP, it was established that impacts will be minimal and acceptable under current operations. This is based on the recommended AD facility not being a significant industrial user of ≥ 25,000 GPD (the estimated AD discharge at 4,109 gallons per day to the Greenfield WPCP) and the WPCP is currently working under its daily flow at 89% capacity. According to the Plant Supervisor, the plant is currently operating under BOD capacity and the recirculation to the plant may in fact improve facility processes over current levels. At the point of project development, the pH, BOD, TSS, FOG, heavy metal and nutrient impacts will be determined and submitted for review by the WPCP.

In addition, while not expected to exceed current WPCP permitting, it should be noted that additional nitrogen and phosphorous may potentially trigger a NPDES permit modification. Currently, the Greenfield WPCP is not required to treat for nitrogen and phosphate, and is only required to monitor. When feedstock sources and types are secured, MassDEP will be notified of expected impacts of nitrogen and phosphorous levels. Additional requirements, if any, will be determined at that point. The Water Facilities Superintendent has clarified that sending the liquid digestate back to the plant through the existing sewer system will likely have no effect on permitting.

B. Water Pollution Control Plant Sludge Disposal Methods

Modifications to the existing WPCP Treatment Work Plan Approval (BRP WP 68) will be required to define that the anaerobic digestion system will serve as the primary sludge disposal method, and the current primary disposal method should be included as a backup. This will be submitted to MassDEP for their approval.

VI-3 Compressed Natural Gas Fueling Station

Compression of natural gas for use in a vehicle fueling station requires that the methane be stored and distributed in hard containers at a pressure of 20–25 MPa (2,900–3,600 psi). Compressed Natural Gas (CNG) guidelines include, but are not limited to, proper ventilation of compression, storage and dispensing equipment, suitable siting, gas detection systems, fire protection, proper signage, safety pressure relief devices, and emergency shutdown equipment. The bioCNG fueling station is a specialized item and is the responsibility of the development team to provide a turnkey system that includes permit applications and adherence to regulations. Additionally, this project has received support from the Clean Cities Coalition,
which has offered to provide additional regulatory support throughout the final design and development process.

The National Fire Protection Association Vehicle Gaseous Fuel System Code (NFPA 52) addresses natural gas vehicle safety standards in the United States; safeguarding people and installations with requirements that mitigate the fire and explosion hazards associated with compressed natural gas (CNG) and liquefied natural gas (LNG) engine fuel systems and fueling facilities. Provisions cover the design, installation, operation, and maintenance of CNG and LNG fuel systems on all vehicle types, plus their respective compression, storage, and dispensing systems.

Through the Board of Fire Prevention Regulations, Compressed Natural Gas Containers and Systems (527 CMR 26) provides the minimum standards for CNG systems to ensure protection and safety. For a detailed list of these standards, see 'Appendix L: Compressed Natural Gas Permitting Guidelines'.

**VI-4 Combined Heat and Power Electrical Interconnection**

Although a CNG facility is recommended in combination with the anaerobic digester, CHP options were also explored. The primary requirements for CHP approval are interconnection with the local electric utility, and the establishment of a power purchase agreement for the electricity generated.

For all systems 500 kW or greater, the facility owner must request and receive a pre-application report from the utility. For the simplified and expedited interconnection paths, technical requirements are based on the IEEE (Institute of Electrical and Electronics Engineers) 1547 and UL 1741 standards and are meant to provide a set of criteria and requirements for the interconnection of distributed generation resources into the power grid in the United States.

A manual external disconnect switch may be required at the discretion of the utility (project-specific, not required in the tariffs). Since this project does not plan to export energy to the grid, the process is made easier. Systems that are under 500kW are eligible for an expedited application process. See 'Appendix M: Summary of Requirements for Proposed Distributed Generations Interconnections with the WMECO Distributions System' for guidelines.

**VI-5 Separated Solid Digestate**

Biosolids refer to sewage sludge that has been treated to meet federal and state standards. As sludge will serve as a primary feedstock in the proposed digester, the digestate is considered a biosolid. To ensure public health and safety, digestate is regulated through current biosolid standards to define digestate use and disposal methods. Both state and federal standards apply for pathogen and contaminant reduction and restrictions of use. The EPA standards regulate the digestate to Class A and Class B, while the MassDEP classifies to Type I, II, II. Please refer to 'Appendix N: NEBRA Summary of Regulations of Sewage Sludge Land Application in Massachusetts (310 CMR 32)' for further specifications and requirements of MassDEP and EPA classifications. Note that official state guidance/regulations should be consulted for full information and this chart is not intended as a substitute.

**A. State Regulations**

The MassDEP regulates biosolid reuse by Land Application of Sludge and Septage (310 CMR 32.00) to ensure that the biosolids are safe to use. It is intended to allow the land application of sludge and septage for beneficial purposes in a manner that will protect public health and the environment from possible...
contamination which could occur from pathogens, metals, or toxic chemical compounds. The DEP classifies sludge and septage into three different types to define use.

- **Type I** - Stringent standards and very high quality product that allows for the biosolids to be used, sold, or distributed or offered for use, sale, or distribution on any site without further approval of the MassDEP, and may be used for growing vegetation. Limitations include - septage may not be eligible for Type I classification; not putrescible; and concentration of substances (heavy metals and chemicals) it contains does not exceed the limits defined in 310 CMR 32.00

- **Type II** - The biosolids meet a lower standard for use than Type I. Sludge and septage approved and prior approval by the MassDEP is required before use, sale, or distribution. Use is restricted to a specific parcel of land which may be used for growing any vegetation.

- **Type III** - Biosolids have been treated for pathogen reduction, but may contain more chemicals and metals than Type II. Sludge and septage approved and prior approval by the MassDEP is required before used, sold, or distributed or offered for use, sale, or distribution for land application on a site. Use is restricted to any vegetation not including direct food chain crops and any application must be recorded on the deed to the parcel of land on which it is applied.

To ensure the safety of biosolids, the following conditions apply:

- **A Sampling and Analysis Plan** to document how samples of biosolids will be collected, analyzed, and reported to MassDEP.
- **Approval of Suitability** that states the classification of biosolids for utilization purposes which is dependent on pathogen reduction and chemical quality. The Approval of Suitability is revisited every two years.
- **Land Application Certification** that defines management standards for the use of biosolids on a specific parcel of land. Land Application Certificates must be updated each year.

Additionally, Massachusetts manages nutrient application. The Massachusetts Department of Agricultural Resources (MDAR) put into effect Plant Nutrient Application Requirement (330 CMR 31.00) to establish limitations on the application of plant nutrients to lawns, non-agricultural turf, and agricultural lands in an effective manner as to prevent these non-point source pollutants from entering the surface and groundwater resources of Massachusetts. The goal is for nutrient management sufficient for plant growth while minimizing the impact of the nutrients on water resources.

### B. Federal Regulations

The EPA Standards for the Use and Disposal of Sludge (40 CFR Part 503), establishes standards which consist of five subparts: general provisions; requirements for land applications; surface disposal; pathogen and vector attraction reduction; and incineration. Biosolids applied to land must meet risk-based pollutant limits specified in Part 503, which includes operational standards to control pathogens and to reduce vector attraction; must not exceed the ceiling concentrations for pollutants (maximum concentration limits for 10 heavy metals); and site restrictions where there are separate requirements for biosolid applied to nonpublic contact sites (agricultural land, forests, and reclamation sites) and public contact sites (public parks, plant nurseries, roadsides, golf courses, lawns, and home gardens).

Class A or Class B Biosolid designations are set in regard to pathogens (disease-causing organisms such as certain bacteria, viruses, and parasite) and vectors (organisms, such as rodents and insects that can spread disease by carrying and transferring pathogens).

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Class A and Class B differ depending on the level of pathogen reduction and vector attraction reduction. Class A Biosolids contain no detectible levels of pathogens and meet vector attraction reduction requirements (1 of 8 vector attraction reduction options are applied). To achieve Class A certification, biosolids must reduce pathogens through methods including, but are not limited to, heating, composting, digestion, increased pH, or use of PFRP’s (Processes to Further Remove Pathogens). Class B Biosolids have less stringent standards for treatment than Class A, and contain small but compliant amounts of pathogens and meet vector attraction reduction requirements (1 of 10 vector attraction reduction options are applied). These standards ensure that pathogens in biosolids have been reduced to levels that protect public health and the environment. Class B has buffer requirements and restrictions for virtually all forms of Class B biosolids for public use, land application and crop harvesting.

VI-6 Massachusetts Environmental Protection Agency (MEPA) Review

The Massachusetts Environmental Policy Act (MEPA) requires state agencies to investigate the environmental consequences of a project in order to determine which agency action is required, including permitting and financial assistance, and take all feasible means to avoid, minimize, and mitigate damage to the environment. The purpose is to provide meaningful opportunities for public review of potential environmental impacts of a project MEPA applies to projects that exceed MEPA review thresholds and that require a state agency action, specifically that they are either proposed by a state agency or are proposed by municipal, nonprofit or private parties and require a permit, financial assistance, or land transfer from state agencies.

MEPA Review is not a permitting process, rather an informal administrative process involving any interested agency or person to perform a public study, disclosure, and development of environmental consequences and feasible mitigation for a proposed project. The Secretary conducts MEPA review and it occurs before permitting agencies act, to ensure that they are fully cognizant of environmental consequences of their actions.

MEPA Review Thresholds identify categories of projects where the nature, size or location is likely, directly or indirectly, to cause damage to the environment. The review thresholds are as follows: land; state-listed species; wetlands, waterways and tidelands; water; wastewater; transportation; energy; air; solid and hazardous waste; historical and archaeological resources; areas of critical concern; and regulations. Please refer to 'Appendix O: MEPA Regulation 301 CMR 11.03 - Threshold Section' for an exhaustive list of these threshold criteria.

If publicly owned treatment works (POTW) sludge from Greenfield is brought to the anaerobic digestion site as a feedstock, the traditional permitting process route may be required, which includes a MEPA review. Governing the MEPA review process is MEPA Regulations (301 CMR 11.00). MEPA review is required when one or more review thresholds are met or exceeded and the subject matter of at least one review threshold is within MEPA jurisdiction. A review threshold that is met or exceeded specifies whether MEPA review shall consist of an Environmental Notification Form (ENF) and a mandatory Environmental Impact Report (EIR) or of an ENF and other MEPA review if the Secretary so requires.

MEPA review is required only when the project is seeking State Financial Assistance or requires a Permit from a State Agency and exceeds a MEPA review threshold that is related to the subject matter of the State Permit. The first threshold test would be to determine if the project will be accepting state financial assistance. If not, no MEPA review is required. If financial assistance is sought, the final system configuration would have to be reviewed according to each of the threshold criteria for land, wetlands, waterways, species (MGL c 131A), water, wastewater, transportation, energy air, solid and hazardous waste, historical and archeological resources, areas of critical environmental concern, and regulations. If the project accepts state financial assistance and triggers a threshold review item (Appendix O), a MEPA review is required.
VII. CONCLUSIONS AND NEXT STEPS

There is a strong desire within the town management of Greenfield to provide cost saving, sustainable solutions regarding waste disposal and renewable energy production through the implementation of an anaerobic digestion system coupled with a CNG fueling station.

VII-1 Feasibility Assessment

The project has been determined to be feasible from a technical, economic, regulatory, and community perspective. Given the educated staff, the favorable siting conditions, and rising operational costs across transportation and waste disposal expenses, this project is deemed feasible with excellent return on investment and provides a long term beneficial service to the residents of Greenfield.

VII-2 Recommended Next Steps

The next steps are for Greenfield to determine if the project is something that they would like to pursue given the expected impacts. The foundations for the project are already being laid by the Town with investigation into CNG vehicles. As the project evolves to the pre-design phase, the following key items should be defined:

- Ownership and operational structure of all or individual components of system
- Establish agreements for feedstock availability and type
- Digestate application or off-taker
- CNG fleet vehicle agreements
- Civil site assessment for Transfer Station location
- Conceptual site plan submitted for a Greenfield Staff Technical Review Group meeting and to MassDEP for a permitting review meeting
- Establishment of community engagement and education plan
APPENDIX A: COMMONWEALTH ORGANIC WASTE BAN

PATRICK ADMINISTRATION FINALIZES COMMERCIAL FOOD WASTE DISPOSAL BAN

BOSTON – Friday, January 31, 2014 – The Patrick Administration today announced final statewide commercial food waste disposal ban regulations to take effect on October 1, 2014. The ban will divert food waste to energy-generating and composting facilities and reduce the Commonwealth’s waste stream.

“We are committed to protecting our natural resources and creating jobs as the Commonwealth’s clean energy economy grows,” said Energy and Environmental Affairs (EEA) Secretary Rick Sullivan. “The disposal ban is critical to achieving our aggressive waste disposal reduction goals and it is in line with our commitment to increase clean energy production.”

The ban, regulated by the Massachusetts Department of Environmental Protection (MassDEP), will require any entity that disposes of at least one ton of organic material per week to donate or re-purpose the useable food. Any remaining food waste will be shipped to an anaerobic digestion (AD) facility, where it will be converted to clean energy, or sent to composting and animal-feed operations.

Food materials and organics make up 25 percent of the current waste stream, making the disposal ban an important component of the Patrick Administration’s strategy to reduce waste disposal. The ban will help the Commonwealth reach its goals to reduce the waste stream by 30 percent by 2020 and 80 percent by 2050.

Residential food materials and food waste from small businesses are not included in the ban. The disposal ban affects approximately 1,700 businesses and institutions, including supermarkets, colleges, universities, hotels, convention centers, hospitals, nursing homes, restaurants and food service and processing companies.

“The establishment of this regulation is an important milestone for the Commonwealth’s effort to divert food waste and organics from disposal. However, there is more work to be done to make this effort a success,” said MassDEP Commissioner Kenneth Kimmell. “Over the next eight months, we plan to join with our organics stakeholders to conduct additional outreach, education, technical assistance and infrastructure development to ensure a smooth transition for the businesses covered by the ban.”

Anaerobic digestion is a process that puts organic wastes into an enclosed chamber where microbes break down the material, producing an energy-creating biogas. The biogas that remains after the organic materials have been broken down can be put to a variety of uses. It can be used to create heat for industrial processes or fed into a generator to create electricity, or used in a combined heat and power (CHP) system to produce both electricity and heat simultaneously. Biogas can also be converted to compressed natural gas (CNG) and used to fuel vehicles like buses or trucks.

“This waste ban helps make anaerobic digestion a real winner for the Patrick Administration’s energy and environmental goals,” said Department of Energy Resources (DOER) Commissioner Mark Sylvia. “Not only will we keep useful organic materials out of landfills, the output of the AD process will power businesses and enhance our clean energy portfolio.”

To ensure that there will be sufficient facilities to manage the organic material resulting from the ban, the Patrick Administration is working to site composting and AD operations on farms, wastewater treatment plants and other public and private locations by providing technical assistance and up to $1 million in grants. MassDEP and DOER

awarded the first AD grant of $100,000 to the Massachusetts Water Resources Agency (MWRA) for its wastewater treatment plant at Deer Island. The MWRA currently processes sludge in 12 massive, egg-shaped digesters and utilizes the biogas created to provide heat and electricity for the plant. A pilot project later this year will introduce food waste into one of the chambers to determine the effects of co-digestion on operations and biogas production.

MassDEP also established the “RecyclingWorks in Massachusetts” program to help businesses and institutions increase recycling and comply with the Massachusetts waste disposal bans. The RecyclingWorks program provides free web-based resources and guidance (www.recyclingworksma.com), including a searchable service provider database, a phone hotline and direct technical assistance. MassDEP also continues to provide technical and financial assistance to municipalities and is adding funding to the existing Recycling Loan Fund to support projects to grow infrastructure for managing organic materials.

Many Massachusetts businesses have already established cost-effective food waste separation programs. Through an innovative partnership between MassDEP and the Massachusetts Food Association, 300 supermarkets have implemented successful food waste separation programs that save up to $20,000 a year per store location.

“We have worked cooperatively with MassDEP over the years on this and other environmental initiatives, fostering a relationship with the Department that has allowed us to work with our members to have a positive environmental impact,” said Massachusetts Food Association President Chris Flynn. “This relationship is why the supermarket industry has been able to play a leadership role in establishing and maintaining food waste diversion programs well in advance of the waste ban.

“This commercial food waste ban is just one more way Massachusetts continues to lead the way with solutions that not only save on energy and protect our environment, but also green up the bottom line,” said Senator Marc R. Pacheco, Senate Chair of the Joint Committee on Environment, Natural Resources and Agriculture. “Through it, we will take another step closer towards achieving our Global Warming Solutions Act goal of reducing greenhouse gas emissions 25 percent below 1990 levels by 2020, and 80 percent below 1990 levels by 2050.”

“I appreciate the efforts by the business community and other public and private entities to reduce food waste,” said Representative Anne Gobi, House Chair of the Joint Committee on Environment, Natural Resources and Agriculture. “New technologies to handle the waste create lasting environmental and economic rewards.”

For more information on the food waste and organics ban and its implementation, turn to: http://www.mass.gov/eea/agencies/massdep/recycle/solid/massachusetts-waste-disposal-bans.html.
APPENDIX B: GREENFIELD LANDFILL PERMIT
November 21, 1994

Re: PERMIT FOR EXISTING LANDFILL
Application for: BWP SW 09
Final Permit

At: Greenfield Sanitary Landfill
Wisdom Way
Greenfield, Massachusetts
94-114-001
Transmittal Number: 36884

Dear Mr. Bean:

The Department of Environmental Protection has completed the permit review process for the above referenced permit application and hereby approves the application and issues the attached FINAL PERMIT for the referenced facility.

Upon careful review of the attached Final Permit you will note that it contains several specific conditions relative to the continued operation of the Greenfield Sanitary Landfill. These conditions have been incorporated into the attached Final Permit in order to assure that the operation of your facility is consistent with the existing regulations. In this regard most of the conditions contained in the attached Final Permit are self explanatory. Some aspects of the attached permit, however, may warrant further clarification.

First, the attached Final Permit requires that the Town of Greenfield develop an alternate mechanism for the management of the Town of Greenfield’s wastewater treatment plant sludge. In this regard, the Final Permit which is being issued requires that by January 1, 1996 the Town of Greenfield enter into contracts or agreements necessary to achieve this end. Further, the Final Permit which is being issued precludes the disposal of wastewater treatment plant sludge in the Greenfield Sanitary Landfill beyond
July 1, 1996. The Department has included this condition into the permit in order to achieve compliance with 310 CMR 19.061(6)(d)(2) Requirements for Sewage Treatment and Water Treatment Sludges which states, in part:

"Sewage treatment sludges may be accepted at a solid waste landfill only after land application and composting options have been investigated by the applicant or by the generator of such sludge and determined by the Department not to be feasible, provided that said investigation of options may be deferred for a reasonable time upon a determination by the Department that adverse impacts may occur as a result delaying disposal of sludge."

In considering the application of this permit condition the Department has considered the information contained in the draft report entitled Market Study For Sludge Products, Erving Regional Sludge Management Project (ECODATA, Inc. April 24, 1992) which addresses the marketability of composted or treated wastewater treatment plant sludges in and around Franklin County. Additionally, the Department has also considered the fact that existing sludge composting facilities are currently accessible to the region as evidenced by the endeavors of the Town of Easthampton, Mead Specialty Paper in Lee, and the presence of a sludge composting facility with available capacity as close as Holyoke, Massachusetts. While the Department considered your presentation in the Existing Facility Permit Application (EFPA) that a regional (Franklin County) sludge composting solution was not expected to be available until June 30, 1997; the reality remains that existing sludge composting capacity is available and accessible in this area.

Secondly, the Department has incorporated permit conditions relative to the unlined Phase I and Phase II areas. Your existing facility permit application presented an interest on the part of the Town of Greenfield to return to these unlined areas for landfilling purposes in order to improve site grading and drainage. First, the attached Final Permit provides clarification that the Town of Greenfield can not return landfilling operations to the Phase I or Phase II areas without prior Department approval via the permitting processes stipulated in 310 CMR 16.00 and 310 CMR 19.000. These areas are unlined and do not meet the performance standards presented at 310 CMR 19.110 Ground Water Protection Systems. Additionally, it is the understanding of the Department that neither the Phase I or Phase II areas have been closed in accordance with the regulations. Therefore, the attached Final Permit requires that certain activities be conducted at the site to achieve final closure. Specifically, the Final Permit requires that a top slope stability/settlement study be conducted relative to the Phase I and Phase II areas and that the information generated be utilized for the development of a closure plan.
Thirdly, the attached Final Permit has been fashioned to reflect the management strategy presented by the Town of Greenfield to the Department in correspondence dated April 7, 1994. In accordance with this correspondence, and discussions held, the attached permit approves the grades proposed in the EFPA for the Step 1 area which provides sufficient capacity for the Town to entertain the sale of landfill capacity in order to help offset additional costs associated with the development of an alternative sludge management strategy. In this regard, the attached Final Permit provides an approved daily tonnage of up to ninety-nine (99) tons per day (the maximum allowable without prior MEPA certification). Additionally, the possibility to close Phases I and II at top slopes of less than 5% remains, contingent upon the development of sufficient settlement/stability data to support a waiver request.

The attached Final Permit also provides for the implementation of remedial activities to mitigate landfill gas migration on the basis of the submitted Corrective Action Alternatives Analysis (CAAA) incorporated in the Draft CSA report. Additionally, the Department is seeking closure of the inactive landfill phases prior to the closure of the Step 1 lined area.

In accordance with the permit review requirements of section 19.037 of 310 CMR 19.000 the "Solid Waste Management Facility Regulations" this permit is being issued as a final decision. Any applicant aggrieved by the Department’s decision may within twenty-one (21) days file a written request that the decision be deemed a provisional decision, and a written statement of the basis on which the applicant believes it is aggrieved, together with any supporting materials. Upon timely filing of such a request, the decision shall be deemed a provisional decision with an effective date twenty-one days after the Department’s receipt of the request. Such a request shall reopen the administration record, and the Department may rescind, supplement, modify, or reaffirm its decision. Failure by the applicant to exercise the right provided in this section shall constitute a waiver of the applicant’s right to appeal.

Should there be any questions, please contact Daniel Hall at 784-1100 ext. 212 or the undersigned at the letterhead address.

Sincerely,

Mark A. Schleeweis
Section Chief
Division of Solid Waste Management

Enclosures
Final permit
cc: John F. Bean, Superintendent, Department of Public Works
Town of Greenfield, Board of Health
certified mail, return receipt requested, Z 082 548 018
DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF SOLID WASTE MANAGEMENT

FACILITY PERMIT
AUTHORIZATION TO OPERATE
LANDFILL

Date: November 17, 1994

Name of Permittee: Board of Selectmen
Town of Greenfield

Mailing Address: Town Hall
Greenfield, Massachusetts 01301

Name of Facility: Greenfield Sanitary Landfill

Address of Facility: Wisdom Way
Greenfield, Massachusetts 01301

DEP Region: Western Regional Office, Springfield

FILE NO: 94-114-001

I. FACILITY DESCRIPTION AND OUTSTANDING APPROVAL STATUS

A. Facility

1. Owner: Town of Greenfield
   Town Hall
   Greenfield, Massachusetts 01301

2. Lessor: Town of Greenfield

3. Operator: Department of Public Works
   Town of Greenfield

4. Description

   a. Types of Waste Accepted: Municipal Solid Waste,
      Municipal Wastewater Treatment Plant Sludge.

   b. Methods of Management: Landfilling, Recycling, &
      Leaf Composting.

   c. Approved Amount of Waste Acceptance: 99 tons per
day.

   d. Estimated Remaining Life: Approximately 22,465
      cubic yards or 2.8 years at current fill rate top
      slope based upon the 1993 Annual Report.
B. Reviews and Approvals Affecting Current or Planned Operation

1. MEPA: Not Applicable
2. Site Suitability Report: Not Applicable
3. Site Assignment: See Specific Permit Conditions
4. Title/Description(s) of Current Approved Plan/Permit:
   
   
   
   April 30, 1984: Approval of Sanitary Landfill Expansion Plans.

C. Existing Facility Permit Application- BWB SW 09 #36884

1. Applicant name: Town of Greenfield
2. DSWM Permit No: 94-114-001
3. Date of Application: July 13, 1992
4. Date of Fee Receipt: Not Applicable, Fee Exempt
5. Registered Professional Engineer: Michael R. Parsons, P.E.
6. Title of Plans & Reports Submission: Existing Facility Permit Application
7. Date of Receipt of Plans & Reports: July 13, 1992

II. FACILITY PERMIT AND AUTHORIZATION TO OPERATE APPLICATION REVIEW AND APPROVAL

This application complies with the application requirements at 310 CMR 19.030(4) [permits] and 19.042 [authorizations to operate] and was reviewed in accordance with 310 CMR 19.037, Review Procedure for Existing Facility Permits. The plans and reports described above establish that the facility complies with the criteria at 310 CMR 19.038(2)(a)1-10 and (d).

This document is a permit issued pursuant to G.L. c. 111, s. 150A and 310 CMR 19.000, subject to the conditions set forth below. In the event this permit and ATO conflicts with all or parts of prior plan approvals or permits issued pursuant to c. 111, s. 150A or
solid waste regulations in effect prior to July 1, 1990 the terms and conditions of this permit and ATO shall supersede the conflicting provisions of the prior permits approvals. This permit/ATO does not convey property rights of any sort or any exclusive privilege.

III. GENERAL PERMIT CONDITIONS

A. Amount of Waste - The facility shall not accept more than 99 tons per day without prior approval pursuant to the Massachusetts Environmental Policy Act and the Western Regional Office of the Department of Environmental Protection.

B. Compliance with Plans - The permittee shall conduct operations in accordance with approved plans, reports, and other submissions described in Section I except as may be modified by the conditions set forth in Sections IV and VI. No material changes in the design or activities described in the approved documents shall be performed without prior written Department approval.

C. Compliance with Other Approvals - The construction, operation, maintenance and closure of this facility shall be performed in compliance with other applicable state and federal laws and regulations.

D. Standard Conditions - The permittee [and the owner] shall operate the facility in accordance with the conditions at 310 CMR 19.007-19.011 and 19.043(5).

E. Joint Liability - This permit is issued subject to the conditions of joint liability of the permittee and owner in accordance with 310 CMR 19.043(3).

F. Transfer - No transfer of the this permit shall be permitted except in accordance with 310 CMR 19.044.

G. Waste Disposal Restrictions - The permittee shall comply with the submission requirements for all waste control plans in accordance with 310 CMR 19.017.

H. Compliance with RCRA/Subtitle D - Notwithstanding the approval of the plans and reports incorporated herein and the applicable regulations [310 CMR 19.100 et seq, Part II- Landfill Design and Operational Standards] in effect on the date this permit issued, the Department may order the permittee or owner to take all necessary actions to comply with the provision of 310 CMR 19.014 including, without limitation, the submission of plans, reports and monitoring data; financial assurance and modifications of approved operating, maintenance and environmental
monitoring procedures. 310 CMR 19.014 prohibits the operation or maintenance of a landfill in violation of the Resource Conservation and Recovery Act, Subtitle D [42 USC 4004(a)(b)] and the regulations and criteria promulgated thereunder.

I. Permit Modification- The Department reserves the right to rescind, suspend or modify this permit by the imposition of additional conditions based upon a determination of actual or the threat of adverse impacts from the construction, operation, maintenance or closure of the facility.

J. Special Waste (General)- The permittee shall not accept special wastes at the Greenfield Sanitary Landfill except as in accordance with the regulations and with prior approval from the Department. Note that this permit allows for municipal sludge which has been generated at the Greenfield wastewater treatment plant to be disposed of at the landfill provided that such disposal is in accordance with 310 CMR 19.061(6)(d) and the SPECIFIC PERMIT CONDITIONS contained in this permit.

IV. SPECIFIC PERMIT CONDITIONS/AUTHORIZATION TO OPERATE CONDITIONS

A. Term- This Authorization to Operate [ATO] shall be valid only for the period of time for the current operating phase to reach its approved limits (as presented in the EFPA: 5% top slope not exceed a crown elevation of 290), or for a fixed term of five [5] years whichever term shall expire first, provided that the Department may amend the term of the ATO: (a) in accordance with an approved modification pursuant to either 310 CMR 19.039 or 19.040; or (b) in order to coincide with the termination or renewal date of other Department permits issued for the solid waste processing, treatment or pollution control equipment located at the facility. If the permittee intends to operate in the current phase of the facility after the expiration of this ATO the permittee is required to submit a request for a renewal of the ATO at least 180 days prior to the expiration of the ATO in accordance with 310 CMR 19.042(4).

B. Approval to Operate in Phase/Permitted Area- This permit has been issued for continued operations in the Step 1 area as identified within the Existing Facility Permit Application. This Permit does NOT allow a return of operations to any unlined portions of the site. Any future operations in the inactive Phase I or Phase II areas, or in currently undeveloped portions of the site, are subject to the permitting processes stipulated in 310 CMR 16.00 and 310 CMR 19.000, as applicable.
C. **Inspections** - Landfill inspections shall be performed on a bi-monthly basis, once every two (2) months. These inspections shall be conducted and reported in accordance with 310 CMR 19.130(35).

D. **Topographic/Volume Control** - The Town of Greenfield shall perform annual comprehensive topographic surveys of the site depicting the Phase I, Phase II, and Step 1 areas. The site survey must be of sufficient resolution to monitor both the settlement of the Phase I/Phase II areas as well as the extent of fill within the Step 1 area. The submittal of the topographic survey shall be submitted coincident with the annual landfill reporting requirements stipulated at 310 CMR 19.130(34).

E. **Demonstration Projects** - Not Applicable.

F. **Variances** - Not Applicable.

G. **Discharge to Surface Waters** - The Town of Greenfield shall within one-hundred and twenty days (120) demonstrate the ownership of all appropriate approvals and permits with respect to the National Point Discharge Elimination System (NPDES) as pertaining to stormwater management.

K. **Compliance Schedule** - The following schedule presents outstanding issues which were not adequately addressed by the submitted Existing Facility Permit Application. Note that for each outstanding issue a compliance schedule has been stipulated. Failure to meet the requirements of the compliance schedule presented below shall constitute a violation of this permit/ATO.

**Compliance Schedule**

1. **Financial Assurance Mechanism(s)** - The permittee shall maintain closure and post closure financial assurance in accordance with 310 CMR 19.051. Within one-hundred and twenty days of the issuance of this Permit the Town of Greenfield shall submit to the Department sufficient documentation evidencing an approved financial assurance mechanism pursuant to 310 CMR 19.051(4).

2. **Special Waste (Wastewater Treatment Plant Sludge)** - In order to achieve compliance with 310 CMR 19.061(6)(d)(2) **Requirements for Sewage Treatment and Water Treatment Sludges**, the permittee shall:

   (a). by no later than July 1, 1995 submit to the Department information which clearly documents a financial assurance instrument (in place and
in effect) which addresses the financial implications of wastewater treatment plant sludge management as it relates to off-site treatment via composting, land application, or other waste diversion technologies.

(b). by no later than September 1, 1995 advertise a Request For Proposals, or otherwise solicit bids, for the purposes of entering into contractual agreements for the off-site management of wastewater treatment plant sludge via composting, land application, or other waste diversion technologies. The permittee shall provide sufficient information to document that this task has been completed to the Department by no later than September 2, 1994.

(c). by no later than January 1, 1996 the Town of Greenfield shall enter into contractual agreements which provide for the long-term management of waste water treatment plant sludge via composting, land application, or other waste diversion technologies. By no later than January 2, 1996 documentation of such contractual agreements shall be forwarded to the Department.

(d). by no later than July 1, 1996 the Town of Greenfield shall cease disposal of any wastewater treatment plant sludge at the Greenfield Sanitary Landfill.

3. **Inactive Phases I and II**—In order to achieve compliance with 310 CMR 19.021(4) Inactive Facility Filing Schedule and 310 CMR 19.130(15)(d) Final Cover, the permittee shall;

(a). by no later than January 15, 1995 submit to the Department a report for review and approval which addresses top slope stability, as it relates to the potential for future settlement, for the inactive Phase I and Phase II areas.

(b). by no later than March 1, 1995 submit to the Department for review and approval a closure/post-closure plan in accordance with 310 CMR 19.030(3)(c)5. for the inactive Phase I and Phase II areas. The submitted closure plan shall provide a final cover system over all areas of previously landfilled wastes.
The landfill closure/post-closure plan may, however, consider the results of the top slope stability analysis as a basis for design relative to the necessity of constructing a 5% top slope.

(c) by no later than April 15, 1995 the Town of Greenfield shall solicit bids for the construction of the closure for the Phase I and Phase II areas.

(d) by no later than July 1, 1995 Town of Greenfield shall award the contract for the construction of the closure of the Phase I and Phase II areas.

(e) by no later than August 1, 1995 construction of the Phase I and Phase II closure shall commence.

(f) by no later than November 15, 1995 the construction of the Phase I and Phase II closure shall be complete.

(g) by no later than January 1, 1996 the Town of Greenfield shall submit to the Department the closure construction certification report.

4. **Active Step 1 Area** - The permittee shall submit to the Department for review and approval a revised minimum grading plan for the Active Step 1 Area by no later than January 1, 1995. The minimum grading plan shall include a maximum elevation of 290 feet (as referenced from plans accompanying the EFPA), 5% top slope, and sideslopes not to exceed 3 horizontal to 1 vertical (3:1).

5. **Environmental Impact Mitigation** - The permittee shall implement remedial activities for the conclusive mitigation of off-site landfill gas migration in either of the following manners (paragraphs a or b) and in accordance with the following schedule (paragraph c).

   a. **Remedial Activity** - The Town of Greenfield shall install landfill gas mitigation technologies consisting of Option #7: Composite System as referenced in the Corrective Action Alternatives Analysis included in the report entitled "Draft Comprehensive Site Assessment (CSA), Greenfield Sanitary Landfill, May 1994". Further, this
remedial Option shall be constructed to the extents depicted on the plan entitled Landfill Gas Mitigation Alternatives accompanying the submitted draft CSA.

b. **Remedial Activity(Option)** - The Town of Greenfield may (as an alternate to paragraph a. above) procure, or otherwise maintain exclusive control via an easement or other such legal mechanism, an adequate tract of land on properties adjacent to the landfill such that the risks associated with the migration of landfill gas can be essentially mitigated via controlled access and restricted use. Note that any proposal to address landfill gas migration in this manner is subject to further consideration and approval by the Department. Note that pending negotiations in this regard shall not be considered sufficient cause for the Town of Greenfield to violate the schedule stipulated in paragraph c. below.

c. **Schedule** - The Town of Greenfield shall implement Option #7: Composite System, or a Department approved alternate pursuant to paragraph b. above, in accordance with the following schedule.

1. by no later than April 15, 1995 the Town of Greenfield shall solicit bids for the construction/implementation of the remedial option.

2. by no later than July 1, 1995 the Town of Greenfield shall execute agreements/contracts for the construction/implementation of the remedial option.

3. by no later than December 15, 1995 the Town of Greenfield shall complete construction/implementation of the remedial option.

VI. RIGHT OF APPEAL

A. **Right to Appeal** - Pursuant to 310 CMR 19.037(5), any person aggrieved by the issuance of this permit or authorization to operate may file an appeal for judicial review of said decision in accordance with the provisions of M.G.L., c. 111, s. 150A and C. 30A not later than
thirty [30] days following notice of this decision.

B. Notice of Appeal- Any aggrieved person intending to appeal the decision to the superior court shall provide notice to the department of intention to commence such action. Said notice of intention shall include the Department File Number and shall identify with particularity the issues and reason(s) why it is believed the approval decision was not proper. Such notice shall be provided to the Office of General Counsel of the Department and the Regional Director for the regional office which made the decision. The appropriate addresses to which to send such notices are:

General Counsel
Department of Environmental Protection
One Winter Street-Third floor
Boston, 02108

Regional Director
Department of Environmental Protection
436 Dwight Street
Springfield, Massachusetts 01103

No allegation shall be made in any judicial appeal of this decision unless the matter complained of was raised at the appropriate point in the administrative review procedures established in those regulations, provided that matter may be raised upon a showing that it is material and that it was not reasonably possible with due diligence to have been raised during such procedures or that matter sought to be raised is of critical importance to the public health or environmental impact of the permitted activity.

__________________________
Mark A. Schleeweis
Section Chief
Division of Solid Waste Management
APPENDIX C: GREENFIELD TRANSFER STATION SITE ASSIGNMENT
Notice of Final Decision
Transfer Station Site Assignment

Facility Name: Transfer Station/Recycling Center
Facility location: Off Wisdom Way
Town: Greenfield, Massachusetts
Type of Facility: Solid Waste Transfer Station
Applicant: Greenfield Department of Public Works

In accordance with the provisions of Massachusetts General Laws, Chapter 111, Sections 150A and 150A 1/2 and the regulations promulgated thereunder, 310 CMR 16.000, the Board of Health, at its regular Board meeting on May 5, 1992, made a final decision to assign a portion of the Town Sanitary Landfill property as the site for a proposed solid waste transfer station. The transfer station will handle residential solid wastes and recyclables. Solid wastes will be transferred within an enclosed structure.

The Board of Health reviewed the site suitability criteria listed in 310 CMR 16.40 as well as DEP's site suitability report in order to make its determination.

Criteria #1

The Board of Health has found that the proposed facility's waste handling or processing area would not be located within the Interim Wellhead Protection Area (IWPA) or a Zone II of an existing public water supply well or a potential public water supply groundwater source.

Criteria #2

The Board of Health has determined that the waste handling and processing area of the proposed facility would not be less than five hundred (500) feet upgradient of a surface drinking water supply as defined by groundwater flow or surface water drainage.
CRITERIA #3
The Board of Health has found that the waste handling or processing area of the proposed facility would not be less than two hundred fifty (250) feet downgradient of a surface drinking water supply as defined by groundwater flow or surface water drainage.

CRITERIA #4
The Board of Health has determined that the waste handling or processing area of the proposed facility would not be within two hundred fifty (250) feet of an existing or potential private drinking water supply well.

CRITERIA #5
The Board of Health has found that the maximum high groundwater table would not be within two (2) feet of the ground surface in the proposed area where waste handling or processing is to occur.

CRITERIA #6
The Board of Health has found that the waste handling or processing area of the proposed facility would not be within two hundred fifty (250) feet of an occupied residential dwelling, prison, bedded health care facility, lower educational institution, or children's pre school, excluding equipment storage and maintenance structures.

CRITERIA #7
The Board of Health has determined that a one hundred (100) foot buffer would be present between the proposed site and active farmland.

CRITERIA #8
The Board of Health has found that the proposed site and operation of the facility would not constitute a danger to the public health, safety, or the environment when taking into consideration the following factors:

1. Traffic Congestion
2. Pedestrian and vehicular safety
3. Road configurations
4. Alternative routes; and
5. Vehicle emissions
CRITERIA #9

The Board of Health has concluded that the proposed site would not have an adverse impact on the following:

1. Endangered, threatened, or special concern species listed by the Natural Heritage and Endangered Species Program of the Division of Fisheries and Wildlife in its database;
2. An ecologically significant natural community as documented by the Natural Heritage and Endangered Species program in its database; or
3. The wildlife habitat of any state wildlife management area.

CRITERIA #10

The Board of Health has found that the proposed site would not:

1. Be located within an Area of Critical Environmental Concern (ACED), as designated by the Secretary of the Executive Office of Environmental Affairs; or
2. Fail to protect the outstanding resources of an ACED as identified in the Secretary's designation.

CRITERIA #11

The Board of Health has determined that the anticipated emission from the proposed facility would meet required state and federal air quality standards or criteria, and would not constitute a danger to the public, the public health, safety, or the environment taking into consideration the following air quality factors:

1. The concentration and dispersion of emissions;
2. The number and proximity of sensitive receptors; and
3. The attainment status of the area.

CRITERIA #12

The Board of Health has determined that the establishment and operation of the proposed facility would not result in nuisance conditions which would constitute a danger to the public health, safety, or the environment taking into consideration the following factors:
1. Noise;
2. Litter
3. Vermin such as rodents and insects;
4. Odors;
5. Bird hazards to air traffic; and
6. Other nuisance problems.
CRITERIA #13

The Board of Health has found that the size of the proposed site would be sufficient to properly operate and maintain the proposed facility.

CRITERIA #14

The Board of Health has made the following determination:
1. The performance of prior and current solid waste activities located adjacent to the proposed site may impact the proposed facility in a very limited fashion in terms of landfill gas migration from the existing disposal facility. This impact can be sufficiently rectified during the design and permitting phase for the proposed facility;
2. the proposed facility would not impact the site previously used for the solid waste activities; and,
3. The nature and extent of any combined impacts of the proposed site and the previously used adjacent site would be limited in effect on the public health, safety, and the environment, and as stated above, would be a direct result from prior activities performed on the adjacent site when the following is taken into consideration:
a. whether the proposed site is an expansion of or constitutes beneficial integration of the solid waste activities with the adjacent site;
b. whether the proposed facility is related to the closure and/or remedial activities at the adjacent site; and
c. the extent to which the design and operation of the proposed facility will mitigate existing or potential impacts from the adjacent site.

CRITERIA #15

The Board of Health has determined that the provision of granting preferential consideration to the proposed site by the Greenfield Board of Health does not apply under this criteria because of the following reasons:
1. the proposed facility is being developed for use by the Town of Greenfield and its citizens; and,
2. the proposed facility is not considered a disposal facility as defined in 310 CMR 16.02, which states that:

Disposal Facility means any solid waste combustion facility rated by the Department at more than one (1) ton per hour or any landfill.
CRITERIA #16

The Board of Health has determined that the provision of granting preferential treatment to the proposed site by the Greenfield Board of Health does apply under this criteria because of the following:

1. Though the proposed site will be located within a community which is participating in a regional disposal facility, the proposed facility would enable the Town of Greenfield to help meet its long-term solid waste management needs, and allow for the continued development of effective and environmentally-sound solid waste management techniques; and,

2. the proposed facility would encourage the practice of recycling by allowing for the accommodation and implementation of additional increases in current and future recycling by the Town, which in turn, may provide for future potential possibilities of further assisting the County, as a whole, to meet its long-term solid waste management needs and recycling objectives.

The Greenfield Board of Health therefore voted to approve the site assignment of the transfer/recycling facility with the following conditions:

1. This transfer station/recycling facility to be for residential waste from Greenfield inhabitants only -- "Not for county or regional use."

2. As many as possible of the existing trees upon the site are to be retained.

3. The entire site is to be fenced in.

4. The building is to be insulated.

5. Overhead doors to remain shut as much as possible.

6. Also to be included -- the hours and days of operation of said facility to remain on the same schedule as the existing facility.

7. The condition of the roadway on Wisdom Way is to be a high priority item for the DPW.

8. Ongoing efforts be made by the DPW to maintain or reconstruct Wisdom Way.
9. Every effort is to be made, particularly throughout the winter, (the snow and ice season), to maintain Wisdom Way.

GREENFIELD BOARD OF HEALTH

Adam Blacksin, Chairman

Margareta Athey, Clerk

Michael Duprey, Member

LAM/sts

bhtrans2
APPENDIX D: GREENFIELD WATER POLLUTION CONTROL PLANT NPDES PERMIT
AUTHORIZATION TO DISCHARGE UNDER THE
NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

In compliance with the provisions of the Federal Clean Water Act as amended, (33 U.S.C. §§1251 et seq.; the "CWA"), and the Massachusetts Clean Waters Act, as amended, (M.G.L. Chap. 21, §§ 26-53),

Town of Greenfield
14 Court Square
Greenfield, MA 01301

is authorized to discharge from the facility located at:

Greenfield Water Pollution Control Plant
384 Deerfield Street (Rear)
Greenfield, MA 01301

to receiving water named:

Deerfield River (MA33-04)

in accordance with effluent limitations, monitoring requirements and other conditions set forth herein.

This permit will become effective on the first day of the calendar month immediately following sixty days after signature. Effective Date: Nov 30, 2011

This permit and the authorization to discharge shall expire at midnight five (5) years from the last day of the month preceding the effective date of the permit.

This permit supersedes the permit issued on October 29, 2002.

This permit consists of 14 pages in Part I including effluent limitations, monitoring requirements, 25 pages in Part II including General Conditions and Definitions, and Attachment A: Freshwater Acute Toxicity Test Procedure and Protocol; Attachment B: Procedures for a pH Adjustment Demonstration Project, Attachment C: Summary of Required Report Submittals.

Signed this 26th day of September, 2011

Director
Office of Ecosystem Protection
Environmental Protection Agency
Boston, MA

Director
Commonwealth of Massachusetts
Massachusetts Wastewater Management Program
Department of Environmental Protection
Boston, MA
### PART I
#### A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

1. During the period beginning the effective date and lasting through expiration, the permittee is authorized to discharge treated effluent from outfall serial number 001 to the Deerfield River. The discharge shall be limited and monitored by the permittee as specified below.

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<td>Average Weekly</td>
</tr>
<tr>
<td></td>
<td>Average Monthly</td>
<td>Average Weekly</td>
</tr>
<tr>
<td></td>
<td>Average Monthly</td>
<td>Average Weekly</td>
</tr>
</tbody>
</table>

### Notes:
- E. Coli (April 1 - November 15):
  - March: 126 Colonies/100 ml
  - April, May, September, October: 409 Colonies/100 ml
- Total Residual Chlorine (April 1 - November 15):
  - March: 0.4% mg/l
  - April, May, September, October: 0.83 mg/l
- Total Nitrogen:
  - March: Report mg/l
  - April, May, September, October: Report mg/l
- Ammonia Nitrogen:
  - March: Report mg/l
  - April, May, September, October: Report mg/l
- Total Kjeldahl Nitrogen:
  - March: Report mg/l
  - April, May, September, October: Report mg/l

---

6.5 - 8.3 see permit page 6 of 14, paragraph 1.a.2.b.

E. Coli limits are not applicable before March 4. E. Coli testing is performed once per month. Total Residual Chlorine testing is not applicable before March 4. Total Residual Chlorine testing is performed once per month.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Average Monthly</th>
<th>Average Weekly</th>
<th>Maximum Daily</th>
<th>Average Monthly</th>
<th>Average Weekly</th>
<th>Maximum Daily</th>
<th>Measurement Frequency</th>
<th>Sample Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Nitrate&lt;sup&gt;11&lt;/sup&gt;</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>Report mg/l</td>
<td>***</td>
<td>***</td>
<td>1/Month</td>
<td>24-Hour Composite&lt;sup&gt;5&lt;/sup&gt;</td>
</tr>
<tr>
<td>Total Nitrite&lt;sup&gt;11&lt;/sup&gt;</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>Report mg/l</td>
<td>***</td>
<td>***</td>
<td>1/Month</td>
<td>24-Hour Composite&lt;sup&gt;5&lt;/sup&gt;</td>
</tr>
<tr>
<td>Total Phosphorus</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>Report mg/l</td>
<td>***</td>
<td>***</td>
<td>1/Month</td>
<td>24-Hour Composite&lt;sup&gt;5&lt;/sup&gt;</td>
</tr>
<tr>
<td>Whole Effluent Toxicity&lt;sup&gt;12, 13,14&lt;/sup&gt;</td>
<td>Acute</td>
<td>LC50 ≥ 100%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2/Year</td>
<td>24-Hour Composite&lt;sup&gt;5&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Sampling Location: Prior to discharge into the Deerfield River, and at a location that provides representative samples of the effluent.
Footnotes:

1. Required for State Certification.

2. Report annual average, monthly average and the maximum daily flow. This limit is an annual average, which shall be reported as a rolling average. The value will be calculated as the arithmetic mean of the monthly average flow for the reporting month and the monthly average flow of the previous eleven months.

3. Effluent sampling shall be of the discharge and shall be collected at the point specified on page 3.

A routine sampling program shall be developed in which samples are taken at the same location, same time and same days of the week each month. Occasional deviations from the routine sampling program are allowed, but the reason for the deviation shall be documented in correspondence appended to the applicable discharge monitoring report.

All samples shall be tested using the analytical methods found in 40 CFR §136 or alternative methods approved by EPA in accordance with the procedures in 40 CFR §136.

4. Sampling required for influent and effluent.

5. A 24-hour composite sample will consist of at least twenty four (24) grab samples taken during one consecutive 24 hour period, either collected at equal intervals and combined proportional to flow or continuously collected proportionally to flow.

6. Escherichia coli (E. coli) and total residual chlorine limits and monitoring requirements are in effect from April 1 through November 15. The average monthly limit for E. coli bacteria is expressed as a geometric mean. Samples for E. coli bacteria shall be collected concurrently with a total residual chlorine sample.

7. The total residual chlorine monitoring requirements apply whenever chlorine is added to the treatment process (i.e. TRC sampling is not required if chlorine is not added for disinfection or other purpose).

The minimum level (ML) for total residual chlorine is defined as 20 ug/l. This value is the minimum level for chlorine using EPA approved methods found in the most currently approved version of Standard Methods for the Examination of Water and Wastewater, Method 4500 CL-E and G. One of these methods must be used to determine total residual chlorine. For effluent limitations less than 20 ug/l, compliance/non-compliance will be determined based on the ML. Sample results of 20 ug/l or less shall be reported as zero on the discharge monitoring report.

8. Chlorination and dechlorination systems shall include an alarm system for indicating system interruptions or malfunctions. Any interruption or malfunction of the chlorine system that may have resulted in levels of chlorine that were inadequate for achieving
effective disinfection, or interruptions or malfunctions of the dechlorination system that may have resulted in excessive levels of chlorine in the final effluent shall be reported with the monthly DMRs. The report shall include the date and time of the interruption or malfunction, the nature of the problem, and the estimated amount of time that the reduced levels of chlorine or dechlorination chemicals occurred.

9. For every day that more than one grab sample is analyzed, the monthly DMR shall include an attachment documenting the individual grab sample results for that day, the date and time of each sample, the analytical method, and a summary of any operational modifications implemented in response to the sample results. This requirement applies to all effluent samples taken, including screening level and process control samples. All test results utilizing an EPA approved analytical method shall be used in the calculation and reporting of the monthly average and maximum daily discharge values submitted on the DMR.

10. Compliance with effluent limits will be determined using the results from grab samples. If the permittee collects and analyzes chlorine residual grab samples more frequently than required by the permit, the results of this monitoring must be included in the calculation and reporting of the data submitted on the DMR.

11. See Part I.B, Special Conditions, for requirements to evaluate and implement optimization of nitrogen removal.

12. The permittee shall conduct acute toxicity tests two (2) times per year and will test the fathead minnow, *Pimephales promelas*. Toxicity test samples shall be collected during the second week of the months of March and September. The test results shall be submitted by the last day of the month following the completion of the test. The results are due by April 31st and October 31st, respectively. The tests must be performed in accordance with test procedures and protocols specified in Attachment A of this permit.

<table>
<thead>
<tr>
<th>Test Dates</th>
<th>Submit Results By:</th>
<th>Test Species</th>
<th>Acute Limit LC$_{50}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Second Week of</td>
<td>April 31st</td>
<td><em>Pimephales promelas</em> (Fathead minnow)</td>
<td>100%</td>
</tr>
<tr>
<td>March</td>
<td>October 31st</td>
<td></td>
<td></td>
</tr>
<tr>
<td>September</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

13. The LC$_{50}$ is the concentration of effluent which causes mortality to 50% of the test organisms. Therefore, a 100% limit means that a sample of 100% effluent (no dilution) shall cause no more than a 50% mortality rate.

14. If toxicity test(s) using receiving water as diluent show the receiving water to be toxic or unreliable, the permittee shall follow procedures outlined in Attachment A (Toxicity Test Procedure and Protocol) Section IV., DILUTION WATER in order to obtain individual approval to use an alternate dilution water, or the permittee shall follow the Self-Implementing Alternative Dilution Water Guidance which may be used to obtain
automatic approval of an alternative dilution water, including the appropriate species for use with that water. This guidance is found on the EPA, Region I web site at http://www.epa.gov/region1/enforcementandassistance/dmr.pdf. If this guidance is revoked, the permittee shall revert to obtaining individual approval as outlined in Attachment A. Any modification or revocation to this guidance will be transmitted to the permittees. However, at any time, the permittee may choose to contact EPA-New England directly using the approach outlined in Attachment A.

Part I.A.2.

a. The discharge shall not cause a violation of the water quality standards of the receiving waters.

b. The pH of the effluent shall not be less than 6.5 or greater than 8.3 at any time. If the permittee submits a written request for an adjustment of the pH range, the permittee must conduct a pH adjustment demonstration project following the procedures in Attachment B of this Permit.

c. The discharge shall not cause objectionable discoloration of the receiving waters.

d. The effluent shall not contain a visible oil sheen, foam, nor floating solids at any time.

e. The permittee’s treatment facility shall maintain a minimum of 85 percent removal of both Biochemical Oxygen Demand (BOD) and Total Suspended Solids (TSS). The percent removal shall be based on monthly average values.

f. The permittee shall minimize the use of chlorine while maintaining adequate bacterial control, and will seasonally disinfect from April 1st – November 15th each year.

g. The results of sampling for any parameter done in accordance with EPA approved methods above its required frequency must also be reported.

3. All POTWs must provide adequate notice to the Director of the following:

a. Any new introduction of pollutants into that POTW from an indirect discharger which would be subject to section 301 or 306 of the Clean Water Act if it were directly discharging those pollutants; and

b. Any substantial change in the volume or character of pollutants being introduced into that POTW by a source introducing pollutants into the POTW at the time of issuance of the permit.

c. For purposes of this paragraph, adequate notice shall include information on:
(1) The quantity and quality of effluent introduced into the POTW; and

(2) Any anticipated impact of the change on the quantity or quality of effluent to be discharged from the POTW.

4. Prohibitions Concerning Interference and Pass Through:

a. Pollutants introduced into a POTW by a non-domestic source (user) shall not pass through the POTW or interfere with the operation or performance of the works.

5. Toxics Control

a. The permittee shall not discharge any pollutant or combination of pollutants in toxic amounts.

b. Any toxic components of the effluent shall not result in any demonstrable harm to aquatic life or violate any state or federal water quality standard which has been or may be promulgated. Upon promulgation of any such standard, this permit may be revised or amended in accordance with such standards.

6. Numerical Effluent Limitations for Toxicants

EPA or MassDEP may use the results of the toxicity tests and chemical analyses conducted pursuant to this permit, as well as national water quality criteria developed pursuant to Section 304(a)(1) of the Clean Water Act (CWA), state water quality criteria, and any other appropriate information or data, to develop numerical effluent limitations for all pollutants, including but not limited to those pollutants listed in Appendix D of 40 CFR Part 122.

B. SPECIAL CONDITIONS

Within one year of the effective date of the permit, the permittee shall complete an evaluation of alternative methods of operating the existing wastewater treatment facility to optimize the removal of nitrogen, and submit a report to EPA and MassDEP documenting this evaluation and presenting a description of recommended operational changes. The methods to be evaluated include, but are not limited to, operational changes designed to enhance nitrification (seasonal and year round), incorporation of anoxic zones, septage receiving policies and procedures, and side stream management. The permittee shall implement the recommended operational changes so that the mass discharge of total nitrogen does not exceed the existing annual average discharge. The annual average total nitrogen load from this facility is estimated to be 428 lbs/day, based on data reported from 2004 through 2005.

The permittee shall also submit an annual report to EPA and the MassDEP, by February 1\textsuperscript{st} each year, that summarizes activities related to optimizing nitrogen removal efficiencies, documents the annual nitrogen discharge load from the facility, and tracks
trends relative to the previous year.

C. **UNAUTHORIZED DISCHARGES**

The permittee is authorized to discharge only in accordance with the terms and conditions of this permit and only from the outfall listed in Part I A.1. of this permit. Discharges of wastewater from any other point sources, including sanitary sewer overflows (SSOs) are not authorized by this permit and shall be reported to EPA and MassDEP in accordance with Section D.1.e(1) of the General Requirements of this permit (24-hour reporting).

Notification of SSOs to MassDEP shall be made on its SSO Reporting Form (which includes DEP Regional Office telephone numbers). The reporting form and instruction for its completion may be found on-line at http://www.mass.gov/dep/water/approvals/surfms.htm#sso.

D. **OPERATION AND MAINTENANCE OF THE SEWER SYSTEM**

Operation and maintenance of the sewer system shall be in compliance with the General Requirements of Part II and the following terms and conditions:

1. **Maintenance Staff**

   The permittee shall provide an adequate staff to carry out the operation, maintenance, repair, and testing functions required to ensure compliance with the terms and conditions of this permit.

2. **Preventative Maintenance Program**

   The permittee shall maintain an ongoing preventative maintenance program to prevent overflows and bypasses caused by malfunctions or failures of the sewer system infrastructure. The program shall include an inspection program designed to identify all potential and actual unauthorized discharges.

3. **Infiltration/Inflow Control Plan:**

   The permittee shall develop and implement a plan to control infiltration and inflow (I/I) to the separate sewer system. The plan shall be submitted to EPA and MassDEP **within three (3) months of the effective date of this permit** (see page 1 of this permit for the effective date) and shall describe the permittee’s program for preventing infiltration/inflow related effluent limit violations, and all unauthorized discharges of wastewater, including overflows and by-passes due to excessive infiltration/inflow. The plan shall specifically address the deficiencies in the previous plan including 1) the inadequate level of funding; 2) a more effective inflow identification and control program focusing on sump pumps and down spouts; 3) the identification and prioritization of areas that will provide increased aquifer recharge as the result of reduction/elimination of
infiltration and inflow to the system and 4) an educational public outreach program for all aspects of I/I control, particularly private inflow.

The plan shall include:

a. An ongoing program, with a five (5) year schedule reflecting the term of the permit, to identify and remove sources of infiltration and inflow. The program shall include the necessary funding level and the source(s) of funding.

b. An inflow identification and control program that focuses on the disconnection and redirection of illegal sump pumps and roof down spouts. Priority should be given to removal of public and private inflow sources that are upstream from, and potentially contribute to, known areas of sewer system backups and/or overflows.

The I/I Control Plan should include summary lists of Suspected Inflow Sources, a Manhole Inspection Inventory and a Sewer Inspection Inventory.

c. Identification and prioritization of areas that will provide increased aquifer recharge as the result of reduction/elimination of infiltration and inflow to the system.

d. An educational public outreach program for all aspects of I/I control, particularly private inflow. Please provide copies of all public education materials, and clippings of any public outreach via newspapers or other sources.

4. Reporting Requirements:

A summary report of all actions taken to minimize I/I during the previous calendar year shall be submitted to EPA and MassDEP annually by March 31. The summary report shall, at a minimum, include:

a. A map and a description of inspection and maintenance activities conducted and corrective actions taken during the previous year.

b. Expenditures for any infiltration/inflow related maintenance activities and corrective actions taken during the previous year.

c. A map with areas identified for I/I-related investigation/action in the coming year.

d. A calculation of the annual average I/I, the maximum month I/I for the reporting year.

e. A report of any infiltration/inflow related corrective actions taken as a result of unauthorized discharges reported pursuant to 314 CMR 3.19(20) and reported pursuant to the Unauthorized Discharges section of this permit.
5. **Alternate Power Source**

In order to maintain compliance with the terms and conditions of this permit, the permittee shall continue to provide an alternative power source with which to sufficiently operate its treatment works (as defined at 40 CFR §122.2).

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**E. SLUDGE CONDITIONS**

1. The permittee shall comply with all existing federal and state laws and regulations that apply to sewage sludge use and disposal practices, including EPA regulations promulgated at 40 CFR Part 503, which prescribe "Standards for the Use or Disposal of Sewage Sludge" pursuant to Section 405(d) of the CWA, 33 U.S.C. § 1345(d).

2. If both state and federal requirements apply to the permittee's sludge use and/or disposal practices, the permittee shall comply with the more stringent of the applicable requirements.

3. The requirements and technical standards of 40 CFR Part 503 apply to the following sludge use or disposal practices.
   
   a. Land application - the use of sewage sludge to condition or fertilize the soil
   b. Surface disposal - the placement of sewage sludge in a sludge only landfill
   c. Sewage sludge incineration in a sludge only incinerator

4. The requirements of 40 CFR Part 503 do not apply to facilities which dispose of sludge in a municipal solid waste landfill. 40 CFR § 503.4. These requirements also do not apply to facilities which do not use or dispose of sewage sludge during the life of the permit but rather treat the sludge (e.g. lagoons, reed beds), or are otherwise excluded under 40 CFR § 503.6.

5. The 40 CFR Part 503 requirements including the following elements:
   
   - General requirements
   - Pollutant limitations
   - Operational Standards (pathogen reduction requirements and vector attraction reduction requirements)
   - Management practices
   - Record keeping
   - Monitoring
   - Reporting

Which of the 40 C.F.R. Part 503 requirements apply to the permittee will depend upon the use or disposal practice followed and upon the quality of material produced by a
facility. The EPA Region 1 Guidance document, “EPA Region 1 - NPDES Permit Sludge Compliance Guidance” (November 4, 1999), may be used by the permittee to assist it in determining the applicable requirements.

6. The sludge shall be monitored for pollutant concentrations (all Part 503 methods) and pathogen vector attraction reduction (land application and surface disposal) at the following frequency. This frequency is based upon the volume of sewage sludge generated at the facility in dry metric tons per year:

<table>
<thead>
<tr>
<th>Volume Range</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>less than 290</td>
<td>1/year</td>
</tr>
<tr>
<td>290 to less than 1500</td>
<td>1/quarter</td>
</tr>
<tr>
<td>1500 to less than 15000</td>
<td>6/year</td>
</tr>
<tr>
<td>15000+</td>
<td>1/month</td>
</tr>
</tbody>
</table>

Sampling of the sewage sludge shall use the procedures detailed in 40 CFR 503.8.

7. Under 40 CFR § 503.9(r), the permittee is a “person who prepares sewage sludge” because it “is ... the person who generates sewage sludge during the treatment of domestic sewage in a treatment works ....” If the permittee contracts with another “person who prepares sewage sludge” under 40 CFR § 503.9(r)—i.e., with “a person who derives a material from sewage sludge”—for use or disposal of the sludge, then compliance with Part 503 requirements is the responsibility of the contractor engaged for that purpose. If the permittee does not engage a “person who prepares sewage sludge,” as defined in 40 CFR § 503.9(r), for use or disposal, then the permittee remains responsible to ensure that the applicable requirements in Part 503 are met. 40 CFR §503.7. If the ultimate use or disposal method is land application, the permittee is responsible for providing the person receiving the sludge with notice and necessary information to comply with the requirements of 40 CFR Part 503 Subpart B.

8. The permittee shall submit an annual report containing the information specified in the 40 CFR Part 503 requirements (§ 503.18 (land application), § 503.28 (surface disposal), or § 503.48 (incineration)) by February 19 (see also “EPA Region 1 - NPDES Permit Sludge Compliance Guidance”). Reports shall be submitted to the address contained in the reporting section of the permit. If the permittee engages a contractor or contractors for sludge preparation and ultimate use or disposal, the annual report need contain only the following information:

- Name and address of contractor(s) responsible for sludge preparation, use or disposal
- Quantity of sludge (in dry metric tons) from the POTW that is transferred to the sludge contractor(s), and the method(s) by which the contractor will prepare and use or dispose of the sewage sludge.

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1 This guidance document is available upon request from EPA Region 1 and may also be found at:
http://www.epa.gov/region1/npdes/permits/generic/sludgeguidance.pdf
MONITORING AND REPORTING

1. For a period of one year from the effective date of the permit, the permittee may either submit monitoring data and other reports to EPA in hard copy form, or report electronically using NetDMR, a web-based tool that allows permittees to electronically submit discharge monitoring reports (DMRs) and other required reports via a secure internet connection. **Beginning no later than one year after the effective date of the permit**, the permittee shall begin reporting using NetDMR, unless the facility is able to demonstrate a reasonable basis that precludes the use of NetDMR for submitting all DMRs and reports. Specific requirements regarding submittal of data and reports in hard copy form and for submittal using NetDMR are described below:

   a. Submittal of Reports Using NetDMR

   NetDMR is accessed from: http://www.epa.gov/netdmr. Within one year of the effective date of the Permit, the permittee shall begin submitting DMRs and reports required under this permit electronically to EPA using NetDMR, unless the facility is able to demonstrate a reasonable basis, such as technical or administrative infeasibility, that precludes the use of NetDMR for submitting DMRs and reports ("opt out request").

   DMRs shall be submitted electronically to EPA no later than the 15th day of the month following the completed reporting period. All reports required under the permit shall be submitted to EPA, including the MassDEP Monthly Operations and Maintenance Report, as an electronic attachment to the DMR. Once a permittee begins submitting reports using NetDMR, it will no longer be required to submit hard copies of DMRs or other reports to EPA and will no longer be required to submit hard copies of DMRs to MassDEP. However, permittees shall continue to send hard copies of reports other than DMRs (including Monthly Operation and Maintenance Reports) to MassDEP until further notice from MassDEP.

   b. Submittal of NetDMR Opt Out Requests

   Opt out requests must be submitted in writing to EPA for written approval at least sixty (60) days prior to the date a facility would be required under the Permit to begin using NetDMR. This demonstration shall be valid for twelve (12) months from the date of EPA approval and shall thereupon expire. At such time, DMRs and reports shall be submitted electronically to EPA unless the permittee submits a renewed opt out request and such request is approved by EPA. All opt out requests should be sent to the following addresses:
Attn: NetDMR Coordinator  
U.S. Environmental Protection Agency, Water Technical Unit  
5 Post Office Square, Suite 100 (OES04-4)  
Boston, MA 02109-3912  

and  

Massachusetts Department of Environmental Protection  
Surface Water Discharge Permit Program  
627 Main Street, 2nd Floor  
Worcester, Massachusetts 01608  

c. Submittal of Reports in Hard Copy Form  

Hard copy DMR submittals shall be completed and postmarked no later than the 15th day of the month following the completed reporting period. MassDEP Monthly Operation and Maintenance Reports shall be submitted as an attachment to the DMRs. Signed and dated originals of the DMRs, and all other reports required herein, shall be submitted to the appropriate State addresses and to the EPA address listed below:  

U.S. Environmental Protection Agency  
Water Technical Unit  
5 Post Office Square, Suite 100 (OES04-4)  
Boston, MA 02109-3912  

The State Agency addresses are:  

Massachusetts Department of Environmental Protection  
Western Regional Office  
436 Dwight Street  
Springfield, MA 01103  

Copies of whole effluent toxicity tests and other reports, except DMRs:  

Massachusetts Department of Environmental Protection  
Surface Water Discharge Permit Program  
627 Main Street, 2nd Floor  
Worcester, Massachusetts 01608  

G. STATE PERMIT CONDITIONS  

1. This authorization to discharge includes two separate and independent permit authorizations. The two permit authorizations are (i) a federal National Pollutant Discharge Elimination System permit issued by the U.S. Environmental Protection
Agency (EPA) pursuant to the Federal Clean Water Act, 33 U.S.C. §§1251 et seq.; and
(ii) an identical state surface water discharge permit issued by the Commissioner of the
Massachusetts Department of Environmental Protection (MassDEP) pursuant to the
Massachusetts Clean Waters Act, M.G.L. c. 21, §§ 26-53, and 314 CMR 3.00. All of the
requirements contained in this authorization, as well as the standard conditions contained
in 314 CMR 3.19, are hereby incorporated by reference into this state surface water
discharge permit.

2. This authorization also incorporates the state water quality certification issued by
21, § 27 and 314 CMR 3.07. All of the requirements (if any) contained in MassDEP’s
water quality certification for the permit are hereby incorporated by reference into this
state surface water discharge permit as special conditions pursuant to 314 CMR 3.11.

3. Each agency shall have the independent right to enforce the terms and conditions of this
permit. Any modification, suspension or revocation of this permit shall be effective only
with respect to the agency taking such action, and shall not affect the validity or status of
this permit as issued by the other agency, unless and until each agency has concurred in
writing with such modification, suspension or revocation. In the event any portion of this
permit is declared invalid, illegal or otherwise issued in violation of state law such permit
shall remain in full force and effect under federal law as a NPDES Permit issued by the
U.S. Environmental Protection Agency. In the event this permit is declared invalid,
illegal or otherwise issued in violation of federal law, this permit shall remain in full
force and effect under state law as a permit issued by the Commonwealth of
Massachusetts.
APPENDIX E: REGIONAL VEHICLE FLEET LINES - POTENTIAL FOR CNG

- Livery Services
- Auto Rentals
- UPS/FedEx
- UMass Amherst
- Greyhound Bus Lines 355 Main - St, Greenfield, MA 01301
- Franklin Regional Transit Authority - 474 Main St Ste 7, Greenfield, MA 01301
- Greenfield Montague Transit Area - 382 Deerfield St, Greenfield, MA 01301
- Price 4 Limo & Party Bus - Serving the Greenfield Area
- First Student - Serving the Greenfield Area
- Prompt Charters and Tours - Serving the Greenfield Area
- F M Kuzmeskus Inc - 52 Main Rd, Gill, MA 01354
- J B Transportation - 6 Porter St, South Deerfield, MA 01373
- Swift River Bus Co - 5 Roche Ave, Orange, MA 01364
- Vermont Transit Lines - 1108 Putney Rd, Brattleboro, VT 05301
- Peter Pan Bus Lines Inc - 1 Roundhouse Plz # 2, Northampton, MA01060
- Transit Express - 51 Industrial Dr, Northampton, MA 01060
- Vermont Transit Lines - 1 Roundhouse Plz, Northampton, MA 01060
- Safari Transit - 351 pleasant st ste 180, Northampton, MA01060
- Strong Corp - 40 Oneil St, Easthampton, MA 01027
- Merrifield E H Bus Co Inc - 1777 Chestnut Hill Ave, Athol, MA 01331
- Dufour Escorted Tours Inc - 969 Church St, North Adams, MA 01247
- Deerfield Valley Transit Association - 127 Route 100, West Dover, VT 05356
- Durham School Service - 77 Ferry St, Easthampton, MA 01027
- Hampshire County Transit - 54 Industrial Dr, Northampton, MA 01060
- Centerline Transportation Services - Serving the Greenfield Area
- Vermont Transit Package Express - 6 Gilbo Ave, Keene, NH 03431
- Berkshire Regional Trnst Auth - 67 Downing Industrial Park, Pittsfield, MA01201
- Mart - 555 Main St, Gardner, MA 01440
- Montachusett Regional Transit Authority - 412 Main St, Gardner, MA 01440
- American Buses & Trucks - 56 Jackson St, Holyoke, MA 01040
- Heritage Truck & Transit - 750 W Broadway, Gardner, MA 01440
- GAAMHA Inc - 208 Coleman St, Gardner, MA 01440
- S C M Elder Bus Inc - 557 S Barre Rd, Barre, MA 01005
- Peter Pan Bus Lines Inc - 206 Maple St # 1R, Holyoke, MA 01040
- Pioneer Valley Transit Auth - 206 Maple St, Holyoke, MA 01040
- Bruce Transportation Group - 475 Housatonic St, Dalton, MA 01226
- School Services and Leasing - 103 South St, Holyoke, MA 01040
## APPENDIX F: GREENFIELD AND FRANKLIN COUNTY ORGANIC GENERATORS (FROM MASSDEP)

<table>
<thead>
<tr>
<th>Generator</th>
<th>Address</th>
<th>Town</th>
<th>Zip</th>
<th>Generation (tons/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Four Leaf Clover</td>
<td>19 South St</td>
<td>Bernardston</td>
<td>01337</td>
<td>45</td>
</tr>
<tr>
<td>Townline Creamies</td>
<td>37 Bernardston Rd</td>
<td>Bernardston</td>
<td>01337</td>
<td>25.5</td>
</tr>
<tr>
<td>Warfield House Inn</td>
<td>200 Warfield Rd</td>
<td>Charlemont</td>
<td>01339</td>
<td>30</td>
</tr>
<tr>
<td>Keystone Market Inc</td>
<td>661 S Shirkshire Rd</td>
<td>Conway</td>
<td>01341</td>
<td>30</td>
</tr>
<tr>
<td>Cains Pickles Inc</td>
<td>15 Jewett Ave</td>
<td>Deerfield</td>
<td>01373</td>
<td></td>
</tr>
<tr>
<td>Deerfield Academy</td>
<td>7 Boyden Lane</td>
<td>Deerfield</td>
<td>01342</td>
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**Total:** 2,501 tons/year
## APPENDIX G: ANAEROBIC DIGESTER EXAMPLE EQUIPMENT LIST

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<td>PRESS/VAC. RELIEF VALVE</td>
<td>VAREC</td>
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<td>SLURRY VALVE</td>
<td>ORBINOX</td>
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<td>ACI</td>
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<td>CUTLER HAMMER</td>
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<td>CUTLER HAMMER</td>
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<td>MCMASTER CARR</td>
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<td>PROCESS PIPING- 316 SS OR SCH. 80 PVC</td>
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APPENDIX H: EXAMPLE SPECIFICATIONS FOR BIO-CNG BIOGAS CLEANING SYSTEM

STANDARD SUB-SYSTEMS:
(A) - Hydrogen Sulfide Removal
(B) - BioCNG™ Skid
   - Gas Compression/Moisture Removal
   - Siloxane Removal
   - Carbon Dioxide Removal
(C) - Glycol Chiller
(D) - Control Panel

OPTIONS:
(1) - Wintertized H₂S Removal Vessel
(2) - Skid Enclosure
(3) - Beam Kit
(4) - Skid Mounted Glycol Chiller/Control Panel
(5) - Electrical Distribution

OPTIONS (NOT SHOWN):
- Siloxane Work Platform
- Final Compression Package
- Gas Storage
- Dispensing System
- Gas Analyzer (CO₂/CH₄/O₂)
APPENDIX I: EXAMPLE FAN SEPARATOR FEATURES AND SPECIFICATIONS

FAN Separator
Innovative Solutions for Solid/Liquid Separation

FAN Press Screw Separator PSS
Separation and Dewatering by Combining Technologies of Screening, Filtering and Pressing

Benefits:
- Separates all kinds of structured Solids like fibre, plastic, minerals
- Starts separation from inlet consistencies less than 0.5 % → no need of pre-thickening
- Produces solid dryness up to 60 %, even if feed varies or is interrupted
- Adjustable dryness of separated solids
- Even particles with a size smaller than the slot size of the screen will be filtered out
- Oscillator to increase capacity
- Easy to install, to operate and to maintain, self-cleaning screens

Applications:
- Dewatering of cleaner rejects
- Dewatering of sorter rejects
- Dewatering of flotation sludge
- Dewatering of sedimentation sludge
- Fibre recovery
- Waste water treatment
- Removal of stickies
- Cleaning of chip washing water
- Cleaning of process water
- Cleaning of log storage sprinkle water

Page 111
FAN Separator
Innovative Solutions for Solid/Liquid Separation

Features:
FAN designed the Press Screw Separator PSS and sold more than 3000 units so far. The PSS combines well established and successfully used technical solutions with interesting and patented innovations from FAN’s own research and development.

- Cylindrical slot screen basket with slot sizes between 0.1 and 1.0 mm
- Swimming screens, flexible screen body
- High dimensional accuracy, very small gap between auger flights and screen
- Self-centering hard coated auger, supported one-sided
- Mechanical control of solid output

Functional principle:
- Feeding by hose/pipe or hopper without pressure
- Medium is hauled into the screen by rotating auger
- Material gets dewatered by gravity in fore part of the screen, dewatering can be supported by an oscillator
- Dewatered matter builds a filter layer on the screen surface \( \rightarrow \) even particles smaller than screen slot size are filtered out
- Filter layer is peeled off by the auger flights continuously and is hauled to back part of the screen (pressure zone)
- Solids build a solid plug at the end of the auger flights, plug renews itself permanently by oncoming material
- Auger generates pressure against wall friction of the solid plug
- Dried solids are discharged out of the press flange continuously
- Mechanical output regulator controls stability of the plug and ensures constant dryness of solids, even if inlet consistency varies
## FAN Separator

Innovative Solutions for Solid/Liquid Separation

### Technical Specifications, Dimensions and Weights:

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<thead>
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<th>Power kW</th>
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<th>Max. Solid Capacity * bdt/d</th>
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* depends on material to be separated, inlet consistency and screens (kind of screen, slot size)

### Production material:

- PSS 3: Cast iron
- PSS 4: Stainless steel, cast
- PSS 5: Stainless steel, welded
- PSS 8: Stainless steel, welded

All parts getting in contact with the medium (e.g. auger, screen, press flange) made out of stainless steel.
APPENDIX J: EXAMPLE MONITORING POINTS LIST

It is recommended that the following data points be monitored by the plant and operator staff.

Feedstock Storage Tank(s):
- Amount fed to digester per day (gal)
- Total digester feed per day (gal)
- Dosing periods per day

Pre-mixing Tank:
- Temperature (°F)
- Level (ft)
- Volume (gal)

Digester Tank and Biogas Storage:
- Temperature (°F)
- Level (ft)
- Volume (gal)
- Pressure
- Biogas Level (%)
- Mixing frequency
- Mixing speed

Biogas:
- Pressure Regulator
- Thermal Safety Shutoff
- Methane content
- Contaminant content (H₂S, moisture, siloxanes)

CHP Engine:
- Run time
- kWh generation
- Thermal generation

Digestate:
- Quantity generated per day
- N, P, K (macronutrients)
- pH
- Moisture content
- Organic matter %
- C:N ratio
- Micronutrient content
- Concentrations of contaminants limited by federal and state regulations
APPENDIX K: THE TOWN OF GREENFIELD GUIDE TO DEVELOPMENT PERMITS
GUIDE TO DEVELOPMENT PERMITS

TOWN OF GREENFIELD

July 2010
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<td>II. TOWN BOARDS, DEPARTMENTS and STAFF</td>
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I. INTRODUCTION

The purpose of this guidebook is to assist developers, realtors, contractors, property owners, and any interested citizen or party wishing to develop a project proposal in the Town of Greenfield. It is the intent of this guidebook to streamline the permitting process for both applicants and Town staff by providing clear, easy to follow procedures and processes required for any proposed development activity in Town. This guidebook is not all inclusive with regard to the necessary approvals, permits and licenses that may be required for a particular project but does provide a basic overview of the development review and permitting process. Prior to proceeding with a development proposal, this guidebook should be referred to.

The following documents are available for purchase:

- Greenfield Zoning Ordinance: $21.00
- Zoning Map (11” x 17”): $6.00
- Subdivision Regulations: $15.00

Copies are available at the following locations:

1) Department of Planning and Development, 114 Main Street, (413) 772-1549, and
2) At [http://www.greenfield-ma.gov/Pages/GreenfieldMA_Planning/forms](http://www.greenfield-ma.gov/Pages/GreenfieldMA_Planning/forms) (PDF versions of the documents can be downloaded at no cost).
II. TOWN BOARDS, DEPARTMENTS and STAFF

The following is a brief description of the function various Town boards, departments and staff have during the development review and permitting process.

**Permits Manager** \[Department of Planning and Development\] 772-1549
The Permits Manager is the first point of contact when designing a project proposal or applying for a permit. This position serves as a “one stop shop” for all development related permit information and applications. Throughout the permitting process, the Permits Manager serves as the “day-to-day” contact and liaison between an applicant and Town boards; helping applicants track where an application is in the process and when a decision on the application can be expected.

**Planning Board** - The Planning Board approves site plans and issues special permits under the Greenfield Zoning Ordinance, approves subdivisions under the Subdivision Control Law and the Town’s Subdivision Regulations, and reviews and makes recommendations on proposed zoning changes.

**Zoning Board of Appeals** - The Zoning Board of Appeals issues special permits and variances under the Greenfield Zoning Ordinance. It also hears petitions on administrative appeals from decisions made by the Inspector of Buildings and Planning Board.

**Conservation Agent** \[Department of Planning and Development\] 772-1551
The Conservation Agent serves as the “day-to-day” contact and liaison between an applicant and the Conservation Commission, helping applicants understand the application forms and procedures when needing to go before the Conservation Commission.

**Conservation Commission** - The Conservation Commission issues permits for work in wetlands, floodplains, rivers, and wetland buffer zones under the Massachusetts Wetlands Protection Act, Massachusetts Rivers Protection Act and Greenfield’s Wetlands Protection Ordinance.

**Inspections/Enforcement Center** 772-1404
The Inspection/Enforcement Center coordinates the processing of permits and inspections for the Health Department, Inspector of Buildings, Wiring Inspector and Plumbing/Gas Inspector.

**Director of Public Health** \[Board of Health\] 772-1404
The Director of Public Health issues permits under local and state health and sanitary codes to include permits for septic system installation, private wells, food service establishments, retail food establishments, temporary food establishments, tanning salons, burials, public swimming pools, recreational camps for children, hotel/motels, bathing beaches, body art establishments and practitioners, beaver removal.

**Building Department** \[Inspections/Enforcement Center\] 772-1404
The Building Department issues building permits, serves as the Zoning Enforcement Officer, reviews site plans for small scale development projects and reviews all projects for compliance with the Greenfield Zoning Ordinance; the Massachusetts Building Code; and federal and state handicapped access standards. Sign permits are also approved through the Building Department.

**Plumbing/Gas Inspector** \[Inspections/Enforcement Center\] 772-1404
The Plumbing/Gas Inspector is responsible for the issuance of both plumbing and gas permits. All work must be conducted by a Contractor that is licensed with the Commonwealth of Massachusetts. The Inspector conducts inspections on permitted by request of the Contractor.
<table>
<thead>
<tr>
<th><strong>Wiring Inspector</strong></th>
<th><strong>Inspections/Enforcement Center</strong></th>
<th>772-1404</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Wiring Inspector is responsible for the issuance of electrical permits, including low voltage and communication lines. All work must be conducted by a Contractor that is licensed with the Commonwealth of Massachusetts. The Inspector conducts inspections on permitted work by request of the Contractor.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Department of Public Works</strong></th>
<th><strong>Engineering Department</strong></th>
<th>772-1528</th>
</tr>
</thead>
<tbody>
<tr>
<td>The DPW reviews applications and advises Town boards on engineering and site design matters such as stormwater management, roadway design, traffic, water/sewer and other utilities. The DPW issues permits for access permits, ladder, staging and crane permits, excavation, water and sewer connections, and stormwater connections.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Fire Chief</strong></th>
<th><strong>Fire Department</strong></th>
<th>774-4737</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Fire Department reviews all site plans and issues permits for storage of flammable materials, blasting, cooking (grills and burn pits), oil burner installations, above ground tanks, fire sprinkler installation reviews, dumpsters over six yards, underground storage tanks, storage of hazardous materials, brush burning, fireworks, oxygen acetylene (cutting and welding), fire alarm systems, smoke and CO certificate with property transfers.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Board of License Commissioners</strong></th>
<th><strong>Mayors Office</strong></th>
<th>772-1560</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Board of License Commissioners issues licenses for liquor, Common Victualler’s (food service), Innholders/B&amp;Bs, entertainment, automatic game machines, anything that will be placed on or over public ways (i.e. chairs, signs, awnings, etc), motor vehicle dealers, junk yards, transient businesses (i.e. ice cream trucks, sidewalk vending, etc), fortune tellers, taxi/livery, pawn brokers, auctioneers, solicitation (i.e. door-to-door sales), junk dealers &amp; collectors (sales or storage of used goods, scraps for recycling, etc), boarding/lodging houses, installation or removal of flammable storage tanks, soil/gravel removal, changes to parking or traffic regulations.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
III. DEVELOPING YOUR PROJECT PROPOSAL

Preliminary Research & Contacts
Before spending a large amount of time and money developing a project proposal, you should first contact the Principal Planner/Permits Manager. The Principal Planner/Permits Manager will be able to tell you if your project meets the Town’s regulations, what permits are needed, and approximately how long the process will take. The feasibility of your project is largely based upon the Greenfield Zoning Ordinance, the Massachusetts Wetlands Protection Regulations and the Greenfield Wetlands Protection Ordinance. Therefore, it is recommended that you review these documents.

Overview of Development Permits
There are five major categories of development permits:

1. **Zoning:** The Greenfield Zoning Ordinance indicates where particular uses are allowed and which development projects require site plan approval, special permits, variances, and/or Major Development Review.

2. **Wetlands:** In accordance with the Massachusetts Wetlands Protection Act, MGL Chapter 131, Section 40, and Greenfield’s Wetlands Protection Ordinance, projects may require permits issued by the Conservation Commission to ensure protection of wetland resource areas.

3. **Subdivision:** The Greenfield Subdivision Regulations in accordance with the Massachusetts Subdivision Control Law, MGL Chapter 41, Sections 81K-81GG, outline the necessary permits required for the dividing up of individual lots.

4. **Building:** The Greenfield Zoning Ordinance indicates that prior to the construction or alteration of a structure, the Inspector of Buildings must issue a building permit.

5. **Related:** Under local, state and federal laws, various licenses, permits and approvals related to the development project may be required.

1. **Zoning:**
The following is a breakdown of zoning within the Town of Greenfield:

**General Zoning:** Greenfield is divided into 11 zoning districts. The Zoning Ordinance will provide detailed information pertaining to land uses along with dimensional and setback requirements within each district. In addition, it will prescribe other requirements such as open space, parking and landscaping.

**Floodplain District (Section 200-4.13):** All land within the 100-year floodplain as shown on the Floodplain Insurance Rate Map (FIRM) and further defined by the Flood Profiles contained in the Flood Insurance Study must comply with the provisions of this section.

**Water Supply Protection District (Section 200-4.14):** Land located within Zones 1, 2 and 3 as shown on the “Aquifer Zone Delineations” and the “Aquifer Zone Delineations Leary Well Site” must comply with the provisions of this section.

**Corridor Overlay District (Section 200-4.16):** Land within the French King Highway and High Street corridors as defined in the Corridor Overlay District Map must comply with the provisions of this section.
Planned Unit Development Overlay District (Section 200-4.17): Land within a PUD Overlay District can be developed as a single entity under the direction of a comprehensive site plan, in which a mixture of land uses, a variety of building types and designs, and open space are provided for in a coherent manner.

Adult Entertainment Overlay District (Section 200-7.13): Adult cabarets, adult motion picture theaters, and establishments which display live nudity for its patrons are only allowed within this overlay district.

**COURSE OF ACTION**

Your project proposal will follow one of three courses of action as the first step in the permit process. They are as follows:

- **Allowed by Right:** If the project proposal meets all of the zoning requirements and does not need any special permits or variances, then the application may proceed to the next phase of the approval process.

- **Special Permits (Section 200-8.3):** Under the Zoning Ordinance, specific uses are allowed by special permit only. Under most circumstances the Special Permit Granting Authority (SPGA) is the Zoning Board of Appeals (ZBA), unless otherwise designated, in which case the Planning Board or the Board of License Commissioners will be the SPGA.

- **Variance to the Zoning Ordinance (Section 200-8.7):** The ZBA may grant a variance from the Greenfield Zoning Ordinance if it finds that:
  a) a literal interpretation of the Ordinance would impose a substantial hardship, financial or otherwise;
  b) the hardship is owing to circumstances relating to the soil conditions, shape or topography affecting the land or structure in a special way, but not the zoning district in general; and
  c) relief may be granted without substantial detriment to the public good or without nullifying or substantially derogating from the intent and purpose of the Ordinance.

2. **Wetlands Permits**

Work in a resource area, within the 100-foot buffer zone of a resource area, or work within 200 feet of a perennial river or stream, as defined by the Massachusetts Wetlands Protection Act and the Rivers Protection Act, is regulated by the Conservation Commission. Many kinds of development are prohibited in such areas, and those that are allowed may require a permit called an Order of Conditions to protect wetland resource areas.

3. **Subdivision Approval**

If the project proposal involves dividing land into lots or parcels (either residential or commercial) and requires the construction of new streets, subdivision approval must be obtained from the Planning Board. If the project does not require new streets, then an endorsement from the Planning Board on an “Approval-Not-Required” (ANR) plan is required.

4. **Building Permit**

Before starting any construction and after obtaining all necessary permits, the Inspector of Buildings will issue a building permit. Final reviews of zoning, building and construction, and handicapped access for local and state compliance are conducted.
5. Related Permits

Components of the proposed project may require additional review and approval from other Town agencies such as:

**Board of Health:** This agency enforces the state and local health and environmental codes. Permits and certificates issued include those for septic systems, wells, restaurants and food retailers, and swimming pools.

**Department of Public Works:** All work within a public way owned by the Town, such as the installation of driveways or utility lines, requires a permit.

**Fire Department:** This department deals with underground storage tanks, blasting permits, dumpsters over 6 yards, brush burning permits, fireworks, and gasoline stations.

**State and Federal Permits:** Depending on the nature of the proposed project, permits from the State or Federal government may be required. Four of the most common are:
- Curb-cut permit from the Massachusetts Highway Department for work affecting a state highway;
- Permit from the U.S. Army Corps of Engineers for work affecting certain wetlands and waterways;
- Certificate of Compliance from the Massachusetts Executive Office of Environmental Affairs for filings under the Massachusetts Environmental Policy Act, and
- Storm water (General Construction) permit from the Environmental Protection Agency for work disturbing an acre or more of land.
IV. DETERMINING THE REQUIRED PERMITS for a DEVELOPMENT PROJECT

Depending upon the specific characteristics of the project and the site, such as use, location, scale and wetlands, a simple project may require only a building permit while a more complex project may require several different types of permits. It is important to check with the Permits Manager early in the design process to determine which permits will be required.

The following list of questions will be helpful to discuss with the Permits Manager to determine the types of permits required for a development proposal.

1. **Which sections of the Zoning Ordinance apply?**
   a. In which zoning district is the project located?
   b. Is the project allowed by right or does it require a special permit, variance or zoning change?
   c. Is the project located within a special overlay district?
   d. Does the project require site plan approval? If so, from which reviewing authority?
   e. What dimensional, parking, landscaping, signage or other site design criteria apply to the project?

2. **Does the Wetlands Protection Act or Town of Greenfield’s Wetlands Protection Ordinance apply?**
   a. Is the project located in or within 100 feet of a stream bank, bordering vegetated wetland, land under water, stream or water body, or land subject to flooding?
   b. Is the project located within 200 feet of any stream, river, creek or brook that runs year round?

3. **Do the Greenfield Subdivision Regulations apply?**
   a. Are any new lots or roads being created?
   b. Are any existing property boundaries being changed?

4. **Are there other uses of the site that may require related development permits?**
   a. Is the project on Town sewer and water or will a septic system or well be needed?
   b. Is the project located on a state highway or will it have access onto a state highway?
   c. Will hazardous materials be stored or used on the site?
   d. Will the property be logged?
   e. Will the project trigger any of the Massachusetts Environmental Protection Act (MEPA) thresholds?
   f. Is the project located within an Estimated or Priority Habitat of Rare Species?
V. THE PERMIT PROCESS

The following outline is a chronological step-by-step explanation of the permit process:

1. Contact the Permits Manager to schedule a preliminary consultation.
   - Identify local, state and federal permits that will be required.
   - If appropriate, meet with the Staff Technical Review Group to discuss details of the project.
   - Permits Manager will assist with the filing of applications.

2. Submit conservation permits to the Conservation Agent and zoning and subdivision applications to the Permits Manager for determination of completeness prior to submission to the Town Clerk for certification.
   - Completed application form.
   - Appropriate filing fee.
   - Appropriate number of copies of all plans and supporting documentation.

3. Attend public hearing or administrative review to present the proposed project.
   - Inspector of Buildings
   - Conservation Commission
   - Planning Board
   - Zoning Board of Appeals

4. A decision is made by the Conservation Commission, Planning Board, Zoning Board of Appeals and Inspector of Buildings on zoning, wetland, subdivision, and building permits.

5. If necessary, record permits at the Registry of Deeds after the specified appeal period. Required for:
   - Special Permits and Variances
   - ANR’s and Definitive Subdivision Plans
   - Orders of Conditions

6. Apply for all other development related permits, approvals and licenses.
   - Department of Public Works
   - Board of Health
   - Fire Department
   - Board of License Commissioners
   - State & Federal

7. Upon receiving all necessary permits, approvals and licenses, apply to the Building Inspector for a Building Permit. Building permit applications are not deemed complete unless they include building plans, a plot plan, and copies of permits.

8. Schedule the required inspections during construction.
   - Electric
   - Gas
   - Construction (including but not limited to, footing inspection, foundation inspection, rough inspection, insulation inspection, final inspection and special inspections)
   - Plumbing
   - Elevators
   - Wetlands
9. Upon completion of construction:
   - Apply to the Conservation Commission for a Certificate of Compliance for projects involving wetlands.
   - Apply to the Planning Board for a Certificate of Completion for subdivision roads and utilities.
   - Apply to the Building Inspector for an Occupancy Permit.
VI. STAFF TECHNICAL REVIEW GROUP

Contact: Permits Manager

Purpose
The purpose of the Staff Technical Review Group is twofold. First, the group assists applicants and potential applicants through the Development Review and Permit process by:

- Identifying Town and State Regulations that apply to the project;
- Identifying site design issues that are of concern and discussion of potential solutions; and
- Identifying permits that will be required and the process for obtaining them.

Secondly, the group assists the Town’s regulatory boards by coordinating internal departmental reviews.

The Staff Technical Review Group consists of the following Departments and Individuals:

- Building & Inspections Department: Inspector of Buildings
- Department of Public Works (DPW): Engineering Superintendent
- Fire Department: Fire Prevention Officer
- Health Department: Director of Health
- Planning Department: Permits Manager, Conservation Agent

The Staff Technical Review Group functions only as an advisory group to applicants and the Town’s regulatory boards. All final decisions and conditions are the purview of the permit granting authority.

Review Process
Based upon the complexity of the proposed project, the Permits Manager or the Inspector of Buildings may recommend a meeting with the Staff Technical Review Group. This allows prospective applicants to discuss proposed developments and receive input prior to officially submitting permit applications. In an effort to make these meetings as productive as possible, it is highly recommended that a preliminary plan or conceptual plan be submitted at least one week prior to the scheduled meeting. This will enable Town staff to conduct a preliminary review. The more detail contained on the plan, the more productive and informative the meeting will be.

Upon completion of the meeting, the Permits Manager will prepare a summary report outlining the issues discussed and permits to be obtained. This report will be forwarded to the project proponent and to the regulatory boards that have jurisdiction over the project.

Projects to be Reviewed
In addition to preliminary review of development proposals, the group also reviews the following permit applications:

- Site Plan Approval
- Major Development Review
- Special Permits
- Access Permits
- Building Permits (for new residential and new & expanded commercial)
- Demolition Permit
VII. SITE PLAN APPROVAL

Contact: Permits Manager

Purpose
The purpose of Site Plan Review is to ensure that new development meets the requirements of the Zoning Ordinance and is designed in a manner that reasonably protects the safety, visual, environmental, and aesthetic qualities of the neighborhood and the Town.

Projects Requiring Site Plans
Single-family homes do not require site plan approval. Most other uses require site plans including the creation, expansion, substantial alteration, or change in use of:

1. All uses requiring a special permit;
2. Any business, commercial, industrial, or institutional use (except home occupations not requiring a special permit);
3. Any residential use of two (2) or more units including subdivisions;
4. Any site containing more than one (1) principal use.

Reviewing Authorities
Site plan review and approval authority varies based upon the type and scale of the project.

Inspector of Buildings: Approves all uses of less than 5,000 square feet of floor area and/or ten (10) or less parking spaces. Maximum review period is 45 days. A public hearing is not required.

Planning Board: Approves all uses greater than 5,000 square feet of floor area and/or more than ten (10) parking spaces and uses which require a special permit from the Planning Board. Maximum review period for site plan approval is 45 days. A public hearing is not required. Site plans for projects requiring a special permit are submitted and acted upon as part of the special permit application.

Zoning Board of Appeals: Approves all uses that require a special permit from the ZBA. The site plan is submitted and acted upon as part of the special permit application.

Review Process
When received, site plans are transmitted to various departments and boards for a 30-day inter-departmental review and comment period. Site plan approvals issued by the Inspector of Buildings and by the Planning Board for uses allowed by right, do not require a public hearing. When a use requires a special permit from the ZBA or the Planning Board a public hearing is required and the site plan is submitted and acted upon as part of the special permit application. A decision must be issued within 90 days of the close of the public hearing.

Filing Fees
All fees are to be paid by check made payable to the Town of Greenfield. The check shall be attached to a complete application and delivered to the Permits Manager located in the Department of Planning and Development. Expenses for notification of abutters, advertising of legal notices and recording of plans is the applicant’s responsibility.

- Inspector of Buildings: No fee
- Planning Board: $100.00
VIII. MAJOR DEVELOPMENT REVIEW

Contact: Permits Manager

Purpose
The purpose of Major Development Review (MDR) is to review large projects for significant impacts to the environment, abutting properties, Town services, traffic patterns, the economy of the Town, the character of the Town, and the public health, safety, and welfare of Town residents.

Projects requiring Major Development Review
1. All uses that generate one thousand (1000) vehicle trips per day or more in the General Commercial District, and/or five hundred (500) vehicle trips per day in any other district.
2. All uses that create fifty (50) or more dwelling units.
3. All subdivisions of land into fifty (50) or more lots.
4. All non-residential uses of one hundred thousand (100,000) square feet of gross floor area or more in the Planned Industry District and fifteen thousand (15,000) square feet or more of gross floor area in the Central Commercial and Limited Commercial Districts, and forty thousand (40,000) square feet or more of gross floor area in all other districts.
5. Any expansion of an existing use in which the expansion combined with the existing use meets or exceeds the above thresholds, and the expansion exceeds twenty percent (20%) of the existing:
   - Vehicle trips per day, or
   - Dwelling units, or
   - Building lots, or
   - Gross floor area or 20,000 square feet whichever is more.

Reviewing Authorities
Projects requiring Major Development Review require a special permit and site plan approval under the Greenfield Zoning Ordinance. The special permit granting authority (SPGA) is as follows:
1. For all uses which require a special permit under other sections of the Zoning Ordinance, the SPGA for major developments will be the same as the SPGA already designated; either the Planning Board or the ZBA.
2. For all other uses that are permitted by right and meet the above MDR thresholds, the SPGA will be the Planning Board.

Review Process
The Major Development Review process requires a special permit. Applications shall be determined complete by the Principal Planner/Permits Manager, submitted to the Town Clerk for certification and then forwarded to the appropriate SPGA. Site plans are transmitted for a 30-day inter-departmental review and comment period. Impact Statements addressing traffic, municipal services, environmental, community and fiscal impacts are required as set forth in the Rules and Regulations for Impact Statements. A public hearing must be held within 65 days of receipt and a decision must be issued within 90 days of the close of the public hearing.

Filing Fees
All filing fees are to be paid by check made payable to the Town of Greenfield. The check shall be attached to a complete application and delivered to the Permits Manager. Expenses for notification of abutters, advertising of legal notices and recording of plans are the applicant’s responsibility. The application fee for Major Development Review is $500.00.
IX. SIGN PERMITS

Contact: Inspector of Buildings
Permits Manager

Purpose
The purpose of sign regulations is to preserve the value of property by ensuring the compatibility of signs with surrounding land uses. All signs require a permit before being installed. It is recommended that the Inspector of Buildings or Permits Manager be contacted prior to designing a sign to ensure that it meets the requirements of the Zoning Ordinance.

Reviewing Authorities
All signs require approval from the Inspector of Buildings or the Zoning Board of Appeals.

Inspector of Buildings: Reviews and approves proposed signs that conform to the sign regulations in the Zoning Ordinance. Approves sign permit applications for non-conforming signs after they receive ZBA approval. Issues permission for temporary sign permits.

Zoning Board of Appeals: Reviews and approves proposed signs that do not conform to the sign regulations. A special permit may be granted for an exception to the sign regulations provided that the Board determines the sign will promote the public interest and that the size, number, height, location, and design of the sign(s) will not be detrimental to the neighborhood. Off-premises signs also require a special permit.

*Please note, even if a sign is approved by the Zoning Board of Appeals, a sign permit must still be submitted and approved by the Inspector of Buildings.

Review Process
All signs require a sign permit approved by the Inspector of Buildings. Special permit applications to the ZBA require a public hearing within 65 days of filing and a decision must be issued within 90 days of the close of the public hearing. If a special permit is granted by the ZBA for an exception to the sign regulations, the next step is to apply for a sign permit from the Building Inspector’s Office.

Filing Fees
All filing fees are to be paid by check made payable to the Town of Greenfield. The check shall be attached to a complete application. Applications for conforming signs are to be filed with the Inspector of Buildings. Special Permit applications shall be determined complete by the Permits Manager prior to submitting to the Town Clerk for certification. Expenses for the notification of abutters, advertising of legal notices and recording of the plans is the applicant's responsibility.

Department of Inspections and Enforcement.

<table>
<thead>
<tr>
<th>Size</th>
<th>Fee</th>
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</thead>
<tbody>
<tr>
<td>1 – 25 sq. ft.</td>
<td>$40.00</td>
</tr>
<tr>
<td>26 – 50 sq. ft.</td>
<td>$50.00</td>
</tr>
<tr>
<td>Above 50 sq. ft.</td>
<td>$50.00 plus $1.00 per sq. ft. over 50</td>
</tr>
</tbody>
</table>

Zoning Board of Appeals: $150.00
X. SPECIAL PERMITS

Contact: Permits Manager

Purpose
The purpose of special permits is to ensure that the proposed use or structure will not adversely impact adjacent properties, the neighborhood, the Town, or the environment and that the project meets the requirements of the Zoning Ordinance.

Special Permit Granting Authority (SPGA)
Three (3) Town boards issue special permits under the Zoning Ordinance. Each SPGA has their own “Rules and Regulations” governing filing and submittal requirements for applications. Application packets may be obtained at the Department of Planning and Development.

The following is a list of special permits issued by each SPGA:

<table>
<thead>
<tr>
<th>Zoning Board of Appeals (ZBA)</th>
<th>Zoning Ordinance Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uses allowed only by Special Permit</td>
<td>200-4.1-4.14</td>
</tr>
<tr>
<td>Floodplain District Uses</td>
<td>200-4.13</td>
</tr>
<tr>
<td>Corridor Overlay District</td>
<td>200-4.16</td>
</tr>
<tr>
<td>Planned Unit Development Overlay District</td>
<td>200-4.17</td>
</tr>
<tr>
<td>Reduced Dimensional Requirements</td>
<td>200-5.3.E</td>
</tr>
<tr>
<td>Expansion of Non-conforming Use</td>
<td>200-6.1</td>
</tr>
<tr>
<td>Accessory Scientific Research &amp; Development</td>
<td>200-6.2.A</td>
</tr>
<tr>
<td>Home Occupations</td>
<td>200-6.3</td>
</tr>
<tr>
<td>Sign Exceptions</td>
<td>200-6.7</td>
</tr>
<tr>
<td>Multi-Family Housing</td>
<td>200-7.2</td>
</tr>
<tr>
<td>Bed &amp; Breakfast/Tourist Home</td>
<td>200-7.5</td>
</tr>
<tr>
<td>Congregate Housing for the Elderly &amp; Handicapped</td>
<td>200-7.6</td>
</tr>
<tr>
<td>Commercial Campgrounds</td>
<td>200-7.9</td>
</tr>
<tr>
<td>Mixed Residential/Business Uses</td>
<td>200-7.10</td>
</tr>
<tr>
<td>Major Development Review</td>
<td>200-7.12</td>
</tr>
<tr>
<td>Adult Entertainment</td>
<td>200-7.13</td>
</tr>
<tr>
<td>Wireless Communications Facilities</td>
<td>200-7.14</td>
</tr>
</tbody>
</table>

| Planning Board                                                                            |                          |
| Water Supply Protection District Uses                                                       | 200-4.14                |
| Corridor Overlay District                                                                   | 200-4.16                |
| Planned Unit Development Overlay District                                                   | 200-4.17                |
| Construction on Slopes of 15% or greater                                                    | 200-6.8.C(8)(e)         |
| Driveways over Side or Rear Lot Line                                                       | 200-6.11.C(3)           |
| Common Driveways                                                                           | 200-6.11.D              |
| Open Space/Cluster Developments (for multi-family only)                                     | 200-7.1                 |
| Flag Lots                                                                                  | 200-7.8                 |
| Major Development Review                                                                    | 200-7.12                |

| Board of License Commissioners                                                              |                          |
| Unregistered Motor Vehicles                                                                 | 200-6.10                |

Review Process
Applications shall be determined complete by the Permits Manager, submitted to the Town Clerk for certification and then forwarded to the appropriate SPGA. Special permits are transmitted for a 30-day
inter-departmental review and comment period. A public hearing must be held within 65 days of filing and a decision must be issued within 90 days of the close of the public hearing.

**Filing Fees**
All filing fees are to be paid by check made payable to the Town of Greenfield. The check shall be attached to a complete application and delivered to the Permits Manager. Expenses for notification of abutters, advertising of legal notices and recording of plans are the applicant’s responsibility.

<table>
<thead>
<tr>
<th>Permitting Board</th>
<th>Fee Amount</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning Board:</td>
<td>$150.00</td>
<td>plus notification of all abutters within 300’ by certified mail</td>
</tr>
<tr>
<td>Zoning Board of Appeals:</td>
<td>$150.00</td>
<td>plus notification of all abutters within 300’ by certified mail</td>
</tr>
<tr>
<td>Board of License Commissioners:</td>
<td>No Fee</td>
<td></td>
</tr>
</tbody>
</table>
SPECIAL PERMIT PROCESS
Special Permit Granting Authority (SPGA) may be the Planning Board, Zoning Board of Appeals or Board of License Commissioners

Application is filed with the Principal Planner/Permits Manager, certified by the Town Clerk and forwarded to the SPGA.

Within 10 days of receipt, the SPGA transmits copies of the application for inter-departmental review. Comments must be received within 30 days of transmittal or deemed to have no objections.

14 days before the public hearing, notice must be posted, published (once in each of 2 consecutive weeks) and sent to abutters.

A public hearing must be held within 65 days of filing with Town Clerk.

Within 90 days after the close of the public hearing, the SPGA must issue a decision.

Within 14 days after decision, the SPGA must file the decision with the Town Clerk.

Decision is sent to applicant and parties in interest specifying 20 day appeal period.

Within 20 days after filing with Town Clerk an appeal may be taken to Superior Court.

Applicant must file certified copy of decision with the Registry of Deeds before the Special Permit becomes effective.

Within 14 days before the public hearing, notice must be posted, published (once in each of 2 consecutive weeks) and sent to abutters.

Decision sent to applicant and parties in interest specifying 20 day appeal period.

Failure to act within 90 days.

With 14 days from the expiration of the 90 days to act, the applicant must notify parties in interest and the Town Clerk of approval due to failure to act and 20 day right to appeal.

If no appeal has been made within 20 days or appeal has been settled, the Town Clerk shall issue certificate stating date of approval for failure to act. Certificate is forwarded to applicant.

After a period of 2 years, applicant may reapply or before if there is a substantial change in the application and the Planning Board consents.

Special Permit expires if substantial use has not commenced within 2 years.
XI. VARIANCES

Contact: Permits Manager

Purpose
The Zoning Board of Appeals (ZBA) hears and decides petitions for variances under the Zoning Ordinance for land or structures that do not meet the requirements of the Zoning Ordinance. A dimensional variance applies to zoning requirements such as lot area, lot frontage, open space, building height and property line setbacks. A use variance applies to a land use that is not allowed in a particular zoning district under the Zoning Ordinance.

Criteria for Approval
In order to grant a variance, the Zoning Board of Appeals must make all three of the following findings required by the State Zoning Act (M.G.L. Chapter 40A):

- A literal enforcement of the Zoning Ordinance would involve a substantial hardship, financial or otherwise, to the petitioner or appellant;
- The hardship is owing to circumstances relating to the soil conditions, shape or topography of such land or structures but not affecting generally the zoning district in which it is located;
- Desirable relief may be granted without substantial detriment to the public good and without nullifying or substantially derogating from the intent or purpose of the Greenfield Zoning Ordinance.

Review Process
Applications shall be determined complete by the Permits Manager prior to submitting to the Town Clerk for certification and then forwarded to the ZBA. Variance applications are transmitted for a 30-day inter-departmental review and comment period. Variances require a public hearing within 65 days of receipt, and a decision within 100 days of filing with the Town Clerk.

The ZBA may impose conditions, safeguards and limitations of time and use, if it decides to grant the variance. The ZBA is under no legal obligation to grant the variance, and in absolutely no circumstances can a variance be granted to allow a prohibited use.

Filing Fees
All filing fees are to be paid by check made payable to the Town of Greenfield. The check shall be attached to a complete application and delivered to the Permits Manager. Expenses for notification of abutters, advertising of legal notices and recording of plans are the applicant’s responsibility. The filing fee for a variance is $150.00 plus notification of all abutters within 300’ by certified mail.
Within 14 days after decision, the ZBA files decision with the Town Clerk. 

Within 20 days after filing with Town Clerk, an appeal may be taken to Superior Court.

Applicant must file certified copy of decision before Variance becomes effective.

Variance expires if not exercised within 1 year, or an extension is granted.

After a period of 2 years, applicant may reapply or before if there is a substantial change in the application and the Planning Board consents.

Decision sent to applicant and parties in interest specifying 20 day appeal period.

Failure to act within 100 days.

With 14 days from the expiration of the 100 days to act, the applicant must notify parties in interest and the Town Clerk of approval due to failure to act and 20 day right to appeal.

If no appeal has been made within 20 days or appeal has been settled, the Town Clerk shall issue certificate stating date of approval for failure to act. Certificate is forwarded to applicant.

A public hearing must be held within 65 days of filing with the Town Clerk.

Within 100 days after date of filing with the Town Clerk, the ZBA must issue decision.

Within 14 days after decision, the ZBA files decision with the Town Clerk.

Decision sent to applicant and parties in interest specifying 20 day appeal period.

Within 20 days, after filing with Town Clerk, an appeal may be taken to Superior Court.

Application is filed with the Principal Planner/Permits Manager, certified by the Town Clerk and forwarded to the ZBA immediately.

14 days before the public hearing, notice must be posted, published (once in each of 2 consecutive weeks) and sent to abutters.

VARIANCE PROCESS
Zoning Board of Appeals
XII. MASSACHUSETTS WETLANDS PROTECTION ACT (MWPA)
AND TOWN OF GREENFIELD’S WETLANDS PROTECTION ORDINANCE

Contact: Conservation Agent

Reviewing Authority
The Greenfield Conservation Commission is responsible for administering the Massachusetts Wetlands Protection Act. The MWPA includes provisions of the Massachusetts Rivers Protection Act. The regulations governing both of these acts are included in the Wetlands Protection Act Regulations 310 CMR 10.00. The Conservation Commission is also responsible for administering the Town of Greenfield’s Wetlands Protection Ordinance. Proposed projects are reviewed based upon the proximity to a resource area and the ability to minimize potential impacts.

Projects Requiring Approval
Any proposed activity or project, that will “remove, fill, dredge, or alter” a wetland resource area, the 200-foot riverfront protection area, or the 100-foot buffer zone associated with a wetland resource area must obtain a permit from the Conservation Commission. The term “alter” includes but is not limited to any development, construction, destruction of vegetation, any change in drainage characteristics or flow patterns, and any change in the groundwater. A wetland resource area includes any stream, river, creek, pond, lake, and the banks associated with them, any meadows, marshes, swamps, bogs, any land under water, land subject to flooding, and any riverfront area.

Applications and Permits
Request for Determination of Applicability (RDA): This application requests the Conservation Commission to determine if the proposed work or property is subject to the MWPA and/or the Town of Greenfield’s Wetlands Protection Ordinance. For simple projects, the Commission may also determine if the work can be done in a manner that will not negatively impact the resource area. In response to an RDA, the Commission may issue one of the following decisions:

a) Positive Determination - the proposed work or property is subject to the MWPA and/or Town of Greenfield’s Wetlands Protection Bylaw and requires the filing of a Notice of Intent.

b) Negative Determination - proposed work is not subject to the MWPA or the Town of Greenfield’s Wetlands Protection Bylaw.

c) Negative Determination with Conditions - proposed work is within the 100-foot buffer zone and will not adversely impact the resource area if simple precautions are taken.

Notice of Intent (NOI): This application provides the Conservation Commission with a detailed description of the proposed work that is located in a resource area, riverfront area or buffer zone that may impact a nearby wetland resource area. In response to an NOI, the Commission may issue an Order of Conditions permitting the proposed work with conditions consistent with the standards in the Wetlands Protection Act Regulations and the Town of Greenfield’s Wetlands Protection Ordinance, which prevent significant adverse impacts to a wetland resource area, or deny the project because it cannot be performed in a manner that prevents negative impacts to a wetland resource area.

Review Process
Request for Determination of Applicability: Within 21 days of receipt, the Commission will conduct a site visit and make a decision at a public meeting that has been advertised in a local newspaper at least 5 days prior to the meeting.

Notice of Intent: Within 21 days of receipt, the Conservation Commission will conduct a site visit and hold a public hearing that has been advertised in a local newspaper at least 5 days prior to the meeting.
The applicant is responsible for notifying all abutters within 100 feet of the subject property prior to application. Within 21 days of the public hearing, the Commission will issue an Order of Conditions approving or denying the request.

**Filing Fees**
All fees are to be paid by check made payable to the Town of Greenfield and to the Commonwealth of Massachusetts as required. Expenses for notification of abutters, advertising of legal notices and recording of permits shall be the responsibility of the applicant.

- Request for Determination: No filing fee.
- Notice of Intent: Notice of Intent:

Filing fee is based upon project type. Refer to Wetlands Filing Fee Calculation Worksheet. Half of the total filing fee (50%) over $25.00 is paid to the State with the remaining portion being paid to the Town of Greenfield.
WETLANDS PROTECTION APPROVAL PROCESS
Conservation Commission

Applicant submits Request for Determination of Applicability (RDA - Form 1) to the Conservation Commission. Applicant may proceed directly to a Notice of Intent (NOI) without filing an RDA.

Within 21 days of receipt, Commission conducts a site visit and issues a decision (Form 2) at a public meeting.

Determination of Applicability
10 Day Appeal Period

- **Negative Determination with Conditions**
  - Work may begin in accordance with all conditions.

- **Positive Determination**
  - Applicant submits Notice of Intent (Form 3) and filing fees to Commission.
  - DEP submits comments and application is deemed complete.
  - Within 21 days of receipt of DEP comments, Commission holds a public hearing. Applicant is responsible for advertising and notice to abutters.
  - Within 21 days after close of public hearing, Commission issues Order of Conditions (OOC).
  - Within 10 days of issuing Order of Conditions an appeal may be filed with DEP.
  - Work may begin after:
    - 10 day appeal period has expired
    - OOC has been recorded at the Registry of Deeds and verified
    - Commission has been notified 3 days prior.
  - Applicant requests a Certificate of Compliance (Form 8A) when all work and conditions are complete.

- **Negative Determination**
  - Work is not subject to the Wetlands Protection Regulations or Town of Greenfield’s Wetlands Protection Bylaw. Work may begin.
XIII. SUBDIVISION APPROVAL

Contact: Permits Manager

Purpose
The Planning Board under the Greenfield Subdivision Regulations must approve any division of land into two or more lots. All plans showing the creation of new lots must be endorsed by the Planning Board before they can be recorded in the Registry of Deeds. Plans stamped by a registered land surveyor certifying that no new lots or changes in existing boundaries are shown on the plan may be recorded without Planning Board endorsement.

There are two types of subdivisions:
1) Approval Not Required; and
2) Plans Requiring Subdivision Approval.

Approval Not Required Plans (ANR’s)
ANR plans show the creation of lots with frontage on existing roads. The Planning Board must determine if there is adequate frontage, as required by the Greenfield Zoning Ordinance, and adequate access. Frontage must be on one of the following types of roads:
- a public way or a way which the Town Clerk certifies is maintained and used as a public way,
- a way shown on a subdivision plan which has been previously approved and endorsed by the Planning Board, or
- a way which was in existence when the Subdivision Control Law took effect in Greenfield and which the Planning Board has determined is suitable for the proposed use of the lots.

Endorsement of an ANR plan does not certify that the lots shown on the plan qualify as building lots under the Zoning Ordinance. This determination is made by the Inspector of Buildings and the Permits Manager. Planning Board endorsement only indicates that the plan shows a division of land that does not require approval under the Subdivision Control Law and the Greenfield Subdivision Regulations.

Review Process and Submittal Requirements
Plans shall be determined complete by the Principal Planner/Permits Manager, submitted to the Town Clerk and forwarded to the Planning Board. The Planning Board has 21 days to review the plan at a regularly scheduled meeting and issue a decision. A complete submittal includes 2 copies of the completed application (Form A), appropriate filing fee, 5 blueprints and 1 mylar.

Filing Fees
All fees are to be paid by check made payable to the Town of Greenfield in the amount of $25.00 per lot. The fee for plans that reconfigure lots but do not create any new lots is $25.00. Dividing one lot into two lots would be $50.00.

Plans Requiring Subdivision Approval
Plans that show a division of land into 2 or more lots with frontage on a proposed new road requires subdivision approval. There is a two step review process of subdivision plans: 1) Preliminary Plans; and 2) Definitive Plans.

Preliminary Plans
The preliminary plan serves as a conceptual design. It includes the proposed street layout, lot boundaries, drainage system and topography. Preliminary Plans are required for all non-residential subdivisions and
optional for residential subdivisions. However, it is recommended that a preliminary plan be submitted for all subdivisions. A preliminary plan cannot be recorded with the Registry of Deeds.

**Definitive Plans**

A definitive plan is the final design plan complete with engineering specifications. This plan must be prepared by a registered Land Surveyor or Civil Engineer. The plan must contain information regarding width and length of every street, lot lines, topography, centerline profiles of streets, layout and design of sewerage, storm drainage, water supply and wetland resource areas as defined by the Massachusetts Wetlands Protection Act.

**Review Process and Submittal Requirements**

**Preliminary Plans:** Applications shall be determined complete by the Permits Manager, submitted to the Town Clerk for certification and then forwarded to the Planning Board and to the Board of Health. The Planning Board and Board of Health must review, issue a decision and notify the Town Clerk and the applicant within 45 days of submission. If the plan is denied, a detailed report shall be provided. A complete submittal includes twelve (12) copies of the plan, one copy reduced to 11” x 17”, a Form B, Application for Approval of a Preliminary Plan, and a certified check made payable to the “Town of Greenfield”. The cost of a preliminary plan is seventy-five dollars ($75) per lot plus a hundred dollar ($100) application fee. One plan is retained by the Town Clerk and the remaining copies are used for inter-departmental review.

**Definitive Plans:** Applications shall be determined complete by the Permits Manager, submitted to the Town Clerk for certification and then forwarded to the Planning Board and to the Board of Health. The Board of Health must, within 45 days of filing with the Town Clerk, report to the Planning Board in writing, approving or disapproving the plan. A public hearing is required prior to approval by the Planning Board. The time period for issuing a decision on a definitive plan is 90 days if a preliminary plan was submitted and 135 days if no preliminary plan was submitted. Definitive plans must also meet the requirements for site plan approval under the Greenfield Zoning Ordinance. A complete submittal includes the following:

(a) A properly completed application form, Form C, Application for Approval of a Definitive Plan;
(b) The cost of a definitive plan is one hundred dollars ($100) per lot plus a five hundred dollar ($500) application fee if a preliminary plan is approved or two hundred dollars ($200) per lot plus a one thousand, two hundred and fifty dollar ($1,250) application fee if no preliminary plan is submitted. The applicant is responsible for paying all advertising costs;
(c) Twelve (12) copies of the definitive plan and road profiles, dark line on white background, one copy reduced to 11” x 17”;
(d) A list of all landowners abutting the land shown on the subdivision plan as appearing on the most recent tax list. The list shall be typewritten and in label format.

**Administrative fees (nonrefundable).**

All fees are to be paid by check made payable to the Town of Greenfield. All expenses for notification of abutters, advertising of legal notices and recording of plans shall be the responsibility of the applicant. The following fees are to be charged to the applicant for the various reviews listed in the following schedule:
$100.00 per hour for a maximum of 2 hours to cover extra time spent by Town Departments beyond 5 hours for either preliminary or final plan review

NOTES: * The fee for approval not required plans which reconfigure existing lots but do not create any additional new lots shall be twenty-five dollars ($25).

<table>
<thead>
<tr>
<th>Subdivision Control</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Endorsement by Planning Board (ANR, Form A)</td>
<td>$25.00 per lot*</td>
</tr>
<tr>
<td>Preliminary Plan (Form B)</td>
<td>$100.00 application fee and $75.00 per lot</td>
</tr>
<tr>
<td>Definitive Plan (Form C)</td>
<td>$500.00 application fee and $100.00 per lot if preliminary plan approved; $1,250.00 application fee and $200.00 per lot if no preliminary plan submitted</td>
</tr>
<tr>
<td>Amendment/Revision to a Definitive Plan</td>
<td>$250.00/subscription</td>
</tr>
<tr>
<td>Inspection Fee</td>
<td>0.5% of total cost of improvements</td>
</tr>
</tbody>
</table>
APPROVAL NOT REQUIRED PLAN (ANR)
Planning Board

ANR application (FORM A) and filing fee filed with Town Clerk. Copies of plans are forwarded to Planning Board.

Endorsement Approved

Within 21 days of receipt by the Town Clerk, the Planning Board must review plan, issue a determination, and give written notice of determination to the Town Clerk and applicant.

Endorsement Denied

Within 20 days of determination being recorded by the Town Clerk, an appeal may be filed in Superior Court with notice to the Town Clerk.

Subdivision Approval is Required

Applicant must submit subdivision plan to the Planning Board or may appeal decision to Superior Court.

Subdivision Approval-Not-Required

Planning Board endorses plan

Applicant records endorsed plan with Registry of Deeds.
SUBDIVISION APPROVAL PROCESS
Planning Board

PRELIMINARY PLAN

Preliminary plan and filing fee filed with Town Clerk and forwarded to the Planning Board. Copy of plan is forwarded to the Board of Health.

Within 45 days of submission, reviewing authorities must notify Town Clerk and applicant of approval with or without modifications or disapproval and the reasons therefore.

Definitive plan must be submitted within 7 months to preserve zoning and subdivision exemptions.

DEFINITIVE PLAN

Definitive Plan and filing fee filed with Town Clerk and forwarded to the Planning Board. Copy of plan is forwarded to the Board of Health.

Within 45 days of receipt, the Board of Health shall issue a written report to the Planning Board and applicant of approval with or without modifications or disapproval.

The Planning Board must hold a public hearing, but not until receipt of report from Board of Health or the lapse of 45 days.

Notice must be posted, published and sent to abutters at least 14 days in advance.

Planning Board must issue and file a decision with the Town Clerk and send notice to the applicant within 135 days or within 90 days if a Preliminary Plan was submitted.

Within 20 days of filing decision with Town Clerk, an appeal may be filed in Superior Court with notice to the Town Clerk.

After the 20 day appeal period has expired, the Planning Board, prior to final endorsement by the Planning Board, must provide a performance guarantee and a timeframe for the construction of ways and municipal services decided upon.

After the 20 day appeal period has expired and prior to final endorsement by the Planning Board, a performance guarantee must be provided and a time frame for construction of ways and municipal services decided upon.

Town Clerk certifies that no appeal was made or granted. Planning Board endorses plan and sends it to the applicant.

Within 6 months of endorsement or certificate, applicant must file plan with Registry of Deeds.

Failure to act within required time frame.

After the 20 day appeal period has expired, the Town Clerk must issue a certificate stating that approval has been granted due to failure to act within the required time.

Town Clerk issues certificate and sends it to the applicant.
XIV. BUILDING PERMITS

Contact: Department of Inspections and Enforcement

Purpose
The purpose of a building permit is to ensure that new development is constructed in accordance with required zoning, wetlands, subdivision and related permits, and is in compliance with the Massachusetts State Building Code.

Projects Requiring a Building Permit
All structures, other than fences 6 feet or less in height, require a building permit. A structure is anything constructed or erected which requires location on the ground or is attached to something on the ground. Projects requiring a building permit are grouped into two categories; projects that require Site Plan Approval, and projects that do not require Site Plan Approval.

Site Plan Approval Required
The creation, expansion, substantial alteration, or change in use of the following uses require Site Plan Approval:

- All uses requiring a special permit;
- Any business, commercial, industrial, or institutional use (except home occupations not requiring a special permit);
- Any residential use of two (2) or more units including subdivisions;
- Any site containing more than one (1) principal use.

Site Plan Approval Not Required
- One unit residential projects;
- All accessory structures (i.e. garages, sheds, decks);
- All swimming pools;
- All signs (i.e. free standing, wall mounted);
- Wood stoves/chimneys;
- Temporary tents;
- Canopies and Awnings.

Review Process
A Building Permit Application is submitted to the Inspector of Buildings. When all zoning, wetlands and subdivision permits are obtained, a building permit may be issued. The maximum review period is 30 days and a public hearing is not required.

Filing Fees
All fees are to be paid by check made payable to the Town of Greenfield. Filing fees shall be in accordance with the fee schedule as adopted by the Town Council and available in the Inspections Department and Town Clerks Office. Checks shall be attached to a complete Building Permit Application and delivered to the Inspections Department located in the Town Hall, 14 Court Square.
XV. RELATED PERMITS

Most projects will require other permits related to the project but not issued under Zoning, Wetlands or Subdivision laws. These permits are called “Related Permits”. Related permits may be Town, state or federal. The following is a summary of the most common related permits.

TOWN

Department of Public Works

Access Permit  New or altered driveways on any Town or State road require the filing and approval of an Application for a Curb Cut in compliance with the DPW’s New Driveway Apron Standards. An Excavation Permit must be obtained prior to beginning work.

Excavation Permit  Required for all subsurface work within the Town of Greenfield including public and private property and within a public right-of-way. The purpose of this permit is to identify all existing subsurface utilities prior to beginning work.

Sewer Permit  Required for all construction, alteration, or disruption of any new or existing residential or non-residential connection to any public sanitary sewer. All permit applications shall comply with the Town of Greenfield Sewer Use Regulations governing the use of public and private sewers and drains; the installation and connection of building sewers and the discharge of waters and wastes into the public sewer system.

Water Permit  Required for all construction, alteration, or disruption of any new or existing residential or non-residential connection to any public water main. All permit applications shall comply with the Town of Greenfield Water Use Regulations.

Stormwater Permit  Required for any new construction or renovation of an existing property that introduces a new discharge or increases the volume currently discharged to any public way, stormwater system or appurtenance thereof.

Inspector of Buildings

Demolition Permit  Required prior to any proposed demolition work to an existing structure.

Building Permit  Required prior to any proposed residential or non-residential construction and associated activities and after receiving Site Plan Approval. Applications shall be made on the official Application for License to Erect a Structure.

Occupancy Permit  Required prior to any residential or non-residential structure being occupied. The Building Inspector will verify that all permits and conditions have been obtained and complied with prior to issuance.

Inspections Department

During construction the following utility and safety inspections shall be scheduled as required:

- Electric – required prior to any electrical work; residential or non-residential
- Gas – required prior to any work; residential or non-residential
- Construction
- Plumbing – required prior to any plumbing work; residential or non-residential
- Elevators

**Board of Health / Director of Health**

Title V Required for any construction of a new septic system or alteration of an existing septic system.

Food Retailers Permit Required for any new business that prepares and sells food on site.

Well Construction Required for any construction of a new well or the destruction of an existing well

**Fire Department**

Permits, licenses and approvals are governed under local bylaws and under MGL Chapter 148 and CMR 5127 for such uses as storage of hazardous materials/flammables, lumberyards, gasoline stations, and above and underground storage tanks.

**Board of License Commissioners**

Motor Vehicle License Required for the operation of a business to sell new or used cars.

Soil Removal License Required for all activities associated with stripping, removing, or conveying away of any soil, loam or gravel from any land in Greenfield not in public use except when in conjunction with the development, improvement or landscaping of land.

Common Victualler Required for all restaurants and food service establishments that provide sit down License service.

**STATE**

Curb Cut Permit Required by the Massachusetts Highway Department for new or altered driveways on any State roadway.

MEPA Massachusetts Environmental Policy Act (MEPA) requires the submission of an Environmental Notification Form (ENF) and Environmental Impact Report (EIR) for “works, projects and activities” undertaken, funded or requiring a permit from state agencies if the project exceeds specified thresholds.

401 Water Quality Certification Required by the Massachusetts Department of Environmental Protection for any project that will alter over 5,000 square feet of wetlands and/or the dredging of more than 100 cubic yards of Land Under Water as defined in the Massachusetts Wetlands Protection Act.

Forest Cutting Permit The Massachusetts Forest Cutting Act (MGL Chapter 132) requires landowners to file a Forest Cutting Plan with the Department of
Environmental Management for the harvesting of forest products that exceeds specified thresholds.

Massachusetts Endangered Species Act (MESA) Requires filing with the Natural Heritage and Endangered Species Program (NHESP) if a project falls within Priority Habitat of Rare Species, as shown on the Massachusetts Natural Heritage Atlas, and does not meet the MESA filing exemptions.

FEDERAL

Section 404 of the Federal Clean Water Act Required by the Army Corps of Engineers (Corps) for work affecting the “course, location, condition or capacity” of navigable rivers and tidal areas.

Storm Water (General Construction) Permit Construction activities (including other land disturbing activities) that disturb one acre or more of land are regulated under the National Pollutant Discharge Elimination System (NPDES) and require a permit from the Environmental Protection Agency.
XVI. ZONING APPEALS

Contact: Permits Manager

Authority
Zoning decisions may be appealed to either the Zoning Board of Appeals or to the Franklin County Superior Court depending upon the type of permit or decision being appealed.

Appeals to the Zoning Board of Appeals (ZBA)
The following decisions may be appealed to the ZBA:
1. Decisions by the Building Inspector or the inability to obtain a permit or enforcement action from the Building Inspector under the Zoning Ordinance.
2. Decision on a site plan by the Inspector of Buildings or the Planning Board.

Who has the Right to Appeal?
1. Any person aggrieved for any of the above reasons.
2. The Franklin Regional Council of Governments.
3. Any person including any officer or board of the Town of Greenfield or of any abutting town, if aggrieved by any order or decision of the Inspector of Buildings or other administrative official in violation of any provision of MGL c. 40A or Greenfield’s Zoning Ordinance.

Appeal Process
Appeals to the ZBA must be made within 30 days from the date of the order or decision that is being appealed. Appeals must follow the procedure required in Section 15 of the Zoning Act, MGL Chapter 40A. The filing fee for appeals to the ZBA is $150.00 plus notification of all abutters within 300’ by certified mail.

Appeals to Franklin County Superior Court
The following decisions may be appealed to the Superior Court:
1. Special permit decisions by the Zoning Board of Appeals, Planning Board or any board authorized to grant a special permit under the Zoning Ordinance or the failure of the board to act within the required time periods.
2. Any decision on an appeal or a variance brought to the Zoning Board of Appeals or the ZBA’s failure to act on an appeal or variance within the required time period.

Who has the Right to Appeal?
1. Any person aggrieved by a decision of the ZBA, Planning Board or any Special Permit Granting Authority whether or not previously a party to the proceeding.
2. Any municipal officer or board.

Appeal Process
Appeals to Superior Court must be filed within 20 days after the decision by the ZBA or the Special Permit Granting Authority has been filed with the Town Clerk. If an appeal is being made because a permit has been automatically granted due to the failure of the ZBA or the Special Permit Granting Authority to act within the required time periods, the appeal must be filed within 20 days after the Town Clerk has received written notice from the applicant that the permit has been automatically granted because of the Board’s failure to act. Appeals must follow the procedure required in Section 17 of the Zoning Act, MGL Chapter 40A.
ZONING APPEALS PROCESS
Zoning Board of Appeals

Notice of Appeal filed with Town Clerk. Applicant forwards copy of notice of appeal to the ZBA and the Officer or Board whose decision is being appealed. Appeal must be made within 30 days of decision being appealed.

14 days before the public hearing, notice must be posted, published (once in each of 2 consecutive weeks) and sent to abutters.

A public hearing must be held within 65 days of filing with the Town Clerk.

Within 100 days after date of filing with the Town Clerk, ZBA must issue decision. Failure to act in time is deemed an approval.

Within 14 days after decision, ZBA files decision with Town Clerk.

ZBA sends decision to applicant and parties in interest, specifying 20 day appeal period.

Within 20 days after filing with Town Clerk, an appeal may be taken to Superior Court.

Failure to act within 100 days.

Within 14 days from the expiration of the 100 days to act, applicant must notify parties in interest and the Town Clerk of failure to act.

If no appeal has been made within 20 days or the appeal has been settled, the Town Clerk shall issue certificate stating date of approval.

Denied
XVII. ZONING CHANGES

Contact: Permits Manager

Who may initiate a Zoning Change?
- Town Council
- Zoning Board of Appeals
- Planning Board
- A landowner to be affected by a zoning change
- Franklin Regional Council of Governments
- A citizen petition signed by at least 10 registered voters as outlined in Section 7-7 of the Greenfield Home Rule Charter.

Review Process and Submittal Requirements
Requests for changes to the Zoning Ordinance or Zoning Map must comply with the procedures required in the Zoning Act, MGL Chapter 40A, Section 5, the Town Charter, and the regulations adopted by the Town for processing zoning amendments. A petition for a zoning change is submitted to the Town Council, who refers the petition to the Planning Board for a public hearing. The Planning Board submits a report on the petition to the Town Council within 21 days. The Town Council Economic Development Committee holds a public hearing and makes a recommendation to the full Council. The zoning change requires a two-thirds vote of the full Town Council for approval. The Council must vote on a zoning change petition within 90 days of the Town Council’s public hearing. Zoning Ordinance amendments adopted by the Town Council are effective on the date of approval.

A petition for a zoning change must include a completed petition form, a property map indicating the lots to be included in the zone change and a completed site plan application if the request is to permit a new use of the property.

Filing Fees and Expenses
All zoning change petitions shall be filed with the Town Council. A copy of the petition, indicating the date and time of the filing, shall be forwarded to the Planning Board and the Town Council. The filing fee for a zoning change petition is $100.00. Expenses for the Planning Board and Town Council public hearings are the petitioner’s responsibility.

All other costs and reasonable expenses incurred by the Town in connection with the review and processing of zone change requests shall be the responsibility of the applicant. Such costs may include but are not limited to staff time, consultant and attorney’s fees, research, data collection, tests, borings, and informational meetings.
Petition is submitted to the Town Council.

Within 14 days of receipt, copies of the petition are forwarded to the Planning Board.

Within 65 days of receipt, the Planning Board must hold a public hearing. 14 days prior, notice must be posted, published (once in each of 2 consecutive weeks), and sent to the FRCOG, DHCD, and the Planning Boards of abutting towns.

Within 21 days after the close of the public hearing, the Planning Board submits a report to the Town Council for initial consideration.

The Town Council forwards the petition to the Economic Development Committee for a public hearing which is posted and published at least 5 days prior.

Within 90 days after the EDC’s public hearing, a vote must be taken by the full Town Council. A two thirds vote of the full Council is required for Approval.

Adoption or amendment shall be effective on the date the full Town Council vote is taken.

Failure to act within required time.

Planning Board must hold another public hearing and process is repeated.

After a period of 2 years, a petition may be reconsidered unless the Planning Board recommended adoption, in which case a petition may be reconsidered sooner.

Denied
APPENDIX L: COMPRESSED NATURAL GAS PERMITTING GUIDELINE

Outdoor Siting

- CNG storage containers charged with CNG not connected for use shall be located outdoors.
- A facility in which CNG compression, storage, and dispensing equipment are sheltered by an enclosure constructed on noncombustible or limited-combustible materials that has at least one side predominantly open and a roof designed for ventilation and dispersal of escaped gas shall be considered to be located outdoors.
- Compression, storage, and dispensing equipment located outdoors

Connecticut and Massachusetts require protection against damage of storage and/or dispensing equipment: For the Massachusetts code, refer to 527 CMR 26.07 (3)

Indoor Siting

- Compression, dispensing equipment, and storage containers connected for use shall be permitted to be located inside of buildings reserved exclusively for these purposes or in rooms within or attached to buildings used for other purposes in accordance with NFPA 52 4-4.3.
- Limits of Storage in Buildings. Storage shall be limited to not more than 10,000 SCF (283 m³) of natural gas in each building or room.
- Deflagration (explosion) venting shall be provided in exterior walls or roof only. Vents shall be permitted to consist of any one or any combination of the following:
  - Rooms within or attached to other buildings shall be constructed of noncombustible or limited-combustible materials.
  - Ventilation - Indoor locations shall be ventilated using air supply units and exhaust outlets arranged to provide uniform air movement to the extent practical.
  - A gas detection system shall be equipped to sound an alarm and visually indicate when the maximum of one-fifth of the lower flammable limit is reached.
- Electrical Installations - Buildings and rooms used for compression, storage, and dispensing shall be classified in accordance with NFPA 52-98 Table 4-12 for installations of electrical equipment.
- Non-electrical Ignition Sources, other than electrical installations as by permitted 4-4.3.8, shall not be permitted.
- Pressure relief devices on storage systems shall have pressure relief device channels to convey escaping gas to the outdoors and then upward to a safe area to prevent impinging on buildings, other equipment, or areas open to the public (e.g., sidewalks).
- Warning Signs - Access doors shall have warning with the signs with the words “WARNING- NO SMOKING- FLAMMABLE GAS.” Such wording shall be plainly legible, bright red letters on a white background, with letters not less than 1 in. (25 mm) high.

Massachusetts sets requirements for container storage inside of buildings: For the Massachusetts code, refer to 527 CMR 26.07 (5).

Installation of Container Appurtenances

- Storage containers shall be installed above ground on stable, noncombustible foundations or in vaults with ventilation and drainage.
- Flow Prevention. Adequate means shall be provided to prevent the flow of flammable or combustible liquids under containers.
Installation of Pressure Relief Devices

- Pressure relief valves shall be so arranged that they discharge to a safe area.
- An Overpressure Protection Device, other than a rupture disc, shall be installed in the fueling transfer system to prevent over pressure in the vehicle; and
- Pressure Regulators. Regulators shall be designed, installed, or protected so that their operation is not affected by the elements/weather conditions.
- Pressure Gauges. Gauges shall be installed to indicate compression, discharge pressure, storage pressure, and fuel supply container fill pressure.

Piping and Hoses

- Piping and hoses shall be run as directly as practical and with adequate provisions for expansion, contraction, jarring, vibration, and settling. Exterior Piping shall be either buried or installed above ground and shall be supported and protected against mechanical damage.
- Manifolds connecting fuel containers shall be fabricated to minimize vibration; and shall be installed in a protected location or shielded to prevent damage from unsecured objects.
- Jointing
- Venting
- At public fueling stations provisions shall be provided to recycle gas used for calibration and testing.

Emergency Shutdown Equipment

- Manually Operated Container Valve / Shutoff Valve.
- Excess flow check valves - Where excess flow check valves are used, the closing flow shall be less than the flow rating of the piping system that would result from a pipeline rupture between the excess-flow valve and the equipment downstream of the excess-flow check valve.
- Gas piping from an outdoor compressor or storage system into a building shall be provided with shut-off valves located outside the building.
- An emergency manual shutdown device shall be provided at the dispensing area and also at a location remote from the dispensing area. This device, when activated, shall shut off the power supply and the gas supply to the compressor and the dispenser.
- Emergency Shutdown devices shall be distinctly marked for easy recognition with a permanently fixed legible sign.
- Breakaway protection shall be provided in a manner that, in the event of a pull-away, natural gas ceases to flow at any separation to be installed at every dispensing point.
- Control Circuits. When an emergency shutdown device is activated or electric power is cut off, systems that shut down shall remain down until manually activated or reset after a safe condition is restored.
- Shutoff Valves. Each line between a gas storage facility and a dispenser at a fast-fill station shall have a valve that closes
- Fast-closing shutoff. A fast-closing, “quarter turn” manual shutoff valve shall be provided at a fast-fill station upstream of the breakaway device
- Compressor Inlet valve. A self-closing valve shall be provided on the inlet of the compressor that shuts off the gas supply to the compressor

Installation of Electrical

- Fixed Electrical equipment and wiring shall be installed in accordance with the National Electric Code.
Operations

- Signage. A warning sign with the words “STOP MOTOR”, “NO SMOKING”, “FLAMMABLE GAS” shall be posted at dispensing station and compressor areas. The lettering must be large enough to be visible and legible from each point of transfer. Note: Massachusetts requires a sign saying “STOP ENGINE WHILE REFUELING”

Fire Protection

- Fire Protection. A portable fire extinguisher having a rating of not less than 20-B:C shall be provided at the dispensing area.47

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47 The Conference of Northeast Regional Fire Safety Officials, A Recommended Permitting Guide For Compressed Natural Gas Fueling Stations, Fall 2000
APPENDIX M: SUMMARY OF REQUIREMENTS FOR PROPOSED DISTRIBUTED GENERATION INTERCONNECTIONS WITH THE WMECO DISTRIBUTION SYSTEM

The following summary information is provided for customers who are interested in the general requirements for interconnecting distributed generation (DG) with WMECO’s distribution system. For more detailed information, please see the Interconnection Tariff, MDPU No. 1039E, which is the first link on the web page: www.wmeco.com/distributedgeneration. For information on compensation for excess generation, please refer to WMECO’s Net Metering Tariff, MDPU No. 1048A posted at www.wmeco.com/netmetering or WMECO’s Power Purchase Schedule, MDTE No. 1014C, which is also posted on the WMECO website: www.wmeco.com/Residential/UnderstandBill/RatesRules/RatesTariffs.aspx

Please note that if the generation will be interconnected with a WMECO distribution circuit that is FERC jurisdictional and you plan to be a market participant, you will need to apply for interconnection with ISO-New England instead of WMECO. You can contact WMECO for assistance in determining which application to submit. For state jurisdictional circuits, if your generation facility will be 1 MW or larger, there are additional requirements by ISO-New England.

Interconnection Information:

1. Prior to installing generation, you must submit an application found on the WMECO website: www.wmeco.com/distributedgeneration.
   - For single phase inverter-based facilities 10 KW or less and three phase inverter-based facilities 25 KW and less using inverters certified to IEEE 1547.1 and UL 1741, you will need to submit a Simplified Application to WMECO.
   - For all other applications, you will need to submit the Expedited / Standard Application to WMECO.

2. Please submit a completed application well in advance of your anticipated installation date. WMECO will do its best to accommodate your anticipated installation or need date. Delays commonly occur due to incomplete and unsigned applications and incorrect addresses and account numbers. Delays can occasionally occur if WMECO personnel are needed to respond to outage emergencies or other urgent business.

3. The application must be signed by and in the name of the person or company whose name is on the WMECO electric account. For commercial accounts, the application must be signed by the person who has authority to do so.

4. WMECO will communicate with our electric customer and the person designated as the alternate contact on the application. In cases where there is third party ownership of the generation, include the appropriate contact information on the application so we can also correspond with that person. When available, please supply email addresses for all parties.

5. Customers are encouraged to submit their interconnection applications well in advance of their estimated install date.

6. For Simplified Applications, one paper copy or one electronic copy is required.
7. For Expedited and Standard Applications, three paper copies of the application package are required. If electronic copies are available only one paper copy of data is required along with the electronic copy. The application package shall include:
   A. Completed and signed interconnection application.
   B. Inverter cut sheet and user manual and inverter settings.
   C. Relay protection scheme, including type of relays and proposed settings, fuse manufacturer, size and fuse curves.
   D. Facility one-line diagram with Massachusetts PE stamp. (Three hard copies required.) Three-line diagram will be necessary for some projects.
   E. Physical location map site plan including revenue meter, generation AC disconnect switch and generation equipment location.
   F. Signed check for the application fee.

8. If there is a change in the design or your project, such as an inverter change, size or number of generation units, from what was submitted on the application, a new application will need to be submitted. If during the Witness Test, it is noticed that the inverters have been changed from what was submitted on the application or the protection is not what was agreed to, you will not have permission to operate until a new application with the correct inverter is submitted and approved.

9. If the project is for new construction or you are doing any electric upgrades to your existing facility, you must indicate this on the application or a separate sheet of paper when submitting the application.

10. Where service-related work is involved, your electrician must submit the proper request for electric service. The DG application is only for interconnection of the generation, not service-related work. We will work with the New Service Department, but please keep in mind that service upgrade work can delay interconnection of the distributed generation facility.

11. WMECO will work with you to install the appropriate revenue meter for your service. The revenue meter must be cold sequenced for services greater than 400 amps. For new construction, service upgrades, and in locations with multiple accounts (such as multi-family houses or commercial facilities) please include a sketch showing the meter, service entrance and how the generation will be interconnected. Please show any metering PT’s and CT’s for services greater than 400 amps which must be cold sequenced.

12. For projects that require a disconnect switch, provide an exterior lockable AC disconnect switch with a door that can be opened to view the switch contacts. This disconnect shall be accessible to WMECO 24-hours a day, 7 days a week. This allows WMECO personnel to disconnect the DG from the grid, lock switch in the open position, and to have the visible means of determining status of the switch. The disconnect switch must be clearly and permanently labeled as a generation disconnect switch.

13. The generation must be equally connected to the legs of the service so as not to cause an unbalance. Three phase generation 30KW and greater must use 3 phase inverters or generators.

14. The facility’s generation and interconnection installation must meet all applicable national, state and local construction codes. The customer must obtain all necessary permits.

15. A copy of the Certificate of Completion, signed by the local wiring inspector, and an electrical permit are required when construction of the DG project is complete and before the unit is interconnected with the WMECO distribution system. These documents must be dated after the date the customer received approval to install the system from WMECO. WMECO does witness tests for all Expedited and Standard projects and some Simplified projects.
16. A copy of the certified test results of protection devices are required to be sent to WMECO prior to the Witness Test. This typically pertains to projects in the Standard Process and some in the Expedited Process.

17. In order to accommodate the scheduling of a Witness Test by year end, please submit the required documentation no later than December 14. This is necessary due to holiday schedules and the expected number of witness tests customers will want completed by the end of the calendar year.

18. For Simplified Process applications, the customer must receive a letter of approval from WMECO to install the system prior to installation. For Expedited and Standard Process applications, a signed Interconnection Service Agreement is required prior to installation. Should the customer install or start to install the generation system prior to receiving approval from the utility, they risk needing to make any changes identified during the application review.

19. Where third party ownership is involved, two documents must be signed. An Interconnection Service Agreement between the Company and Interconnection Customer and an Agreement between the Company and the Company’s Retail Customer.

20. Insurance is required for most DG facilities over 60 KW. The owner of the facility is required to add WMECO to the insurance certificate and the certificate must be sent to WMECO prior to any required distribution system upgrades (if applicable). If there are no distribution system upgrades, insurance is required before the generating unit is interconnected to the WMECO distribution system. The owner of the facility will be required annually to provide a certificate of continued insurance.

21. If distribution system upgrades are required to accommodate the interconnection of your generation, you will be notified of the cost for work to the electric power system (EPS). For Expedited/Standards projects, the cost will be included in the Interconnection Service Agreement. Please note that the customer is responsible for any costs for associated work by other parties, such as the Phone Company, cable TV, fire alarms and fiber. WMECO is not responsible for the timing of work done by other parties.

22. For Expedited and Standard Process projects, the DG facility shall provide WMECO at least two weeks notice before the initial energizing and start-up testing of the generating equipment. WMECO will review test procedure, certified test results and drawings, schedule and witness the testing of any equipment connected with the interconnection.

23. A Transfer of Ownership form must be signed by the new electric customer prior to the electric account being put in their name.

24. A customer will not be compensated for any excess generation from a generation facility that goes on line prior to receiving approval to operate from WMECO. Operating an interconnected generation facility prior to approval to operate can result in disconnection of your electric service.

25. Customers with installed generation are typically compensated according to WMECO’s Net Metering Tariff or Power Purchase Schedule.

26. If you want to apply for net metering compensation, submit a Schedule Z net metering application along with your interconnection application (found on www.wmeco.com/netmetering).
27. Customers compensated under the Net Metering Tariff are required to report their facility’s output in kWh twice per year, once in January and once in September. The output information can be found on the inverter or the customer’s production meter (NOT the WMECO revenue meter).

28. If you are a Qualified Facility (QF), please supply a copy of the certificate from FERC for compensation under the Power Purchase Schedule.

29. If you are interested in learning more about the distributed generation interconnection process, please contact the WMECO DG team at wmecodg@nu.com and we will arrange to meet with you.
APPENDIX N: NEBRA SUMMARY OF REGULATIONS OF SEWAGE SLUDGE LAND APPLICATION IN MASSACHUSETTS (310 CMR 32)

By North East Biosolids & Residuals Association (NEBRA) 2012, from tables created by New England Interstate Water Pollution Control Commission (NEIWPC). "Official state guidance/regulations should be consulted for full information. This chart is not intended as a substitute."

LAND APPLICATION OF CLASS A (TYPE I) WASTEWATER RESIDUALS

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### Monitoring Requirements

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<td>PCBs (ppm)</td>
<td>N/A</td>
<td>2/110</td>
</tr>
<tr>
<td>Dioxin (ppt)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Pathogens</td>
<td>Class A</td>
<td>PFRP</td>
</tr>
<tr>
<td>Other Tests</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1Type 1.
2Class A.
3Erosion Controls are required.
4Use of the product.
5The producing facility.
6When slope is greater than 3%, erosion controls are required.
7Table 3 of §503.13 - Pollutant Concentrations (Exceptional Quality).
810 mg/kg if sludge is applied to land utilized for grazing on or land upon which one or more forage crops are intended to be grown. Otherwise, 25 mg/kg.
9Cannot exceed agronomic rate.
102.0 mg/kg for a commercial fertilizer, 1.0 mg/kg for a soil conditioner.
11Class I.
12Class II.
13Pesticide: Endrin 0.1 mg/kg
   Aldrin/Dieldrin 0.006
   DDD 0.1 mg/kg
   DDE 0.1 mg/kg
   DDT 0.1 mg/kg
   2,4,5-T 0.1 mg/kg
   2,4,5-TP Silver 0.1 mg/kg

14For distribution site only.
15Applicant can choose either to issue a general public notice or notify land abutters directly.
16AAP= Vermont acceptable agricultural practices.
17Original treatment/storage facility only, not regulated after change of ownership or land applied.
18Vermont requires nitrogen testing for labeling biosolids for distribution and marketing.
197 days, after which the stockpiling must be covered with an odor control material
20Public roads other than federal interstate highways/federal interstate highways
21Sludge/low metal sludge

"Official state guidance/regulations should be consulted for full information. This chart is not intended as a substitute."

**LAND APPLICATION OF CLASS B (TYPE II) WASTEWATER RESIDUALS**

*Guidance / Regulation Spreadsheet*
<table>
<thead>
<tr>
<th><strong>General Information</strong></th>
<th><strong>EPA</strong></th>
<th><strong>MA</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Generator Permit Required</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Site Permit Required</td>
<td>No</td>
<td>No</td>
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<tr>
<td>Local Approval</td>
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<td>Yes</td>
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<tr>
<td>Public Notice</td>
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<td>No</td>
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<tr>
<td>Public Hearing</td>
<td>Possible</td>
<td>No</td>
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<tr>
<td>Abutter Notification</td>
<td>In Plan</td>
<td>No</td>
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<tr>
<td>Permit Term (yrs)</td>
<td>5 yrs</td>
<td>1 year</td>
</tr>
<tr>
<td>Permit Fees ($)</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Recordkeeping</td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>Recordkeeping-Post-closure</td>
<td>5 yrs to Infinity</td>
<td>3 yrs.</td>
</tr>
<tr>
<td>Additional Testing</td>
<td>Potential</td>
<td>5 yrs</td>
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<tr>
<td>Inspection and Entry</td>
<td>Yes</td>
<td>Yes</td>
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<table>
<thead>
<tr>
<th><strong>Access Controls</strong></th>
<th><strong>EPA</strong></th>
<th><strong>MA</strong></th>
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<tbody>
<tr>
<td>Animal Grazing (days)</td>
<td>Class B- 30 days</td>
<td>PSRP – 30 days</td>
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<tr>
<td>Public Access</td>
<td>30 days - 1 yr.</td>
<td>PSRP – 30 days</td>
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<tr>
<td>Endangered Species</td>
<td>Yes</td>
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<tr>
<td>Food Crop Limit. (months)</td>
<td>1 - 38 Months</td>
<td>24 Months</td>
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<tr>
<td>Feed Crop Limit. (months)</td>
<td>1 Month</td>
<td>1 Month</td>
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<table>
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<tr>
<th><strong>Seasonal Restrictions</strong></th>
<th><strong>EPA</strong></th>
<th><strong>MA</strong></th>
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</thead>
<tbody>
<tr>
<td>Frozen soil</td>
<td>3</td>
<td>Prohibited</td>
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<tr>
<td>Wet Soil</td>
<td>N/A</td>
<td>Prohibited</td>
</tr>
<tr>
<td>Flooded</td>
<td>3</td>
<td>Prohibited</td>
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<tr>
<td>High Water Table</td>
<td>N/A</td>
<td>Saturated</td>
</tr>
<tr>
<td>Rainfall</td>
<td>N/A</td>
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<table>
<thead>
<tr>
<th><strong>Stockpiling/Storage</strong></th>
<th><strong>EPA</strong></th>
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<tr>
<td>Time Limit</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
<td>Setbacks</td>
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<td>Yes</td>
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<tr>
<td>Quantity</td>
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<td>N/A</td>
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<tr>
<td>Site Restrictions</td>
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<table>
<thead>
<tr>
<th><strong>Other</strong></th>
<th><strong>EPA</strong></th>
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<tbody>
<tr>
<td>Odor Control</td>
<td>N/A</td>
<td>No</td>
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<tr>
<td>Vector control</td>
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<td>No</td>
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<tr>
<td>Pathogen Reduction</td>
<td>Yes</td>
<td>Yes</td>
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<td>pH</td>
<td>Possible</td>
<td>Soil - 6.5</td>
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<td>Run-off/Run-on Controls</td>
<td>Possible</td>
<td>Yes</td>
</tr>
<tr>
<td>Transport Requirements</td>
<td>No</td>
<td>Yes</td>
</tr>
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<td>------------------------</td>
<td>----</td>
<td>-----</td>
</tr>
<tr>
<td><strong>Site Characteristics</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Topography/Slope</td>
<td>N/A</td>
<td>up to 8%</td>
</tr>
<tr>
<td>Permeability (&quot;/hr)</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
<td>Area</td>
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<td>N/A</td>
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<tr>
<td>Soil Analysis</td>
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<td>Yes</td>
</tr>
<tr>
<td>Soil Type</td>
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<td>Yes</td>
</tr>
<tr>
<td>Depth to Water Table</td>
<td>N/A</td>
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<tr>
<td>Vegetative Cover</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
<td>Depth to Bedrock</td>
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<td><strong>Land Use Type</strong></td>
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<tr>
<td>Agricultural</td>
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<td>Yes</td>
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<tr>
<td>Forest</td>
<td>Yes</td>
<td>Yes</td>
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<td>Public Contact</td>
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<td>Restricted</td>
</tr>
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<td>Reclamation</td>
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<td>Lawn</td>
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<td>Other</td>
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<td>Garden</td>
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<tr>
<td><strong>Monitoring Requirements</strong></td>
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<td></td>
</tr>
<tr>
<td>Soil Monitoring (#/acre/yr)</td>
<td>N/A</td>
<td>Yearly</td>
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<tr>
<td>GW Monitoring (#/yr)</td>
<td>N/A</td>
<td>Possible</td>
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<tr>
<td>Sludge Monitoring (#/yr)</td>
<td>1 - 12</td>
<td>1 – 12</td>
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<tr>
<td>Sample Type</td>
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<td>Composite</td>
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<tr>
<td>% Solids</td>
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<tr>
<td>Mineralization</td>
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<td><strong>Buffers/Setbacks</strong></td>
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<tr>
<td>Surface Water</td>
<td>30</td>
<td>Discretionary</td>
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<td>Public Water Supply wells</td>
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<td>Private Water supply wells</td>
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<td>300 ft</td>
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<td>On-site/Off-site</td>
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<td>Property Lines</td>
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<td>Public Roads</td>
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<tr>
<td>Drainage Swale</td>
<td>30</td>
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<td>Floodplain</td>
<td>N/A</td>
<td>N/A</td>
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<td>Wetlands</td>
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<td>100 ft</td>
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<td>Public Areas</td>
<td>N/A</td>
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<td>Sinkholes</td>
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<td>N/A</td>
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<tr>
<td>Max. Concentration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------------------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>Arsenic (mg/kg)</td>
<td>75^9</td>
<td>N/A</td>
</tr>
<tr>
<td>Boron(mg/kg)</td>
<td>N/A</td>
<td>300</td>
</tr>
<tr>
<td>Cadmium(mg/kg)</td>
<td>85^9</td>
<td>25</td>
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<tr>
<td>Chromium(mg/kg)</td>
<td>N/A</td>
<td>1000</td>
</tr>
<tr>
<td>Copper(mg/kg)</td>
<td>4300^9</td>
<td>1000</td>
</tr>
<tr>
<td>Lead(mg/kg)</td>
<td>840^9</td>
<td>1000</td>
</tr>
<tr>
<td>Mercury(mg/kg)</td>
<td>57^9</td>
<td>10</td>
</tr>
<tr>
<td>Molybdenum(mg/kg)</td>
<td>75^9</td>
<td>10/25^13</td>
</tr>
<tr>
<td>Nickel(mg/kg)</td>
<td>420^9</td>
<td>200</td>
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<tr>
<td>Nitrogen(mg/kg)</td>
<td>N/A</td>
<td>N/A^10</td>
</tr>
<tr>
<td>Selenium(mg/kg)</td>
<td>100^9</td>
<td>N/A</td>
</tr>
<tr>
<td>Zinc(mg/kg)</td>
<td>7500^9</td>
<td>2500</td>
</tr>
<tr>
<td>PCBs(mg/kg)</td>
<td>N/A^12</td>
<td>10</td>
</tr>
<tr>
<td>Dioxin (ppt)</td>
<td></td>
<td>N/A</td>
</tr>
<tr>
<td>Other Tests</td>
<td></td>
<td>TCLP</td>
</tr>
</tbody>
</table>

^1 Marketing and distributing of biosolids products (one time application).

^2 Type 2 numbers used. Type 3 - Concentrations exceed any limit for Type 2, cannot be used for food chain crops and site must be recorded in the Registry of Deeds.

^3 The sludge cannot be applied to frozen, snow-covered or flooded land such that it enters a surface water.

^4 ME only licenses compost facilities, not sites where compost is used. Class B utilization requires a site license.

^5 Or Other Involved party (hauler, farmer) can hold permit.

^6 When slope is greater than 3%, erosion controls are required.

^7 Slope <15%. If sludge <20% total solids, slope must be 8% unless subsurface injection is used.

^8 Table 1 of §503.13 - Ceiling Concentrations.

^9 Agronomic rate application requirements cover nitrogen.

^10 Bathing or drinking 100 ft.

^11 Sludges with PCB’s above 50 mg/kg are not regulated under §503.

^12 10.0 mg/kg if applied to land utilized for grazing or on land upon which one or more forage crops are intended to be grown. Otherwise, 25.0 mg/kg.


^14 WHPA = Wellhead Protection Area.

^15 Must test for nitrogen but there is no standard.

^16 Pesticides: Endrin 0.1 mg/kg

Toxaphene 0.1 mg/kg

2,4,5-T 0.1 mg/kg

2,4,5-TP Silver 0.1 mg/kg

^17 Applicant can choose either to issue a general public notice or notify land abutters directly.

"Official state guidance/regulations should be consulted for full information. This chart is not intended as a substitute."
APPENDIX O: MEPA REGULATION 301 CMR 11.03 - THRESHOLDS SECTION

11.03 Review Thresholds

The review thresholds identify categories of Projects or aspects thereof of a nature, size or location that are likely, directly or indirectly, to cause Damage to the Environment. Except when the Secretary requires fail-safe review, the review thresholds determine whether MEPA review is required. MEPA review is required when one or more review thresholds are met or exceeded and the subject matter of at least one review threshold is within MEPA jurisdiction. A review threshold that is met or exceeded specifies whether MEPA review shall consist of an ENF and a mandatory EIR or of an ENF and other MEPA review if the Secretary so requires. The subject matter of a review threshold is within MEPA jurisdiction when there is full-scope jurisdiction (i.e., the Project is undertaken by an Agency or involves Financial Assistance) or when the subject matter of the review threshold is conceptually or physically related to the subject matter of one or more required Permits (provided that the review thresholds for Land and Areas of Critical Environmental Concern shall be considered to be related to the subject matter of any required Permit) or the area subject to a Land Transfer. The review thresholds do not apply to: a lawfully existing structure, facility or activity; Routine Maintenance; a Replacement Project; or a Project that is consistent with a Special Review Procedure review document, or other plan or document that has been prepared with the express purpose of assessing the potential environmental impacts from future Projects, has been reviewed as such in accordance with MEPA and 301 CMR 11.00, and has been allowed or approved by any Participating Agency, unless the filing of an ENF and an EIR was required by a decision of the Secretary on any such review document, plan or document. The review thresholds are the following:

(1) Land.
   
   (a) ENF and Mandatory EIR.
   
   1. Direct alteration of 50 or more acres of land, unless the Project is consistent with an approved conservation farm plan or forest cutting plan or other similar generally accepted agricultural or forestry practices.
   2. Creation of ten or more acres of impervious area.

   (b) ENF and Other MEPA Review if the Secretary So Requires.
   
   1. Direct alteration of 25 or more acres of land, unless the Project is consistent with an approved conservation farm plan or forest cutting plan or other similar generally accepted agricultural or forestry practices.
   2. Creation of five or more acres of impervious area.
   3. Conversion of land held for natural resources purposes in accordance with Article 97 of the Amendments to the Constitution of the Commonwealth to any purpose not in accordance with Article 97.
   4. Conversion of land in active agricultural use to nonagricultural use, provided the land includes soils classified as prime, state-important or unique by the United States Department of Agriculture, unless the Project is accessory to active agricultural use or consists solely of one single family dwelling.
   5. Release of an interest in land held for conservation, preservation or agricultural or watershed preservation purposes.
   6. Approval in accordance with M.G.L. c. 121A of a New urban redevelopment project or a fundamental change in an approved urban redevelopment project, provided that the Project consists of 100 or more dwelling units or 50,000 or more sf of non-residential space.
   7. Approval in accordance with M.G.L. c. 121B of a New urban renewal plan or a major modification of an existing urban renewal plan.

---

48 Energy and Environmental Affairs, MEPA Statute & Regulations, 11.03 Review Thresholds
(2) State-listed Species under M.G.L. c. 131A.
   (a) ENF and Mandatory EIR. None.
   (b) ENF and Other MEPA Review if the Secretary So Requires.
       1. Alteration of designated significant habitat.
       2. Greater than two acres of disturbance of designated priority habitat, as defined in 321 CMR 10.02, that results in impacting a state-listed endangered or threatened species or species of special concern.

(3) Wetlands, Waterways and Tidelands.
   (a) ENF and Mandatory EIR.
       1. Provided that a Permit is required:
              a. alteration of one or more acres of salt marsh or bordering vegetating wetlands; or
              b. alteration of ten or more acres of any other wetlands.
       2. Alteration requiring a variance in accordance with the Wetlands Protection Act.
       3. Construction of a New dam.
       4. Structural alteration of an existing dam that causes an Expansion of 20% or any decrease in impoundment Capacity.
       5. Provided that a Chapter 91 License is required, New non-water dependent use or Expansion of an existing non-water dependent structure, provided the use or structure occupies one or more acres of waterways or tidelands.
   (b) ENF and Other MEPA Review if the Secretary So Requires.
       1. Provided that a Permit is required:
              a. alteration of coastal dune, barrier beach or coastal bank;
              b. alteration of 500 or more linear feet of bank along a fish run or inland bank;
              c. alteration of 1,000 or more sf of salt marsh or outstanding resource waters;
              d. alteration of 5,000 or more sf of bordering or isolated vegetated wetlands;
              e. New fill or structure or Expansion of existing fill or structure, except a pile-supported structure, in a velocity zone or regulatory floodway; or
              f. alteration of one half or more acres of any other wetlands.
       2. Construction of a New roadway or bridge providing access to a barrier beach or a New utility line providing service to a structure on a barrier beach.
       3. Dredging of 10,000 or more cy of material.
       4. Disposal of 10,000 or more cy of dredged material, unless at a designated in-water disposal site.
       5. Provided that a Chapter 91 License is required, New or existing unlicensed non-water dependent use of waterways or tidelands, unless the Project is an overhead utility line, a structure of 1,000 or less sf base area accessory to a single family dwelling, a temporary use in a designated port area, or an existing unlicensed structure in use prior to January 1, 1984.
       6. Construction, reconstruction or Expansion of an existing solid fill structure of 1,000 or more sf base area or of a pile-supported or bottom-anchored structure of 2,000 or more sf base area, except a seasonal, pile-held or bottom-anchored float, provided the structure occupies flowed tidelands or other waterways.

(4) Water.
   (a) ENF and Mandatory EIR.
       1. New withdrawal or Expansion in withdrawal of:
              a. 2,500,000 or more gpd from a surface water source; or
b. 1,500,000 or more gpd from a groundwater source.

2. New interbasin transfer of water of 1,000,000 or more gpd or any amount determined significant by the Water Resources Commission.

3. Construction of one or more New water mains ten or more miles in length.

4. Provided that the Project is undertaken by an Agency, New water service to a municipality or water district across a municipal boundary through New or existing pipelines, unless a disruption of service emergency is declared in accordance with applicable statutes and regulations.

(b) ENF and Other MEPA Review if the Secretary So Requires.

1. New withdrawal or Expansion in withdrawal of 100,000 or more gpd from a water source that requires New construction for the withdrawal.

2. New withdrawal or Expansion in withdrawal of 500,000 or more gpd from a water supply system above the lesser of current system-wide authorized withdrawal volume or three-years' average system-wide actual withdrawal volume.

3. Construction of one or more New water mains five or more miles in length.

4. Construction of a New drinking water treatment plant with a Capacity of 1,000,000 or more gpd.

5. Expansion of an existing drinking water treatment plant by the greater of 1,000,000 gpd or 10% of existing Capacity.

6. Alteration requiring a variance in accordance with the Watershed Protection Act, unless the Project consists solely of one single family dwelling.

7. Non-bridged stream crossing 1,000 or less feet upstream of a public surface drinking water supply for purpose of forest harvesting activities.

(5) Wastewater.

(a) ENF and Mandatory EIR.

1. Construction of a New wastewater treatment and/or disposal facility with a Capacity of 2,500,000 or more gpd.

2. New interbasin transfer of wastewater of 1,000,000 or more gpd or any amount determined significant by the Water Resource Commission.

3. Construction of one or more New sewer mains ten or more miles in length.

4. Provided that the Project is undertaken by an Agency, New sewer service to a municipality or sewer district across a municipal boundary through New or existing pipelines, unless an emergency is declared in accordance with applicable statutes and regulations.

5. New discharge or Expansion in discharge of any amount of sewage, industrial waste water or untreated stormwater directly to an outstanding resource water.

6. New Capacity or Expansion in Capacity for storage, treatment, processing, combustion or disposal of 150 or more wet tpd of sewage sludge, sludge ash, grit, screenings, or other sewage sludge residual materials, unless the Project is an Expansion of an existing facility within an area that has already been sited for the proposed use in accordance with M.G.L. c. 21 or M.G.L. c. 83, section 6.

(b) ENF and Other MEPA Review if the Secretary So Requires.

1. Construction of a New wastewater treatment and/or disposal facility with a Capacity of 100,000 or more gpd.

2. Expansion of an existing wastewater treatment and/or disposal facility by the greater of 100,000 gpd or 10% of existing Capacity.

3 Construction of one or more New sewer mains:
a. that will result in an Expansion in the flow to a wastewater treatment and/or disposal facility by 10% of existing Capacity;
b. five or more miles in length; or
c. 1/2 or more miles in length, provided the sewer mains are not located in the right of way of existing roadways.

4. New discharge or Expansion in discharge:
a. to a sewer system of 100,000 or more gpd of sewage, industrial waste water or untreated stormwater;
b. to a surface water of:
   i. 100,000 or more gpd of sewage;
   ii. 20,000 or more gpd of industrial waste water; or
   iii. any amount of sewage, industrial waste water or untreated stormwater requiring a variance from applicable water quality regulations; or
c. to groundwater of:
   i. 10,000 or more gpd of sewage within an area, zone or district established, delineated or identified as necessary or appropriate to protect a public drinking water supply, an area established to protect a nitrogen sensitive embayment, an area within 200 feet of a tributary to a public surface drinking water supply, or an area within 400 feet of a public surface drinking water supply;
   ii. 50,000 or more gpd of sewage within any other area;
   iii. 20,000 or more gpd of industrial waste water; or
   iv. any amount of sewage, industrial waste water or untreated stormwater requiring approval by the Department of Environmental Protection of a variance from Title 5 of the State Environmental Code for New construction.

5. New Capacity or Expansion in Capacity for:
a. combustion or disposal of any amount of sewage sludge, sludge ash, grit, screenings, or other sewage sludge residual materials; or
b. storage, treatment, or processing of 50 or more wet tpd of sewage sludge or sewage sludge residual materials.

(6) Transportation.

(a) ENF and Mandatory EIR.

1. Unless the Project consists solely of an internal or on-site roadway or is located entirely on the site of a non-roadway Project:
   a. construction of a New roadway two or more miles in length; or
   b. widening of an existing roadway by one or more travel lanes for two or more miles.
2. New interchange on a completed limited access highway.
3. Construction of a New airport.
4. Construction of a New runway or terminal at an existing airport.
5. Construction of a New rail or rapid transit line along a New, unused or abandoned right-of-way for transportation of passengers or freight (not including sidings, spurs or other lines not leading to an ultimate destination).
6. Generation of 3,000 or more New adt on roadways providing access to a single location.
7. Construction of 1,000 or more New parking spaces at a single location.

(b) ENF and Other MEPA Review if the Secretary So Requires.

1. Unless the Project consists solely of an internal or on-site roadway or is located entirely on the site of a non-roadway Project:
Organics to Energy: Anaerobic Digestion

2. Construction, widening or maintenance of a roadway or its right-of-way that will:
   a. alter the bank or terrain located ten more feet from the existing roadway for one-half or more miles, unless necessary to install a structure or equipment;
   b. cut five or more living public shade trees of 14 or more inches in diameter at breast height; or
   c. eliminate 300 or more feet of stone wall.

3. Expansion of an existing runway at an airport.

4. Construction of a New taxiway at an airport.

5. Expansion of an existing taxiway at Logan Airport.

6. Expansion of an existing terminal at Logan Airport by 100,000 or more sf.

7. Expansion of an existing terminal at any other airport by 25,000 or more sf.

8. Construction of New or Expansion of existing air cargo buildings at an airport by 100,000 or more sf.

9. Conversion of a military airport to a non-military airport.

10. Construction of a New rail or rapid transit line for transportation of passengers or freight.

11. Discontinuation of passenger or freight service along a rail or rapid transit line.

12. Abandonment of a substantially intact rail or rapid transit right-of-way.

13. Generation of 2,000 or more New adt on roadways providing access to a single location.

14. Generation of 1,000 or more New adt on roadways providing access to a single location and construction of 150 or more New parking spaces at a single location.

15. Construction of 300 or more New parking spaces at a single location.

7) Energy.

   (a) ENF and Mandatory EIR.
   1. Construction of a New electric generating facility with a Capacity of 100 or more MW.
   2. Expansion of an existing electric generating facility by 100 or more MW.
   3. Construction of a New fuel pipeline ten or more miles in length.
   4. Construction of electric transmission lines with a Capacity of 230 or more kv, provided the transmission lines are five or more miles in length along New, unused or abandoned right of way.

   (b) ENF and Other MEPA Review if the Secretary So Requires.
   1. Construction of a New electric generating facility with a Capacity of 25 or more MW.
   2. Expansion of an existing electric generating facility by 25 or more MW.
   3. Construction of a New fuel pipeline five or more miles in length.
   4. Construction of electric transmission lines with a Capacity of 69 or more kv, provided the transmission lines are one or more miles in length along New, unused or abandoned right of way.

8) Air.

   (a) ENF and Mandatory EIR. Construction of a New major stationary source with federal potential emissions, after construction and the imposition of required controls, of: 250 tpy of any criteria air pollutant; 40 tpy of any HAP; or 100 tpy of any combination of HAPs.

   (b) ENF and Other MEPA Review if the Secretary So Requires.
   1. Construction of a New major stationary source with federal potential emissions, after construction and the imposition of required controls, of: 100 tpy of PM as PM10, CO, lead or SO2; 50 tpy of VOC or NOx; 10 tpy of any HAP; or 25 tpy of any combination of HAPs.
2. Modification of an existing major stationary source resulting in a "significant net increase" in actual emissions, provided that the stationary source or facility is major for the pollutant, emission of which is increased by: 15 tpy of PM as PM10; 100 tpy of CO; 40 tpy of SO2; 25 tpy of VOC or NOx; 0.6 tpy of lead.

(9) Solid and Hazardous Waste.
   (a) ENF and Mandatory EIR. New Capacity or Expansion in Capacity of 150 or more tpd for storage, treatment, processing, combustion or disposal of solid waste, unless the Project is a Transfer Station, is an Expansion of an existing facility within a validly site assigned area for the proposed use, or is exempt from site assignment requirements.
   (b) ENF and Other MEPA Review if the Secretary So Requires.
       1. New Capacity or Expansion in Capacity for combustion or disposal of any quantity of solid waste, or storage, treatment or processing of 50 or more tpd of solid waste, unless the Project is exempt from site assignment requirements.
       2. Provided that a Permit is required in accordance with M.G.L. c. 21D, New Capacity or Expansion in Capacity for the storage, recycling, treatment or disposal of hazardous waste.

(10) Historical and Archaeological Resources.
   (a) ENF and Mandatory EIR. None.
   (b) ENF and Other MEPA Review if the Secretary So Requires. Unless the Project is subject to a Determination of No Adverse Effect by the Massachusetts Historical Commission or is consistent with a Memorandum of Agreement with the Massachusetts Historical Commission that has been the subject of public notice and comment:
       1. demolition of all or any exterior part of any Historic Structure listed in or located in any Historic District listed in the State Register of Historic Places or the Inventory of Historic and Archaeological Assets of the Commonwealth; or
       2. destruction of all or any part of any Archaeological Site listed in the State Register of Historic Places or the Inventory of Historic and Archaeological Assets of the Commonwealth.

(11) Areas of Critical Environmental Concern.
   (a) ENF and Mandatory EIR. None.
   (b) ENF and Other MEPA Review if the Secretary So Requires. Any Project within a designated ACEC, unless the Project consists solely of one single family dwelling.

(12) Regulations.
   (a) ENF and Mandatory EIR. None.
   (b) ENF and Other MEPA Review if the Secretary So Requires. Promulgation of New or revised regulations, of which a primary purpose is protecting against Damage to the Environment, that significantly reduce:
       1. standards for environmental protection;
       2. opportunities for public participation in permitting or other review processes; or
       3. public access to information generated or provided in accordance with the regulations.