Final

Solids Management Facility Plan

Green Bay Metropolitan Sewerage District

December 2011

CH2MHILL

Solids Management Facility Plan

Submitted to

Green Bay Metropolitan Sewerage District

December 2011

CH2MHILL

Executive Summary

Background

The Green Bay Metropolitan Sewerage District (GBMSD) is a public utility, established in 1931, that reclaims 38 million gallons of wastewater daily at two treatment facilities in Green Bay and De Pere, Wisconsin. Its service area covers 285 square miles, and it serves more than 217,000 people. GBMSD's mission is to promote public health and welfare through the collection, treatment, and reclamation of wastewater, while assessing stable, competitive rates. In conjunction with others, the organization encourages pollution prevention and supports programs to help ensure that water contaminated by human activity is returned clean to the environment. GBMSD conducts its business using a sustainable approach within the social, environmental, and economical values of its customers and stakeholders.

GBMSD initiated the development of a Solids Management Facility Plan in 2008 to address aging solids handling facilities, new air pollution regulations, and the solids loadings of the recently acquired De Pere Facility (DPF). The plan was submitted to the Wisconsin Department of Resources in November 2010. Several conditions that changed subsequent to submittal of the plan are now addressed in this refined plan. These changes include:

- A reduction in the system size to reflect the decrease in solids loads from major industrial customers and other factors
- Incorporation of the most recent incineration air pollution regulations
- Reconsideration of rehabilitation of the existing solids facility
- Evaluation of codigestion of high strength industrial wastes
- Re-evaluation of digestion struvite control methods
- Addition of a new alternative: Digestion with Thermal Processing and Electrical Generation.

The existing solids processing system consists of belt press dewatering followed by multiple hearth incineration. The system is located at the Green Bay Facility (GBF). Solids from the DPF are transferred by pipeline to the GBF for processing. The solids system was constructed in the 1970s and is reaching the end of its useful life. Multiple hearth incineration is now considered an outdated technology. Current incineration technology uses fluidized beds, which consume less fuel and have lower air emissions.

The solids management planning effort was undertaken to develop a long-term facility plan for handling, processing, and disposing of solids. The plan includes a comprehensive evaluation of numerous solids management technologies and approaches. This executive summary describes the process used to develop the plan, the alternatives considered, the alternatives evaluation process, and the selected solids management alternative.

Alignment of Project Goals to Strategic Planning

Figure 1 is an overview of the planning process. Development of the Solids Management Facility Plan began by confirming the project goals. Given the rapidly changing nature of the conditions under which GBMSD delivers services, GBMSD developed a Strategic Plan to help manage various challenges. The plan established a comprehensive planning process to guide GBMSD work and direct future initiatives. Figure 2 presents the goals of the Strategic Plan.

FIGURE 1
Solids Management Plan Project Process

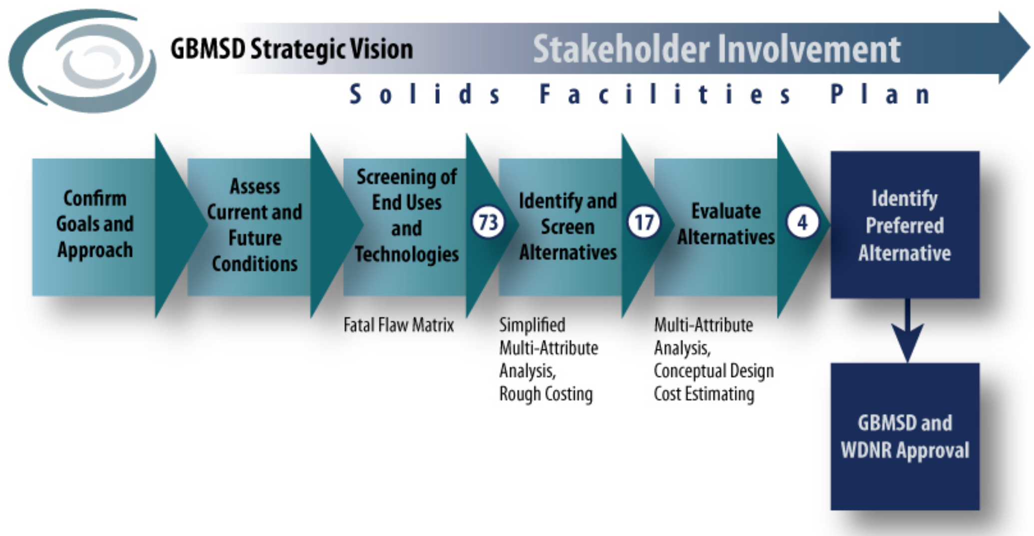
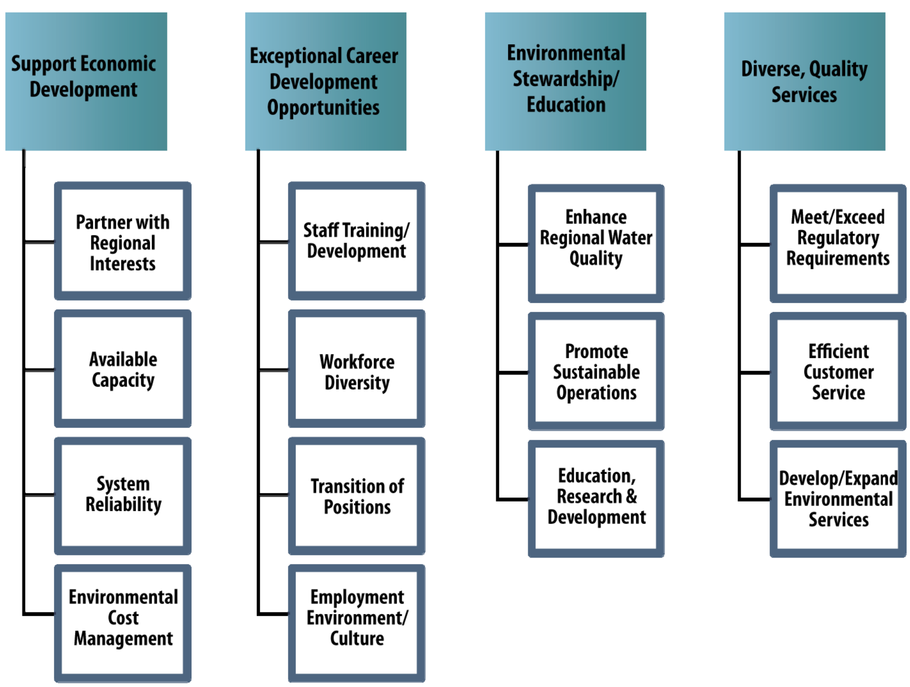


FIGURE 2
GBMSD s Strategic Plan Goals



Both the Strategic Plan and the Solid Management Facility Plan emphasize the importance of regional collaboration, leadership, education, and sustainability.

Using the Strategic Plan as guide, the project team developed a mission statement for the Solids Management Facility Plan, with the goal to "Establish a regional Solids Management Plan using a sustainable approach for energy, air, and solids within the social, environmental, and economical values of our customers and stakeholders." Based in part on this mission statement, the following objectives were established:

- **Regulatory Compliance—**Ensure that **s**olids production, storage, processing, use, disposal, reporting, and management meet or exceed existing and potential future federal, state, and local regulatory requirements.
- **Operations—**Perform solids management safely at desired service levels, and enable incremental expansion and flexibility of process configurations under variable flow and load conditions.
- **Financial—**Minimize life-cycle costs and impacts on rate payers.
- **Social/Community Impacts—**Promote stakeholder acceptance and support of partnering and education and limit adverse aesthetic impacts.
- **Environmental—**Minimize impacts on the environment by maximizing beneficial reuse/recycling and by minimizing energy consumption and greenhouse gas emissions.

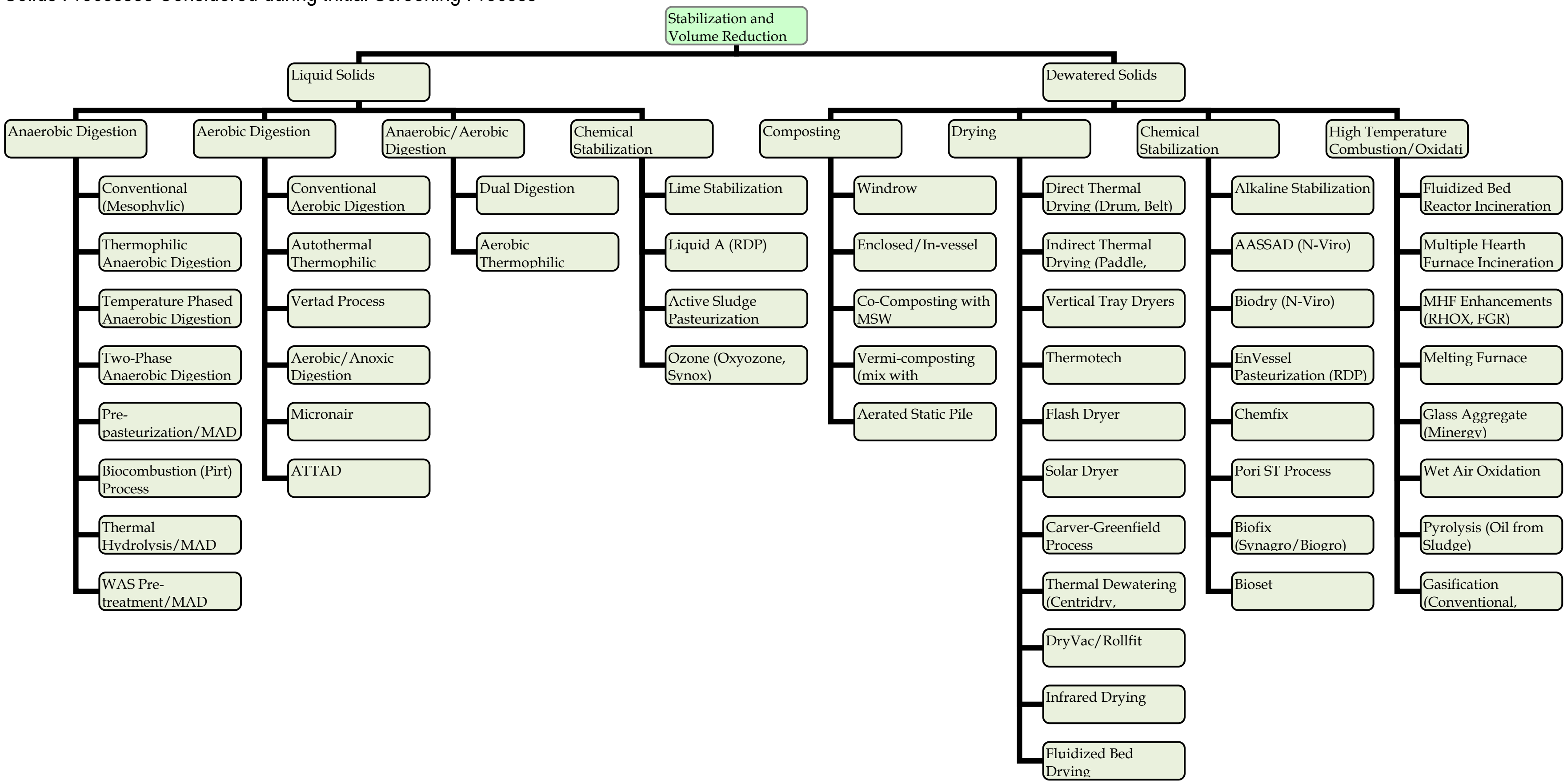
Initial Technology Screening

An assessment of current and future solids loadings and conditions confirmed the need for upgrading and expanding the solids processing system. The existing system does not have the capacity to process peak loadings, and most of the major equipment pieces have reached the end of their useful lives.

The planning team identified 73 solids processing technologies that could be used. Only technologies that had been proven at full scale were considered. To mitigate risk associated with processes that may not be fully established, the planning team eliminated technologies that did not have at least 5 years of operation at a scale at least as great as GBMSD's. The remaining 53 technologies (Figure 3) were used to develop 17 process trains as alternative solutions.

- Alternative 1—Incineration
- Alternative 2—Incineration with Energy Recovery
- Alternative 3—Digestion with Further Thermal Processing
- Alternative 4—European Incineration with Pre-drying
- Alternative 5—Thermal Hydrolysis with Digestion
- Alternative 6—Conventional Digestion with Drying
- Alternative 7—Prepastuerization with Digestion
- Alternative 8—Digestion Class B Land Application
- Alternative 9—Codigestion with Other Organic Wastes
- Alternative 10—Alkaline Stabilization
- Alternative 11—Conventional Composting

FIGURE 3
Solids Processes Considered during Initial Screening Process



- Alternative 12—Co-composting
- Alternative 13—Drying for Fuel
- Alternative 14—Incineration and Drying
- Alternative 15—Landfill/Methane Recovery
- Alternative 16—Rehabilitate MHF Incineration
- Alternative 17—Autothermal Aerobic Digestion

Initial Alternative Screening

Process flow diagrams, process narratives, and conceptual cost estimates were developed for the 17 alternatives. The alternatives were evaluated using a simplified multi-attribute utility analysis that used objectives and criteria developed to align closely with the Strategic Plan. Using this information and the results of the simplified multi-attribute analysis, 4 alternatives were selected for further evaluation:

- Alternative 2—Incineration with Energy Recovery
- Alternative 3—Digestion with Further Thermal Processing
- Alternative 11—Conventional Composting
- Alternative 14—Incineration and Drying

Following selection and evaluation of these four alternatives, a modified version of Alternative 3, referred to as Alternative 3B, was added to the short list of alternatives. Alternative 3B is Digestion with Thermal Processing and Electrical Generation. The original Alternative 3 is now referred to as Alternative 3A. Also, GBMSD stakeholders requested that Alternative 16, Rehabilitate MHF Incineration, be reconsidered to attempt to identify a lower cost option. Table 1 shows the 6 alternatives that were evaluated in more detail as described below.

TABLE 1
Alternatives Selected for Detailed Evaluation

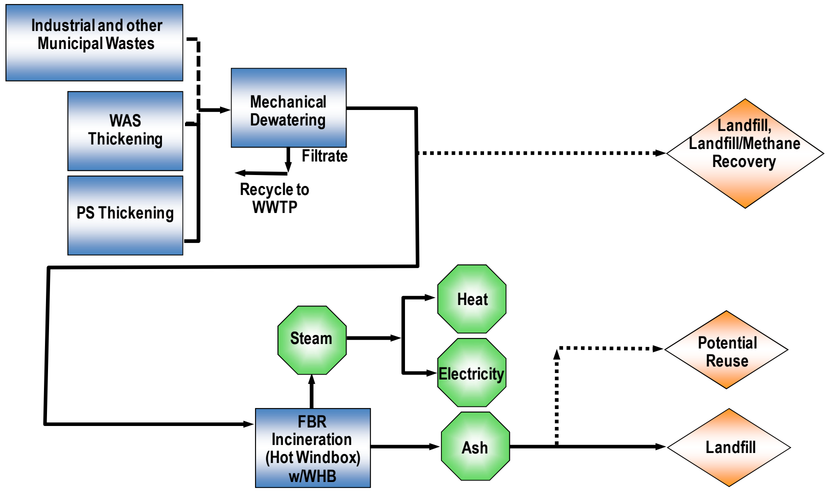
Alternative	Alternative
2	Incineration with Energy Recovery
3A	Digestion with Thermal Processing
3B	Digestion with Thermal Processing and Electrical Generation
11	Conventional Composting
14	Incineration with Drying
16	Rehabilitate MHF Incineration

Evaluation of Six Remaining Alternatives

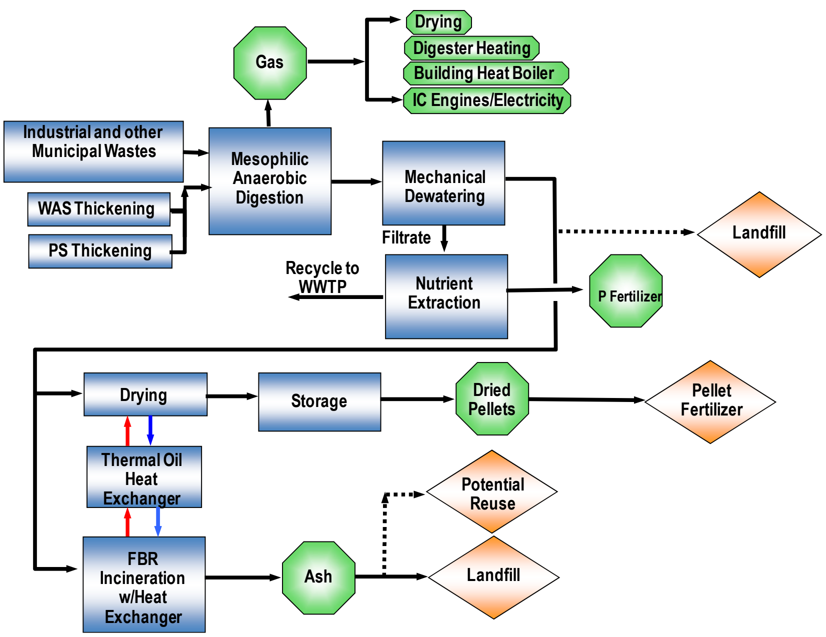
The six remaining alternatives (Figure 4) were evaluated to identify a single, preferred alternative. The evaluation included preparation of detailed process flow diagrams, cost estimates and conceptual facility and site drawings for each remaining alternative.

Energy balances were prepared for each alternative to estimate the energy use and size equipment for each alternative. A comparison of energy costs for the six alternatives is shown in Figure 5. The energy costs for some alternatives is negative because the alternative facility generates more energy than can be used in the solids facility that can be utilized for other plant energy needs.

FIGURE 4
Process Flow Alternatives

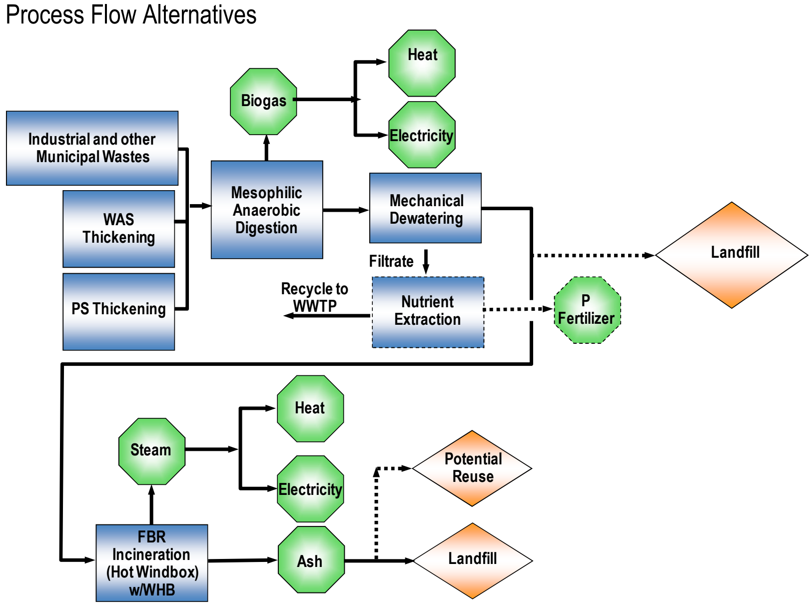


Alternative 2—Incineration with Energy Recovery

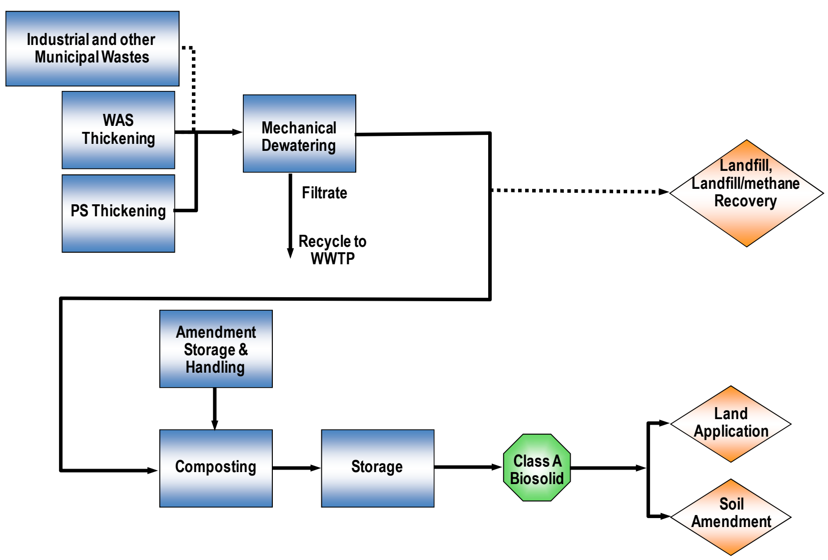


Alternative 3A—Digestion with Thermal Processing

FIGURE 4 (cont.)
Process Flow Alternatives

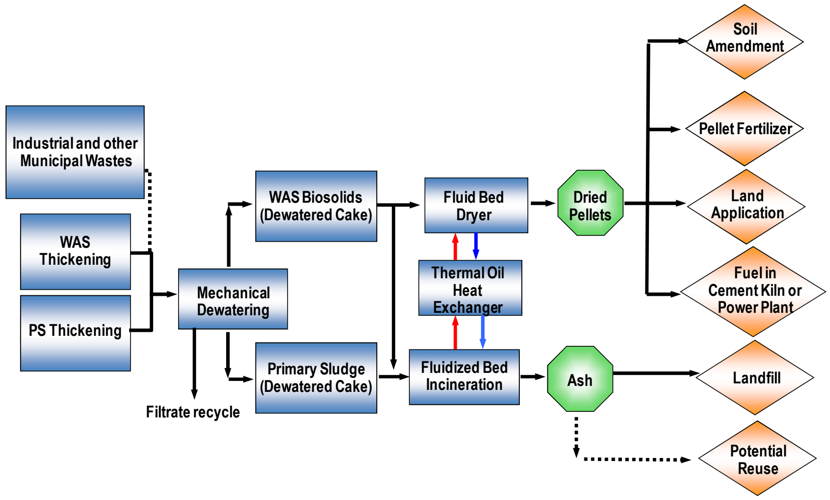


Alternative 3B—Digestion with Thermal Processing and Electrical Generation

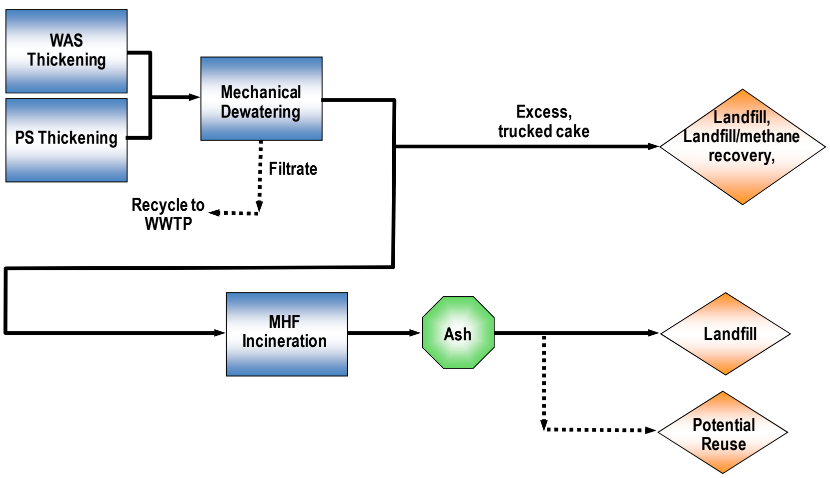


Alternative 11—Conventional Composting

FIGURE 4 (cont.)
Process Flow Alternatives

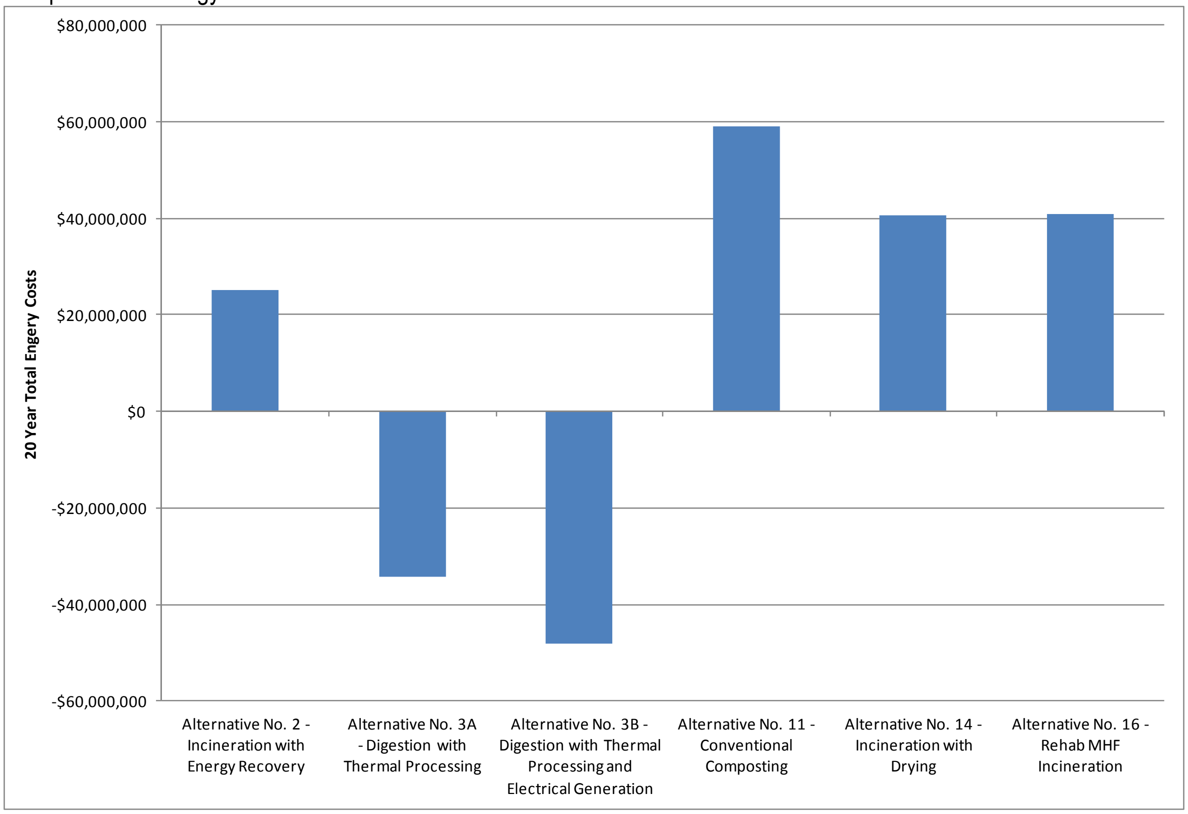


Alternative 14—Incineration and Drying



Alternative 16—Rehabilitate MHF Incineration

FIGURE 5
Comparison of Energy Costs

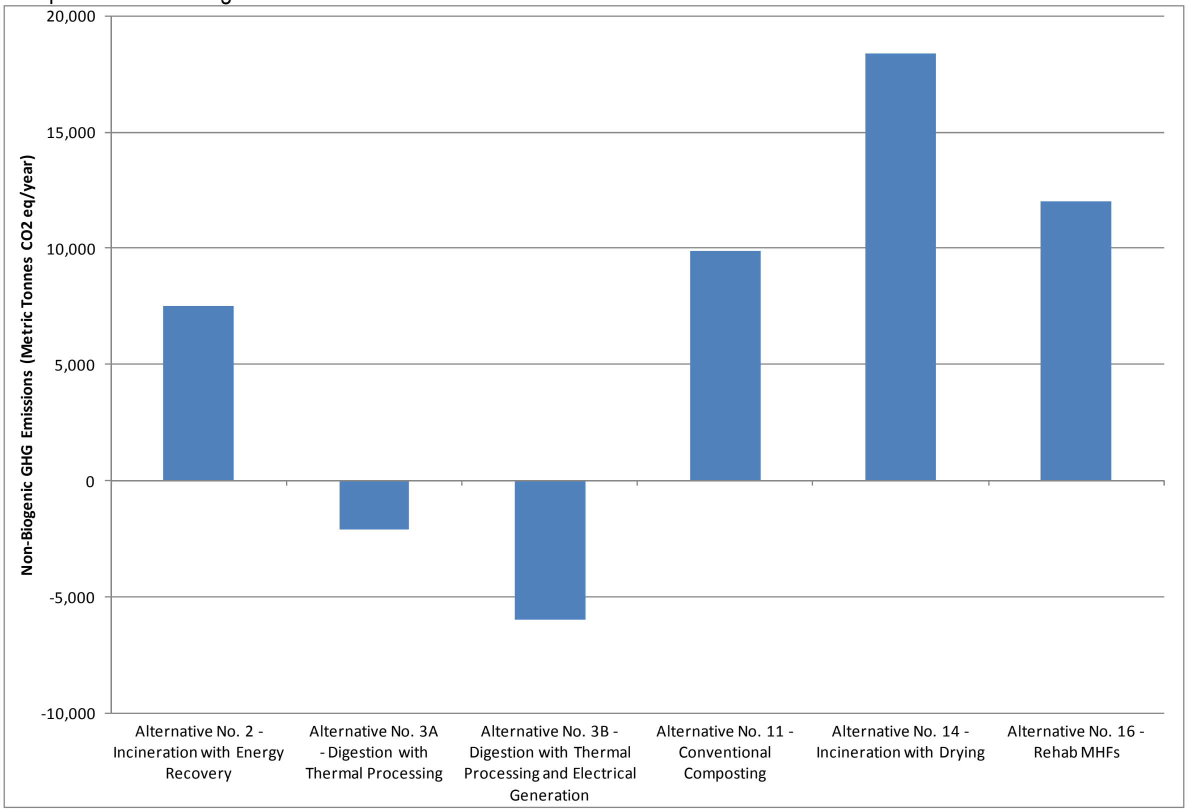


Note: The energy costs for some alternatives is negative because the alternative facility generates more energy than can be used in the solids facility. The excess energy can be used for other plant energy needs.

Greenhouse gas emissions from the six alternatives were estimated in terms of equivalent metric tons of carbon per year. The greenhouse gas emissions associated with the solids processes include direct emissions from the solids processes, such as the incinerators, boilers, and dryers, and indirect greenhouse emissions from the coal power plant that supplies electricity to GBMSD. Other indirect greenhouse gas emissions in the estimate include emissions from ancillary activities, such as trucking ash, chemicals, and pellets, and the energy used in the production of polymers.

Greenhouse gas emissions are classified as biogenic and nonbiogenic. Emissions from the combustion of digester gas and biosolids used for electricity, building heat, digester heating and drying pellets are classified as biogenic emissions. The reason they are biogenic is that the carbon-based diets of humans contribute to the production of the digester gas methane and biosolids cake that are the end products of wastewater treatment. The digester gas and biosolids cake combustion carbon emissions are taken up by food plants and other vegetation. Unlike, nonbiogenic, or man-made emissions from fossil fuel, this recycling of carbon results in no net increase in carbon emissions. Figure 6 compares the nonbiogenic greenhouse gas emissions from each alternative. The emission estimate reflects the fact that emissions may be avoided. For example, under Alternative 3A, emissions are avoided because it would supply a fertilizer produced using a biogenic fuel (waste heat from incineration), which would reduce the use of commercial fertilizers made using fossil fuels, and the emissions associated with their production.

FIGURE 6
Comparison of Nonbiogenic Greenhouse Gas Emissions

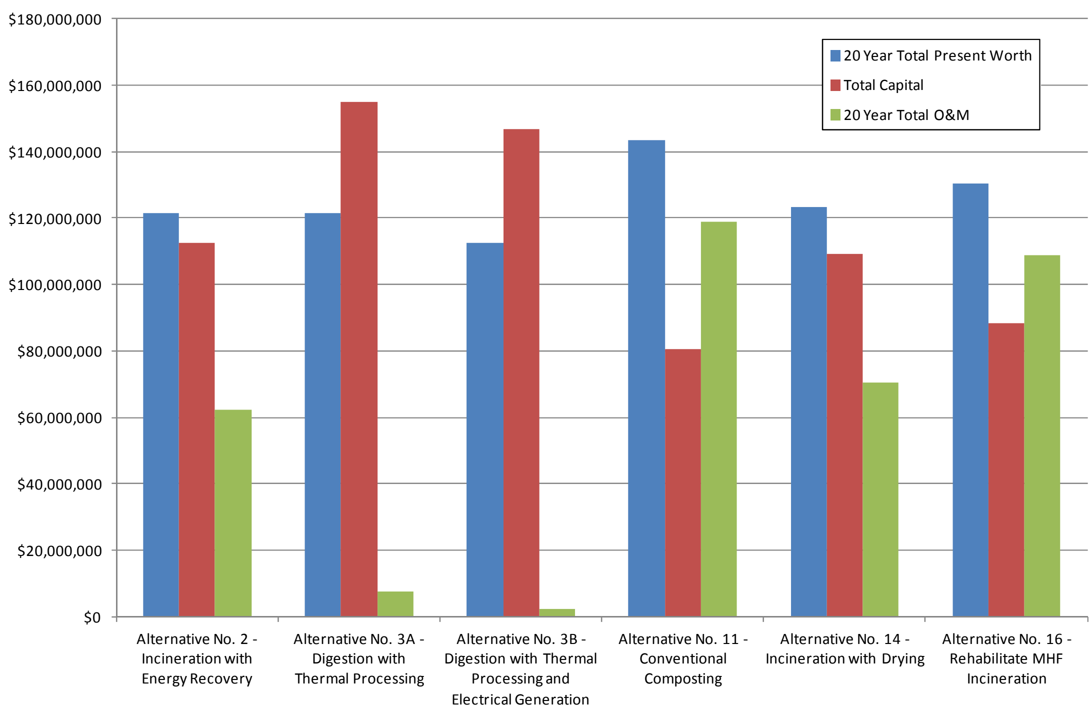


The cost of each alternative was estimated, including the costs of construction, operation and maintenance (O&M), engineering, and GBMSD's administrative and legal costs. Those costs were used to estimate the 20- and 40-year present worth of each alternative. A period of 40 years was used to calculate present worth, in addition to the more commonly used 20-year period, because it may better reflect the true life of the facilities knowing that the existing GBMSD solids facilities will have achieved a useful life of about 40 years when they are replaced by the new, planned facilities. The cost estimates are shown in Figure 7.

FIGURE 7
Comparison of Cost Estimates

	Alternatives					
	2	**3A**	**3B**	**11**	**14**	**16**
Capital Cost	$112,700,000	$154,900,000	$146,900,000	$80,600,000	$109,100,000	$88,400,000
Total Present Worth (40 year)	$180,200,000	$149,000,000	$134,600,000	$218,100,000	$187,800,000	$215,800,000
Total Present Worth (20 year w/ Salvage Value)	$121,500,000	$121,600,000	$112,600,000	$143,400,000	$123,500,000	$130,300,000
Annual O&M in 2015	$2,100,000	$700,000	$500,000	$3,500,000	$2,300,000	$3,300,000
Annual O&M in 2025	$2,900,000	$400,000	$200,000	$5,400,000	$3,300,000	$5,000,000
Annual O&M in 2035	$4,100,000	($100,000)	($520,000)	$8,700,000	$4,800,000	$7,700,000
Annual O&M in 2045	$5,800,000	($1,300,000)	($1,900,000)	$13,900,000	$7,000,000	$11,500,000
Annual O&M in 2055	$8,300,000	($3,600,000)	($4,600,000)	$22,800,000	$10,200,000	$17,300,000
20 Year Total O&M	$62,300,000	$7,500,000	$2,400,000	$119,000,000	$70,400,000	$108,800,000
40 Year Total O&M	$183,900,000	($23,800,000)	($42,800,000)	$417,000,000	$216,500,000	$350,200,000

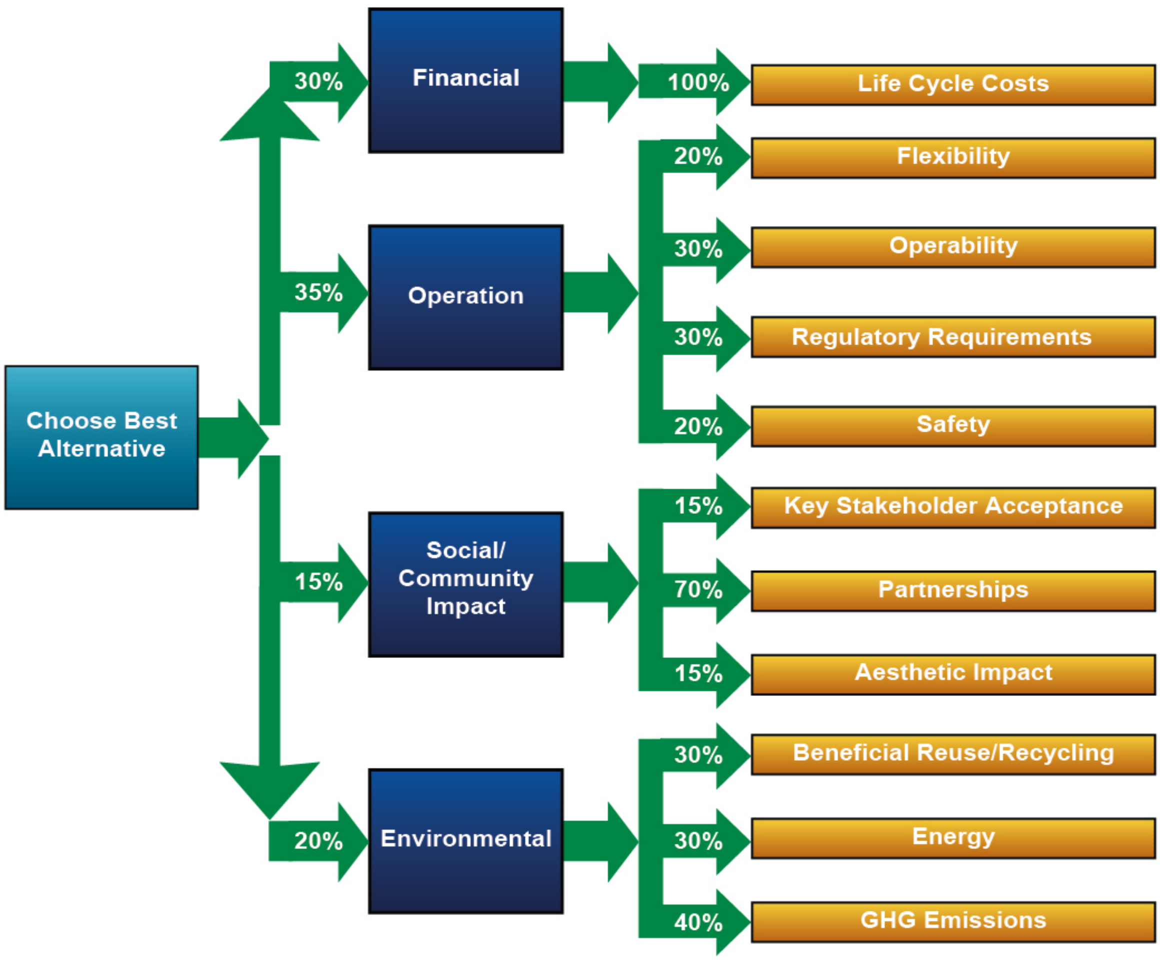
Note: All costs are June 2011 dollars referenced to ENR CCI = 9104.



Detailed Multi-attribute Utility Analysis

The project team employed a detailed, multi-attribute utility analysis to select the preferred alternative from the six remaining alternatives using the objectives and weightings shown in Figure 8. As in the screening process used to reduce the number of alternatives from 17 to 6, the evaluation criteria and weightings for this more detailed, multi-attribute analysis were closely aligned with GBMSD's Strategic Plan.

FIGURE 8
Objectives, Criteria, and Weightings Used for the Multi-attribute Utility Analysis



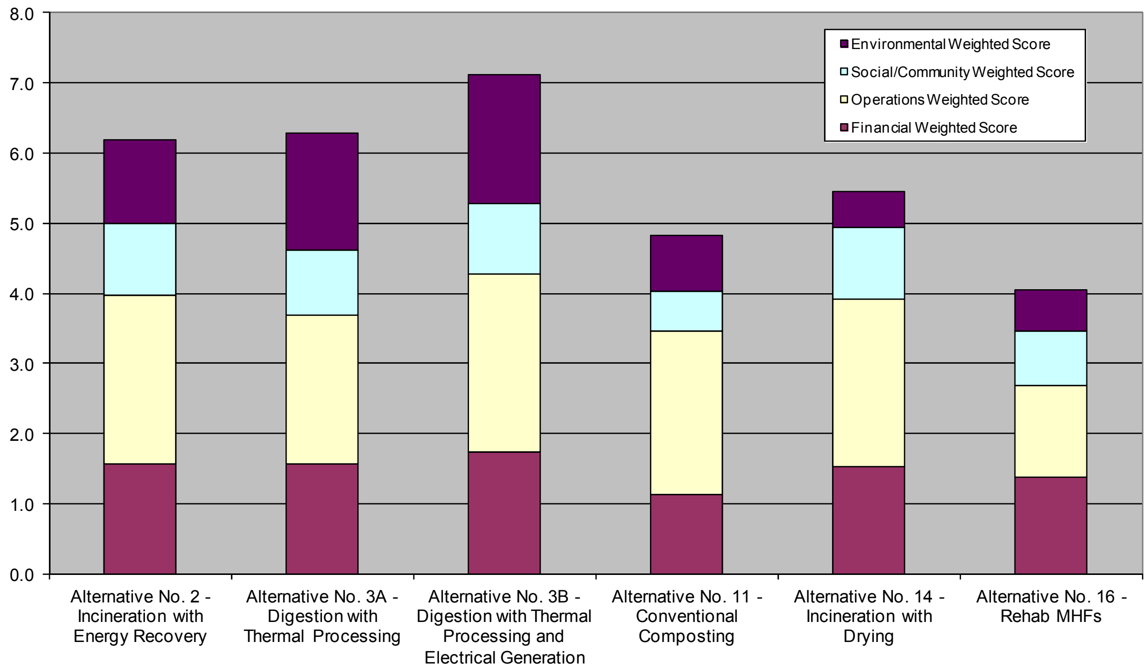
Recommended Alternative

Figure 9 presents the results of the multi-attribute utility analysis. Using these multi-attribute scoring results to help inform its decision, the team selected Alternative 3B. Alternative 3B was selected because it is best aligned to the fundamental goals and objectives articulated in GBMSD's Strategic Plan. Specifically, Alternative 3B was selected for the following reasons:

- It has the lowest 20 year life-cycle cost.

FIGURE 9
Multi-attribute Utility Analysis Score Comparison

Alternative	Total Weighted Score	Financial	Operations	Social / Community	Environmental
2—Incineration with Energy Recovery	**6.2**	5.2	6.9	6.8	6.0
3A—Digestion with Thermal Processing	**6.3**	5.2	6.1	6.3	8.3
3B—Digestion with Thermal Processing and Electrical Generation	**7.1**	5.8	7.3	6.7	9.1
11—Conventional Composting	**4.8**	3.8	6.7	3.8	3.9
14—Incineration with Drying	**5.5**	5.1	6.8	6.9	2.5
16—Rehabilitate Multiple Hearth Furnaces	**4.1**	4.6	3.7	5.2	3.0



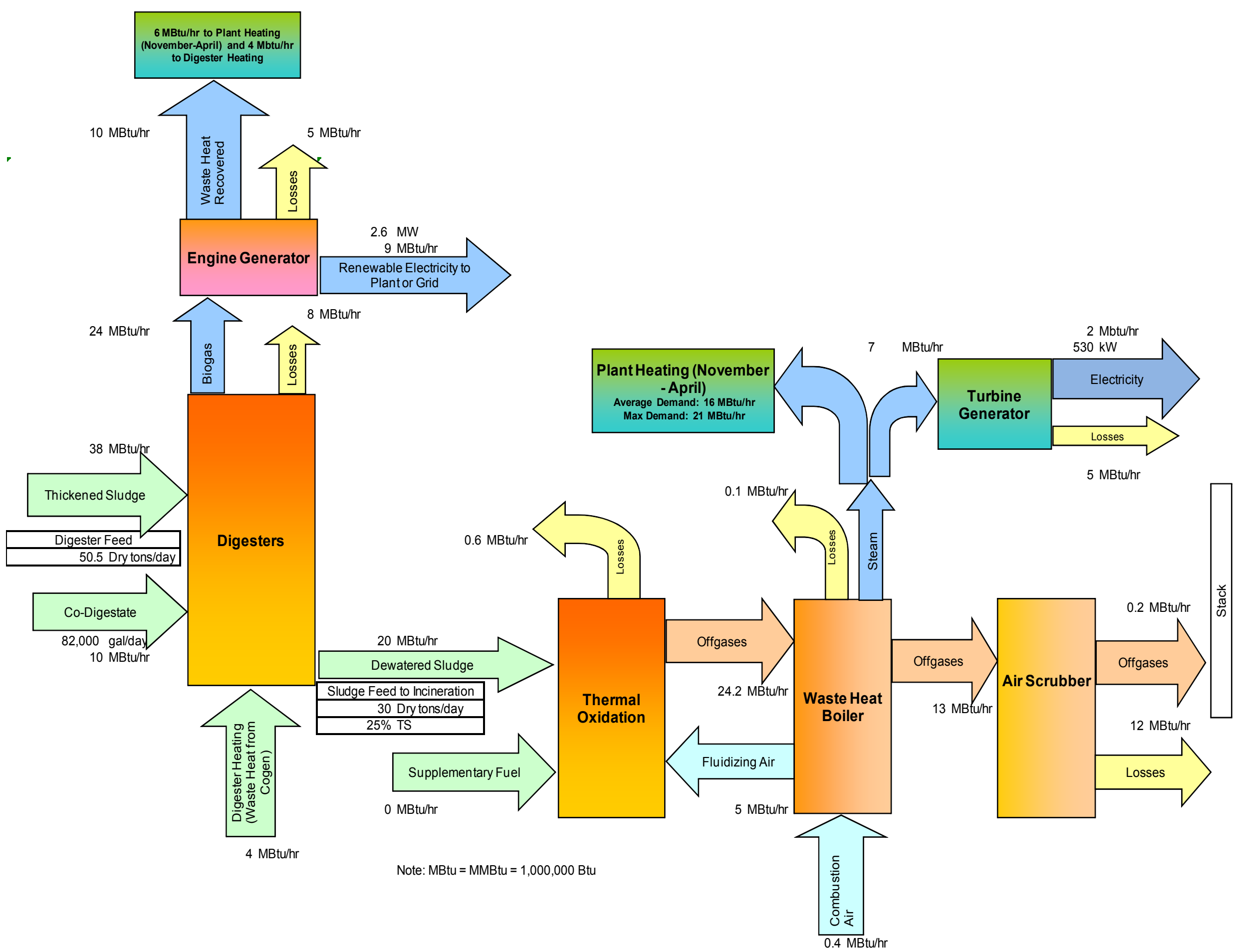
- It will reduce GBMSD's energy costs annually by an average of almost $4 million over 20 years, for a total estimated savings of $82 million over 20 years.
- It will allow GBMSD to generate about 60 percent of its own energy needs using renewable sources.
- It mitigates GBMSD's customer's exposure to the impacts of the costs of potential future increases in energy prices and greenhouse gas regulations.
- It has the potential to generate revenue from selling renewable energy certificates (renewable energy certificates are tradable, non-tangible energy commodities that represent proof that electricity was generated from an eligible renewable energy resource that can be sold and traded, and the owner of a certificate can claim to have purchased renewable energy).

- It will reduce greenhouse gas emissions by about 22,000 metric tons/year of equivalent carbon dioxide, equivalent to the annual emissions from 14,000 to 15,000 automobiles.
- It will reduce emissions of toxic air pollutants and air pollutants that form ozone (smog) by 50 to 90 percent. (Removal percents for individual compounds vary.)
- It will recover energy from industrial wastes in the codigestion process that otherwise typically would have been disposed of by applying on agricultural land, where wastes could run off or seep into rivers, streams, and groundwater.

Selected Alternative

The following section describes the selected alternative and issues that must be addressed during project design and implementation. As discussed, a reduction in energy costs was one of the important reasons for selecting Alternative 3B. Figure 10 shows through a preliminary energy balance how the energy savings will be achieved.

FIGURE 10
Preliminary Energy Balance for the Selected Alternative



Solids Loadings

Table 2 lists the solids loadings used to size the selected alternative. It was assumed that the system will start up in 2015, and that it will be sized for the projected 2035 loads. As part of pre-design of the solids facilities, the solids loadings may be refined further to:

- Consider changes in actual loads and conditions that may have occurred since the solids projections were completed in July 2011.
- Consider adding additional capacity for future industrial loads that have not been identified. WDNR code typically would provide an allowance of up to 5 percent for future unplanned industrial loads.
- Review the assumed volumes and characteristics of the wastes that will be codigested and how they may affect digester sizing and design.

TABLE 2
2035 Solids Loadings Projections for Sizing the Selected Alternative

Thickened solids to digestion	Avg. Day	51 dtpd
	Max. Month	64 dtpd
Digested, dewatered solids to incineration	Avg. Day	30 dtpd
	Max. Month	38 dtpd

Codigestion

One goal of the Strategic Plan is to be a regional provider of wastewater services. That goal can be partially met if GBMSD processes solids from industrial or agricultural sources.

Codigestion of wastes was evaluated, and it was concluded that codigestion is feasible and would be cost-effective for the selected alternative. Codigestion involves adding non-municipal waste sources directly to the digesters to increase biogas production and decrease energy costs. Although codigestion could have some adverse impacts on digester operation, the increased revenues from increased energy production, tipping fees and other non-monetary benefits outweigh the potential disadvantages.

Several waste sources in northeastern Wisconsin are suitable and desirable for codigestion. The proximity of some sources to the GBF should allow GBMSD to negotiate a competitive tipping fee. The most suitable of the wastes available in large quantities are dairy wastes. Dairy wastes with the highest strength would be most desirable, largely because they would minimize the need to increase the digester size while significantly increasing biogas production. Codigestion will be evaluated further during predesign. That evaluation may include laboratory testing of wastes, continuing discussion with potential waste sources to better define waste characteristics and quantities, continued assessment of potential tipping fees, and evaluation of methods to mitigate potential problems such as foaming and chloride toxicity.

Digestion Sizing

The digestion system will reduce the quantities of solids sent to the incineration facility and produce biogas for electrical generation and other uses. Because biosolids will not be applied to land, the digestion system will not be subject to nor be designed specifically to meet the requirements of Part 503 Class B Biosolids. For this reason, the digesters will not comply with the maximum volatile solids loading rate required by Wisconsin Administrative Code NR 110.26.5.B. However, they will be designed to meet GBMSD's desired volume reduction requirements and gas production rates, and based on other properly designed installations that use similar solids loadings rates, the digesters should produce Class B solids.

Digestion Pretreatment

The benefits of digestion pretreatment include greater volatile solids reduction, lower solids volumes, and greater biogas production. Digestion pretreatment will be considered in the future to provide additional capacity, if needed, or to increase biogas production if solids loadings increase.

Nutrient Extraction, Ammonia Recycle, and Struvite Control

The anaerobic digestion process results in ammonia production and release of soluble phosphorus. During dewatering, the soluble ammonia and phosphorus remain in the liquid and are recycled to the liquid treatment processes. It is likely that recycled wastes will not adversely affect the liquids treatment process, but that must be confirmed during design.

One option for managing recycled phosphorus is to use a nutrient extraction process to remove struvite, a compound rich in phosphorus that can be sold as a fertilizer product. Phosphorus extraction would also prevent the formation of struvite in equipment and pipes. A second option for controlling phosphorus and preventing struvite formation is to use ferric chloride. The selected alternative assumes that ferric chloride will be used, but if the required dose is found to be higher than average, nutrient extraction could be more cost-effective than use of ferric chloride. Installation of a nutrient extraction system will be deferred until after construction, when some full-scale operating experience is gained with digestion to determine the actual ferric usage and costs.

Incinerator Air Pollution Control

The USEPA published *Standards of Performance for New Stationary Sources and Emission Guidelines for Existing Sources: Sewage Sludge Incineration Units* (final rule, March 21, 2011).The rule, known as the SSI MACT rule, will affect existing and new incineration process trains developed as part of the Solids Management Facility Plan. For the selected alternative, the SSI MACT rule applies only to emissions from the fluidized bed incinerators. The following air pollution control devices will be used to meet the SSI MACT rule for the fluidized bed incinerator:

- Ammonia or urea injection at the fluid bed reactor to control emissions of nitrogen oxides
- Multiple venturi/impingement wet scrubber with a wet electrostatic precipitator combination to control particulate matter, cadmium, lead, sulfur dioxide (caustic addition to scrubber may be required), and hydrogen chloride emissions
- Application of granular activated carbon to control mercury emissions.

Other regulated pollutants include carbon monoxide and dioxins/furans. The fluidized bed reactor controls these pollutants through inherent combustion efficiency.

Thickening Improvements

Gravity thickeners are used to thicken primary sludge and gravity belt thickeners to thicken waste activated sludge. These systems require modification. Some components of the gravity thickeners are almost 40 years old and have reached the end of their useful life The pumps for gravity belt thickened sludge require modification to be compatible with the new solids system.

Cost Estimate

Table 3 shows the cost estimate of the selected alternative. At this level of project definition, the 90th percentile accuracy of the cost estimate is -20 to +40 percent.

TABLE 3
Capital Cost Estimate of the Selected Alterative

Item	Capital Cost
Anaerobic Digestion System	$35,900,000
Dewatering: Centrifuges and Polymer System	$13,600,000
Boilers and Cogeneration System	$20,800,000
Incinerator and Ancillary Systems	$57,368,000
Waste Heat Boiler and Steam Turbine System	$12,032,000
New Sludge Storage Tanks	$1,200,000
Demolition of Existing Solids Building	$1,600,000
Liquid and Dewatered Sludge Receiving and Storage	$1,100,000
Gravity Thickening and Gravity Belt Thickening Rehabilitation	$3,300,000
Initial Capital	**$146,900,000**

Note: All costs are June 2011 dollars referenced to ENR CCI: 9104 . Costs include construction, engineering and GBMSD administration costs.

Impacts on User Rates

GBMSD has constructed a strategic financial planning model to enable the evaluation of alternative capital program financing strategies in terms of system-wide rate implications and financial performance metrics. For this modeling, GBMSD cash flows were projected over a 20-year forecast period. System-wide rate increases were specified to fund projected capital improvement expenditure requirements as well as prospective operations and maintenance expenses (incorporating expense impacts of new facilities). Alternative capital funding sources including low-interest loans from the State of Wisconsin, municipal revenue bond issues, and available reserves may be drawn upon in different proportions to manage rate increase requirements. All model scenarios were tested against key financial performance metrics (i.e., debt service coverage ratio, fund balance minimums) to ensure that resultant financial plans preserve and enhance the District's financial integrity.

Expenditures for design, equipment and facility construction of the selected alternative are scheduled between 2012 and 2016 and are estimated to cost $146.9 million (in 2011 dollars); other GBMSD capital requirements are projected to range between $9 million and $20 million in each year of the 15 year period until 2026 (with significant capital improvement requirements projected in the final 5 years of the forecast period for potential phosphorous removal upgrades to the District's treatment facilities).

Scheduled design and construction of the selected alternative in the 2012-2016 period will require increases in GBMSD revenue generation to support associated debt financing. Annual system-wide rate increases of 8 to 9.5 percent are therefore scheduled between 2012 and 2016, an additional rate increase of 6 percent is anticipated in 2017 (to accommodate debt service on bonds issued in 2016), with annual rate increases in the 3 to 4 percent range anticipated throughout the remainder of the 15 year period preceding the projected need to finance phosphorous removal upgrades. Though service revenues between 2011 and 2017 are projected to increase by approximately 45 percent during this period, increases in unit charges for individual billing determinants (i.e., flow, BOD, TSS) will vary based on cost-of-service allocations and policy-based rate adjustments that may mitigate bill impacts for selected user groups.

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Acronyms and Abbreviations

ATAD	autothermal aerobic digestion
BACT	best available control technology
BC WTP	Brown County Waste Transformation Project
BFP	belt filter press
BOD, BOD_5	5-day biochemical oxygen demand
BTU	British thermal unit
DPF	De Pere Facility
DS	dry solids
ENR CCI	Engineering News Record construction cost index
ft/sec	feet per second
GBF	Green Bay Facility
GBMSD	Green Bay Metropolitan Sewerage District
GBT	gravity belt thickener
gpd	gallons per day
gpm	gallons per minute
H_2S	hydrogen sulfide
hp	horsepower
HRT	hydraulic residence time
lb/day	pounds per day
m	meters
MACT	maximum achievable control technology
mg	milligrams
MG	million gallon
mg/L	milligrams per liter
mgd	million gallons per day
MHF	multiple hearth furnace
MPN	most probably number
MUA	multi-attribute utility analysis
MVA	megavolt ampere
O&M	operations and maintenance
PCB	polychlorinated biphenyl
pH	potential hydrogen
PS	primary sludge
psi	pounds per square inch
RAS	return activated sludge
REC	renewable energy certificate
SS	suspended solids (same as TSS)
SSI	sewage sludge incinerator
SWD	side water depth
TDH	total dynamic head
TKN	total Kjeldahl nitrogen
TM	technical memorandum

TSS	total suspended solids
TWAS	thickened activated sludge
USEPA	United States Environmental Protection Agency
VFA	volatile fatty acid
VSS	volatile suspended solids
WAS	waste activated sludge
WDNR	Wisconsin Department of Natural Resources
WPDES	Wisconsin Pollutant Discharge Elimination System
WWTP	wastewater treatment plant

CHAPTER 1

Introduction

1.1 Background

The Green Bay Metropolitan Sewerage District (GBMSD) owns and operates an interceptor system and two wastewater treatment plants that serve 17 municipal customers and 1 contract customer in the Green Bay metropolitan area (Figure 1-1). GBMSD provides service to about 217,000 people within a 285 square mile area. Its interceptor system conveys wastewater to two wastewater treatment plants (WWTP); most of the wastewater flows to the WWTP in Green Bay, and the balance flows to the WWTP in De Pere.

1.1.1 Green Bay Facility

The Green Bay Facility (GBF) has an average flow of roughly 30 million gallons per day (mgd). The wastewater treatment process consists of screening, grit removal, primary clarification, and activated sludge treatment with biological phosphorus removal. Appendix 1-1 contains a copy of the plant's WPDES permit. Treated wastewater is discharged to the Fox River, which flows into Green Bay of Lake Michigan. Solids produced at the GBF are dewatered and incinerated, and the resulting ash is landfilled.

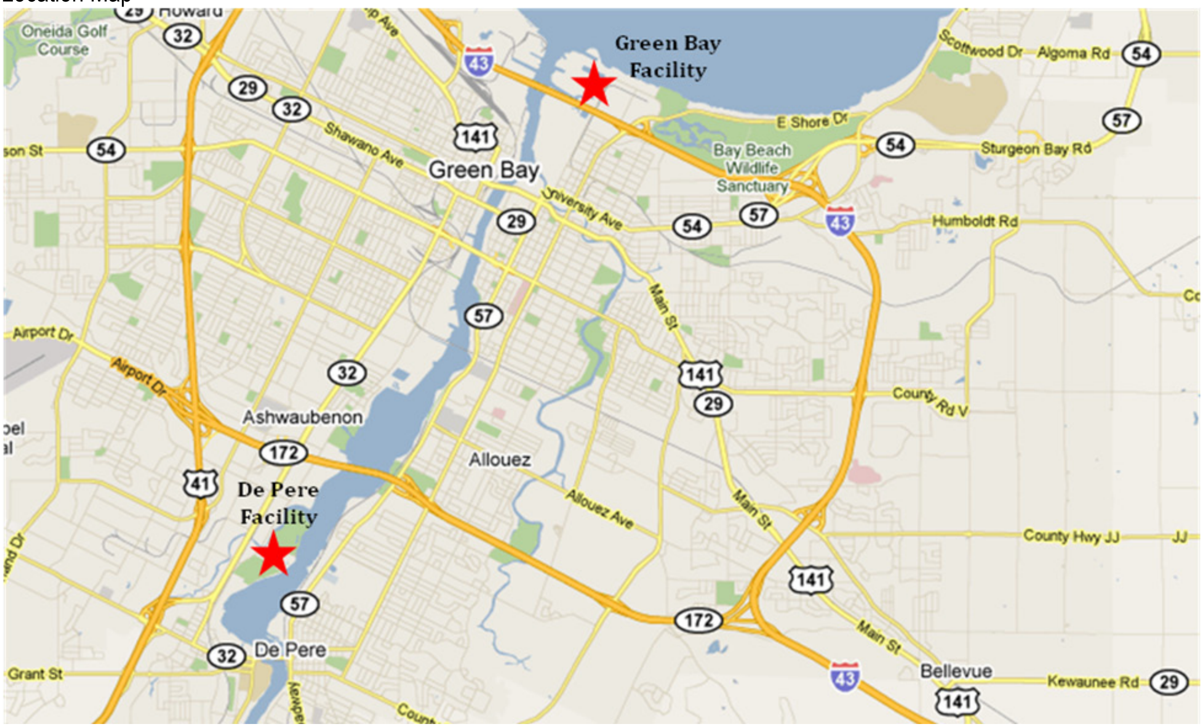
1.1.2 De Pere Facility

The De Pere Facility (DPF) has an average flow of roughly 8 million gallons per day (mgd). The wastewater treatment process involves screening, grit removal, and activated sludge treatment with biological phosphorus removal and effluent filtration. Appendix 1-2 contains a copy of the WPDES permit for the WWTP. Treated wastewater is discharged into the Fox River, about seven miles upstream of the Green Bay facility outfall. The plant solids are pumped to the Green Bay facility where they are dewatered and incinerated with the GBF solids. The DPF has belt filter presses onsite to dewater the solids, if needed, before sending them to a landfill for disposal.

1.2 Current Conditions

The City of De Pere owned and operated the DPF until GBMSD acquired it in 2007 as a result of recommendations provided in the *Facilities Plan for Regional Wastewater Management in the South Service Area* (November 2006). Following recommendations in the facilities plan, interplant pipelines were installed in 2010 to connect two plants to offload one-third of the average raw wastewater flow and all waste activated sludge from the DPF. The DPF solids-handling processes were then decommissioned so the DPF can continue to operate without requiring additional infrastructure. The interplant pipelines connecting the two facilities also provide the ability to pump mill wastewater from DPF to GBF to aid in biological phosphorus removal at the GBF.

FIGURE 1-1
Location Map



The two multiple-hearth incinerators at the GBF were started up in 1975 and are reaching the end of their useful service lives. The incinerators have nearly reached their capacity and now require a considerable amount of operation and maintenance attention. Both incinerators need to be operational most of the time to process the combined solids from both plants. In 2010, a short-term solids facility was constructed at the GBF to offload dewatered solids to a landfill when one of incinerator is offline for maintenance.

GBMSD finalized its strategic plan in 2009 to ensure operations continue to be successful and to identify opportunities to enhance the organization and communities it serves (Appendix 1-3). The plan's overarching theme of "Collaborative Regional Leadership, Education, and Sustainability" was supported by four fundamental goals:

- Support local economic development.
- Provide exceptional career development opportunities.
- Advance environmental stewardship and education.
- Provide diverse quality services to current and future customers.

The objective of this solids management facility plan is to identify a cost-effective solids processing system that best meets the goals of GBMSD's strategic plan in order to replace its aged infrastructure and to provide reliable and sustainable solids management solutions for GBMSD customers over the next 40 years.

CHAPTER 2

Current Conditions

2.1 Green Bay Facility

The GBF has an average flow of roughly 30 mgd. It provides wastewater screening, grit removal, primary clarification, and activated sludge treatment with biological and chemical phosphorus removal. Treated effluent is discharged just upstream of the mouth of the Fox River, before it flows into Green Bay of Lake Michigan. Solids produced in the GBF are dewatered and incinerated, and the resulting ash is landfilled.

2.2 De Pere Facility

The DPF has an average flow of roughly 8 mgd. It provides wastewater screening, grit removal, and activated sludge treatment with biological and chemical phosphorus removal, and effluent filtration. Treated effluent is discharged into the Fox River, about 7 miles upstream of the GBF outfall. The waste activated sludge from the DPF is pumped to the Green Bay facility for processing. For redundancy, the DPF has belt filter presses onsite to dewater solids for the purpose of hauling to a landfill.

2.3 Connection between Facilities

The DPF had been owned and operated by the City of De Pere until GBMSD acquired it in 2007 as a result of recommendations provided in the *Facilities Plan for Regional Wastewater Management in the South Service Area* (November 2006). As recommended in this plan, three pipelines were installed in 2010 to connect the two plants to allow about one-third of the average raw wastewater flow and all waste activated sludge from the DPF to be transported to the GBF. The DPF solids handling processes were then decommissioned, so the DPF can continue operating under increasing loads without requiring additional treatment capacity. The pipelines also provide the ability to pump mill wastewater from the DPF to provide an additional organic load, which aids in removing biological phosphorus at the GBF. The loading data presented in this chapter is from the period of 2006 to 2008 - before the pipeline was started up. See chapters 3 and 6 for more recent loading data including data following the pipeline startup.

2.4 Planning Area Description

2.4.1 Area Description

The study area for this facilities plan includes 17 surrounding municipalities served by the DPF and the GBF.

2.4.2 Demographics and Growth

Appendix A of the *Facilities Plan for Regional Wastewater Management in the South Service Area* (November 2006) contains detailed population data for each community in the study area. The data developed by Brown County Planning include 2005 population data along with projected population data for 2010, 2015, 2020, and 2025. Also included in that Appendix are drainage basin and sewer service area maps from the *2002 Brown County Sewage Plan*. The following information was obtained from the *2002 Brown County Sewage Plan*.

TABLE 2-1
Estimated Population within the GBF Service Area

Community	Year 2000 Population		
	Sewered	**Nonsewered**	**Total**
City of De Pere	500	0	500
City of Green Bay	102,013	300	102,313
Village of Allouez	15,443	0	15,443
Village of Ashwaubenon	4,040	0	4,040
Village of Bellevue	11,328	500	11,828
Village of Hobart	1,971	2,269	4,240
Village of Howard	12,889	657	13,546
Village of Pulaski	3,013	0	3,013
Town of Green Bay	362	1,410	1,772
Town of Humboldt	90	230	320
Town of Lawrence	0	0	0
Town of Ledgeview	0	0	0
Town of Pittsfield	300	2,133	2,433
Town of Red River	265	320	585
Town of Scott	2,712	1,000	3,712
Total	**154,926**	**8,819**	**163,745**

The GBMSD serves the municipalities listed in Table 2-1. GBMSD acts as a wastewater treatment wholesaler for what was, in the year 2000, an estimated population of 154,926 within an area of 232.0 square miles. The 2009 population served by the GBF was 175,692. The sewer service areas encompass 104.8 square miles. The GBMSD serves the municipalities listed in Table 2-1.

TABLE 2-2
Estimated Population within the DPF Service Area

Community	Year 2000 Population		
	Sewered	**Nonsewered**	**Total**
City of De Pere	20,059	0	20,059
Village of Ashwaubenon	13,594	0	13,594
Village of Hobart	850	0	850
Town of Lawrence	400	1,148	1,548
Town of Ledgeview	2,006	1,357	3,363
Total	**36,909**	**2,505**	**39,414**

The 2000 population of De Pere was 20,059. However, the sewer service area for the DPF serves areas other than De Pere including a significant portion of the villages Ashwaubenon and Hobart, and parts of the towns of Lawrence and Ledgeview. The 2000 population of the entire service area was estimated to be 36,909 (Table 2-2). The 2009 population served by the DPF was 45,677.

2.4.3 Land Use

The general land use pattern is residential and commercial in the central metropolitan Green Bay area. Industrial land use is located primarily along the lower Fox River and around the junction of the river with Green Bay. Natural areas are scattered throughout the planning area. Large natural areas are adjacent to the bay shoreline at Bay Beach Wildlife Sanctuary and the Fort Howard Paper Foundation Wildlife area, along Baird Creek and parts of the Fox River, west of U.S. 41 in the City of Green Bay, in the Town of Scott, and within the reservation area of the Oneida Tribe of Indians. The predominant land use in outlying areas of the planning area is agricultural.

De Pere and Ashwaubenon contain a mixture of residential, industrial, and commercial land use. Hobart, Lawrence, and the Oneida tribal land are predominantly residential with some minor areas of commercial and industrial. Ledgeview is predominantly residential with some minor commercial development at the intersections of major arterials.

Allouez is predominantly residential with some commercial land. Pulaski is mostly residential with some commercial and industrial land. Howard includes residential, commercial, industrial, and agricultural land. Bellevue includes residential, commercial, and agricultural land and a small area of industrial land. Humboldt, Pittsfield, Red River, Scott, and the Town of Green Bay are primarily agricultural with some natural areas.

2.5 Existing Environment

2.5.1 Climate and Weather

Climate information was obtained from the Facilities Plan for Regional Wastewater Management in the South Service Area (November 2006).

The Fox River, one of the largest northward-flowing rivers in the United States, empties into the southwest end of Green Bay on Lake Michigan. The effects of Lakes Superior and Michigan, combined with the limited hours of sunshine caused by cloudiness, produce a narrow temperature range within the bay. Three-fifths of the total annual rainfall occurs during the growing season, May through September. The high degree of precipitation, combined with the narrow temperature range, led to the development of the dairy industry. Long winters with snowstorms are common, although winter extremes are not as severe as other climates at similar northern latitudes.

The mean daily temperatures for Green Bay are 54.3 degrees F maximum and 34.4 degrees F minimum (Table 2-3). On average, the temperature in Green Bay reaches 90 degrees F or greater only 6 times per year. The temperature drops to 32 degrees F or less 160 days per year.

About 57 percent of the total annual precipitation in Green Bay falls in 5 months from May through September (Table 2-4). February is the driest month, with only 3.5 percent of the total precipitation. Green Bay averages 122 days of rain each year and an average total snowfall of 48 inches. The maximum wind speed recorded in Green Bay was 46 mph. Average wind speed ranges from 7.9 mph in August to 11.2 mph in April.

TABLE 2-3
Green Bay Historical Temperature Data

Month	Mean Daily Maximum (°F)	Mean Daily Minimum (°F)	Highest Recorded Temperature (°F)	Lowest Recorded Temperature (°F)
January	24.1	7.1	53	-31
February	28.9	12.1	61	-28
March	40	22.6	78	-29
April	54.6	33.9	89	7
May	68	44.7	91	21
June	76.8	54	98	32
July	81.2	58.6	103	40
August	78.5	56.5	99	38
September	70.2	47.5	95	24
October	57.9	36.9	88	15
November	42.4	25.6	74	-9
December	29	13.3	64	-27
Annual	54.3	34.4	103	-31

Source: National Oceanic and Atmospheric Administration.

2.5.2 Geography, Geology, and Hydrogeology

The information in the following subsections was obtained from the *Facilities Plan for Regional Wastewater Management in the South Service Area* (November 2006) to provide an overview of the geographical setting, geology, and water resources of the Green Bay area. Detailed information can be found in *Water Resources of the Green Bay Area* published by the United States Geological Survey in 1964, the Wisconsin Department of Natural Resources (DNR) Web site, the *Brown County Sewer Plan of 2002*, and Web sites of the Green Bay Water Utility and Central Brown County Water Authority.

TABLE 2-4
Green Bay Historical Rainfall Data (NOAA)

Month	Mean Precipitation (in.)	Mean Number of Days with Rain > 0.1 in.	Average Snowfall (in.)
January	1.21	10	12.1
February	1.01	8	8.5
March	2.06	11	9.1
April	2.56	11	2.7
May	2.75	11	0.2
June	3.43	11	Trace
July	3.44	10	0
August	3.77	11	Trace
September	3.11	10	Trace
October	2.17	9	0.2
November	2.27	10	4.5
December	1.41	10	10.7
Annual	29.19	122	48

Source: National Oceanic and Atmospheric Administration

Geography

Lake Michigan dominates the geography of the Green Bay area. Green Bay is located at the mouth of the Fox River, one of the largest northward-flowing rivers in the United States, which empties into the southwest end of Green Bay on Lake Michigan. Drainage patterns generally are northeasterly toward the lake or toward the Fox River. Lake Michigan has the lowest elevation in the state of Wisconsin at 579 feet above mean sea level.

Green Bay is situated within the Eastern Ridges and Lowlands geographical province of Wisconsin. The area is generally characterized by gently sloping topography. The relatively flat topography was formed beneath glacial ice of the Green Bay lobe during the most recent glacial period. The flat-lying soil consists of glacial clays and sands in a layer covering bedrock. During the Ice Age, which ended about 10,000 years ago, a number of ice sheets pushed southward across Wisconsin and adjoining areas. The ice sheets ground off the hills of the preglacial landscape, filled the ancient valleys with sediment, and created the fairly smooth plain that covers most of eastern Wisconsin.

A large part of Brown County is associated with the roughly 4-mile-wide Fox River Valley, a continuation of the same depression forming Green Bay. The area slopes northeastward from Lake Winnebago in east central Wisconsin, drains to Green Bay, and is generally level to gently rolling. The lowland area contains many glacial landforms, including eskers, moraines, and remnants of extinct glacial lakes.

Geology

The most prominent topographic feature is the northwest-facing, southwestward-trending Niagara escarpment. The area northwest of the escarpment drains into Green Bay through the Fox River, Suamico River, Duck Creek, and their tributaries. The area southeast of the escarpment is drained by streams that flow into Lake Michigan.

The Niagara escarpment forms the eastern boundary of the Fox River Valley, rising relatively abruptly to as high as 200 to 250 feet above the valley floor. The escarpment was formed by the erosion of older, softer bedrock underlying harder, more resistant bedrock and accentuated by the scouring action of glaciers. East of and alongside most of the escarpment is a narrow strip of level land. East of that strip is a slightly rolling plain that drains east and southeast toward Lake Michigan. Several streams that drain to Lake Michigan have their headwaters within the area. However, gaps in the escarpment allow two streams—Baird Creek and Bower Creek—to flow westward to Green Bay. The area generally is well drained, but in places there are many small, wet depressions.

The depth to bedrock in the Green Bay area ranges from zero to roughly 100 feet, depending on the thickness of unconsolidated material above bedrock. The unconsolidated material consists of glaciolacustrine deposits, mainly lake sediments of sand, silt, and clay. Most of the agricultural soils formed in Brown County were formed on glacial tills or lake sediment, both of which consist mostly of clay particles. The characteristic soils are slowly permeable clay loam to clays. The soils have slight to moderate limitations for farming, with wetness being one of the greatest management concerns. The slow permeability and a relatively high shrink-swell potential impose moderate to severe limitations for many residential and industrial related uses, including road construction and conventional septic system siting.

There are also areas of loamy or sandy glacial till, outwash sand and gravel, and lacustrine sediments. The soils generally are friable and have moderate to rapid permeability. These conditions create slight to moderate limitations for farming and most residential and industrial uses. There may be post-glacial alluvial deposits of unconsolidated material immediately adjacent to the Fox River.

The bedrock geology consists of horizontally oriented sedimentary rock layers, originally deposited in shallow seas and later hardened into consolidated rock material. These layers have a slight downward slope toward Lake Michigan to the east; in the Green Bay area they consist of dolomite, limestone, or shale rock types.

The bedrock within Green Bay was formed during the Precambrian and Paleozoic eras. The underlying Precambrian bedrock is about 1.5 billion years old. There are no known outcrops or exposures of the bedrock in Brown County. Overlying the Precambrian bedrock is Paleozoic bedrock 375 to 600 million years old. Exposures of the Paleozoic bedrock are found along the Niagara Escarpment, within several larger quarries, and along some streambeds. The Paleozoic bedrock is sedimentary in origin and formed at the bottom of ancient shorelands and seas. Over time and under pressure, the deposits of sands, silts, and clays eventually were transformed into sandstone, limestone, dolomite, and shale. Over the past 350 million years, erosion has removed many of the younger rock units so that today the youngest that remain are the Alexandrian and Niagaran dolomites in the eastern part of the area. The boundary between this bedrock and the next oldest period of bedrock can be seen along the escarpment.

Hydrogeology

Groundwater is available in the planning area from three general sources: the sandstone aquifer, the Niagara dolomite aquifer, and the shallow sand and gravel aquifers. The only rock units that contain little or no recoverable water are the Maquoketa Formation and the Precambrian granite.

Groundwater typically is found in one or more of the bedrock aquifers in the area, but it can also be found in some limited areas of unconsolidated sand and gravel deposits. East of Green Bay, the Silurian-Devonian aquifer, consisting of limestone and dolomite, is several hundred feet thick. The Silurian-Devonian is absent beneath most of Green Bay, where the uppermost bedrock systems are Ordovician and Cambrian sandstones, a small eastern area of which is overlain by the Ordovician-aged Maquoketa shale unit. In the Green Bay area, these combined sandstone units range from roughly 400 to 800 feet in thickness. Pumping tests performed in the material indicate yields of 20 to more than 1,000 gallons per minute (gpm).

2.5.3 Drinking Water

Municipal water systems in the planning area obtained their water from wells that tapped into a deep aquifer. As early as 1953, researchers discovered that closely spaced wells in the Green Bay area resulted in the formation of a deep cone of depression in the groundwater level near the wells. This resulted in a serious decline in water levels within the center of the planning area. Since 1957, the city of Green Bay has used a combination of Lake Michigan water and groundwater for its water supply needs. The construction of the pipeline to Lake Michigan and reliance upon groundwater only during times of high demand in the summer resulted in an immediate rebound of groundwater levels in the area. However, since that time, groundwater levels have steadily declined because of increased usage by the communities surrounding the city of Green Bay.

The Central Brown County Water Authority (consisting of De Pere, Allouez, Howard, Bellevue, Lawrence, and Ledgeview) was established in 1999 to address water supply concerns regarding radium. In 2007, a pipeline was completed to convey treated Lake Michigan water from the Manitowoc drinking water treatment plant to the member communities.

2.5.4 Endangered Resources

The Wisconsin DNR classifies a narrow corridor of terrestrial area associated with the Fox River as environmentally sensitive. An area immediately south of the GBF also is deemed environmentally sensitive.

Green Bay and surrounding communities are located in what is known as the Northern Lake Michigan Coastal Ecological Landscape (Reference: dnr.wi.gov). The Northern Lake Michigan Coastal Ecological Landscape is located in northeastern Wisconsin, and includes Green Bay and the northern part of the Door Peninsula. Its landforms consist of the Niagara escarpment, a prominent dolomite outcropping along the east side of Green Bay, a lacustrine plain along the west side of Green Bay, and ground moraine elsewhere. Low sand dunes and beach ridges that support Great Lakes endemics and many other rare species are found along the Great Lakes shoreline. The Northern Lake Michigan Coastal Ecological Landscape, which includes part of the Green Bay area, has many rare and endemic natural communities along Lake Michigan. This landscape presents unique ecological management challenges:

- Key stretches of the Niagara Escarpment that are important for rare species need to be protected.
- The coastal ridge and swale forest, and the beaches, dunes, and boreal forest unique to the Great Lakes shoreline need to be protected and managed.
- Within the interior of the ecological landscape, there are opportunities for management of large conifer and hardwood swamps.
- There are opportunities for restoring and managing lakeshore marshes, sedge meadows, and wet forests along the west shore of Green Bay.
- Species endemic to the Lake Michigan shoreline require protection of alkaline rock shores, coastal estuaries, boreal forests, and alvar, beach, and dune communities.
- Most of the coastline in the ecological landscape is important for migratory birds.
- Maintenance of migratory corridors, resting, and feeding areas for migratory birds (raptors, songbirds, and waterfowl) is important throughout the ecological landscape.
- Colonial waterbird island rookeries occur along the Lake Michigan coast in Green Bay and the Grand Traverse Islands. The rookeries need protection, monitoring, and management.
- Green Bay is a significant fish spawning area.

If left under natural conditions, most upland areas in the region would be vegetated with hardwood forests. Areas that previously had been cleared but were allowed to return to a “natural state” will experience a succession of varied plant growth. This succession can include an initial invasion of hardy annual weeds followed by perennial species, such as woody shrubs and pioneer trees. Next appears more shade tolerant tree species, and a forest begins to be established. Over time, the local soil is built up with humus. If the area remains undisturbed, the forest eventually will reach a climax state. Within the area, a climax forest is a mature hardwood forest often dominated by sugar maple, basswood, hemlock, and American beech. These species once dominated the local landscape.

There are few, if any, climax plant communities left within the planning area. Most were either burned by Native Americans or by fires during times of drought, lumbered by early settlers, or cleared for agriculture. Today, woodlands are much less extensive, less ecologically diverse, and more disturbed. They typically consist of isolated stands of successional stages of woody growth or mature second growth. The largest remaining areas of woodlands are located in the northern part of the planning area.

The other major historic plant communities within the area were the inland and coastal wetlands. The wetlands commonly were located on organic soils of ancient glacial lake basins and drainageways, along the floodplains of rivers and streams, and along the shore of Green Bay. The wetland community type depended upon vegetation and water depth and included seasonally flooded basins, shallow fresh water marshes, deep fresh water marshes, inland fresh meadows, open fresh water, shrub swamps, wooded swamps, and bogs.

Wetlands are thought to have once been widespread throughout the area, following the retreat of the last glacier and before human habitation. The few wetlands that remain today are scattered throughout the area, with the largest remaining wetland complex located along the west and southwest shore of Green Bay.

2.5.5 Fox River

Between about 1954 and 1971, paper companies using polychlorinated biphenyls (PCBs) to make carbonless copy paper discharged nearly 700,000 pounds of the chemicals into the Fox River. The dangers posed by PCBs were unknown until the early 1970s, and their use and discharge into the environment were banned by federal environmental regulations in 1976. The ban was successful, but because PCBs bind to soil and break down very slowly, they are still found today in the sediment of the Lower Fox River and Green Bay (dnr.wi.gov).

2.5.6 Green Bay

Green Bay is about 119 miles long and an average of 23 miles wide. The narrow bay is bounded by the City of Green Bay at the south end and by both Big and Little Bays de Noc, in Michigan´s Upper Peninsula, on the north end. In Wisconsin, the bay is separated from Lake Michigan by the Door Peninsula, whereas the Upper Peninsula´s Garden Peninsula separates Big Bay de Noc from Lake Michigan. At the south end the bay is a freshwater estuary because of the shallow water depths, but the northern end is a deep-water lake. The average depth of the bay is 65 feet, with much shallower bottoms near its shores. Few areas are more than 131 feet deep. Green Bay covers an area of about 1,600 square miles. The Green Bay watershed drains 15,625 square miles, or about one-third of the Lake Michigan drainage basin. Two-thirds of the Green Bay drainage are in Wisconsin and one-third is in Michigan´s Upper Peninsula. The Lower Fox River is the largest tributary to Green Bay, contributing about 42 percent of the total drainage, more than 95 percent of the PCB load, and 70 percent of the suspended sediments. Because of the dominant currents in the bay, most of the Fox River sediment is deposited along the southern and eastern parts of Green Bay.

Since the 1970s there has been significant improvement in the water quality in the system. This improvement has resulted in the restoration of a diverse fishery, including a world-class walleye fishery. Levels of PCBs and mercury in fish are still high enough that consumption advisories for most species are needed to protect human health.

The Wisconsin DNR has led a project to clean up the contaminated sediment from the Lower Fox River and Green Bay. The project began more than 25 years ago. The goal of the cleanup is to reduce contaminant levels in fish so that people can eat them safely and to ensure that the environment is protected.

The Wisconsin DNR has moved forward to implement new statewide limits on phosphorus. The Department of Natural Resources has proposed revisions to Chapters NR 102 and NR 217 of the Wisconsin Administrative Code relating to phosphorus water quality standards criteria and limitations and effluent standards. The rule revision proposal has two parts. The first is a set of phosphorus water quality standards criteria for rivers, streams, various types of lakes, reservoirs and Great Lakes. The second is procedures for determining and incorporating phosphorus water quality based effluent limitations into Wisconsin Pollutant Discharge Elimination System (WPDES) permits. The limits will be specific to each discharger and will be based on the water quality of the receiving water body. The new phosphorus limits may require GBMSD to implement a tertiary treatment process to remove phosphorus to low levels. This process would likely utilize a chemical precipitant in conjunction with a separation process to remove phosphorus. The tertiary treatment process would produce a chemical sludge that is mostly inert. The new phosphorus effluent limits have not yet been defined. The predesign of the solids facility should account for the new regulations as they are further defined.

2.5.7 Lake Michigan

Lake Michigan is a vital resource as it supplies drinking water to more than 10 million people in cities along its shore, such as Green Bay, Milwaukee, and Chicago. It is also a major mode of transport for bulk goods and hosts car ferries. Lake Michigan is a valuable natural resource as it provides recreational boating, and is an economic asset for tourism. Sport and commercial fishing on the lake is a billion-dollar industry with salmon, whitefish, smelt, lake trout, and walleye as the main catches. Proper management of the Lake Michigan watershed is critical to protect this resource from pollutant and nutrient contamination.

2.6 Solids Processing and Disposal Requirements

Existing federal and state regulations are described for the GBMSD’s current incineration program, as well as other biosolids management methods, such as land application (which includes the distribution and marketing of compost, alkaline stabilized biosolids, heat-dried pellets, etc.) and surface disposal. The following are the principal regulations related to the GBMSD’s solids processing and disposal program:

- Federal Part 503 Regulations, Standards for the Use and Disposal of Sewage Sludge
- Federal Clean Air Act Amendments
- Wisconsin State Regulations

2.6.1 Federal Part 503 Regulations

The U.S. Environmental Protection Agency (EPA) promulgated the Part 503 Regulation in February 1993 and amended them in August 1999, as follows:

- Subpart A, General Provisions—The Part 503 Regulation applies to biosolids that are land-applied, surface disposed, or incinerated. Several exclusions are noted in the rule.
- Subpart B, Land Application—Numerical limits and associated management practices are specified.
- Subpart C, Surface Disposal—Surface disposal refers to biosolids-only landfills and dedicated land disposal practices. Pollutant concentration limits are specified for the biosolids as well as for that site; nitrogen in the groundwater must be monitored. If cover is placed daily, pathogen requirements do not have to be satisfied.
- Subpart D, Pathogen and Vector Attraction Reduction—Criteria are specified for two categories: Class A or B. Reduction of vector attraction (e.g., control of flies, rats) is also required. Management options and reduction standards are provided.
- Subpart E, Incineration—Pollutant limits, operational standards, and monitoring and reporting requirements are specified.

2.6.2 Federal Clean Air Act and Amendments

The Clean Air Act Amendments regulate biosolids incinerators. Particulate emissions and opacity limits are required. It also requires monitoring and reporting, and performance testing.

The GBF was required to obtain a Federal Title V Operating Permit (40 CFR 70) because it is classified as a "major" source under those regulations. Table 2-5 summarizes actual and potential emissions taken from the 1995 Title V Permit Application for the entire GBF. If the solids facilities are modified or new facilities constructed, Federal Clean Air Act Permitting for construction could be required. The permits would have several requirements, the most significant being for air emissions controls.

TABLE 2-5
Actual and Potential Annual Emissions from the GBF

Pollutants	Actual (tons/year)	Potential (tons/year)
Carbon monoxide (CO)	8.0	177.5
Volatile organic compounds (VOC)	12.3	64.1
Nitrogen oxides (NO_x)	48.5	226.0
Total particulate matter (PM)	9.4	39.8
Sulfur dioxide (SO_2)	7.7	163.6
Total hazardous air pollutants (HAP)	2.06	6.43
Maximum individual HAP	0.925	3.0

Source: GBMSD Title V Air Operating Permit Application, June 1995.

The USEPA published*: Standards of Performance for New Stationary Sources and Emission Guidelines for Existing Sources: Sewage Sludge Incineration Units* (final rule, March 21, 2011).The rule, known as the SSI MACT rule, will affect existing and new incineration process trains developed as part of the Solids Management Facility Plan. See the technical memorandum Impact of SSI MACT Standards on the Selection of Alternatives (Appendix 2-1) and Chapter 6 for a description of what air pollution controls will be required for existing and future incineration facilities.

2.6.3 State of Wisconsin Air Regulations

Many air pollution control requirements in state statutes and rules reflect mandates contained in the federal Clean Air Act. Under the Clean Air Act, the U.S. EPA created federal regulations that Wisconsin air pollution control rules must reflect.

Wisconsin's air pollution control rules are found in Chapters 400 through 499 of the state administrative code. Most of these regulations are identical to the federal Clean Air Act requirements with a few exceptions, the most important being Chapter NR 445, Control of Hazardous Pollutants. The DNR adopted NR 445 in 1989, which is the part of Wisconsin's Air Toxic Rule that addresses hazardous air contaminants. The regulation applies only to pollutants that are not regulated by a Clean Air Act MACT Standard.

Revisions made to NR 445 in July 2004 added 103 compounds and removed 5, resulting in 535 regulated compounds. The revisions reclassified some compounds according to their toxicity and lowered emission thresholds for other compounds.

NR 445 contains three tables that dictate the compounds regulated and controlled. Table A applies to all sources including GBMSD, Table B to manufacturers of pesticides, herbicides, and similar chemicals, and Table C to pharmaceutical manufacturers. If a compound exceeds an emission threshold, then, depending on the compound, one of the following compliance standards must be met:

- The emissions cannot result in ambient air concentrations off the source's property that exceed certain health-based limitations.
- Emissions shall be controlled to a level that is the "lowest achievable emission rate" or LAER. LAER is the most stringent control requirement.
- The best available control technology (BACT) must be applied. BACT is defined in part by NR 445 as "the maximum degree of reduction practically achievable as specified by the department on an individual case-by-case basis taking into account energy, economic and environmental impacts and other costs related to the source."

The NR 445 thresholds are expressed in pounds per hour or pounds per year and vary depending upon the stack height.

2.6.4 Applicability to GBMSD

1992 NR 445 Compliance Plan

GBMSD completed a NR 445 compliance plan in 1992. At that time, GBMSD emissions from the GBF exceeded the NR 445 thresholds for chloroform and cadmium from the incinerators and wastewater treatment processes. The compliance plan, approved by the DNR, demonstrated that BACT for these compounds was to control the amount of cadmium and chloroform in the wastewater influent. Since the plan was accepted, emissions of chloroform and cadmium have been below the NR 445 thresholds.

2007 NR 445 Compliance Demonstration

In 2007, the DNR requested that GBMSD conduct incinerator emission tests to verify compliance with NR 445. The tests were also used to demonstrate compliance with NR 440, 40 CFR Part 503 and to generate emission factors for reporting emissions under NR 438. In April and May 2007, GBMSD conducted extensive incinerator stack testing as part of the NR 445 compliance plan development. In November 2007, GBMSD submitted the NR 445 Compliance Demonstration that included the results of the incinerator testing.

The DNR requested that NR 445 compliance be demonstrated at the maximum incinerator throughput of 3.1 dry tons per hour (74.4 tons per day)—a rate much higher than that at which the incinerators historically have been operated. The testing showed that the incinerator emissions were below NR 445 emission thresholds except for PCBs. The measured PCB emissions were 0.504 pound per year assuming continuous operation of the incinerators at 74.4 dry tons per day of solids throughput. This exceeds the NR 445 threshold for stacks higher than 75 feet of 0.1 pound per year. NR 445 allows for a human health risk demonstration for PCBs if the emission threshold is exceeded. This demonstration was performed in 2008 and it showed that unit risk was 3×10^{-10}, which is far below the NR 445 standard of 1×10^{-6}.

USEPA documents show that dioxin and furan formation does not readily occur at temperatures above 840 degrees F, requires from thirty minutes to several hours to react, and occurs only between the temperatures of 390 and 840 degrees F. Therefore, the secondary combustion chamber temperatures during the incinerator stack tests were required to be maintained well above 840 degrees, ranging from 938 to 1,115 degrees F with an average of about 950 degrees. The GBMSD heat recovery boiler was not operated during the incinerator stack tests because its use would decrease gas exhaust temperatures to the identified temperature range that could promote dioxin/furan formation. When the heat recovery boiler is not used, the gases exhausted from the secondary combustion chamber are quenched nearly instantaneously to less than 200 degrees F in the scrubber precooler, which is outside the temperature range that promotes dioxin/furan formation.

GBMSD’s Air Operating Permit requires that the secondary combustion chamber temperature average at least 950 degrees F over an 8-hour period. This means that GBMSD cannot operate the heat recovery boiler because it would decrease exhaust temperatures, which could promote dioxin/furan formation. GBMSD is considering doing additional stack testing at lower exhaust temperatures to demonstrate NR 445 compliance when operating the heat recovery boiler.

Incinerator testing also determined that the emissions were in compliance with GBMSD’s Part 70 Air Pollution Control Operation Permit (known as the Clean Air Act “Title V” permit).

2.6.5 Land Application Requirements

40 CFR, Part 503, sets standards for the use or disposal of sewage biosolids. These regulations set metals limits, establish pathogen reduction standards, and establish vector attraction reduction standards for biosolids applied to land. The DNR administers these regulations through the Wisconsin Administrative Code, NR 204.

503 Regulations

Incineration of biosolids is regulated under CFR 40, Part 503, "Standards for the Use or Disposal of Sewage Sludge." Nonhazardous incinerator ash generated during the firing of biosolids must be disposed of according to the solid waste disposal regulations in 40 CFR Part 258; however, if the ash is applied to the land or placed on anything other than a municipal solid waste landfill, the regulations in 40 CFR Part 257 must be followed.

Land application of sewage biosolids is regulated under CFR 40, Part 503, "Standards for the Use or Disposal of Sewage Sludge." The regulation establishes two levels of sewage biosolids quality with respect to heavy metal concentrations (ceiling concentrations and exceptional quality; see below), two levels of quality, with respect to pathogen densities (Class A or B), and two types of approaches for meeting vector attraction reduction. In order for the biosolids to qualify for land application, metals must be below ceiling limits, and the biosolids must meet Class B requirements as a minimum for pathogens and vector attraction reduction requirements.

Metals

Metals limits for land application of sewage biosolids are summarized in Table 2-6. To be applied to land, bulk sewage biosolids must meet either the Pollutant Concentration limits or both the pollutant Ceiling Concentrations *and* Cumulative Pollutant Loading limits.

TABLE 2-6
Land Application Pollutant Limits (All Weights on Dry Weight Basis)

Pollutant	**Table #1** Ceiling Concentration Limits (mg/kg)	**Table #2** Cumulative Pollutant Loading Rates (kg/ha)	**Table #3** "High Quality" Pollutant Concentration Limits (mg/kg)	**Table #4** Annual Pollutant Loading Rates (lb/acre/yr)
Arsenic	75	41	41	1.78
Cadmium	85	39	39	1.69
Copper	4,300	1,500	1,500	66.9
Lead	840	300	300	13.4
Mercury	57	17	17	0.76
Molybdenum	75	N/A	N/A	N/A
Nickel	420	420	420	18.7
Selenium	100	100	100	4.4
Zinc	7,500	2,800	2,800	125

Note: Adapted from the 503 regulation.

Pathogen Reduction

Sewage biosolids that are applied to land must meet Class A or B pathogen requirements. For Class A, the biosolids must meet one of the following criteria:

- Fecal coliform density less than 1,000 most probable number (MPN) per gram of total dry solids

- Salmonella density less than 3 MPN/4 grams of total dry solids

Class B sewage biosolids must meet one of the following pathogen requirements:

- The sewage biosolids must be treated by a process identified by the EPA as a "process to significantly reduce pathogens"
- At the time of disposal, the geometric mean of sewage biosolids samples must be less than 2,000,000 MPN/gram total solids (dry weight)

Vector Attraction

Vector attraction reduction reduces the potential for spreading of infectious disease agents by vectors (flies, rodents and birds). At least one of the following must be met before land application of the biosolids for anaerobic processes:

- The minimum volatile solids reduction is 38 percent of raw sludge, compared to stabilized biosolids.
- Liquid biosolids should be injected beneath the soil surface, with no significant amount of sewage biosolids present after 1 hour of injection for Class B or 8 hours for Class A.
- Dewatered sewage biosolids that are applied at a surface disposal site should be incorporated into the soil within 6 hours of application for Class B or 8 hours for Class A.

NR 204 Regulations

The DNR regulates biosolids disposal through Chapter NR 204 of the Wisconsin Administrative Code. The 1996 Revisions to NR 204, for the most part, mirror the 503 Regulations. Major NR 204 revisions are summarized below:

a. Additional testing of the biosolids is required, depending upon its end use and facility size. These will be specified in the WPDES permit. Additional tests could include Specific Oxygen Uptake Rate, salmonella, viruses, viable helminth ova, and a priority pollutant scan.

b. The DNR defines an "Exceptional Quality Sludge" as one that meets Class A pathogen requirements, high quality pollutant concentrations, and vector reduction requirements of the 503 Regulations. Biosolids certified as "exceptional quality" is exempt from the minimum separation distances to residences, businesses, recreational areas, or property lines, if applied to land. A permit is not required to apply biosolids to land, and site life is unlimited. Biosolids may be commercially distributed in bulk only if certified as of exceptional quality.

c. Application of biosolids on frozen or snow-covered ground is prohibited, unless a permittee can demonstrate that no other reasonable disposal method is available and there is absolutely no likelihood that the biosolids will enter the waters of the state. Application may be approved on a case-by-case basis until storage is available.

d. Biosolids quality standards, with respect to vector attraction reduction, pathogen reduction and metals from the 503 Regulations are incorporated into these regulations, including site restrictions.

e. All municipal mechanical treatment plants must be able to store biosolids for 180 days if land application is the primary management method to accommodate Wisconsin's climate and the crops' nutrient needs.

2.7 Description of Solids Processing Facilities

2.7.1 De Pere Facility

The DPF is rated for a design flow of 14.2 mgd and a peak day flow of 30 mgd. Design BOD load is 41,000 lb/day, whereas the design load for suspended solids is 23,700 lb/day. Figure 2-1 is a schematic of the existing solids processing facilities. Table 2-7 lists the DPF solids processing components. All of the waste activated sludge (WAS) from the clarifiers is pumped to the GBF for processing. The belt filter presses at the DPF provide the ability to dewater and landfill as an emergency backup.

FIGURE 2-1
DPF Solids Schematic

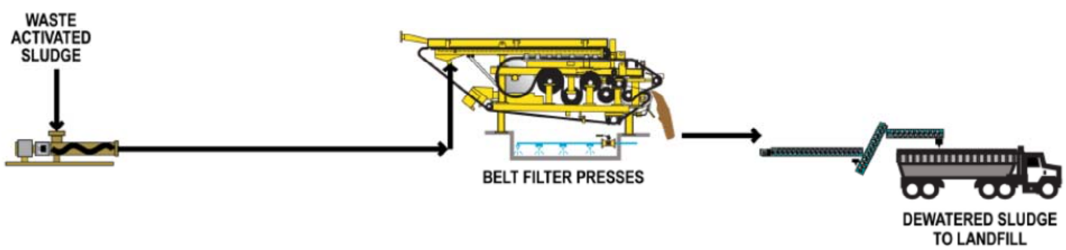


TABLE 2-7
Existing De Pere Solids Processing Components

Process or Facility	Equipment	Capacity
WAS Transfer Pumps	Two 40 hp variable speed centrifugal pumps 650 gpm each at 107 ft TDH	0.94 mgd with one pump out of service
Belt Press Dewatering	Three 30 hp pumps, 450 gpm each Two belt filter presses; 2 m belt width	1.3 mgd with one pump out of service (108,420 lb DS /day at 1% solids) 43,200 lb DS /day per unit

2.7.2 Green Bay Facility

Table 2-8 lists the solids processing equipment at the GBF. Figure 2-2 is a treatment schematic of the GBF.

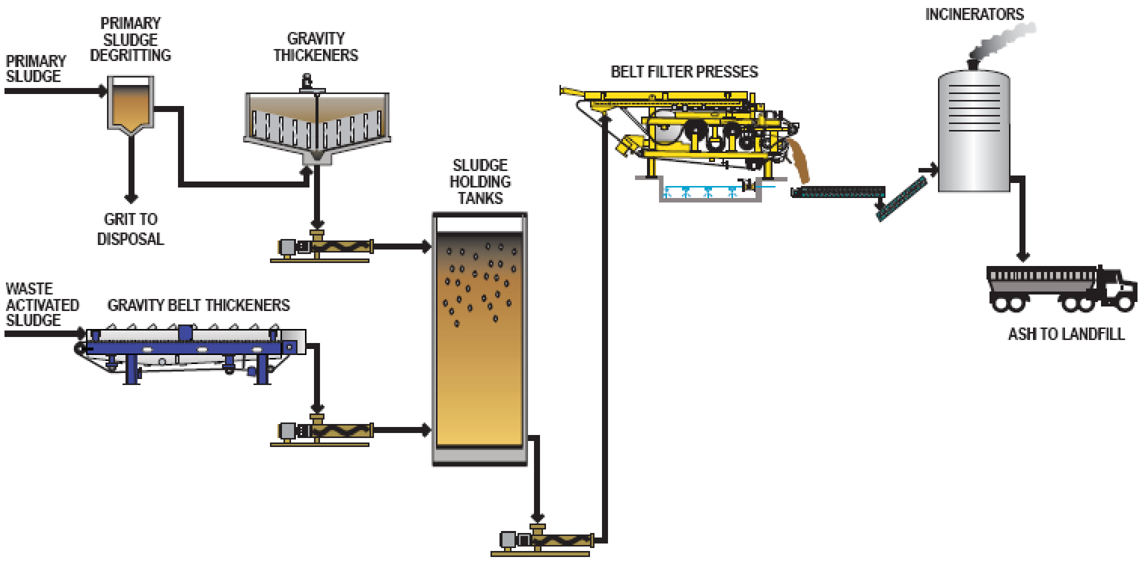
Primary sludge is degritted and thickened by gravity. WAS is thickened on gravity belt thickeners. After thickening, the solids are mixed in sludge holding tanks, conveyed to belt presses for dewatering, and incinerated. Ash is hauled to a landfill.

The GBF is rated for a peak month flow of 49.2 mgd. The design peak month BOD load is 103,110 lb/day, while the peak month design TSS load is 89,460 lb/day.

TABLE 2-8
Existing GBF Solids Processing Components

Process or Facility	Equipment	Capacity
Primary Treatment		
Primary sludge and grit pumping	Six 20 hp pumps, 300 gpm each	1.73 mgd with two pumps out of service
Primary sludge degritting	Four teacup degritters, 400 gpm each	2.3 mgd with all degritters online
Grit classifiers	Two dewatering belt classifiers, 10 yd^3/hr each	20 yd^3/hr with all classifiers online
Primary sludge and scum pumps	Eight 15 hp pumps, 340 gpm each	1.96 mgd with four pumps out of service
North Complex Secondary Treatment		
WAS pumps	NA	WAS conveyed from RAS pump discharge lines
South Complex Secondary Treatment		
WAS pumps	Six 5 hp pumps, 200 gpm each	1.15 mgd with 2 pumps out of service
Solids Processing		
Primary sludge thickening	Four gravity thickeners, 0.12 MG each, 1,590 ft^2 each	3,200 gpm (4.61 mgd) with all units in service
	Solids loading: 24 lb/day/ft^2 maximum	152,640 lb DS/day with all units in service
	Hydraulic loading: 800 gpm (1.15 mgd) per unit	
	Three thickened sludge pumps (1 standby) 150 gpm each	
	Four thickened sludge pumps (2 standby), 160 gpm each (0.23 mgd each)	
WAS thickening	Three gravity belt thickeners, 3 m belt width	270,000 lb DS/day at 1% solids (2,250 gpm (3.24 mgd) with all gravity belt thickeners in service)
	Hydraulic loading: 250 gpm/m maximum	
	Three thickened WAS pumps: 220 gpm each (0.32 mgd each)	
Sludge holding tanks	Two 36 × 36 × 36 ft tanks, 348,000 gal. each	348,280 lb DS at 6% solids with both tanks in service
	Gas mixing system	
Sludge dewatering	Four grinder/feed pumps, 150 gpm each (0.22 mgd each)	600 gpm (0.86 mgd) with all units in service
	Four belt filter presses, 2 m belt width	278,400 lb DS/day total. 69,600 lb DS/day/unit maximum
Incinerators	Two multiple hearth incinerators, seven hearths each	69,600 lb DS/hr each at 25% solids, 8,800 lb/hr moisture loading each

FIGURE 2-2
GBF Solids Schematic



2.8 Solids Loads

2.8.1 De Pere Facility Loads

The DPF does not have primary clarifiers, so no primary sludge is produced. Solids that typically would be removed in a primary clarifier enter the aeration basins and are removed as part of the WAS. WAS production at the DPF has averaged 37,947 lb DS/day from January 2006 to July 2008 as shown in Table 2-9. Note that solids loadings for both the DPF and GBF for 2009 and 2010 are presented in the Flows and Loads technical memorandum (Appendix 2-2). The peak month (peak 30-day rolling average) WAS production during that period was 50,314 lb DS/day, in March 2007.

Figure 2-3 shows seasonal WAS production at the DPF. The average solids content of the WAS from January 2006 to July 2008 was 1.05 percent.

The recommended alternative from the *Facilities Plan for Regional Wastewater Management in the South Service Area* (November 2006) provides for all solids processing to be done at the GBF. Consequently, historical loads to existing De Pere solids processes are not documented here, as the facilities have been decommissioned.

TABLE 2-9
DPF WAS Production

	January 2006–July 2008	2006	2007	January—July 2008
Average load, lb DS/day	37,947	36,442	38,789	39,083
Average solids concentration (% DS)	1.05	1.03	1.07	1.05
Peak month load, lb DS/day	50,314	40,227	50,314	45,920

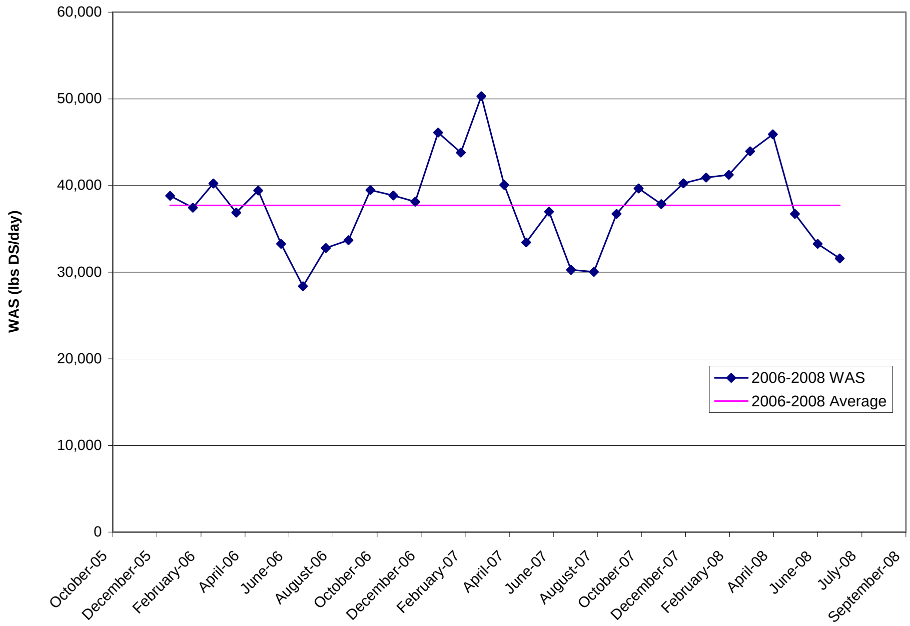
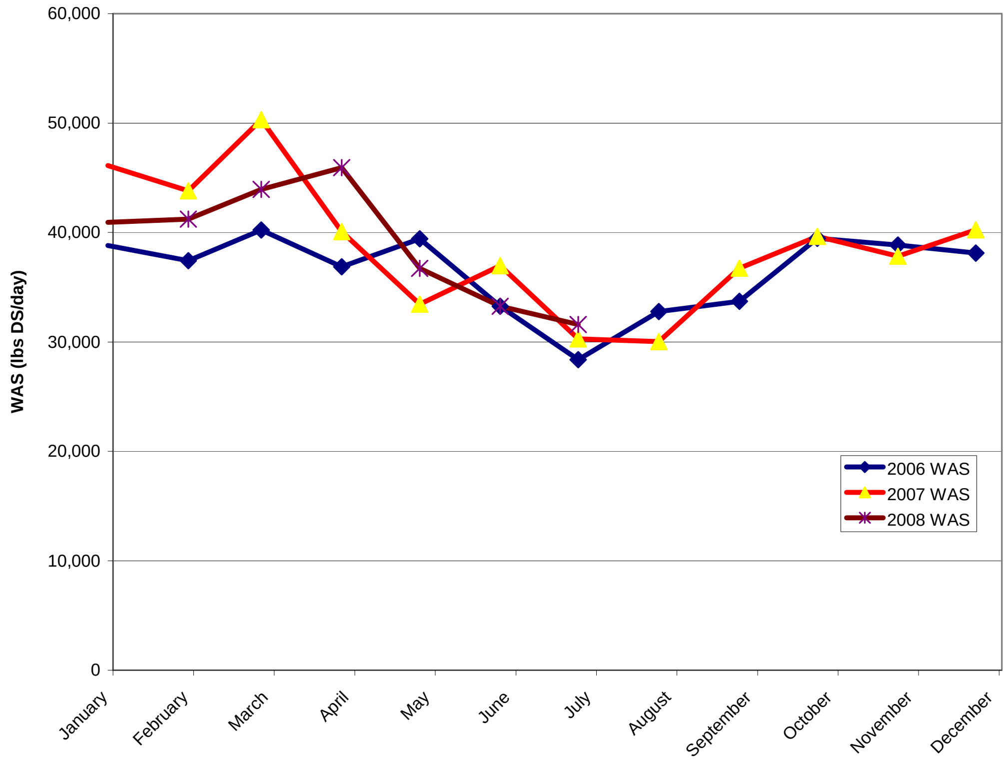


FIGURE 2-3
DPF Seasonal Waste Activated Sludge Production



2.8.2 Green Bay Facility Loads

Green Bay Facility Primary Sludge Loads

The average primary sludge load to the gravity thickeners was 40,909 lb DS/day from January 2006 through July 2008 (Table 2-10). The maximum month primary sludge load to the gravity thickeners during that period was 50,415 lb DS/day, in January 2006.

Figure 2-4 shows seasonal primary sludge load to the gravity thickeners from 2006 through July of 2008. There is no consistent seasonal variation in primary sludge production.

Green Bay Facility Waste Activated Sludge Loads

Table 2-11 shows the WAS load to the gravity belt thickeners. The average WAS load for January 2006 to July 2008 was 25,923 lb DS/day. The maximum month WAS load was 33,036 lb DS/day, occurring in March 2007. Figure 2-5 shows the seasonal variation of WAS load to the gravity belt thickeners. WAS production appears to peak during January and February.

TABLE 2-10
GBF Thickened Primary Sludge Production

	January 2006–July 2008	2006	2007	January–July 2008
Average load, lb DS/day	40,909	40,573	41,362	40,709
Peak month load, lb DS/day	50,415	50,415	46,896	46,410

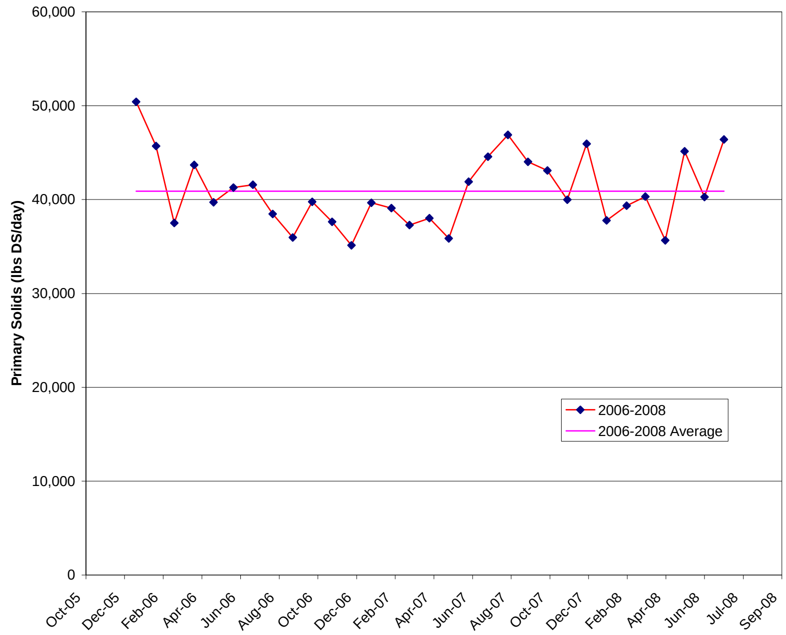


FIGURE 2-4
GBF Seasonal Thickened Primary Sludge Production

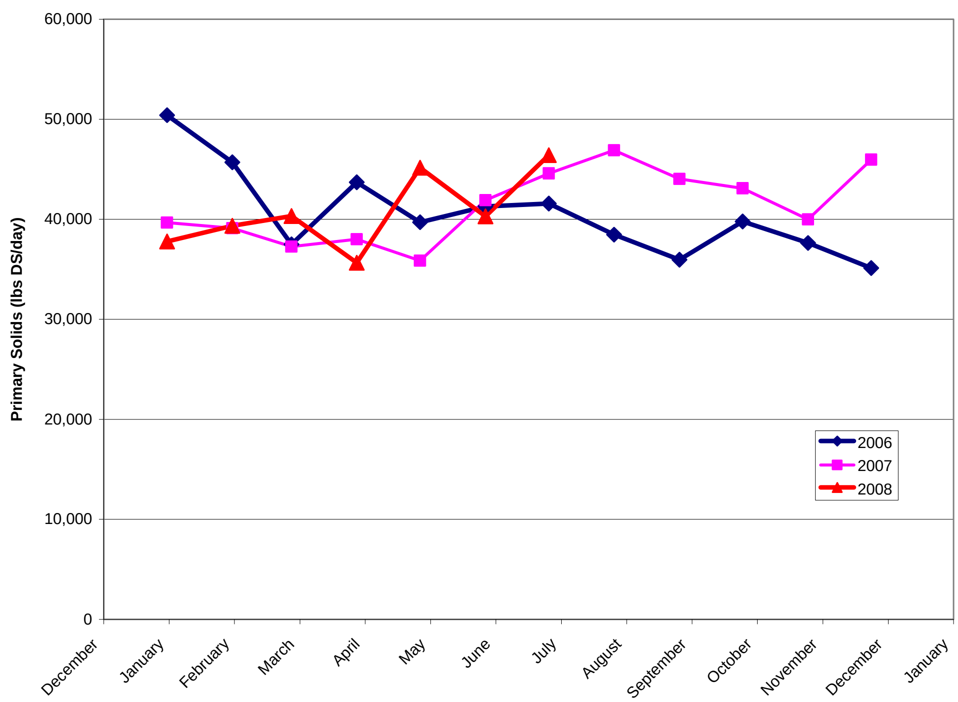


TABLE 2-11
GBF Thickened WAS Production

	January 2006–July 2008	2006	2007	January–July 2008
Average load, lb DS/day	25,923	24,614	26,456	27,253
Peak month load, lb DS/day	33,036	29,276	33,036	31,685

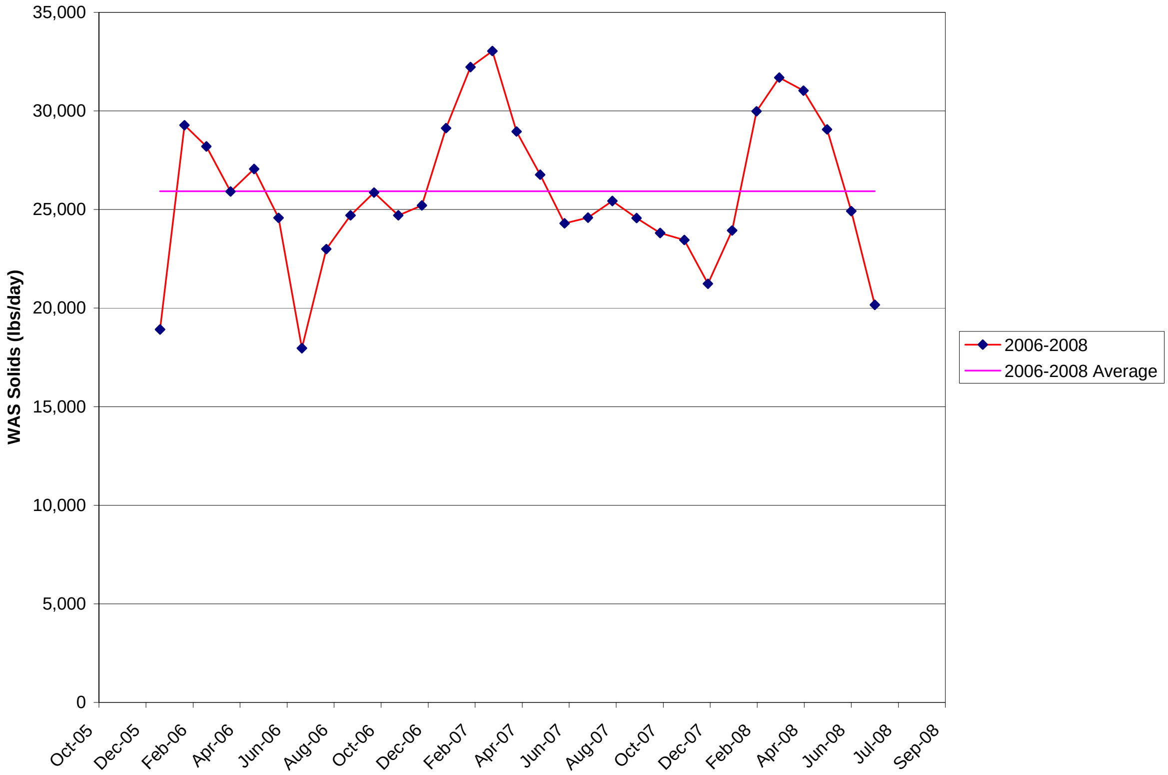
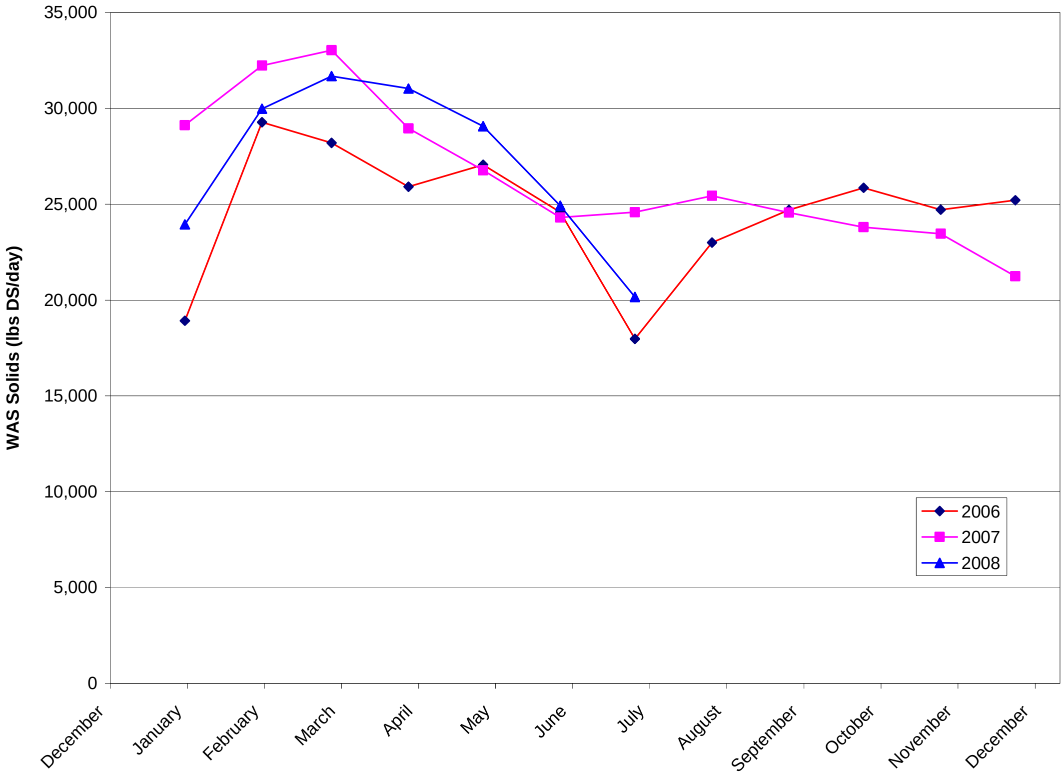


FIGURE 2-5
GBF Seasonal Thickened Waste Activated Sludge Production

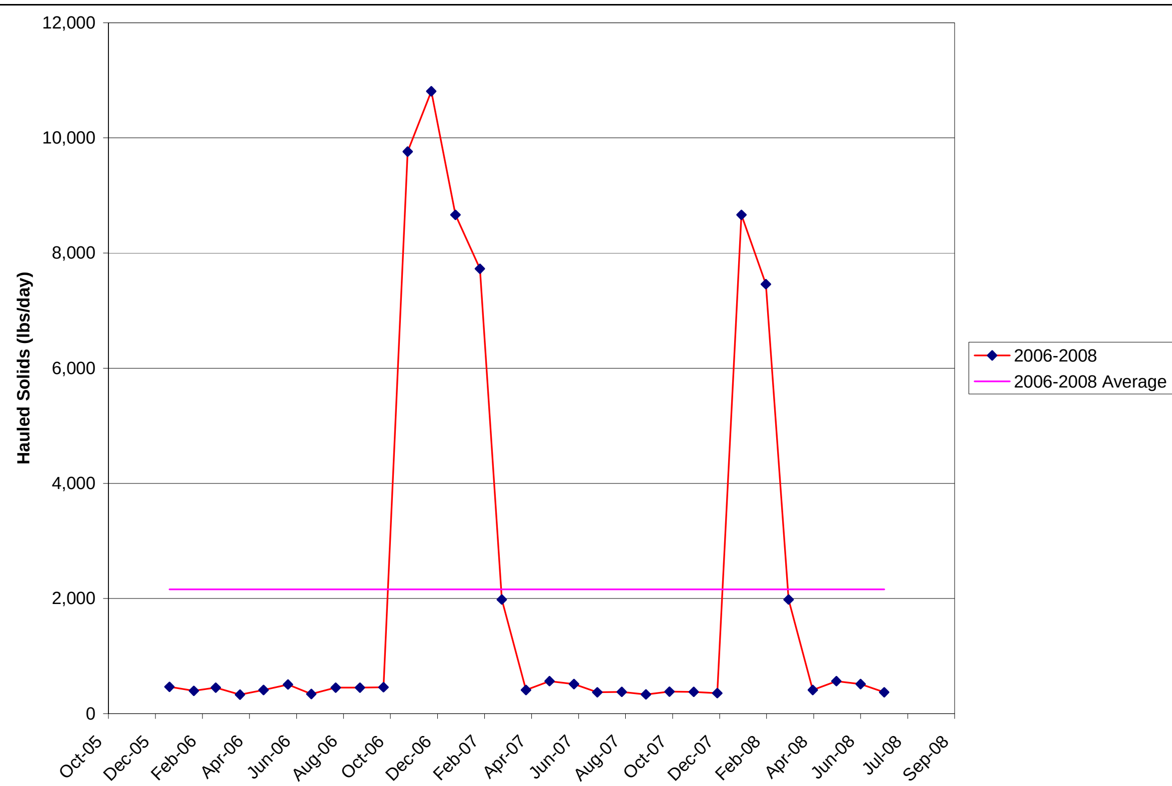


Green Bay Facility Hauled Solids

Thickened solids from the gravity thickeners (thickened primary sludge) and gravity belt thickeners (thickened WAS) are combined in the sludge holding tanks and fed to the belt filter presses for dewatering. Hauled solids, which are primarily solids from other wastewater treatment facilities, are also combined with the thickened solids before dewatering in the belt filter presses. Hauled solids accounted for as much as 10 to 15 percent of the solids load to the belt filter presses during the winters of 2006 and 2007 because the Heart of the Valley WWTP was hauling solids while its solids system was being upgraded. Hauled solids make up only about 1 percent of solids load during the rest of the year. Table 2-12 shows the hauled solids load to the belt filter presses. The average hauled solids load for 2006 to July 2008 was 2,156 lb DS/day. The maximum month hauled solids load was 10,810 lb DS/day, in December 2006.

TABLE 2-12
GBF Hauled Solids Load

	January 2006–July 2008	2006	2007	January–July 2008
Average load, lb DS/day	2,156	2,069	1,837	2,851
Peak month load, lb DS/day	10,810	10,810	8,664	8,664



Green Bay Facility Belt Filter Press Loads

Table 2-13 shows the total solids load to the belt filter presses. The average total solids load for 2006 to July 2008 was 61,964 lb DS/day. The maximum month total solids load was 72,836 lb DS/day, occurring in February of 2007.

TABLE 2-13
GBF Combined Solids to Belt Filter Presses

	January 2006–July 2008	2006	2007	January–July 2008
Average load, lb DS/day	61,964	61,157	62,148	63,033
Average feed concentration, % solids	5.3	5.4	5.0	5.4
Average volatile solids, % VS	4.2	4.3	3.9	4.4
Peak month load, lb DS/day	72,836	70,295	72,836	67,734

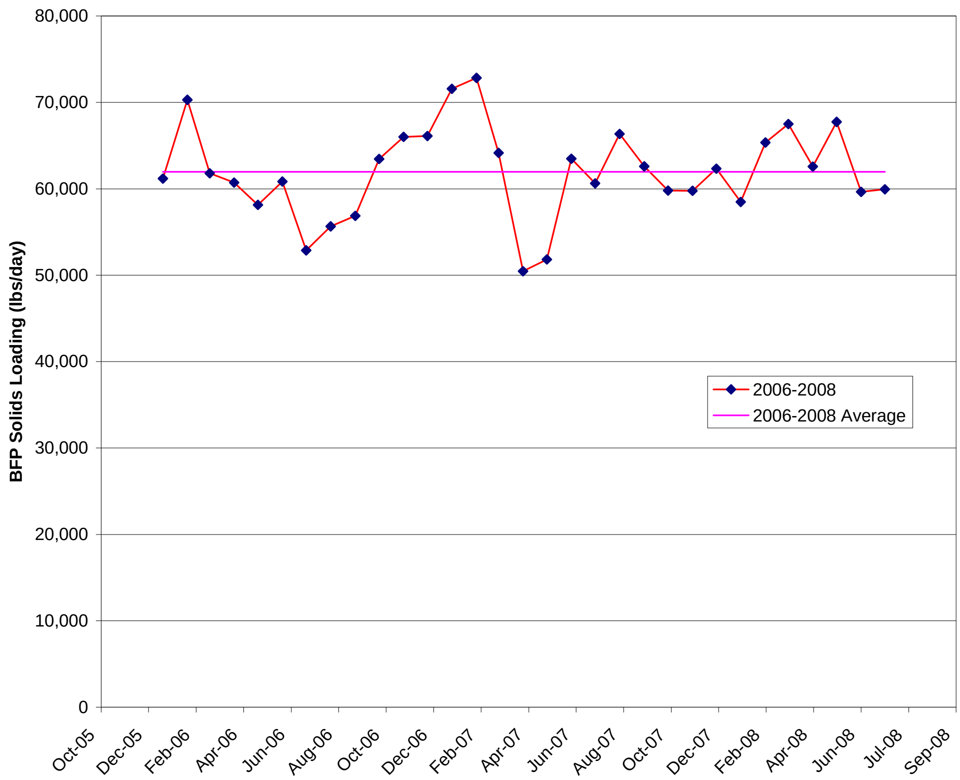


Figure 2-6 lists the seasonal variation of total solids load to the belt filter presses. Solids loads are somewhat higher in January and February because of increased WAS loads and hauled solids.

Figure 2-7 summarizes the composition of solids going to the belt filter presses. During most of the year, thickened primary sludge accounts for 60 to 70 percent of total solids whereas thickened WAS accounts for 30 to 40 percent, with a negligible contribution from hauled solids. During winter, hauled solids can be 10 to 15 percent of total solids whereas thickened WAS accounts for 35 to 40 percent and thickened primary sludge for 50 to 55 percent.

FIGURE 2-6
GBF Seasonal Combined Solids to Belt Filter Presses

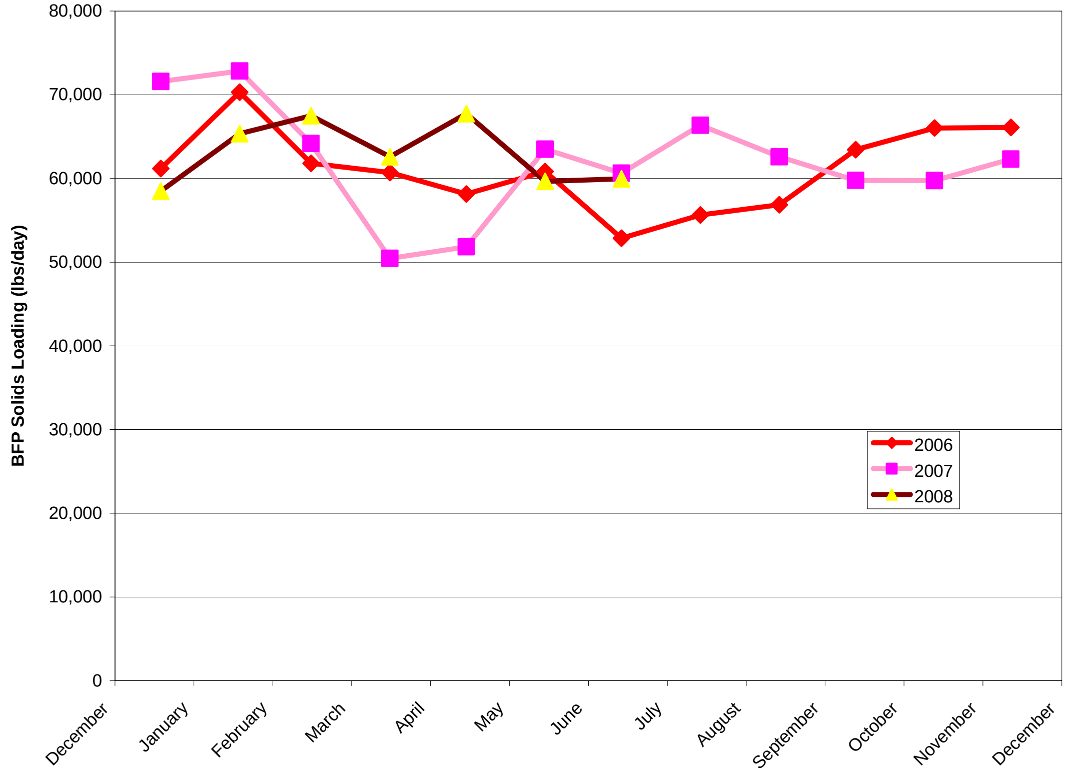
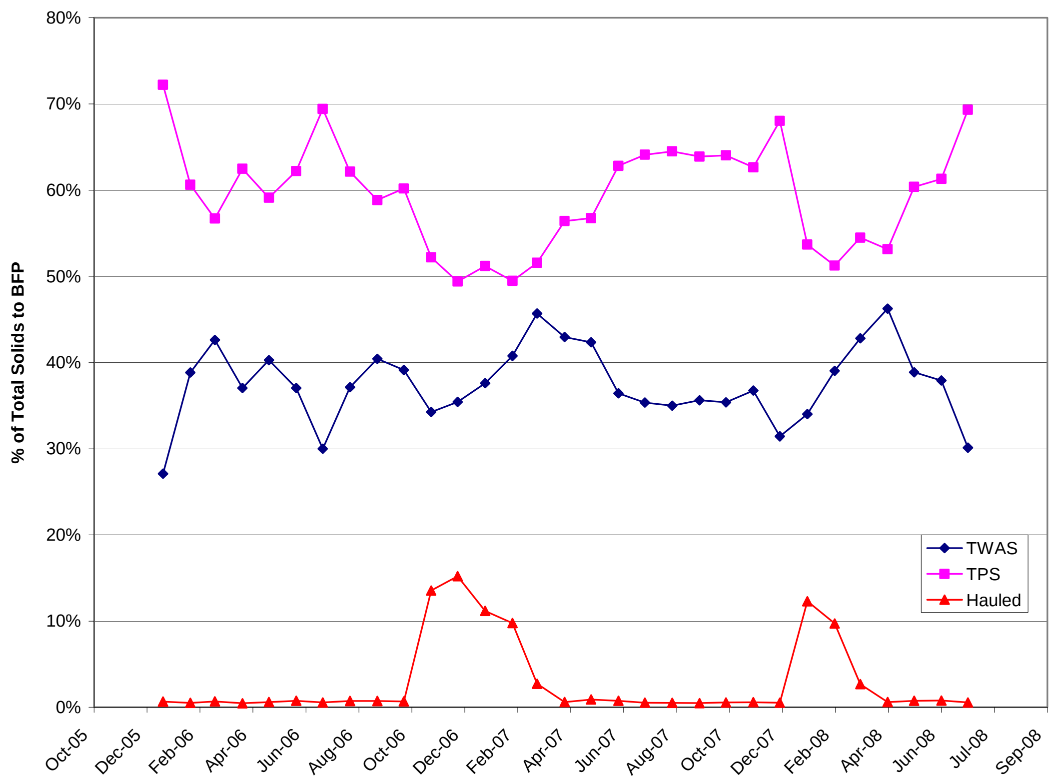


FIGURE 2-7
GBF Solids Composition to Belt Filter Presses

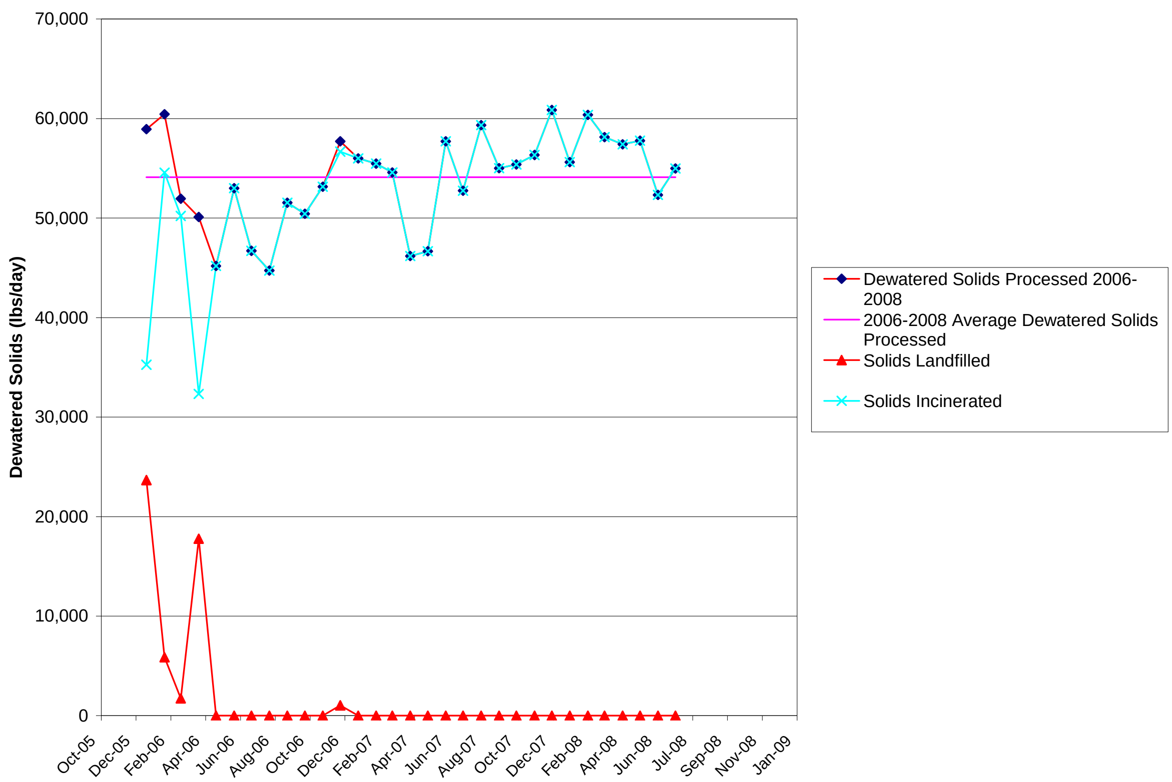


Green Bay Facility Dewatered Solids

After dewatering, solids are conveyed to the incinerators. The ash from the incinerators is hauled to a landfill. During an incinerator upgrade project, some dewatered solids were hauled to the landfill instead of incinerated in early 2006 (1,517,264 lb DS total). Table 2-14 summarizes the dewatered solids processed. The average dewatered solids processed for January 2006 to July 2008 was 54,089 lb DS/day. The maximum month dewatered solids processed was 60,865 lb DS/day, occurring in December of 2007. The average ash hauled to landfill was 10,558 lb DS/day and the maximum month for solids hauled to landfill was 23,671 lb/day in January 2006.

TABLE 2-14
GBF Dewatered Solids Processed

	January 2006–July 2008	2006	2007	January–July 2008
Dewatered solids average, lb DS/day	54,089	51,988	54,691	56,661
Dewatered solids max month, lb DS/day	60,865	60,430	60,865	60,361
Ash to landfill average, lb DS/day	10,558	9,793	11,498	10,259
Ash to landfill peak month, lb DS/day	13,745	11,375	13,745	10,938
Dewatered solids to landfill average, lb DS/day	1,616	4,174	0	0
Dewatered solids to landfill peak month, lb DS/day	23,671	23,671	0	0



2.8.3 Green Bay Facility Performance

WAS Thickening

Figure 2-8 shows that the WAS loading on the gravity belt thickeners averaged 32,293 lb DS/day. The maximum month loading rate was 40,826 lb DS/day (340 gpm at 1 percent solids) or 570 lb DS/m/hr with one unit online. The design capacity of each gravity belt thickener is 750 gpm/unit and 1,500 to 2,400 lb DS/m/hr. The average polymer dose was 2.3 lb/dry ton solids from 2006 to July 2008.

FIGURE 2-8
GBF WAS Loading to Gravity Belt Thickeners

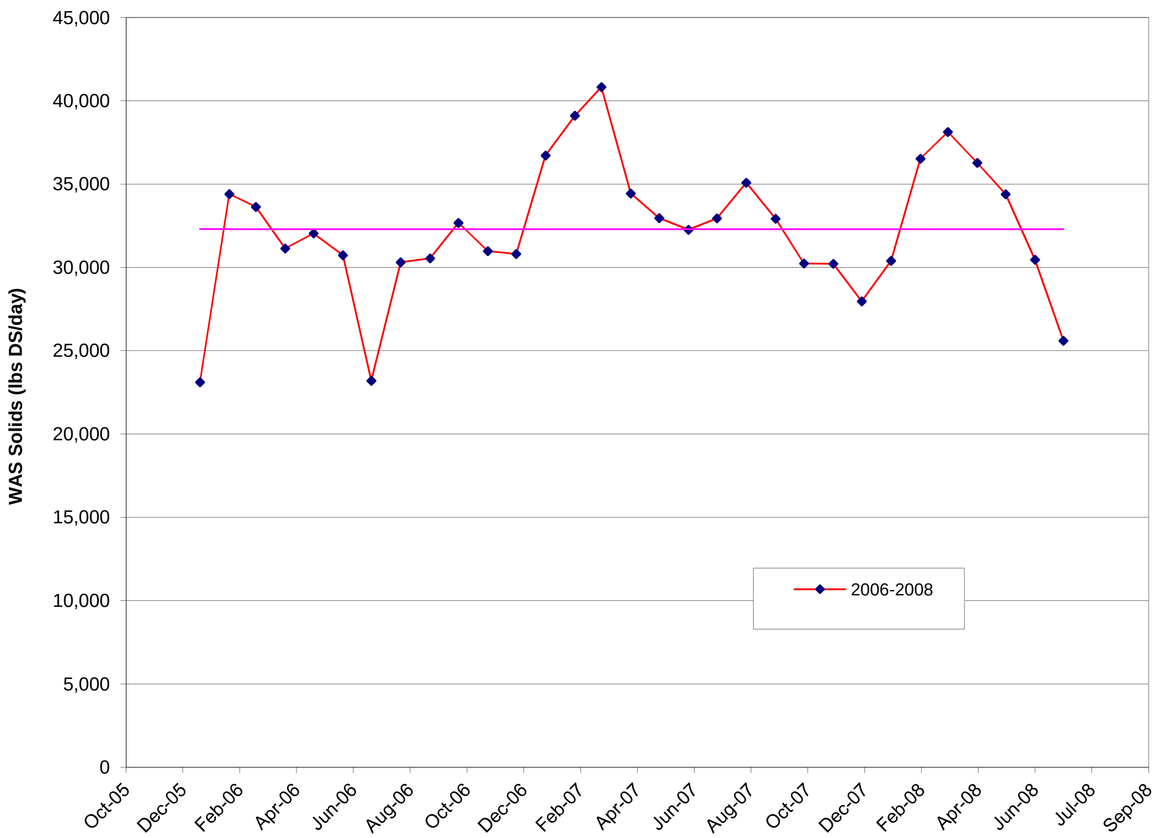


Figure 2-9 shows that the gravity belt thickeners consistently produced thickened WAS at 6 to 7 percent dry solids concentration. For the period January 2006 through July 2008, the average was 6.3 percent dry solids. Gravity belt thickener performance appears be fairly consistent, but it did decrease slightly during the period March through May.

Figure 2-10 shows the gravity belt thickeners solids capture performance ranged from 68 to 82 percent, and averaged 76.6 percent. Capture efficiency typically decreased during the period April to September.

FIGURE 2-9
Gravity Belt Thickener Performance

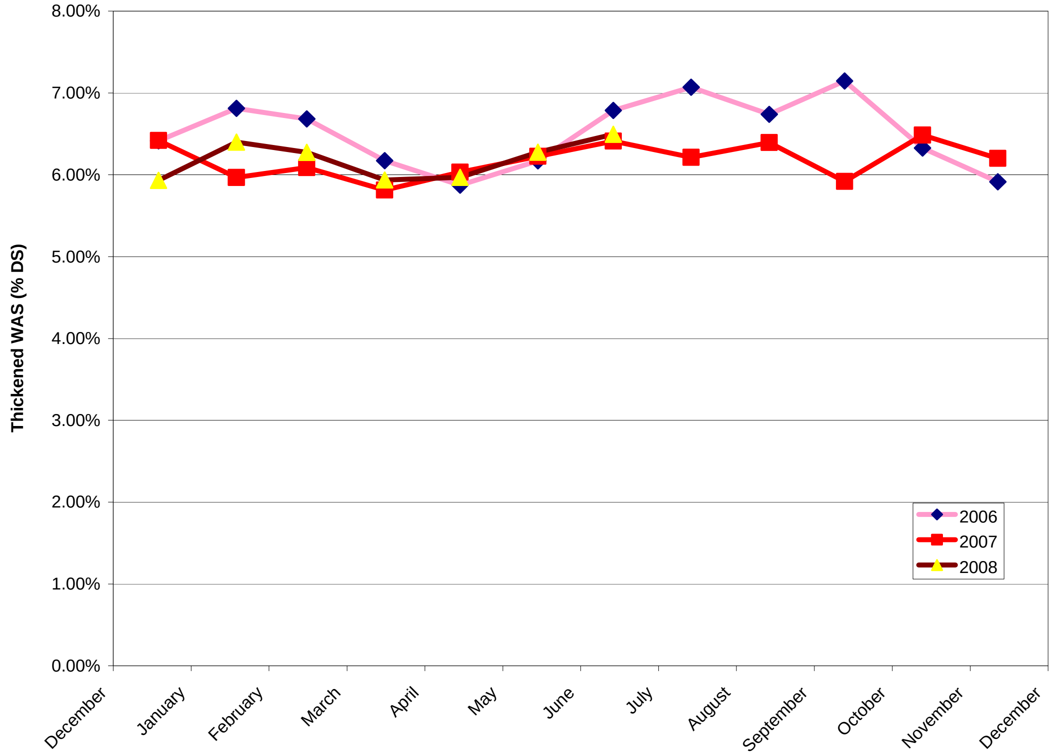
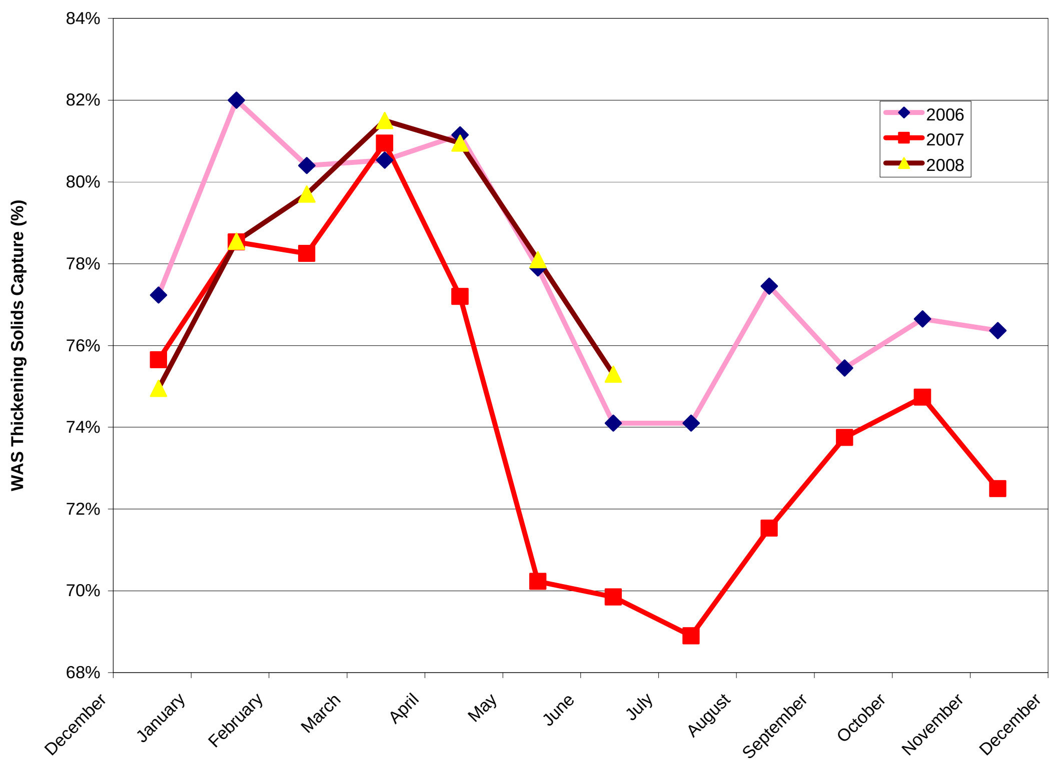


FIGURE 2-10
GBF GBT Solids Capture



Primary Sludge Thickening

Figure 2-11 shows the solids loading to the gravity thickeners averaged 17 lb DS/day/ft^2. The maximum month solids loading was 22 lb DS/day/ft^2 in August, 2006 and the maximum day solids loading rate was 27 lb DS/day/ft^2. The hydraulic load averaged 390 gpd/ft^2 with a maximum month of 410 gpd/ft^2. In May 2006, the maximum day hydraulic loading was 656 gpd/ft^2. The design maximum hydraulic loading is 725 gpd/ft^2 and the design maximum solids loading rate is 24 lb DS/day/ft^2. The maximum capacity of the gravity thickeners is 152,640 lb DS/day with all four thickeners in service (1,590 ft^2 each).

FIGURE 2-11
GBF Gravity Thickeners Loading

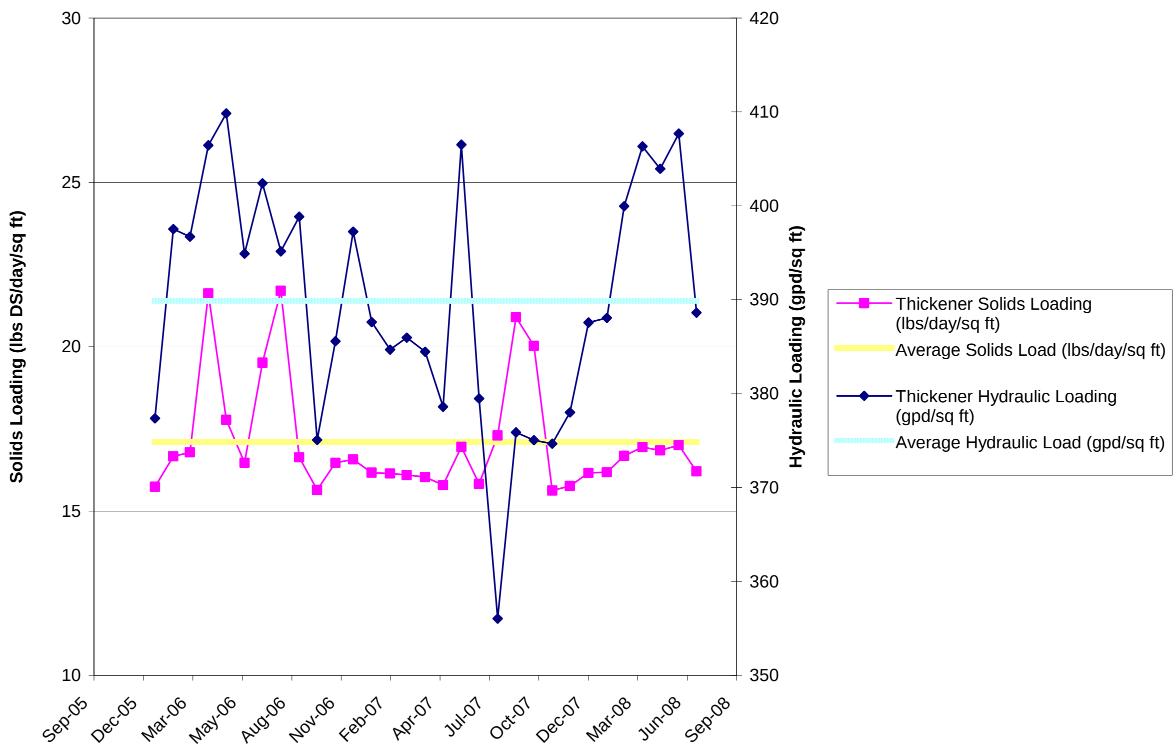


Figure 2-12 shows that the gravity thickeners produce thickened primary sludge at 4 to 7 percent solids concentration, averaging 5.1 percent solids. The solids concentration was lower during the period from April to October, and higher during winter.

Sludge Dewatering

Figure 2-13 shows the hydraulic loading to the belt filter presses (2 m wide each). The average total flow rate was 104 gpm, while the average unit loading rate was 26.5 gpm/m, indicating that, on average, normally two belt filter presses are in service. The maximum day hydraulic load was 188 gpm, while the maximum day unit loading rate was 60 gpm/m. The maximum month hydraulic load processed was 129 gpm (August 2007), while the maximum month unit loading rate was 32.8 gpm/m (July 2007). The average polymer dose was 8.4 lb/dry ton solids from 2006 to July 2008. The maximum design capacity of the belt filter presses is 150 gpm each, or 75 gpm/m.

FIGURE 2-12
GBF Gravity Thickeners Performance

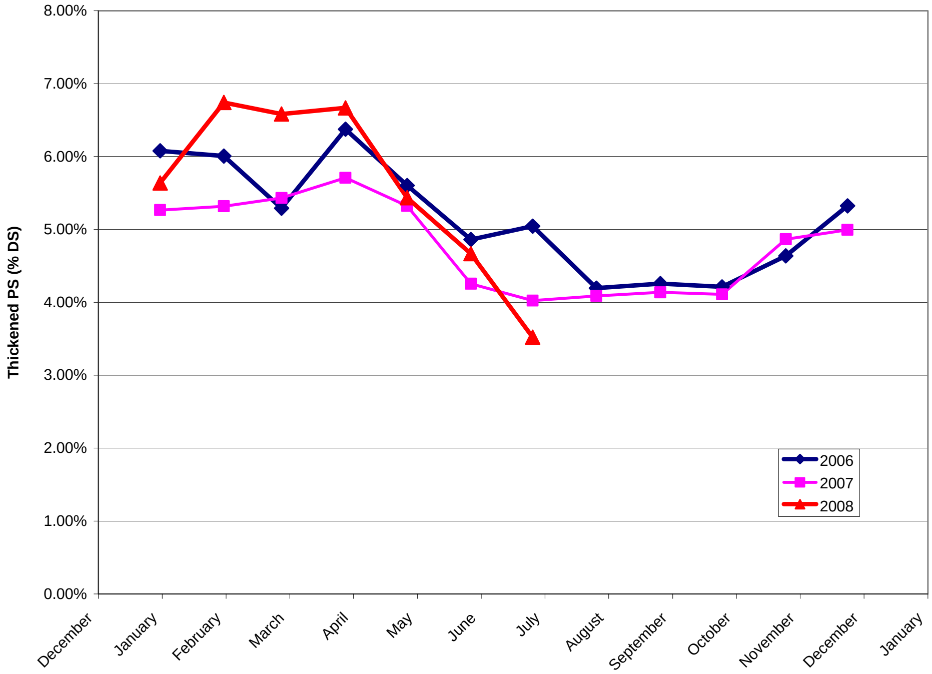


FIGURE 2-13
GBF Belt Filter Press Loading

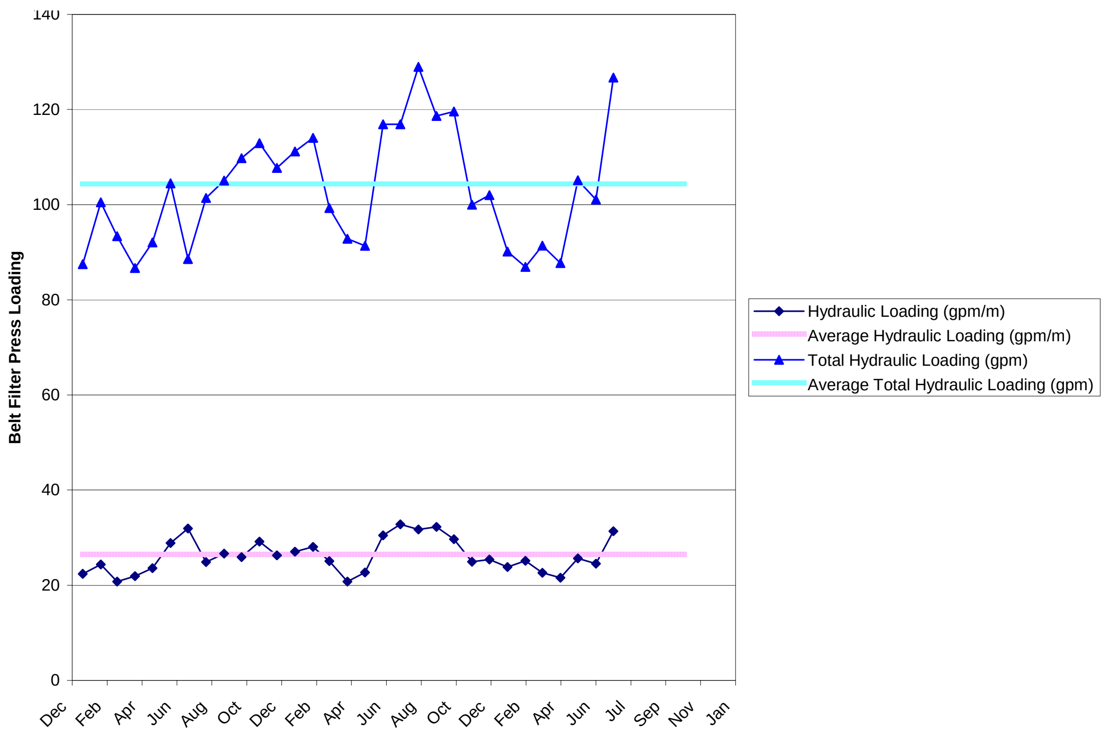
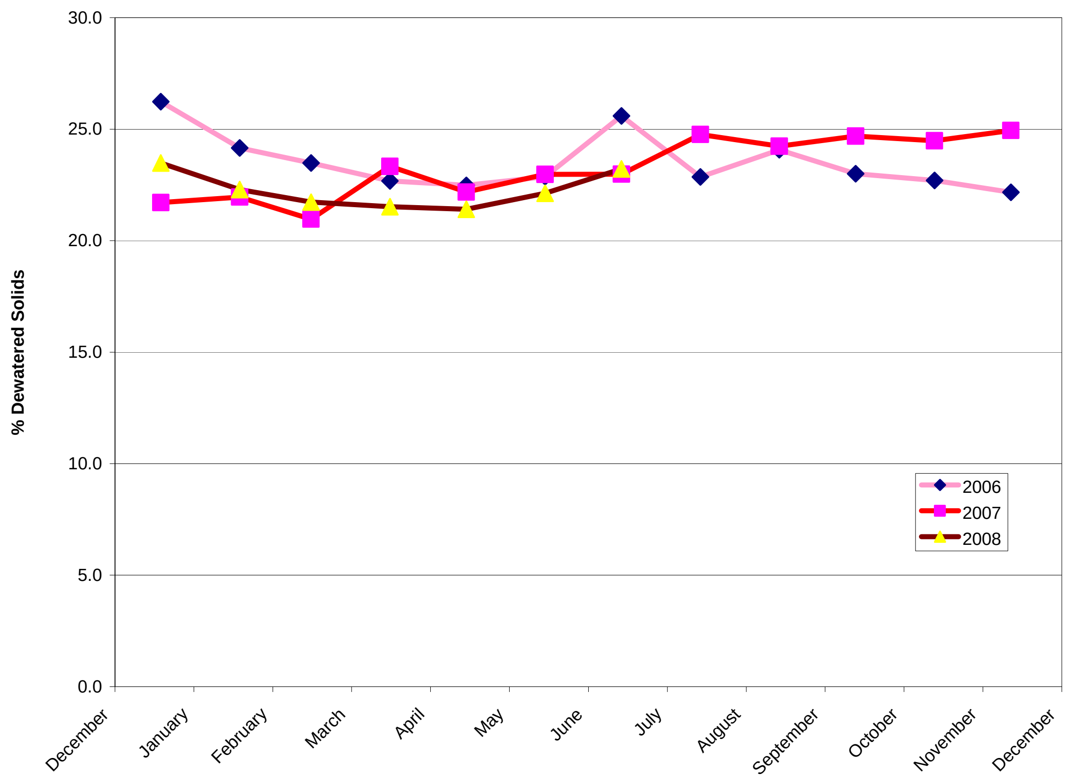


Figure 2-14 shows that the belt filter presses produce dewatered solids at 21 to 26 percent solids concentration, averaging 23.1 percent solids for the period.

FIGURE 2-14
GBF Belt Filter Press Performance



Incineration

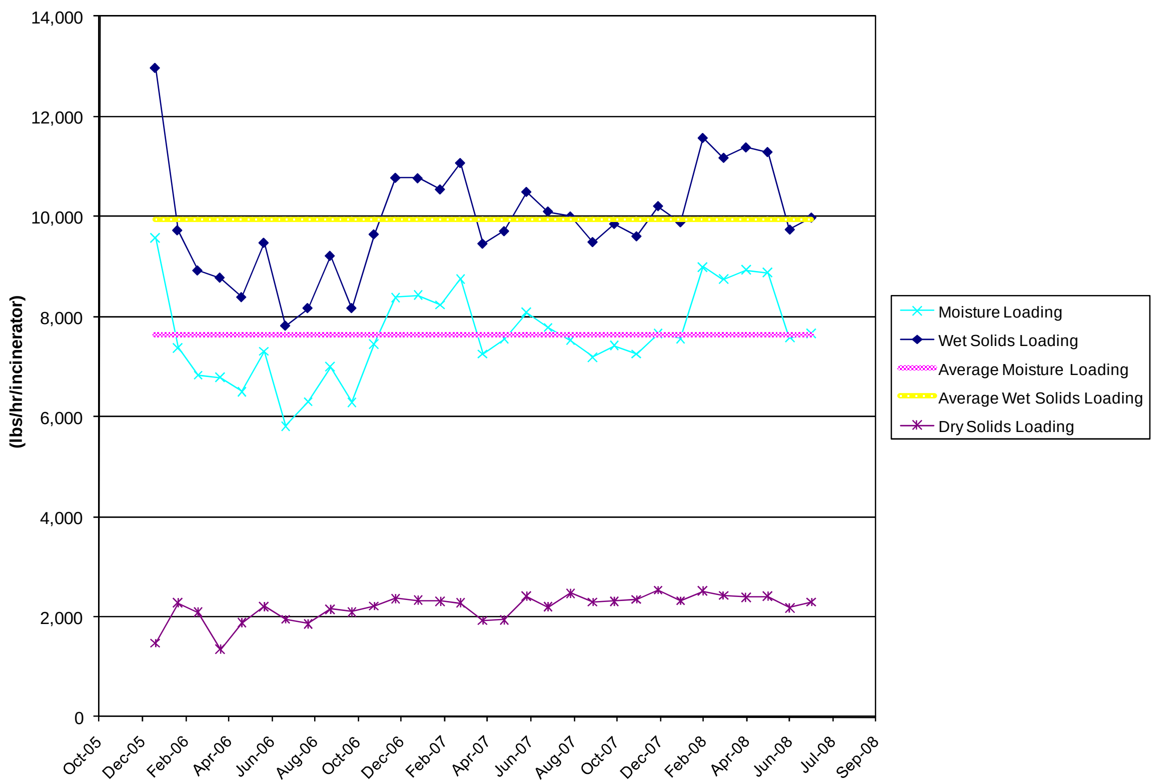
Figure 2-15 shows the solids and moisture unit loadings to the incinerators. Usually, two incinerator are used.

The overall average load to the incinerators was 9,560 wet lb/hr. The maximum day incinerator loading was 14,615 wet lb/hr. One incinerator was used to process the maximum load. The maximum month unit loading was 11,248 lb/hr with one incinerator operating.

The design moisture loading capacity of each incinerator is 19,600 lb/hr. The maximum day moisture load was 11,571 lb/hr. One incinerator processed this maximum moisture load. The maximum month moisture load was 8,841 lb/hr for one incinerator. The overall average moisture load was 7,341 lb/hr.

Figure 2-15 shows that the moisture loading to the incinerators has increased since 2006 and that the dry solids loading has remained steady at about 2,000 lb/hr.

FIGURE 2-15
GBF Incinerator Unit Loading



2.8.4 Condition Assessment

Green Bay Facility

Most of the solids processing equipment at the GBF is either about 20 or 40 years old (Table 2-15). The belt filter presses, incinerators, and associated equipment will be replaced as part of the recommended alternative of this facilities plan. The gravity thickeners and gravity belt thickeners will be rehabilitated or replaced as needed.

2.8.5 De Pere Facility

The DPF solids processing equipment has been fully decommissioned and solids are pumped to the GBF as per the recommendation in the *Facilities Plan for Regional Wastewater Management in the South Service Area* (November 2006). The belt filter presses will remain in service for backup as needed. These presses are only about 10 years old (Table 2-16).

TABLE 2-15
GBF Solids Processing Equipment

Equipment	Units and Type	Size, Each Unit	Motor	Year Installed	# Units in Operation, Typical
Primary sludge pumps	Six torque flow pumps	300 gpm at 46 ft each	20 hp; constant speed	1974	4
Primary sludge degritting	Four teacups, cyclone degritters	400 gpm	NA	1992	4
Primary sludge degritting	Two dewatering conveyor classifiers	10 yd^3/hr	NA	1992	2
Primary sludge and scum pumps	Eight torque flow pumps	340 gpm at 45 ft	15 hp; variable frequency	1974	4
South complex WAS pumps	Four screw-induced centrifugal pumps	200 gpm at 44 ft	5 hp; variable frequency	1992	2
Gravity thickeners	Four center feed circular	45 ft dia mechanisms 10 ft SWD	NA	1974 (2); 1992 (2)	4
Thickened primary sludge pumps	Four progressing cavity pumps	160 gpm at 20 psi	15 hp; constant speed	1994	2
	Three progressing cavity pumps	150 gpm at 20 psi	15 hp; VFD	1974	2
GBT WAS feed pumps	Three dry-pit centrifugal pumps	800 gpm at 15 ft	10 hp; variable frequency	1992	1
Gravity belt thickeners	Three gravity belt thickeners; belt width: 3 m	750 gpm	5 hp	1992	1
GBT thickened WAS pumps	Three progressing cavity pumps	220 gpm at 230 psi	15 hp; variable frequency	1992	1
Sludge holding tank gas compressors	Three liquid ring compressors	560 SCFM at 14 psi	75 hp; constant speed	1992	1 holding tank operates
Sludge holding tank gas mixing system	Sixteen Shearfuser diffusers per tank	4.85 SCFM/ 1,000 gal.	NA	1992	1 holding tank operates
Sludge grinders	Four grinders;	190 gpm @ 5% solids	10 hp	1974	2
Belt press feed pumps	Four progressing cavity pumps	150 gpm at 70 ft	15 hp; variable frequency	1992	2
Belt filter presses	Four presses; belt width: 2 m	150 gpm	3 hp	1992	2
Incinerators	Two multiple hearth incinerators w/Venturi Pak emission control	Seven hearths; 19,600 lbs/hr moisture load		1974	2

TABLE 2-16
DPF Solids Processing Equipment

Equipment	Units and Type	Size, Each Unit	Motor	Year Installed	# Units in Operation, typical
1st stage RAS pumps	Five centrifugal pumps	2,500 gpm at 44 ft	50 hp; variable speed	1975	2
1st stage WAS BFP pumps	Three progressive cavity positive displacement	450 gpm at 67 ft	30 hp; variable speed	2000	intermittent
1st stage WAS Transfer pumps	Two progressive cavity positive displacement pumps	450 gpm	30 hp; variable speed	2000	1
2nd stage WAS pumps	Two centrifugal pumps	100 gpm at 98 ft	20 hp; variable speed	1975	intermittent
2nd stage RAS pumps	Five centrifugal pumps	2,500 gpm at 62 ft	75 hp; variable speed	1975	intermittent
Belt filter presses	Three 30 hp pumps, 450 gpm each	1.3 mgd with one pump out of service (108,420 lb DS/day @ 1% solids)	5 hp; variable speed	2000	intermittent
	Two belt filter presses, 2 m belt width	1,800 lb DS/hr per unit			
Interplant WAS transfer pumps and force mains	Two 40 hp pumps; 650 gpm each	0.94 mgd with one pump out of service (78,400 lb DS/day at 1% solids)	40 hp; variable speed	2009	1

CHAPTER 3

Future Conditions

3.1 Introduction

3.1.1 Regional Treatment

The recommended alternative (Alternative E-6) of the *Facilities Plan for Regional Wastewater Management in the South Service Area* (November 2006) represents a load-sharing operational scheme, to maximize use of treatment units at both the GBF and the DPF. It involves conveying some of the influent flow from the DPF to the GBF for treatment. Mill wastewater from one of the De Pere area paper mills were removed from the gravity interceptor system and conveyed directly to DPF aeration basins by force main. The recommended alternative also provided for conveyance of all waste activated sludge (WAS) from the DPF to the GBF for centralized solids processing. As a result, the solids processing train of gravity belt thickening, plate and frame presses, and multiple hearth incineration at the DPF was decommissioned, but the belt filter press dewatering and appurtenant systems and facilities were be retained for emergency standby use. Table 3-1 summarizes the solids processing components remaining after implementation of the recommended alternative.

TABLE 3-1
De Pere Solids Processing Components

Facilities	Equipment	Capacity
WAS transfer pumps	Two 40 hp pumps: 650 gpm and 545 gpm	0.94 mgd with one pump out of service (78,400 lb DS/day at 1% solids)
Belt press dewatering	Three 30 hp pumps, 450 gpm each Two belt filter presses, 2 m belt width	1.3 mgd with one pump out of service (108,420 lb DS/day at 1% solids) 1,800 lb DS/hr per unit

Subsequent advanced facilities planning efforts and engineering design provided definition of the recommended alternative, including an enhancement to the recommended plan to include a redundant WAS conveyance line between De Pere and Green Bay. That redundant line can be used to convey part of the mill wastewater from the DPF to the GBF. This capability enhances the ability to balance loads, maintain biological phosphorus removal, and provided relief for the DPF for construction.

The design of upgrades, including pumping facilities and pipelines required to convey part of the raw wastewater and mill wastewater and all the WAS from the DPF to the GBF, was completed in January 2009. The project was constructed and became operational in 2010.

3.2 Wastewater Flows and Loads

3.2.1 Solids Load upon Startup of Solids Processing Facilities

Loads from May 2010 to May 2011 were used in estimating future solids loadings. It was assumed that these loads from residential, commercial, and smaller industries will increase in proportion to the projected increase in population. The Brown County Planning Department estimates that population in the GBMSD service area will increase by about 1 percent per year for the next 20 years. The projected loads from each of the 7 major industries served by GBMSD were based on a survey which projected loads from these major industries will be flat throughout the planning period. Table 3-2 lists the projected 2035 thickened solids loadings. Table 3-3 breaks down the 2035 average flows and loads by treatment plant and source.

See the Flows and Loads Technical Memorandum in Appendix 2-2 for a detailed discussion of how the loadings were estimated.

TABLE 3-2
2035 Design Solids Loading

	2035 Average, lb/day (dtpd)	2035 Maximum Month, lb/day (dtpd)
Total Raw Sludge to Thickening	**120,532 (60.3)**	
Primary sludge (~1% TS)	45,470 (22.7)	
Thickened PSD (~6% TS)	**40,923 (20.5)**	
De Pere pumped WAS (~1% TS)	24,592 (12.3)	
Green Bay WAS (~1% TS)	50,470 (25.2)	
WAS processed (~1% TS)	75,062 (37.5)	
Thickened WAS (~6% TS)	**60,050 (30.0)**	
Total Thickened Sludge to Dewatering (~6% TS)	**100,973 (50.5)**	**127,226 (63.6)**

3.3 GBF Solids Processing Capacity Evaluation

The major GBF solids processing facilities were evaluated to determine the projected flows and loads (Table 3-4). The results do not consider standby capacity for reliability or loads beyond the maximum month condition. These factors may require adding units to maintain reliable operations.

3.3.1 Gravity Thickening

The four existing gravity thickeners provide sufficient surface area for thickening primary sludge (Table 3-4). The loading is independent of where the De Pere mill waste is treated because the mill waste treated at the GBF would be introduced downstream of the primary clarifiers, and consequently does not generate primary sludge directly. Thickened primary sludge is expected to be 6 percent solids, on a dry weight basis.

TABLE 3-3
2035 Average Flows and Loads with Mill Waste Transfer from the DPF

	Flow (mgd)	BOD (lb/day)	SS (lb/day)	WAS (lb/day)	PSD (lb/day)
DPF					
Residential/commercial	8.1	7,226	16,561		
Thilmany	1.1	7,334	579		
Sonoco	0.1	4,415	1,406		
Total Influent (residential/commercial plus industrial)	9.2	18,985	18,546	***24,592***	
GBF					
JBS Green Bay	1.0	4,792	3,312		
American Foods Group	0.5	3,922	1,295		
Bay Valley Foods	0.2	2,549	686		
Metro Waste (residential/commercial and other industries)	25.6	29,832	35,835		
Procter & Gamble	4.5	1,400	3,000		
Mill Waste (FRF) Force Main (to GBF)	1.0	19,457	1,063		
Total Influent (metro waste plus mill waste plus transfer from De Pere)	32.9	61,952	45,190	**50,470**	**45,470**
De Pere WAS Pumped from De Pere to GBF	0.4[a]			***24,592***	
Total WAS to be Processed at GBF	1.3[a]			**75,062**	
GBF + DPF	42.1	80,937	63,736		

Industrial loads are based on May 2010–April 2011 data. Major industrial loads were assumed to remain constant to the year 2035. Residential/commercial/small industrial loads are based on May 2010–April 2011 data plus 1% estimated growth to 2035.
No metro waste assumed to be transferred from DPF to GBF. All FRF mill waste assumed to be pumped to GBF.
Georgia-Pacific East and EcoFibre loads assumed to be zero. Not included in table.

[a]WAS flows assume 0.8% solids content

TABLE 3-4
Existing GBF Solids Processing Components

Process or Facility	Equipment	2035 Max Month Load	Capacity
Primary sludge thickening	Four gravity thickeners, 0.12 MG each, 1,590 ft^2 each; solids loading: 24 lb/day/ft^2 maximum; hydraulic loading, 800 gpm per unit Four thickened sludge pumps (2 standby), 160 gpm each	51,660 lb DS/day (860 gpm at 0.5% TS)	3,200 gpm with all units in service 152,640 lb DS/day with all units in service
WAS thickening	Three gravity belt thickeners, 3 m belt width; hydraulic loading: 250 gpm/m maximum (750 gpm) Three thickened WAS pumps, 220 gpm each	75,600 DS lb/day (629 gpm at 1% TS)	2,250 gpm with all gravity belt thickeners in service (270,000 lb DS/day at 1% solids)
Sludge holding tanks	Two 36 × 36 × 36 ft tanks, 348,000 gal each Gas mixing system	127,260 lb DS/day (254,000 gal/day at 6% TS)	2.7 days of thickened sludge storage at 2035 max month condition
Sludge dewatering	Four grinder/feed pumps, 150 gpm each (0.22 mgd each) Four belt filter presses, 2 m belt width	5,302 lb DS/hr (177 gpm at 6% TS)	600 gpm with all units in service; 11,600 lb DS/hr/ maximum with all units in service
Incinerators	Two multiple hearth incinerators, seven hearths each	120,897 lb DS/day; 22,897 lb water/hr at 18% TS	139,200 lb DS/day @ 25% TS; 17,600 lb/hr water total (8,800 lb/hr water each)

3.3.2 WAS Thickening

The three gravity belt thickeners provide sufficient capacity for thickening WAS from both the Green Bay and De Pere facilities (Table 3-4). Thickened WAS is expected to be 6 percent solids, on a dry weight basis.

3.3.3 Solids Dewatering

The four existing belt presses provide sufficient capacity for dewatering the thickened primary sludge and thickened WAS assuming a feed concentration of 6 percent solids. However, the dewatering performance of the belt presses has declined as the equipment has aged and the proportion of WAS increased with the transfer of WAS from the DPF. As a result, the belt presses have not been able to achieve the design dewatered cake solids content of 25 percent and actual 2011 cake solids has ranged from 17 to 19 percent solids.

3.3.4 Solids Incineration

As shown in Table 3-4, the two existing multiple hearth incinerators do not have capacity to process the projected loads because of the projected increase in loads and the decrease in dewatering performance.

3.4 Solids Markets and Disposal Options

Solids use or disposal options are identified in this section. For each feasible option, a summary assessment is provided to present an overview of the market potential including addressing potential solids users, market competition, and market drivers. The summary assessment was performed by making telephone contacts to various organizations, by collecting data over the Internet and from GBMSD, and through the collective team efforts.

3.4.1 Feasible Use or Disposal Options for Solids

Table 3-5 lists six feasible use or disposal options. There are several solids products that can be used or disposed of under each alternative. Table 3-6 lists potential solids products, including advantages and disadvantages. It also indicates the most typical end-use or disposal option from the list of options in Table 3-5 for each solids product.

3.4.2 End Use and Disposal Assessment

The following sections provide an of the overview of the market potential for each of the six viable solids end-use or disposal options, including potential solids users, market competition, and market drivers.

Agricultural Land

Market Description. Application of biosolids products on agricultural land is a well-established and routine practice throughout the state of Wisconsin. Biosolids can be applied either in liquid form or as a dewatered cake to provide nutrients for crop growth and offset the need for commercial fertilizer products. The GBMSD does not apply biosolids products to agricultural land, but several smaller wastewater treatment plants and industrial wastewater treatment plants do apply biosolids to agricultural land in Brown County. This suggests that the agricultural community is familiar with biosolids products.

Biosolids application to agricultural land is subject to regulations. The land available for application can be reduced based on seasonal restrictions, setbacks based on specific site characteristics, agronomic rates, and weather conditions that restrict the ability to access fields. Biosolids storage consisting of 180 days of storage is typically required.

Market Potential. Brown County has 41,000 cows producing manure that is managed and land-applied. About one-third of the operations are permitted by NPDES because of their size. Facilities under NPDES permits generally are more restrictive and have greater setbacks, which limits the land available for application.

Three major industries apply biosolids to land in Brown County: two packing plants and one rendering facility. These industries account for 58,000 tons of biosolids per year. According to the Brown County Agricultural Extension office, based on current phosphorus statutes (NR151 and ATCP50) the county already is over capacity with respect to agronomic rates for phosphorus. In general, expanding livestock operations (and associated manure management on agricultural land) in this area of Wisconsin have resulted in direct competition with biosolids land application.

TABLE 3-5
Viable Biosolids End Use or Disposal Options

End Use or Disposal Option	Description	Advantages	Disadvantages
Agricultural land	Injection/incorporation of biosolids into soil on farm sites used for crop growth or pasture land	Nutrients in biosolids recycled for crop growth Indirect benefit to region by reduced fertilizer costs for farmers Biosolids dewatering not required Much agricultural acreage within short distance from treatment plant	Seasonal application; storage facilities required Application rates limited by agronomic rate and requires large land acreage Average farm size is small and requires permitting and managing many sites Dependent on willingness of farmers to accept biosolids and farming practices Public acceptance related to biosolids phobia or odors Weather-dependent Complex monitoring and reporting requirements
Forested land	Application of biosolids on forested sites to provide fertilizer for tree growth Typically surface applied on mature stands from logging roads	Nutrients recycled for tree growth Biosolids dewatering not required Improves nature habitat	Seasonal application; storage facilities required Consistent application rate difficult due to rough terrain and limited trails for application vehicles Application to clear-cuts may affect tree survival due to weed and brush growth Long travel distances to application sites Requires special regulatory review and approval
Land reclamation	Application on disturbed lands at high application rates to provide sufficient organic matter for veget-ative growth	Organic matter and nutrients supports vegetative growth Reduces environmental impacts High application rates	Pretreatments to reduce risks of nutrient and pathogen runoff may be required Long travel distances to application sites Requires special regulatory review and approval
Landfill disposal (monofill, co-disposal, dedicated land disposal)	Biosolids disposed of in a landfill	Year-round operation (not weather-dependent) Reliable disposal method	Landfill space consumed Very high tipping fees

TABLE 3-5
Viable Biosolids End Use or Disposal Options

End Use or Disposal Option	Description	Advantages	Disadvantages
Soil amendment – (public contact, e.g., golf courses, landscapers, garden centers)	Application to turf grass, gardens, nurseries to provide nutrients for vegetative growth High level of pathogen reduction required since the public may come into contact with the biosolids	Potential revenue from sale of biosolids	High degree of processing required Potential liability due to public perceptions Competition with other topsoil and blended soil products Requires product development and marketing investment
Incinerator ash use as flowable fill or in concrete, cement, or asphalt products	Blending incinerator ash with aggregate or soil for use as fill material Introducing incinerator ash into construction products as a substitute to sand or coal ash	Potential revenue from sale of ash	Ash disposal other than in landfill requires special regulatory review and approval

TABLE 3-6
Biosolids Products

Biosolids Product	Description	Advantages	Disadvantages	Typical End Use or Disposal
Digested biosolids (liquid)	Liquid product with solids content of 3 to 5% TS	Nutrient content conserved Dewatering not required	Limited end uses (primarily agricultural or forested land) Large storage facilities required	Agricultural land, forested land
Digested biosolids (dewatered)	Digested biosolids dewatered to a solid material	Volume reduced	High odor potential	Agricultural land, forested land, land reclamation, landfill, soil amendment
Compost	Aerobically stabilized organics	Low odor potential Potential revenue from sale of biosolids as a soil amendment	High operating costs	Agricultural land, soil amendment
Ag-lime substitute	Alkaline stabilized biosolids with a high calcium carbonate equivalency	Increases pH of soil Soil conditioner	Potential for odor redevelopment	Agricultural land, forested land, land reclamation, landfill, soil amendment
Fertilizer	Dried biosolids used as a component in fertilizer production	Revenue from sale as fertilizer, usually based on nitrogen content	Potential for odor redevelopment High costs to produce	Agricultural land, forested land, soil amendment
Ash	Ash from incineration process	Application to agricultural land in some cases Blending with aggregate or soil for use as fill material Use in construction products as a substitute to sand or coal ash	Generally limited to landfill disposal Ash disposal other than in landfill requires special regulatory review and approval	Agricultural land, landfill, fill material, construction products

As a result of the phosphorus limitations, GBMSD would have to displace agricultural land application of manure and the three industries in order to enter the market in Brown County. It is more likely that GBMSD would have to target counties to the north and west (Shawano, Oconto, and Marinette). GBMSD should expect haul distances greater than a 50-mile radius from the treatment plant for a land application program.

Public acceptance issues are impacting biosolids land application programs across the country. Biosolids bans have been implemented in some townships and counties, and are typically the result of biosolids phobia and/or odor issues that impact nearby residents. As urban population centers continue to grow and develop, available land for application of biosolids moves farther out into the country. It is logical to assume that biosolids hauling distances to land application sites will increase as Brown County and the surrounding counties grow and develop.

Implementing a program that includes paying customers will require greater investment in the way GBMSD manages a land application program. Farmers will demand a high level of responsiveness when they pay for a service, rather than simply allowing things to happen on their farms. Success factors for operating a fee-based program include the following:

- A paying customer will expect service in addition to supplying biosolids. Service may include tillage, nutrient management assistance, permitting, etc.
- Service must be responsive to the farmer's needs, 7 days per week. When weather is good and farming needs to be done, a farmer will expect service on weekends or after hours.
- An ample supply of biosolids product will be required to respond to farmer requests on short notice. Regular storage of biosolids will be necessary to ensure product availability.
- Consistent administration of the program is essential. Even though some farms may be closer to the wastewater treatment plant than others, a uniform fee system must be adhered to.

3.4.2.2 Forested Land

Market Description. Land application of Class B biosolids on forest lands has been practiced on a limited basis for many years throughout North America. The best known program is that operated by King County, Washington. The program provides nutrients to fertilize and preserve working forests. In 2007, King County applied about 7,700 dry tons (about 30 percent of its annual production) of Class B biosolids to forest land. The County has negotiated arrangements with landowners to provide access roads to the sites. The County provides the vehicles to transport and apply biosolids.

Market Potential. Although significant state, county, and private forest land exists in Wisconsin, most forested land is north and west of Brown County. The pulp and paper industry takes the general position that fertilization of trees does not make economic sense. This is true if they have to buy the fertilizer. However, biosolids application around the country has been shown to be beneficial and to significantly increase production.

A barrier to developing a forestry application program is the time and cost it would take to convince companies who own the land that biosolids application makes sense and that there is a financial benefit to them. Such an effort would require an investment of resources and equipment over several years to gather data regarding yield improvements on tree types normally grown in Wisconsin and site data to determine viability in Wisconsin. Application of biosolids in forests is not a common practice in Wisconsin, so research and demonstration to collect data would be necessary to satisfy regulators.

Equipment for forestry application sites must be more robust because of stumps, unlevel terrain, and unimproved roads. Forestry equipment typically has 18-ply tires, whereas agricultural equipment has 12-ply. A bull dozer typically is required to knock over stumps that may be too high for equipment operation or to pull equipment out of the forest.

3.4.2.3 Land Reclamation

Market Description. Land reclamation consists of biosolids application in drastically disturbed sites, such as mined land or restoration of construction sites. Land reclamation often allows for high biosolids application rates, resulting in large quantities of product applied at a single site. This can be advantageous if the site provides a long-term outlet for biosolids application.

Market Potential. Construction sites typically are undesirable for biosolids application because they do not provide a long-term outlet for disposal. Mined land generally is the most successful land reclamation option. Mined land can provide a significant available capacity for biosolids and result in a long-term biosolids disposal option. Most mining operations in Wisconsin are nonmetallic and provide aggregates such as sand, gravel, and crushed stone. NR 135 of the Wisconsin Administrative Code governs nonmetallic mining reclamation programs. As part of this program, all mining operations continuing after September 1, 2004, needed to have approved reclamation plans. The use of biosolids for continuing operations would likely involve amending existing reclamation plans and reapplying for state approval. There does not appear to be an incentive for a mining operation to go through the application process again.

3.4.2.4 Landfill Disposal

Market Description. Disposal of solids directly to a landfill can be a reliable option. Landfills generally accept wastewater sludge as long as the material passes a paint filter test. Landfills may also have their own specific restrictions that could limit the acceptance of sludge. The advantage of landfills is that they reliably accept sludge year-round. The disadvantages are that sludge can consume landfill capacity quickly and tipping fees are high. GBMSD contracts with Veolia for hauling of ash from its GBF. Veolia transports the ash to the Hickory Meadows Landfill in Hilbert, WI.

Market Potential. Brown, Outagamie, and Winnebago counties formed a tri-county solids disposal plan in 2003 that resulted in operating only one landfill at a time while the other landfills act as transfer stations to transport solid waste to the active landfill. The Winnebago landfill currently is the active landfill, but it will be closed in 1 to 1.5 years, at which point the Outagamie landfill will become the active landfill. Other landfills include the Hickory Meadows Landfill, the Ridgeview landfill in Whitelaw, and the Shawano Landfill in Shawano. Landfill information is summarized in Table 3-7.

TABLE 3-7
Area Landfills

Name of Landfill and Location	Distance to GBF (miles)	Currently Accepts Wastewater Treatment Sludge	Requirements	Beneficial Use of Sludge?
County of Outagamie Appleton, WI	31	Yes; Part of tri-county landfill operation; Currently acts as a transfer station to the Winnebago Landfill	n/a	n/a
County of Winnebago Oshkosh, WI	53	Yes; Currently the active landfill in a tri-county landfill operation	Paint Filter Test; 20% solids; landfill manager stated that he didn't think the 20% solids was an issue as long as the sludge passed the paint filter test	Cannot be used as daily cover due to odor
Brown County Oneida, WI	8	Yes; Part of tri-county landfill operation; Currently acts as a transfer station to the Winnebago Landfill	n/a	n/a
Veolia Hickory Meadows Hilbert, WI	32	Yes	Will accept wet sludge and mix with amendment (such as ash)	Paper mill sludge used as daily cover; Unsure whether wastewater sludge could be approved for use as cover
Ridgeview Landfill – Waste Management Whitelaw, WI	42	Yes	n/a	n/a
Shawano Landfill Shawano, WI	40	n/a	n/a	n/a

Preliminary investigation indicates that there are several landfills within a 50-mile haul distance from the GBMSD facility that could accept wastewater sludge. However, recently GBMSD has had to haul sludge to as far away as a Wisconsin Rapids landfill which is more than 100 miles from Green Bay.

3.4.2.5 Soil Amendment

Market Description. Soil amendment products generally consist of compost, biosolids-based products such as granular fertilizer pellets (like Milorganite®) and topsoil or blended-soil products. Typical market segments for soil amendment products include the following:

- Landscape designers
- Landscape contractors
- Retail/wholesale nurseries
- Golf courses
- Garden centers

Table 3-8 lists examples of soil amendment biosolids processing and end-use systems.

TABLE 3-8
Example Soil Amendment Biosolids Processing and End Use Systems

Agency	Treatment Method	Biosolids Quantity (DT/yr)[a]	Date Started	Markets	Product Revenues	Other Comments
Sturgeon Bay, WI[b]	Anaerobic digestion Air dry on pad	1,600	1980s	Evergreen nursery	None; Delivered to nursery at no cost	Happy with use as amendment in the nursery field
Chicago, IL[b]	Anaerobic digestion Dry in lagoons	90,000	1970s	50% used as soil amendment (golf courses and recreational areas) 50% used as fertilizer on farmland	None; Delivered at no cost to the users	Challenges include meeting local guidelines for biosolids use and some odor issues
Tacoma, WA[b]	Anaerobic digestion Blend with sawdust, sand, and bark	3,600 (3,200 in program)	1992	80% local residents 20% local professional landscapers	$10/yd^3 to $30/yd^3 depending on product mix, plus delivery at $1/mile.	Excellent success selling the product at a set price; Employ two master gardeners to manage end-user concerns
Davenport, IA[c]	Anaerobic digestion Compost with yard trimmings in aerated static pile	25,000	1980s	Market as Earth Cycle Soil Builder to residents and to professional landscaping industry as top dressing and mulch	$1.50/ft^3 bag, picked up $5 to $10/yd^3 bulk depending on quantity, picked up	100,000 yd^3 of yard trimmings are combined with 35,000 yd^3 of biosolids and converted to 30,000 yd^3 of compost and 6,000 yd^3 of wood mulch, annually

[a]For comparison, GBMSD produced 57,400 DT dewatered cake in 2007.
[b]Based on survey data collected in 2006.
[c]Source: http://www.cityofdavenportiowa.com/department/division.asp?fDD=28-375

In the examples above, Sturgeon Bay manages 100 percent of its biosolids production for use as a soil amendment, Chicago manages 50 percent, and Tacoma manages 90 percent. Modifying the physical characteristics of the dewatered sludge through composting, blending, or drying improves the product's acceptance and expands the types of applications in which it can be used.

The goal of a soil amendment program is to generate a product that meets the physical and chemical requirements of the end user (for example, landscaper) or a specific application (for example, topdressing and topsoil blending). Based on the experience of the Tacoma program and many other biosolids management programs (such as composting and granulation) throughout the U.S., it is apparent that if a larger volume of biosolids is to be treated in this fashion, then relying on sales to "green industry" professionals is a sounder practice than relying on sales to residents. Regardless of the user, a soil amendment program will require implementing promotional and educational programs to help gain product acceptance.

Market Potential. Quantitative market research typically requires at least 20 percent of all end end-user groups be surveyed. This type of market research is beyond the scope of this study. However, the following steps could be implemented to learn more about market potential:

- Establish a local geographic market based on a reasonably large population base (such as the Green Bay metropolitan area).
- Survey all horticulture-related businesses within the geographic market base and collect data on compost usage, topsoil usage, and blended soil usage.

The sales potential for biosolids-based compost can be directly compared to the quantity of compost that is currently being moved within the geographic market base. Likewise, the sales potential for biosolids-based soil products can be directly compared to the quantity of topsoil or blended soil that is currently being moved within the geographic market base. A possible initial target would be to penetrate up to 10 percent of the current compost or topsoil and blended soil markets. While specific quantities have not been estimated, it is likely that based on the size of the Green Bay metropolitan area and the quantity of biosolids produced, the GBMSD could initially market only a small fraction (less than 20 percent) of its current biosolids production as part of a soil amendment program.

Other survey data critical to evaluating market potential for a soil amendment program include the following:

- Product characteristics necessary for a successful soil amendment product
- Experience or acceptance of biosolids-based products
- Pricing of various existing soil amendment products

Although it is technically feasible to develop a soil amendment program, such a program could initially support only a fraction of GBMSD biosolids production and would have to be a part of an overall biosolids management program. Market research is required to determine the potential market for soil amendment products. Marketing of biosolids-based compost or soil amendment blends will require implementing promotional and educational programs to help gain product acceptance. Pricing for biosolids-based compost or soil amendment blends will have to be competitive with similar products in the marketplace.

3.4.2.6 Incinerator Ash

Market Description. GBMSD generates ash from its incineration process and contracts Veolia to haul ash from the GBF to the Hickory Meadows Landfill in Hilbert, WI. Landfilling is the most common disposal method for incinerator ash. In 2007, the City of Palo Alto, CA, surveyed 91 sewage sludge incineration plants and found that 74 plants practice landfill disposal. Other options for managing ash exist and have been practiced by other utilities. Ash management options other than landfilling require regulatory review and approval. Potential options include:

- **Flowable Fill—**Incinerator ash is used for backfilling of excavations, used as a roadbase, and placed under structures such as underground pipe, manholes, and foundations. The cities of Manchester, NH, and Dubuque, IA, have practiced this option. Various percentages of ash can be blended with aggregate or soil to achieve desired properties.
- **Concrete, Cement, or Asphalt Products—**Incinerator ash can serve as mineral filler in these products as a substitute for sand and coal ash. In the past, MCES in St. Paul, MN, marketed ash through a third party as a mineral filler in the production of Portland cement. MCES has since modified the incineration process to include carbon injection and ash removal on baghouses to remove mercury from the incinerator exhaust stream. Because of the process change, MCES has moved to landfilling ash to prevent rerelease of mercury that could result from processing incinerator ash in a cement kiln. A startup company, RECO Cement, has expressed interest in building a facility in Green Bay or Milwaukee to produce cement using fly ash. This could be a future outlet for GBMSD. This option would help offset carbon emissions by offsetting the energy-intensive production of Portland cement.
- **Bricks and Brick Filler—**Ash may be used as a filler material in the manufacture of bricks and blocks. The City of Atlanta has two plants that send ash to brickyards.
- **Land Application/Soil Amendment—**Ash can have fairly high levels of phosphorus, which is desirable as a soil amendment in areas that have phosphorus poor soils. The City of Palo Alto sends ash to farms to be used as a soil amendment. This is not likely appropriate for GBMSD given the phosphorus issues in Brown County. Other utilities have blended ash into a compost mix or topsoil blend.

Market Potential. Like developing a market for biosolids-based soil amendments, finding a market for incinerator ash requires research to determine the potential ash products, testing of potential products to satisfy regulators, and implementing promotional and educational programs to help gain product acceptance. Specific barriers to developing a market for incinerator ash include the following:

- Existing potential markets for incinerator ash are familiar with sand, rock, and gravel, but must be educated on the properties of incinerator ash.
- Contractors generally need construction products like flowable fill relatively quickly. Gaining case-by-case approvals in a suitable time period may be challenging.

- The supply of incinerator ash is relatively small compared to other feedstocks, such as coal ash. Displacing coal ash or sand as a feedstock will be difficult.
- Incinerator ash requires special handling.
- Seasonal factors or low or variable demand of alternative markets will require landfilling as a backup.

The cost to manage incinerator ash through alternatives other than landfill disposal will depend on the amount of investment required to develop alternative markets, gain regulatory approval, and determine haul distance to the alternative market. If alternative ash markets are pursued, a logical initial approach is to seek markets for a small percentage of the GBMSD ash production while maintaining landfill disposal as the primary disposal method.

CHAPTER 4

Alternatives Identification and Description

An assessment of the current and future solids loadings and conditions confirmed the need for upgrading and expanding the solid processing system. The planning team then identified 73 solids processing technologies that could be used. Some were eliminated immediately because they are no longer commercially available. Figure 4-1 shows the remaining 52 technologies that were evaluated. Only technologies that had been proven at full scale were considered. To mitigate risk associated with processes that may not be fully established, technologies that did not have at least 5 years of operation at a scale at least as large GBMSD's were eliminated. The remaining technologies were then combined into the different process trains listed below to form alternative solutions.

- Alternative 1—Incineration
- Alternative 2—Incineration with Energy Recovery
- Alternative 3—Digestion with Further Thermal Processing
- Alternative 4—European Incineration with Pre-Drying
- Alternative 5—Thermal Hydrolysis with Digestion
- Alternative 6—Conventional Drying with Digestion
- Alternative 7—Prepastuerization with Digestion
- Alternative 8—Digestion Class B Land Application
- Alternative 9—Codigestion with Other Organic Wastes
- Alternative 10—Alkaline Stabilization
- Alternative 11—Conventional Composting
- Alternative 12—Co-composting
- Alternative 13—Drying for Fuel
- Alternative 14—Incineration and Drying
- Alternative 15—Landfill / Methane Recovery
- Alternative 16—Status Quo: Rehabilitate MHF Incineration
- Alternative 17—Autothermal Aerobic Digestion

This chapter introduces the 17 alternatives evaluated for this solids management plan to replace the existing GBF solids processing system. The alternatives would be sized to process the projected 2035 solids loads from the DBF and the GBF. Tables 4-1 and 4-2 summarize the process, products, and disposal methods associated with each of the 17 alternatives. Note that during the alternative evaluation process described in Chapter 5, Alternative 3, Digestion with Further Thermal Processing, was renumbered as Alternative 3A and a new alternative was added: Alternative 3B, Digestion with Thermal Processing and Electrical Generation.

FIGURE 4-1
Solids Processes Considered During Initial Screening Process

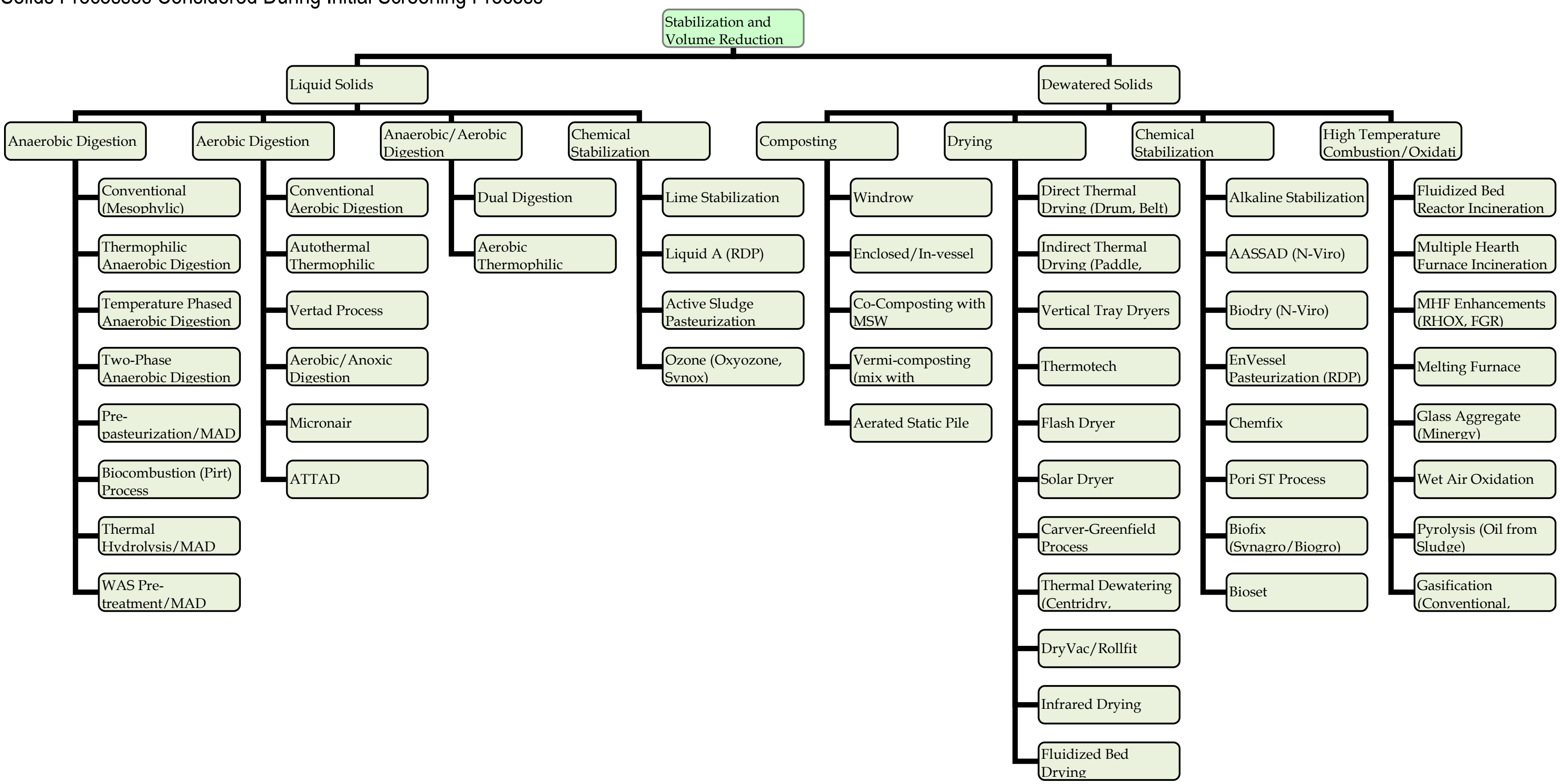


TABLE 4-1
Solids Management Unit Processes by Alternative

	Alternative																
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
Receiving other waste organics	X	X	X	X	X	X	X	X	X		X	X	X	X			
Gravity thickening	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Gravity belt thickening	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Mechanical dewatering	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Pre-digestion process			[a]		X		X										
Mesophilic digestion			X		X	X	X	X	X								
Nutrient Extraction			X		X	X	X	X	X								
Pre-drying				X													
Fluidized bed incineration	X	X	X											X			
Drying			X	X		X							X	X			
Alkaline stabilization										X							
Composting											X						
Co-composting												X					
Multiple hearth incineration																X	
Autothermal aerobic digestion												X					X

[a]Design will include in order to accommodate future process.

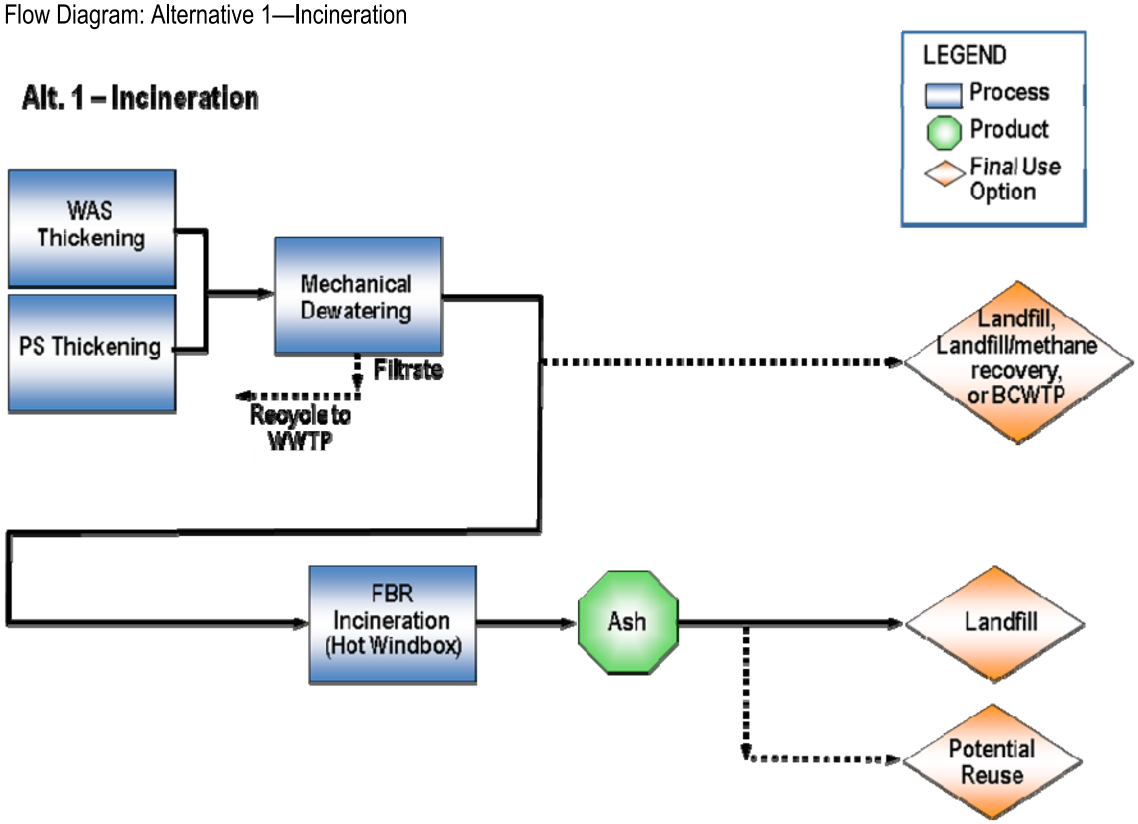
TABLE 4-2
Solids Management Products and Disposal by Alternative

	Alternative																
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
Products																	
Ash	X	X	X	X										X		X	
Steam		X		X													
Heat		X	X	X	X	X	X	X	X								
Electricity		X	X	X	X	X	X	X	X								
Class A biosolids			X		X	X	X			X	X	X	X	X			X
Class B biosolids								X	X	X							
Phosphate fertilizer			X		X	X	X	X	X								X
Dewatered sludge															X		
Ultimate Disposal																	
Landfilling	X	X	X	X										X	X	X	
Pellet fertilizer			X			X							X	X			
Soil amendment			X		X	X	X		X	X	X	X	X	X			X
Land application			X		X	X	X	X	X	X	X	X	X	X			X
Fuel in kiln or power plant			X			X							X	X			
Potential Reuse																	
Potential reuse of ash	X	X	X	X										X		X	
Landfill gas recovery or BCWTP	X														X	X	X

4.1 Alternative 1—Incineration

Alternative 1 (Figure 4-2) is similar to the existing solids processing train, except that a fluidized bed incineration process replaces the multiple hearth furnace incinerators. Gravity-thickened primary sludges and gravity-belt thickened, waste activated sludges would be combined in a storage tank and then concentrated to about 25 percent solids using dewatering centrifuges. As is the case with all alternatives, other methods of dewatering could be used. The dewatered cake would be fed to the fluidized bed incineration process. The resulting ash could be beneficially reused if a suitable application is identified, or otherwise placed in a landfill. Oxidation of solids in a multiple hearth furnace involves a two-step process: drying, then combustion. In a fluidized bed incinerator, water flashes off and the sludges burn in one process.

FIGURE 4-2
Process Flow Diagram: Alternative 1—Incineration



A fluidized bed incinerator is a cylindrical, vertically oriented, refractory-lined steel shell that contains a sand bed and fluidized air diffusers called tuyeres. The combustion process of biosolids is based on the experience of and hardware developed by fluidized bed incinerator manufacturers in the metallurgical and chemical industries. The fluidized bed incinerator typically is 9 to 34 feet in diameter. The sand bed in the incinerator is about 3.5 feet thick and sits on a refractory-lined or metal grid. The grid contains tuyeres through which air is injected into the furnace at a pressure of 3 to 5 psig to fluidize the bed. The bed expands to about 200 percent of its at-rest volume. The temperature of the bed is controlled between 1,400° and 1,500°F by injecting fuel into the sand bed. In some installations, a water spray system in the bed controls the furnace temperature.

The incinerator is a single chamber unit in which both drying and combustion occur in a fluidized sand bed. The residence time within the combustion zone is several seconds at 1,400° to 1,500°F. Ash is carried out the top of the furnace and removed by air pollution control devices, usually venturi/impingement tray scrubbers. Sand carried out with the ash must be replaced. Sand loss typically is about 5 percent of the bed volume for every 300 hours of operation. Feed is introduced to the furnace either above or directly into the bed. Airflow in the furnace is determined by several factors. Fluidizing and combustion air must be sufficient to expand the bed to a proper density yet low enough to prevent the biosolids from rising to and floating on top of the bed. Too much air blows sand and products of incomplete combustion into the offgases. This depletes the stored heat energy and increases fuel consumption unnecessarily. Minimum oxygen requirements must be met to ensure complete oxidation of all combustible biosolids. Temperatures must be sufficiently high to ensure complete deodorizing, but low enough to prevent slag formation and protect the refractory, heat exchanger, and flue gas ducting.

The quantity of excess air is maintained in the range of 20 to 45 percent of the quantity required for combustion to minimize fuel cost. Fluidized bed incinerators operate at much lower excess air rates than typical multiple hearth furnace operations, resulting in a greater heat efficiency of the fluidized-bed system at similar exit temperatures. There are two basic process configurations for the fluidized bed incinerator. In one design, the fluidizing air passes through a heat exchanger, or recuperator, before injection into the combustion chamber. This arrangement is known as a hot windbox design. In the cold windbox design, the fluidizing air is injected directly into the furnace. The first arrangement increases the thermal efficiency of the process by using the exhaust gases to preheat the incoming combustion air, but adds substantial capital costs.

Mixing in the fluidized bed assures rapid and uniform distribution of fuel and air and consequently good heat transfer and combustion. The bed itself provides substantial heat capacity, which helps to reduce short-term temperature fluctuations that may result from varying feed heating values. This heat storage capacity enables quicker startup, if the shutdown period has been short. Organic particles remain in the sand bed until they are reduced to mineral ash. Mixing the bed comminutes the ash material, minimizing the buildup of clinkers. The resulting fine ash is constantly stripped from the bed by the upflowing gases. The fluidized bed incinerator is relatively simple to operate, has a minimum mechanical components, and typically has a slightly lower capital cost than a multiple hearth furnace. Experience indicates that although the capital cost for the fluidized bed incinerators may be slightly lower than that for the multiple hearth furnaces, the cost of the ash system, which requires thickening and dewatering, results in comparable capital costs. Normal operation of the fluidized bed incinerator results in exhaust temperatures greater than 1,400°F. Because the exhaust gases are exposed to this temperature for several seconds, odors and carbonyl and unburned hydrocarbon emissions are minimal. This results in the ability to meet hydrocarbon emission regulations without the use of an afterburner.

Advantages

- Easy implementation; very similar to existing solids processing system
- Improved emissions compared to existing multiple hearth furnace incinerators
- Proven technology
- Low O&M costs
- Volume reduction

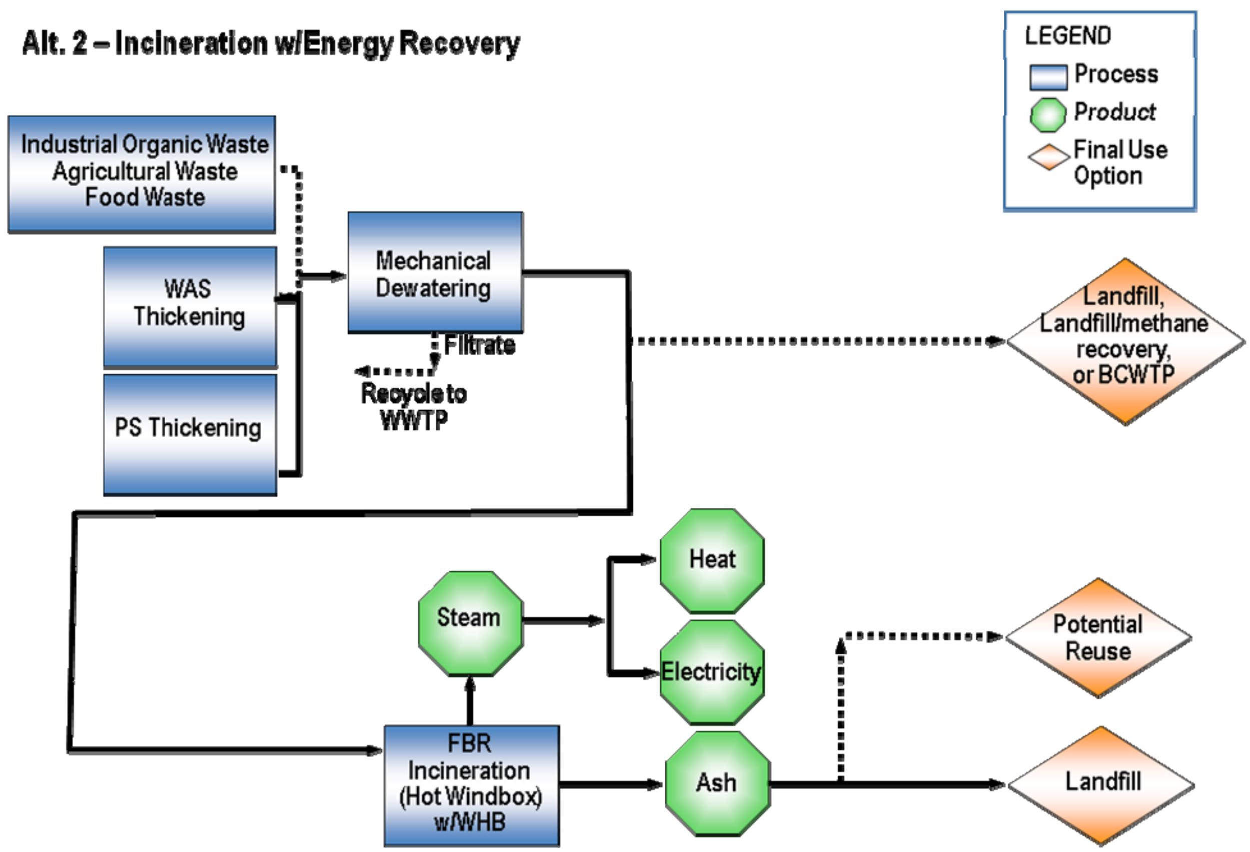
Disadvantages

- No capture of energy potential of biosolids
- Greenhouse gas and other emissions from incinerators
- Ash would likely be landfilled instead of beneficially reused
- High capital cost
- Potential safety concerns

4.2 Alternative 2—Incineration with Energy Recovery

Alternative 2 (Figure 4-3) is very similar to Alternative 1, except that a waste heat boiler would use waste heat from incineration for plant heating or to generate electricity to supplement plant electrical requirements. The waste heat boiler would help to offset plant energy needs and reduce greenhouse gas emissions from the burning of natural gas and coal for plant heating and electricity. Gravity-thickened primary solids and thickened waste activated solids would be dewatered to about 25 percent solids. The dewatered cake would then be fed to the incinerators. As in Alternative 1, the resulting ash could be reused if a suitable application is identified, or could otherwise be placed in a landfill. Refer to Alternative 1 for a description of fluidized bed incineration.

FIGURE 4-3
Process Flow Diagram: Alternative 2—Incineration with Energy Recovery



Advantages

- Easy implementation; very similar to existing solids processing system
- Improved emissions as compared to existing multiple hearth furnace incinerators
- Reduced greenhouse gas emissions due to energy capture in the waste heat boiler
- Proven technology
- Low O&M costs
- Volume reduction

Disadvantages

- Greenhouse gas and other emissions from the incinerator
- Ash would likely be landfilled instead of beneficially reused
- High capital cost (additional equipment, such as waste heat boiler, boiler feedwater equipment, turbine/generator, steam piping)
- Potential safety concerns

4.3 Alternative 3—Digestion with Further Thermal Processing

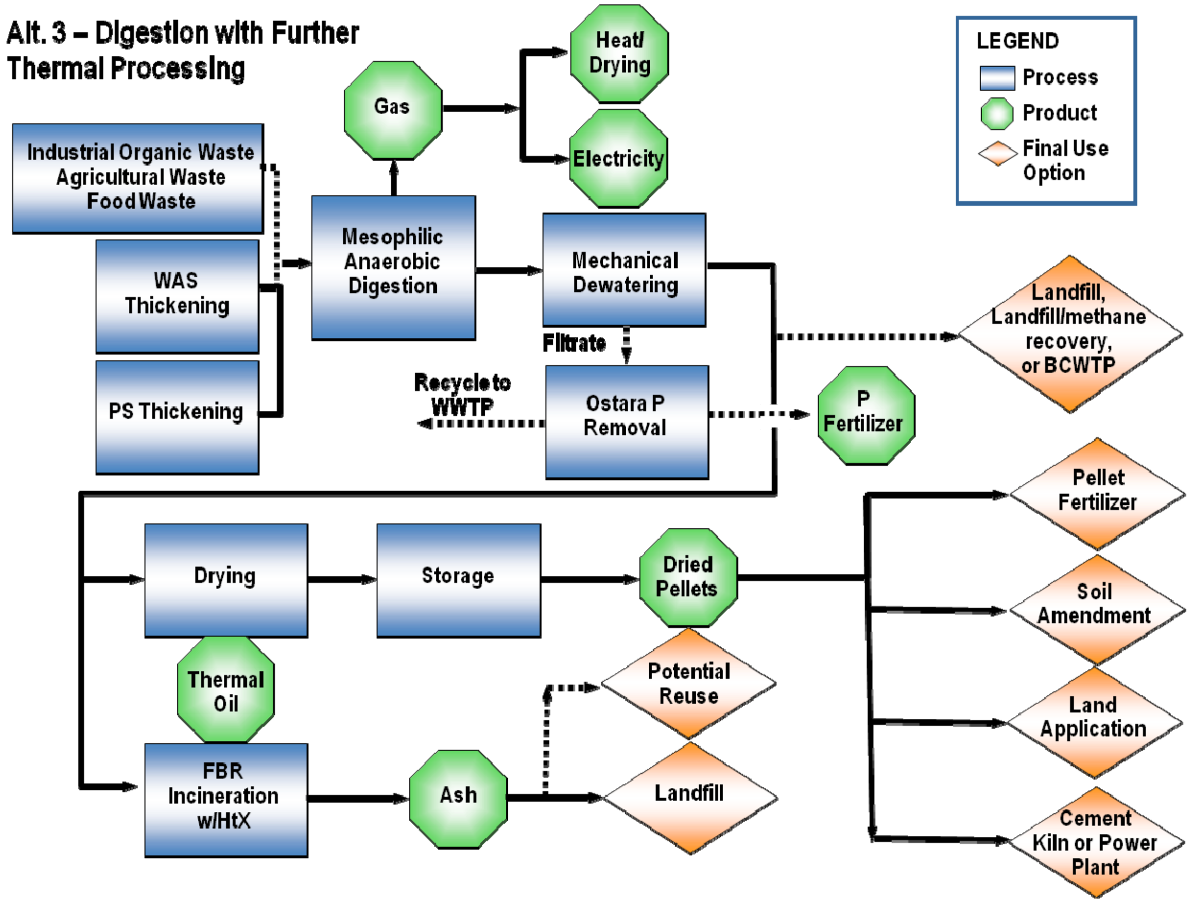
Alternative 3 (Figure 4-4) includes mesophilic anaerobic digestion. Gravity-thickened primary and thickened waste activated sludges would be fed at about 6 percent solids to the digesters. Digested solids would be dewatered to about 25 percent solids. Following dewatering, part of the solids would be conveyed and fed to a heat dryer. The balance would be fed to the fluidized bed incinerator. The incineration and drying processes would be thermally coupled such that the dryer would use waste heat from the incinerator to produce a dried granule product. The thermal needs of the dryer would be matched with the waste heat available from the incinerator, with two-thirds of the solids incinerated and one-third dried. (Refer to Alternative 1 for a description of fluidized bed incineration.) The resulting granules, at about 90 percent dry solids or more, would be removed from the dryer and stored before transporting offsite for beneficial reuse. Depending on the amount of dried granules desired, the drying process could require supplemental fuel, such as natural gas or digester biogas. As in Alternative 1, ash could be reused beneficially if a suitable application is identified, or could be placed in a landfill.

4.3.1 Mesophilic Anaerobic Digestion

The digesters are completely mixed and operated under anaerobic conditions at 35° to 38°C. Solids are retained in the digester at least 15 days. Digesters produce biogas that can be used to heat buildings, produce electricity, or fire the heat dryer. The purpose of digestion in this alternative is not to reduce pathogens and produce Class A or B biosolids. Instead, it is to convert biomass to bioenergy that will be used to make the treatment plant more sustainable.

Digestion would provide flexibility to add other organic wastes if excess capacity is available. Food, industrial, and dairy wastes could be added to digesters to enhance biogas production. Additional digestion capacity could be added as needed.

FIGURE 4-4
Process Flow Diagram: Alternative 3—Digestion with Further Thermal Processing



4.3.2 Biosolids Drying

There are two ways to dry biosolids: direct heating and indirect heating. Direct-fired dryers drive heated air directly over and around the sludge. Dust is generated during this type of drying, and dust handling is often a major equipment component. Because of the need for additional safety measures and higher fuel usage, direct drying may not be a good fit in many settings. Indirect dryers usually dry the material within an enclosed or semi-enclosed chamber that conducts heat from steam or thermal fluid. There is virtually no air flow around the material, so dust and odor are not problematic. Indirect dryers can operate at lower temperatures for a safer, more energy-efficient process. In Alternative 3, heat is recovered from the incinerator waste heat boiler using thermal oil as the heat transfer medium. Either a fluidized bed dryer or an indirect dryer, such as a multi-tray type would be used for drying the solids to produce a granule product. Refer to Alternative 1 for a description of incineration technology.

4.3.3 Nutrient Extraction and Recovery

The Ostara process (or other nutrient extraction processes) could be used to significantly reduce the phosphorus concentration in the biosolids. The Ostara process is a sidestream treatment for recycle from dewatering. The process removes phosphorus from the sidestream, and ultimately lowers the phosphorus in the biosolids. Lower phosphorus content in the heat dried biosolids granules would result in a more marketable product in areas where phosphorus is already abundant. The Ostara process would also result in a mineral fertilizer product rich in phosphorus that could more easily be transported to areas of the country that are phosphorus deficient and address struvite in the digesters.

Advantages
- Greatest energy production and heat recovery
- Lowest greenhouse gas emissions because of production of heat and electricity from digester gas, heat recovery for drying, and potential carbon savings due to offsetting of fertilizer production and carbon sequestration from granule sales
- Valuable Class A fertilizer product
- Greatest flexibility to produce several different products (Class B biosolids, Class A granules, ash)
- Greatest ability to accept wastes from other sources (meat packers, dairies, food waste)
- Greatly reduced emissions due to solids reduction in digestion and incineration of only two-thirds of solids
- Ability to use nutrient extraction technologies to remove phosphorus from biosolids and produce a mineralized phosphorus fertilizer product
- Recycles nutrients
- Volume reduction

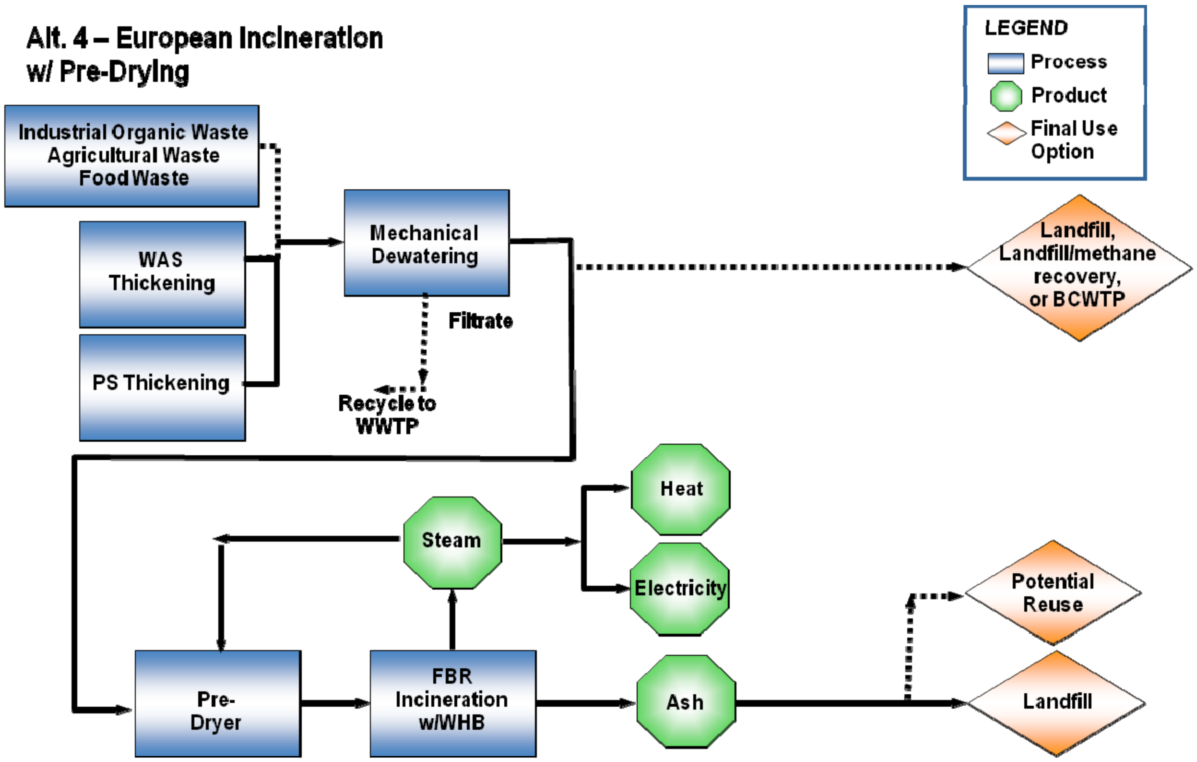
Disadvantages
- Increased complexity because of the operation of an anaerobic digester, incinerator, and dryer and the management of two separate solids streams/products
- Landfilling of ash instead of beneficial reuse
- Greenhouse gas and other emissions from the incinerator
- Limited full-scale operations
- High capital cost
- Potential safety concerns with dryer and digester gas

4.4 Alternative 4—European Incineration with Pre-drying

Alternative 4 (Figure 4-5) is very similar to Alternative 2 except that it would use waste heat from the incinerators to drive an upstream drying process to enhance heat production in the incineration process. The waste heat would be used to create steam. Part of the steam would be used to drive the pre-drying process, whereas the balance would be used for plant heating and to generate electricity to supplement the plant's electrical needs.

Gravity-thickened primary and thickened waste activated sludges would be dewatered to about 25 percent solids. Following dewatering, the solids would be conveyed and fed to a heat dryer to be thermally dewatered to about 38 to 40 percent. Waste heat from incineration would be used in the dryer, where some of the moisture remaining after dewatering would be evaporated. As in Alternative 1, ash from the incineration process could be beneficially reused if a suitable application is identified or placed in a landfill. Refer to Alternative 1 for a description of fluidized bed incineration.

FIGURE 4-5
Process Flow Diagram: Alternative 4—European Incineration with Pre-drying



Advantages

- Reduced greenhouse gas emissions compared to an alternative that does not capture waste heat from the incinerators
- Improved emissions compared to the existing multiple hearth furnaces
- Low O&M costs
- Volume reduction

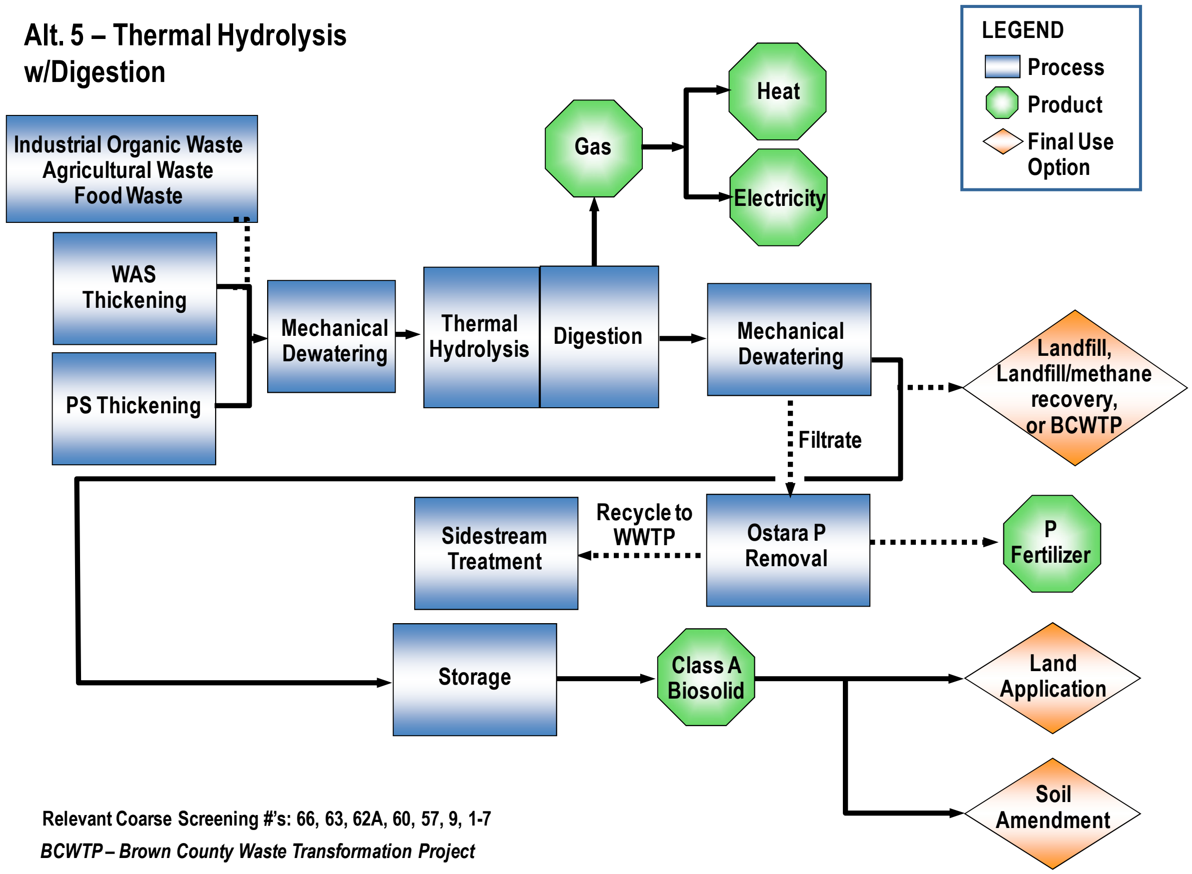
Disadvantages

- Increased complexity because of the operation of an incinerator and dryer
- Greenhouse gas and other emissions from incinerators
- Not many full-scale operations
- Ash likely landfilled instead of beneficially reused
- High capital cost

4.5 Alternative 5—Thermal Hydrolysis with Digestion

In Alternative 5 (Figure 4-6), gravity-thickened primary solids and thickened waste activated solids are dewatered to about 12 percent solids and fed to the batch thermal hydrolysis reactors, where solids are heated and pressurized to lyse cells and partially oxidize organics.

FIGURE 4-6
Process Flow Diagram: Alternative 5—Thermal Hydrolysis with Digestion



In the thermal hydrolysis process, solids are heated to 340°F for 30 minutes. The mixed raw sludge is thermally hydrolyzed and sterilized to yield a digester feed optimized for digestion, dewatering, and pathogen control. The high temperature, high pressure hydrolysis process results in Class A solids following digestion. Thermal hydrolysis also increases digestion efficiency (that is, greater overall volatile solids reduction and increased biogas production) and improved dewaterability following digestion. Belt filter press performance achieves up to 32 percent solids, and centrifuges achieve up to 35 percent solids when dewatering thermal hydrolysis digested sludge. Adding thermal hydrolysis as a pretreatment to anaerobic digestion increases dewaterability by 10 to 12 percent points compared to conventional digestion and dewatering. The main effect on digestibility and dewaterability is on the waste activated fraction of mixed sludge. This has been demonstrated in tests and at full scale on plants operating only on waste activated sludge.

The need for energy efficiency suggests that thermal hydrolysis of waste activated sludge only is a good way of getting maximum benefits for minimum cost and energy demand for a mixed raw sludge. Thermal hydrolysis applied to waste activated sludge has yielded only 8 percentage points of improvement in dewaterability, plus a 25 percent increase in biogas production in a laboratory scale simulation of a full-scale plant with 50:50 mixed sludge. However, pathogen control and Class A biosolids are not ensured unless all solids are pretreated. Thermal hydrolysis pretreatment is in place in 20 plants around the world that range in size from 5 to 150 mgd.

Following thermal hydrolysis, solids are cooled to about 95°F and transferred to mesophilic anaerobic digesters. Digested solids conditioned with polymer can be dewatered to about 32 to 35 percent solids. Refer to Alternative 3 for a description of mesophilic anaerobic digestion.

Mesophilic anaerobic digestion alone would not produce Class A biosolids. However, when digestion is coupled with thermal hydrolysis, the resulting biosolids meet Class A requirements. After dewatering, Class A biosolids could be applied to agricultural lands, sold as a soil amendment, or disposed of in a landfill. If land application is the disposal method, 180 days of storage must be provided. Receiving soils would benefit from the nitrogen, phosphorus, and organic materials in the digested solids. The digester gas produced in the digestion process would be used to heat the solids flow entering the digesters, as necessary, to maintain the operating temperatures near 95°F. Excess digester gas could be used to augment the plant heating requirements or to produce electricity and heat in a cogeneration system.

As in Alternative 3, digestion would provide flexibility to add other organic wastes if excess capacity is available. Wastes such as food waste, industrial waste, or dairy waste could be added to digesters to enhance biogas production. Additional digestion capacity could be added as needed.

Nutrients would be extracted from the dewatering recycle as described in Alternative 3.

Advantages

- Class A fertilizer product
- Produces source of renewable energy (digester gas) that can be converted to electricity or heat, higher gas production than mesophilic anaerobic digestion only
- Closed nutrient cycle if biosolids are applied to land (more sustainable practice)
- Digestion produces ammonia, which can be used to extract phosphorus by struvite precipitation, allowing phosphorus to be sold outside the region
- High reduction in volatile solids, resulting in reduced solids quantities
- Drier cake (32–35%)
- Commonly used and well-understood process (though not currently used by GBMSD)
- Flexibility to add to facilities in the future to accept other sources of solids (food waste, industrial, agricultural)

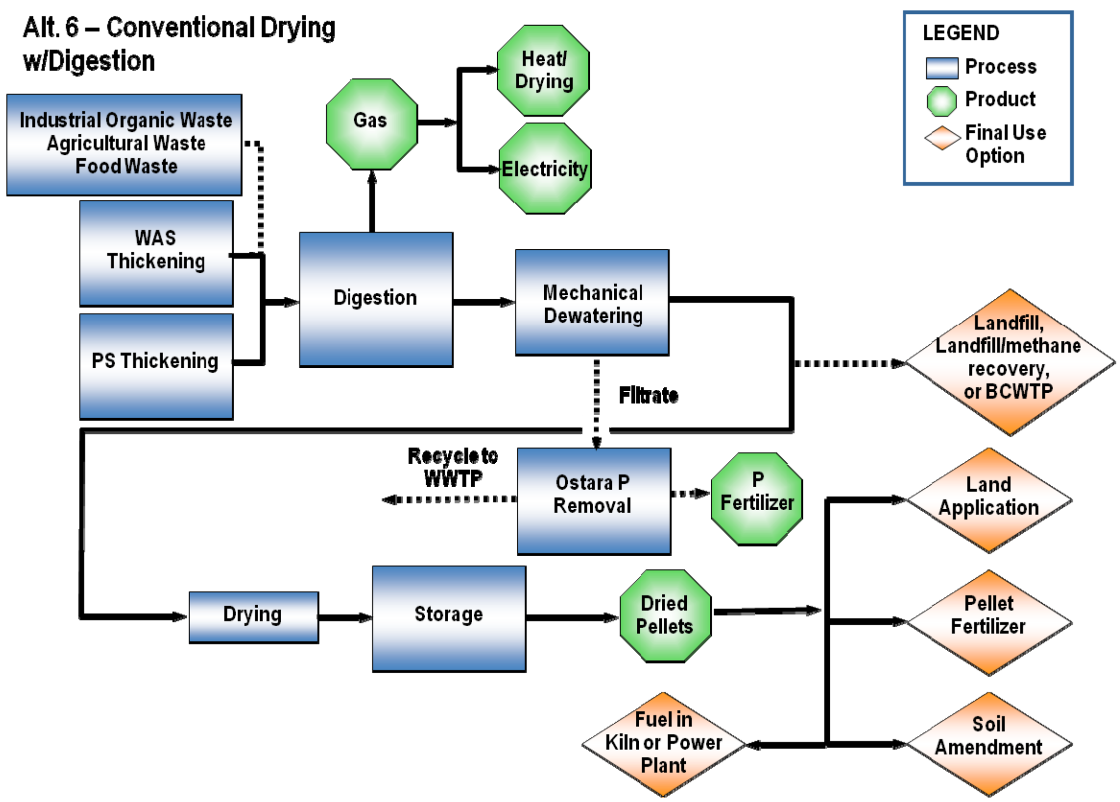
Disadvantages

- High potential for odors and scaling problems with thermal hydrolysis
- High capital cost
- High O&M costs
- Limited full-scale experience (~20 facilities)
- Potential for process upset, more difficult to operate digesters fed 12 percent solids
- Relatively complex operation (dewatering twice, steam boilers and associated steam piping, thermal hydrolysis equipment, digesters)
- Requires large storage tanks for digested solids (180 days)
- High transportation cost to move 32 to 35 percent solids product
- Potential safety concerns associated with methane gas

4.6 Alternative 6—Conventional Digestion with Drying

In Alternative 6 (Figure 4-7), gravity-thickened primary solids and thickened waste activated solids are fed at about 6 percent solids to mesophilic anaerobic digestion. Refer to Alternative 3 for a description of mesophilic anaerobic digestion. Digested solids would be conditioned with polymer and dewatered to about 25 percent solids. Following dewatering, the solids would be conveyed and fed to a heat dryer, where most of the moisture remaining after dewatering would be evaporated. Refer to Alternative 3 for a description of mesophilic anaerobic digestion and biosolids drying.

FIGURE 4-7
Process Flow Diagram: Alternative 6—Conventional Drying with Digestion



Mesophilic anaerobic digestion alone would not produce Class A biosolids, but when coupled with drying, the resulting biosolids meet Class A requirements. The final product would be a dried granule that could be sold as a fertilizer or soil amendment. The granules could also be applied to agricultural land or burned in a power plant or cement kiln furnace as a fuel source. The granules could be considered a renewable fuel.

Receiving soils would benefit from the nitrogen, phosphorus, and organic materials in the digested solids. The digester gas produced in the digestion process would be used to heat the solids flow entering the digesters, as necessary, to maintain the operating temperatures near 95°F. Excess digester gas could be used to augment the plant heating requirements, to produce electricity and heat in a generator, or for drying the solids.

Following dewatering, the solids could be transported directly from the site for other uses, such as land application or landfill disposal. Landfill disposal would be a contingency if drying or an outlet for the product were unavailable.

Nutrients would be extracted from the dewatering recycle as described in Alternative 3.

Advantages

- A source of renewable energy (biogas) that can be converted to electricity or heat, but offset if natural gas is needed to fire the dryer
- Class A granule product could be sold as renewable fuel or fertilizer/soil amendment, although revenue markets usually take time to develop
- Digestion produces ammonia, which could be used to extract phosphorus by struvite precipitation, allowing phosphorus to be sold outside the region
- Closed nutrient cycle, if biosolids would be applied to (more sustainable practice)
- Mass and volume of solids reduced, reducing transportation costs
- Commonly used and well-understood process (though not currently used by GBMSD)
- Class A biosolids
- Less storage capacity required because of high solids concentration in granule product

Disadvantages

- High capital cost
- Complex operation
- Safety concerns with dryers
- Potential safety concerns associated with digester gas
- High O&M costs for drying

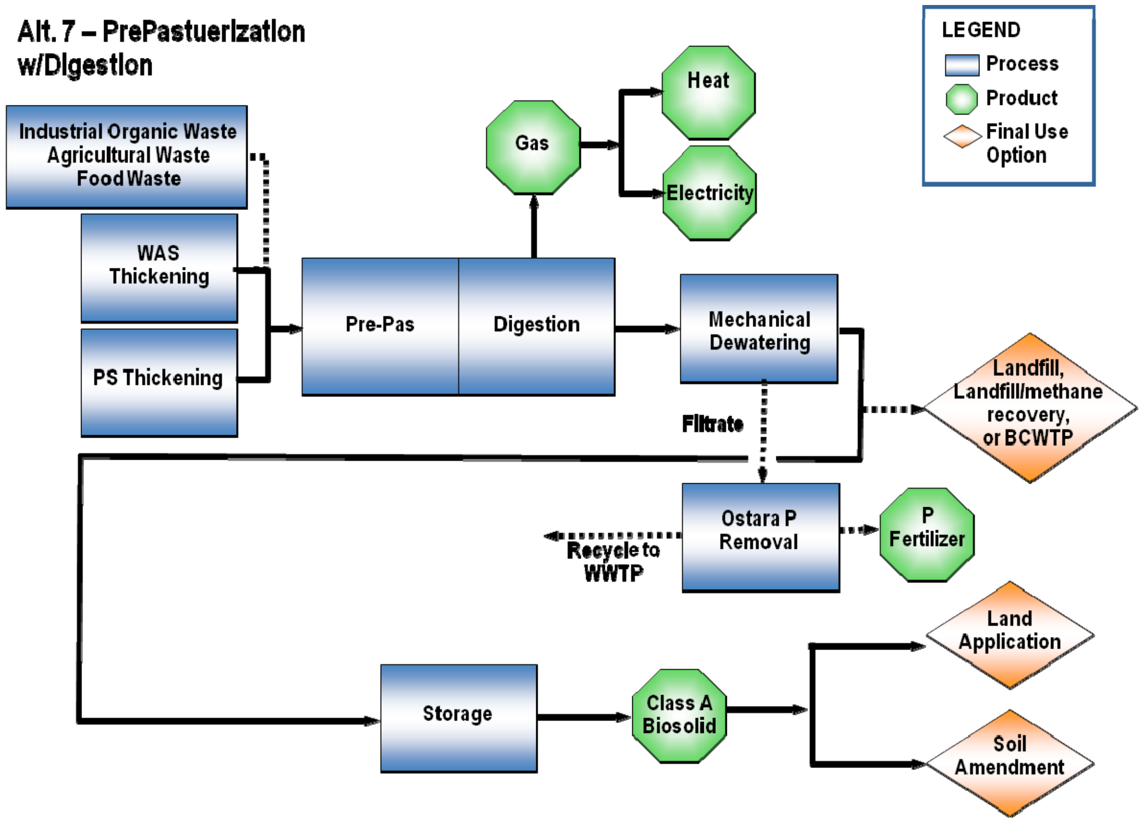
4.7 Alternative 7—Prepastuerization with Digestion

In Alternative 7 (Figure 4-8), gravity-thickened primary sludge and thickened waste activated sludge would be fed at about 6 percent solids to prepasteurization reactors, where solids would be heated to greater than 70°C in batch vessels with retention times greater than 30 minutes. Prepasteurized solids would then be transferred to mesophilic anaerobic digesters. Refer to Alternative 3 for a description of mesophilic anaerobic digestion. Digested solids conditioned with polymer can be dewatered to about 22 to 26 percent solids.

Mesophilic anaerobic digestion alone would not produce Class A biosolids, but when digestion is coupled with prepasteurization, the resulting biosolids meet Class A requirements. The Class A biosolids could be applied to agricultural lands, sold as a soil amendment, or disposed of in a landfill. If land application is the disposal method for the biosolids, 180 days of storage must be provided. Receiving soils will benefit from the nitrogen, phosphorus, and organic materials in the digested solids. The digester gas produced would be used to heat the solids flow entering the digesters, as necessary, to maintain the operating temperatures near 95°F. Excess biogas could be used to augment the plant heating requirements or to produce electricity and heat in a cogenerator.

Following dewatering, the solids could be transported from the site for other uses, such as land application, the Brown County Waste Transformation Project, or landfill disposal. Landfill disposal would be a contingency if drying or an outlet for the product were unavailable.

FIGURE 4-8
Process Flow Diagram: Alternative 7—Prepasteurization with Digestion



Digestion provides flexibility to add other organic wastes if excess capacity is available. Wastes such as food waste, industrial waste, or dairy waste could be added to digesters to enhance biogas production. Additional digestion capacity could be added as needed.

Nutrients would be extracted from the dewatering recycle as described in Alternative 3.

Advantages

- Class A biosolids
- A source of renewable energy (biogas) that can be converted to electricity or heat
- Digestion would produce ammonia, which can be used to extract phosphorus by struvite precipitation, allowing phosphorus to be sold outside the region
- Closed nutrient cycle if biosolids would be applied to land (more sustainable practice)
- Mass and volume of solids is reduced
- Commonly used and well-understood process (though not currently used by GBMSD)

Disadvantages

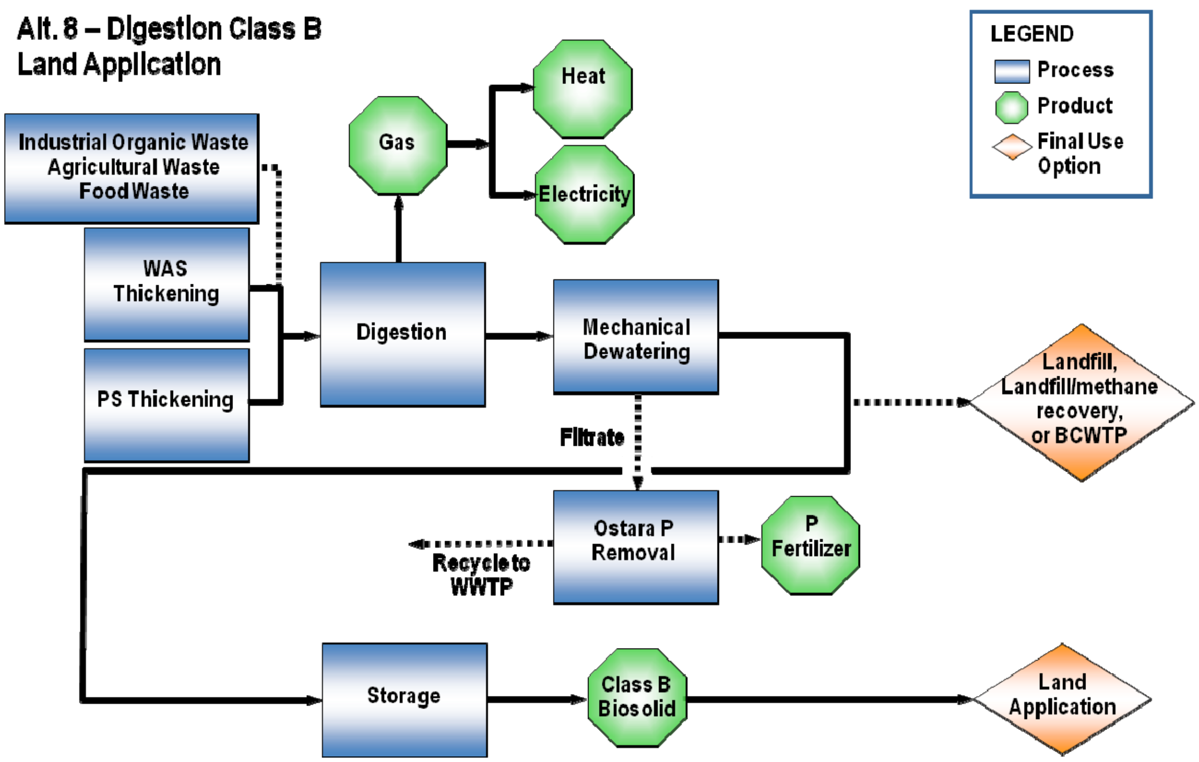
- Prepasteurization uncommon in full-scale applications
- High capital cost associated with digesters
- Relatively complex operation
- High O&M costs for prepasteurization
- Potential odor and scaling problems from prepasteurization
- Potential safety concerns associated with methane gas

- Requires large storage tanks (180 days)
- High transportation cost to move 22 to 26 percent solids product

4.8 Alternative 8—Digestion Class B Land Application

In Alternative 8 (Figure 4-9), gravity-thickened primary solids and thickened waste activated solids would be fed at about 6 percent solids to mesophilic anaerobic digesters. The digesters are completely mixed and operated under anaerobic conditions at 35° to 38°C. Solids are retained in the digester at least 15 days. Anaerobic digestion will convert roughly 50 percent of the volatile organics in the solids into methane and carbon dioxide (digester gas, biogas). The solids content after digestion is about 3 percent. Digested solids conditioned with polymer are dewatered to about 22 to 26 percent solids.

FIGURE 4-9
Process Flow Diagram: Alternative 8—Digestion Class B Land Application



The digestion process would produce Class B biosolids. Class B biosolids must be applied to land and cannot be sold for public use. Class B biosolids must comply with state NR204 and USEPA 503 regulations for land application. USEPA 503 regulations also have pollutant (metal) limits and requirements to reduce vector attraction for land application of Class B biosolids. State regulations require 180 days of onsite storage to account for winter months when biosolids cannot be applied to land.

Receiving soils would benefit from the nitrogen, phosphorus, and organic materials in the digested solids. The gas produced in the digestion process would be used to heat the solids flow entering the digesters, as necessary, to maintain the operating temperatures near 95°F.

Excess digester gas could be used to augment the plant heating requirements or to produce electricity and heat in a cogenerator.

Dewatered solids could be transported from the site for use at the Brown County Waste Transformation Project or for landfill disposal. Landfill disposal would be a contingency if digestion or an outlet for the product were unavailable.

Digestion provides the flexibility to add other organic wastes if capacity is available. Food, industrial, or dairy wastes could be added to digesters to enhance biogas production. Digestion capacity could be added as needed.

Nutrients would be extracted from the dewatering recycle as described in Alternative 3.

Advantages

- A source of renewable energy (biogas) that can be converted to electricity or heat
- Ability to use nutrient extraction technologies to remove phosphorus from biosolids and to produce a mineralized phosphorus fertilizer product
- Closed nutrient cycle if biosolids are applied to (more sustainable practice)
- Commonly used and well understood process (though not currently used by GBMSD)
- Less complex, more proven process than mesophilic anaerobic digestion with hydrolysis or pasteurization
- Has a regional precedence (Madison MSD)
- Biosolids suitable for application on land as a soil conditioner
- Digestion reduces mass of solids

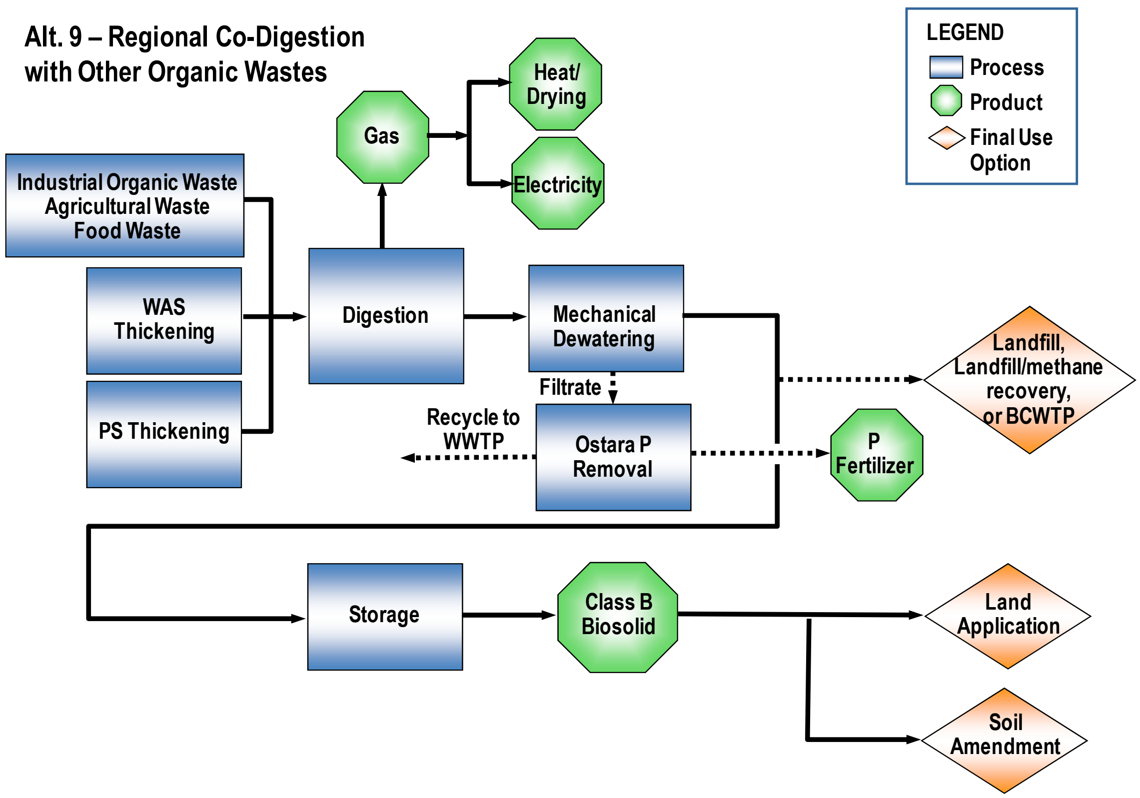
Disadvantages

- Class B biosolids may be difficult to market and may have poor public reception because of perceived public health risk and environmental impacts
- Land for land application is becoming increasingly difficult to find and therefore haul distances would likely continue to increase
- Produces less biogas than mesophilic anaerobic digestion with hydrolysis and pasteurization
- Nominally larger volume of biosolids to handle, compared to alternatives that use hydrolysis or pasteurization
- High capital cost associated with digesters
- Relatively complex operation
- Potential safety concerns associated with methane gas
- Requires large tanks to provide 180 days of storage
- High transportation cost to move 22 to 26 percent solids product

4.9 Alternative 9—Codigestion with Other Organic Wastes

In Alternative 9 (Figure 4-10), the solids processing facilities are sized to accommodate solids from sources besides GBMSD. This alternative includes six digesters instead of four digesters (as in the other digestion alternatives) to provide digestion capacity for wastewater solids from other municipalities, industrial organic waste, meatpacker waste, food waste, and dairy waste. The additional waste streams could greatly increase the biogas production capability of the digestion facilities and would reduce the cost per Btu produced because of economies of scale, resulting in a shorter payback period. Municipal solids from GBMSD are a small waste source when compared with industrial and agricultural waste produced in Brown County. The biogas potential from all these waste sources is substantial. Central processing of solids could benefit the regional economy by reducing the cost of handling and disposal and waste for industries and dairy farms in the area.

FIGURE 4-10
Process Flow Diagram: Alternative 9—Regional Codigestion with Other Organic Wastes



Alternative 9 has positive greenhouse gas implications. Most of the industrial and agricultural waste solids in Brown County are currently applied to land without processing. The solids decompose on the land and release methane (a potent greenhouse gas). By collecting and digesting the solids, greenhouse gas emissions would be reduced, and the renewable energy produced would displace fossil fuel energies and further reduce greenhouse gas emissions. If a market develops for carbon credits, the digestion facility could become a seller of carbon credits.

Collection and centralized processing of waste solids in Brown County would provide the opportunity to remove phosphorus from the solids before land application. The extracted phosphorus could be sold to phosphorus-deficient areas of the country.

Gravity-thickened primary solids and thickened waste activated solids are fed at about 6 percent solids to mesophilic anaerobic digesters. Other solids may require preprocessing (grinding, hydrolysis, etc.) before entering the digesters. Municipal solids could be digested separately from other waste solids streams to keep those solids from having to meet biosolids regulations. The municipal solids digester could be coupled with thermal hydrolysis or prepasteurization to produce class A biosolids.

The digesters are completely mixed and operated under anaerobic conditions at 35° to 38°C. Solids are retained in the digester at least 15 days. Two-stage systems include an unheated, unmixed second stage for thickening and further stabilization. Anaerobic digestion will convert some of the volatile organics in the solids into methane and carbon dioxide, or biogas.

State regulations require 180 days of onsite storage to account for winter months when biosolids cannot be applied to land. This option may require vast amounts of storage.

Advantages

- Revenue from sale of renewable energy, and potentially of carbon credits
- Digestion produces ammonia, which can be used to extract phosphorus by struvite precipitation, allowing phosphorus to be sold outside the region
- Meets strategic vision of becoming a regional environmental services provider, steward of the environment, supporter of the regional economy, and leader in sustainability (producer of renewable energy)
- Flexibility to add digestion capacity as needed
- Could reduce greenhouse gas emissions in the region

Disadvantages

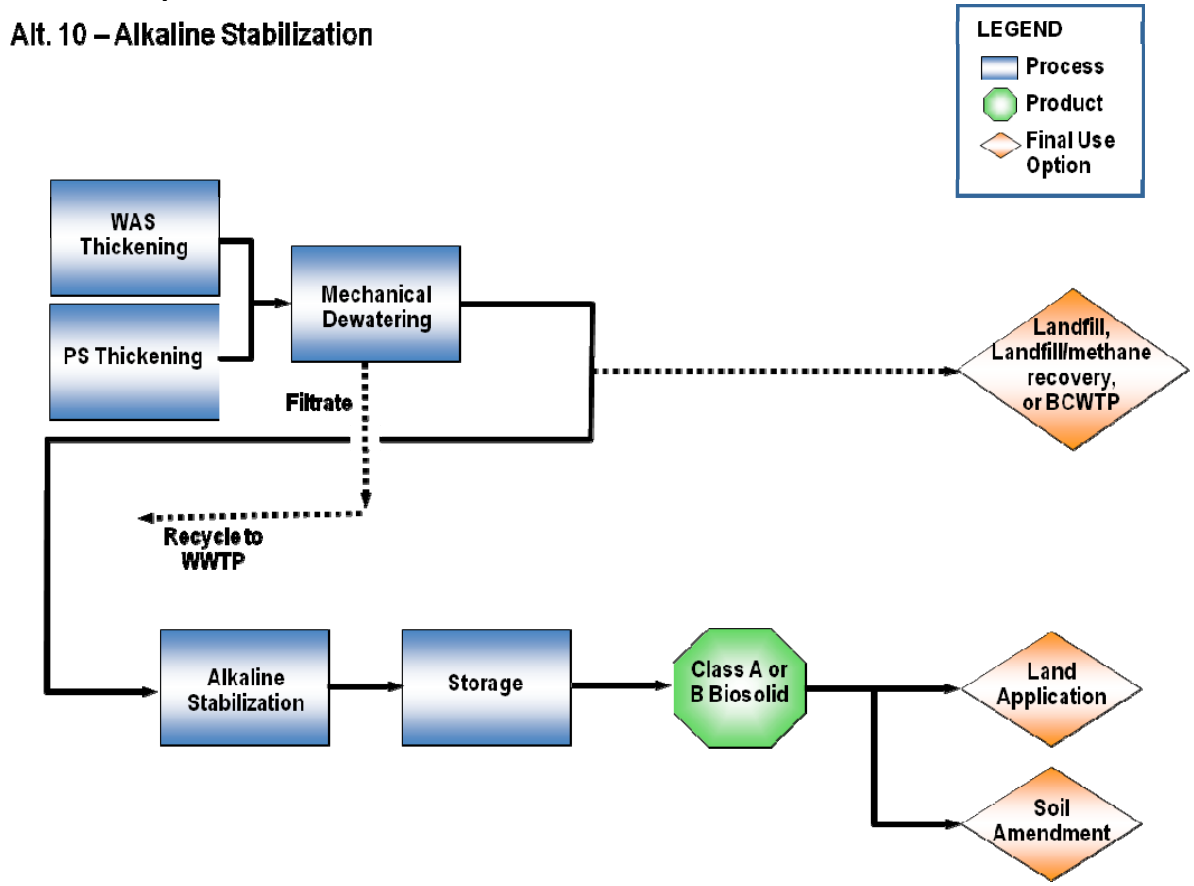
- May require significant time to analyze feasibility and identify partners and funding
- May require significant testing and research
- Potentially large winter storage requirements
- Increased responsibility for management of solids other than municipal
- Large up-front cost
- Large, complex operation
- Potential safety concerns associated with methane gas

4.10 Alternative 10—Alkaline Stabilization

In Alternative 10 (Figure 4-11), Gravity-thickened primary and thickened waste activated sludges would be dewatered to about 25 percent solids. The dewatered cake would be fed to a solids mixer where lime or other alkaline material would be added to increase the pH of the mixture.

Alkaline stabilization meets the Class B requirements when the pH of the mixture of wastewater solids and alkaline material is at 12 or above after 2 hours of contact. Class A requirements can be achieved when the pH of the mixture is maintained at or above 12 at least 72 hours, with a temperature of 52°C maintained at least 12 hours during that time. In one process, the mixture is air-dried to more than 50 percent solids after the 72-hour period of elevated pH. The process may be adjusted to maintain temperatures at or above 70°C for 30 or more minutes, while maintaining the pH requirement of 12. The higher temperature can be achieved by overdosing with lime (that is, adding more than is needed to reach a pH of 12), by using a supplemental heat source, or by using a combination of the two. Monitoring for fecal coliforms or *Salmonella* sp. is required before the generator may release the solids for use.

FIGURE 4-11
Process Flow Diagram: Alternative 10—Alkaline Stabilization



Alkaline stabilization can be achieved using hydrated lime, quicklime (calcium oxide), fly ash, lime and cement kiln dust, and carbide lime. Quicklime commonly is used because it has a high heat of hydrolysis (491 Btu) and can significantly enhance pathogen destruction. Fly ash, lime kiln dust, or cement kiln dust often are used for alkaline stabilization because of their availability and low cost.

The stabilized product is suitable for application in landscaping, agriculture, and mine reclamation. The product serves as a lime substitute, source of organic matter, and specialty fertilizer. Alkaline stabilized biosolids create favorable conditions for growth of vegetation by improving soil properties such as pH, texture, and water holding capacity.

Class A alkaline stabilized biosolids are useful in agriculture and as a topsoil blend ingredient. Alkaline stabilized biosolids provide pH adjustment, nutrients, and organic matter, reducing reliance on other fertilizers. Alkaline stabilized biosolids are also useful as daily landfill cover.

Alkaline stabilization is not a proprietary process, meaning that no fee must be paid to a patent holder to use the process. However, several variations on the basic process are proprietary, such as:

- RDP En-Vessel pasteurization system (marketed by RDP Company)

- N-Viro advanced alkaline stabilization with drying (marketed by N-Viro International Corporation)
- N-Viro BioDry (marketed by N-Viro International Corporation)

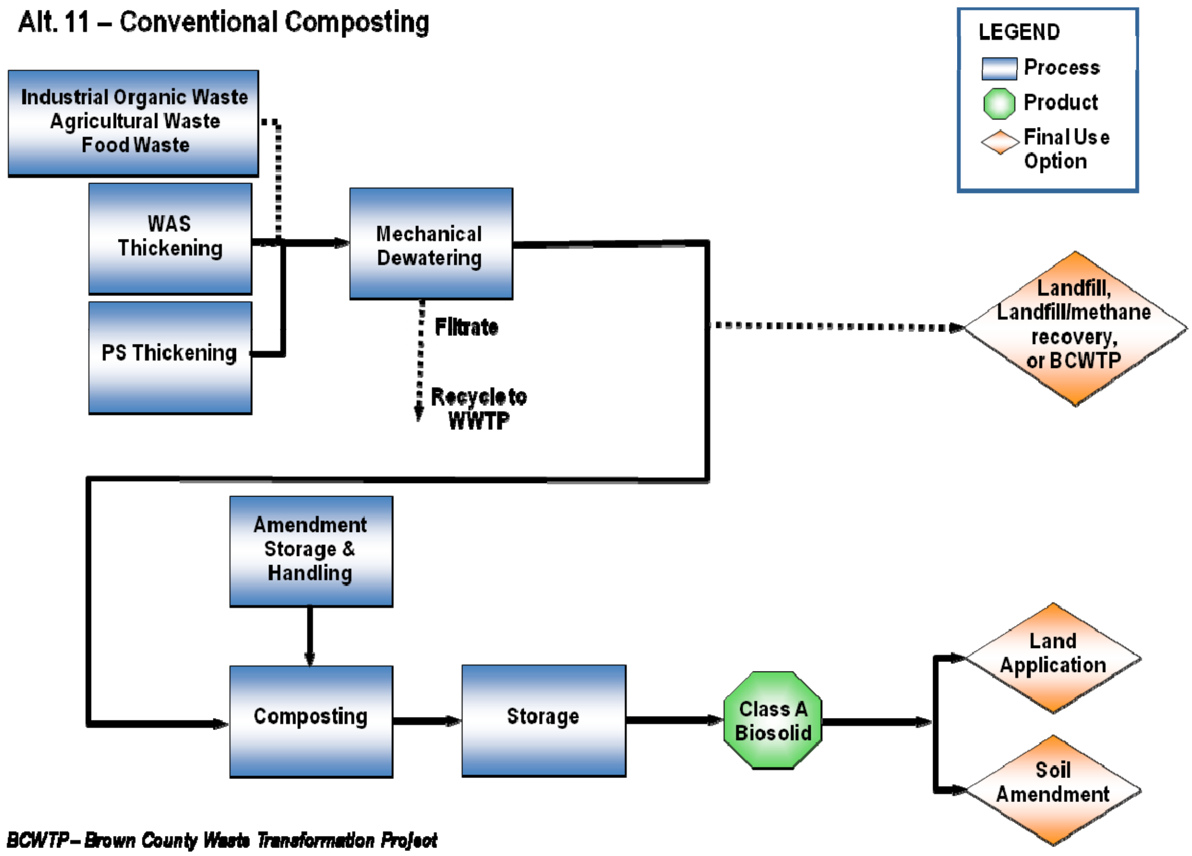
Advantages
- Low capital cost
- Results in a product suitable for various uses
- Simple technology requiring few special skills for reliable operation
- Easy to construct using readily available parts
- Required land area is small
- Flexible operation, easily started and stopped
- Relatively safe process

Disadvantages
- There is potential for odor generation at both the processing and end-use sites
- Corrosive materials that make handling and operation of facilities difficult and unfriendly to operators
- Product unsuitable for use on all soil (soils in and near Brown County are already relatively alkaline)
- Volume of material to be managed and moved offsite increased by roughly 15 to 50 percent compared to other stabilization techniques, such as digestion, resulting in higher transportation costs when material is moved offsite
- Potential for dust production
- Potential for pathogen regrowth if the pH drops below 9.5 while the material is stored before use
- Lower nitrogen content in final product than that in other biosolids products (During processing, nitrogen is converted to ammonia, which is lost to the atmosphere through volatilization. In addition, plant available phosphorous can be reduced through the formation of calcium phosphate.)
- Fees associated with proprietary processes (Class A stabilization)

4.11 Alternative 11—Conventional Composting

In Alternative 11 (Figure 4-12), Gravity-thickened primary and thickened waste activated sludges would be dewatered to about 25 percent and fed to an in-vessel aerated composting process. In composting, sludge is mixed with yard waste or other suitable carbon amendment materials, air is added to aid in decomposition, and heat from decomposition is retained in the vessel to heat the compost. Yard waste is mixed in to attain an optimum carbon to nitrogen ratio of 20:1 to 40:1. The moisture content of the compost is maintained between 50 and 60 percent. Compost can be sold as a valuable soil amendment. Receiving soils will benefit from the nitrogen, phosphorus, and organic materials in the compost.

FIGURE 4-12
Process Flow Diagram: Alternative 11—Conventional Composting



Composting is an aerobic thermophilic process and, as such, achieves Class A solids. Aeration also reduces odor potential and increases the speed of the composting process. Elevated temperatures in the composting process provide high pathogen destruction. In-vessel/in-building composting systems use mechanical agitation to turn the piles and ensure sufficient air contact. A biofiltration air pollution control system addresses odors from the composting process.

Class A designation requires a satisfactory level of pathogen reduction in the composting process. Exceptional quality biosolids must also meet vector attraction reduction requirements and pollutant (metal) limits. Requirements to reduce vector attraction include meeting certain pathogen densities. Fecal coliforms cannot exceed 1,000 most probable number per gram [MPN/g] of total solids, salmonella cannot exceed 3 MPN/4g of total solids), as well as composting at a temperature above 55°C (131°F) for 3 days in a vessel or static, aerated pile.

Following dewatering, the solids can be transported from site for other uses, such as land application, the Brown County Waste Transformation Project, or landfill disposal. Landfill disposal would be a contingency if composting or an outlet for the product were unavailable.

Advantages

- Class A biosolids
- Produces a valuable soil amendment product

- Positive public perception of composting process
- Nutrient cycle is closed when compost is applied to land (more sustainable practice)
- Reduced greenhouse gas emissions, since a significant amount of the organic carbon is sequestered in the compost
- Commonly used and well understood process
- Relatively safe process

Disadvantages
- Potential odor concerns
- Relies on collection of wood waste
- Relies on ability to market compost product
- Energy in biosolids is not captured
- High capital cost associated with compost facility
- Large winter storage requirements
- Increases volume of solids
- Large facility footprint

4.12 Alternative 12—Co-composting

Alternative 12 (Figure 4-13) has two separate composting operations. An in-vessel aerated composting facility would compost municipal biosolids, meatpacker waste, yard waste, and other suitable organic feedstocks as described in Alternative 11. A separate windrow facility could compost animal waste from farms.

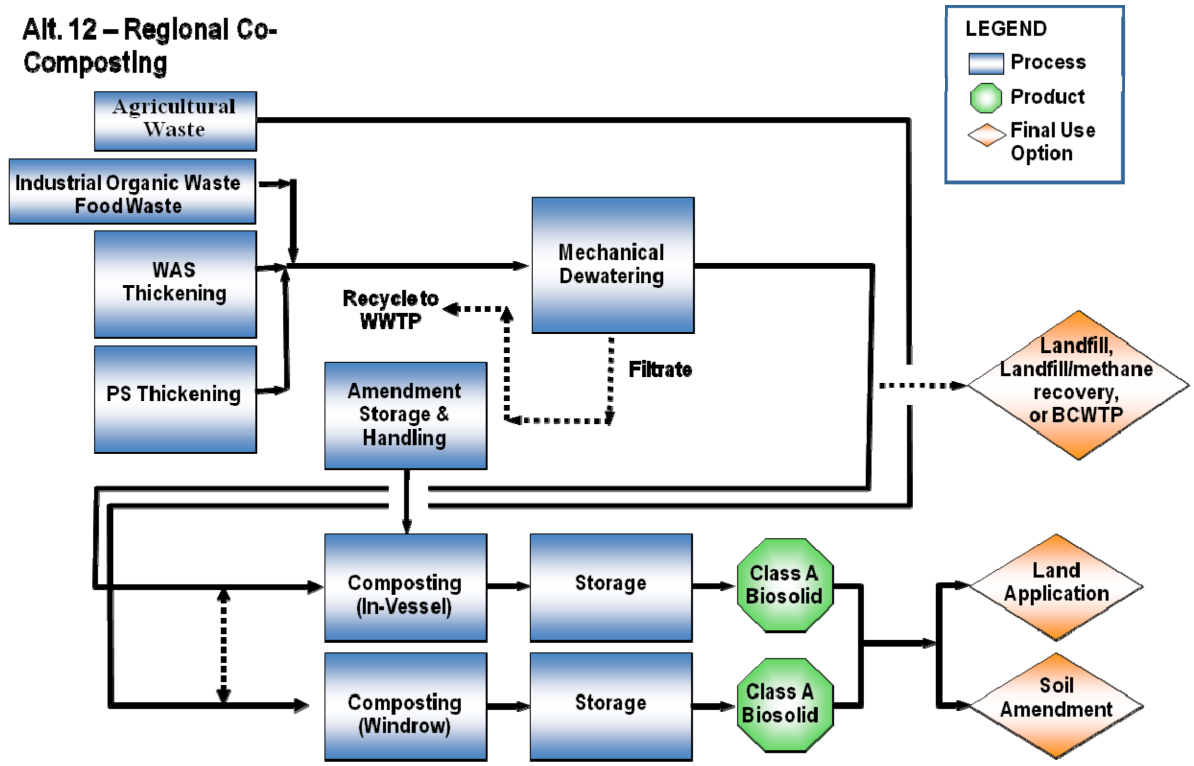
Central processing of solids could benefit the regional economy by reducing the cost of handling and disposal and waste for industries and dairy farms in the area.

A separate windrow composting facility would process animal waste (refer to the *Brown County Regional Composting Feasibility Study* [Harvey Economics, 2005]). The facility would be designed to accommodate the waste from 6,000 animals, growing to 12,000 or more as acceptance of this disposal technique by farmers takes hold. A mobile dewatering unit would move from farm to farm. The water from which solids have been removed would be returned to the lagoon for subsequent land application. The dry solids from the animal waste would be trucked to a single windrow facility.

Composted material can be sold as a valuable soil amendment. Receiving soils will benefit from the nitrogen, phosphorus, and organic materials in the digested solids.

Advantages
- Class A biosolids
- Processing of meatpackers and animal wastes would help meet GBMSD's strategic goals of becoming a regional environmental services provider and leader in sustainability
- Valuable soil amendment product
- Nutrient cycle would be closed when compost is applied to land (more sustainable)
- Reduced greenhouse gas emissions; a significant amount of the organic carbon is sequestered in the compost
- Commonly used and well understood process
- Relatively safe process

FIGURE 4-13
Process Flow Diagram: Alternative 12—Regional Co-composting



BCWTP – Brown County Waste Transformation Project

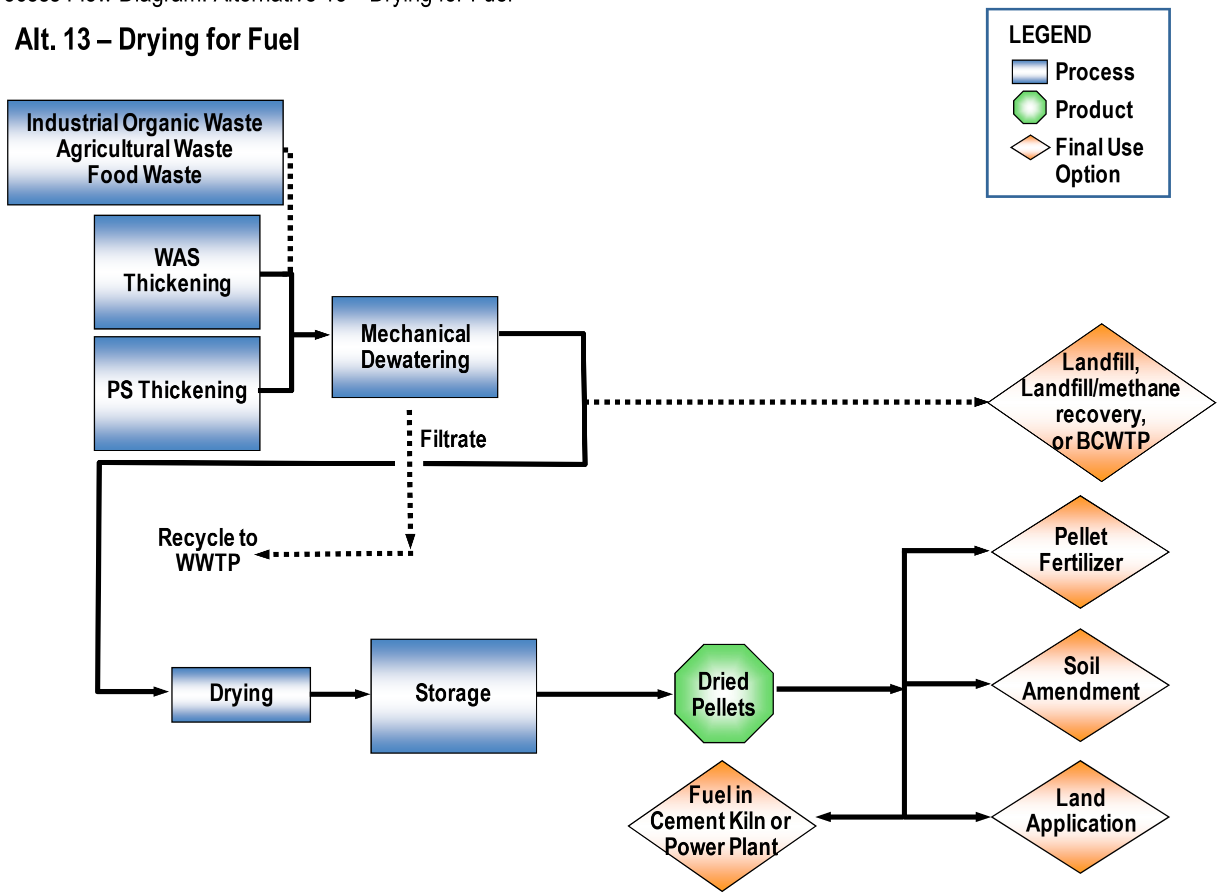
Disadvantages

- Responsibility for a larger amount of solids
- Complexity posed by two separate composting operations
- Windrow facility would be a large operation with large land area requirement
- Collection of various wastes could be logistically difficult
- Energy in biosolids is not captured
- Potential odor concerns
- Requires collection of yard waste
- Large winter storage requirements
- Uncertainty regarding marketability of compost

4.13 Alternative 13—Drying for Fuel

Alternative 13 (Figure 4-14) uses a dryer to produce a dry granule material that can be used as a fertilizer or soil amendment or burned as fuel in a cement kiln or power plant furnace.

FIGURE 4-14
Process Flow Diagram: Alternative 13—Drying for Fuel



Gravity-thickened primary and thickened waste activated sludges would be dewatered to about 25 percent solids. Following dewatering, solids would be conveyed to a heat dryer, where most of the moisture remaining after dewatering is evaporated. Solids would be heated to at least 212°F for more than 30 minutes during the drying process to eliminate harmful pathogens. The resulting granules, at about 90 percent dry solids or more, would be removed from the dryer and stored before transporting offsite. The drying process requires supplemental fuel, such as natural gas. The granules can as be sold as a fertilizer, soil amendment, or fuel.

As a Class A biosolids, with minimal permitting requirements, the dried granule material can be made available for use on farms, public parks, golf courses, reforestation projects—anywhere a soil amendment is needed. The material is soil-like in appearance and aroma.

Heat-dried biosolids can be produced by direct or indirect heating. Direct-fired dryers drive heated air directly over and around the sludge. Dust is produced during this type of drying, and dust handling is often a major equipment component. Because of additional safety measures and higher fuel usage, direct drying may not be a good fit in many settings. Indirect dryers usually dry the material within an enclosed or semi-enclosed chamber that conducts heat from steam or thermal fluid. There is virtually no air flow around the material, so dust and odor are not problematic. Indirect dryers can also operate at lower temperatures for a safer, more energy-efficient process. However, the product may be nonuniform and dusty, and may not be suitable as a fuel.

Advantages

- Low capital cost
- Simplicity; drying is the only major process
- Drying is a proven technology
- Reduced greenhouse gas emissions if the granules are used as fuel in a cement kiln or at a power plant
- Volume reduction

Disadvantages

- High fuel cost for dryer
- Greenhouse gas emissions from operation of the dryer
- Potential safety issues

4.14 Alternative 14—Incineration and Drying

Alternative 14 (Figure 4-15) consists of drying most of the waste activated sludge and incinerating all primary sludge. Some of the sludge would be mixed as needed with primary sludge prior to incineration. The amount of sludge sent to drying would be such that the dryer heating demand is matched with the waste heat available from the incinerator. Roughly 60 percent of all solids would be incinerated, and 40 percent would be dried. Natural gas would not be required for drying.

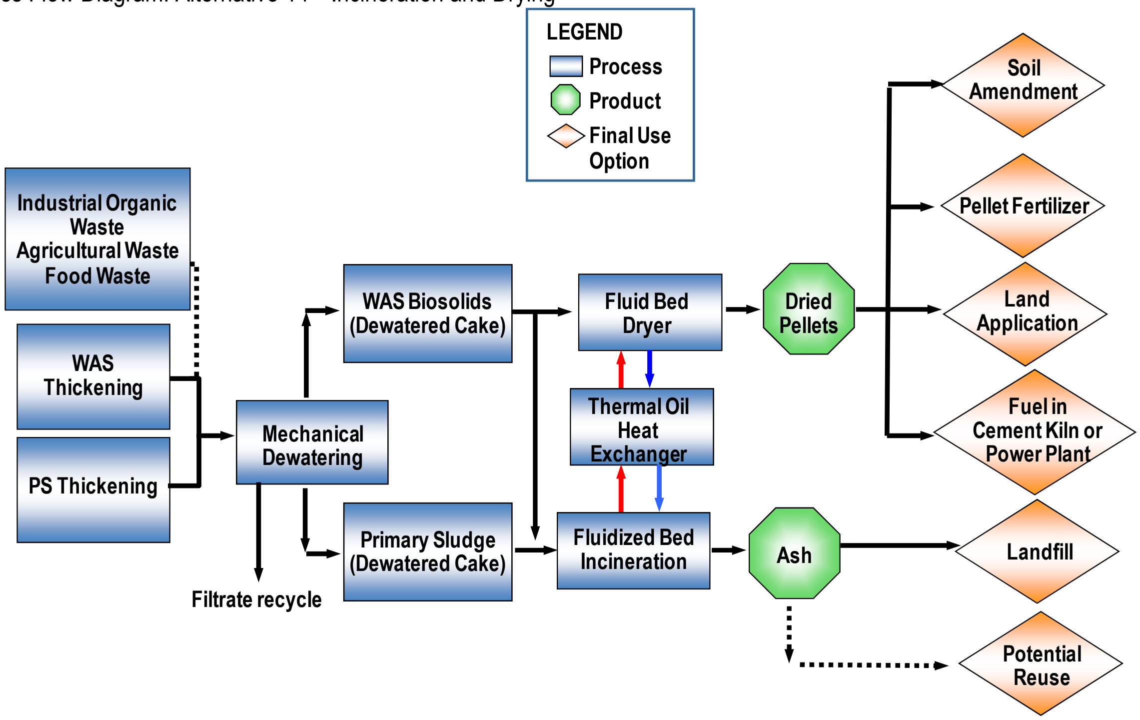
4.14.1 Drying of Waste Activated Sludge

Waste activated sludge would be dewatered to 25 percent, then conveyed to the fluid bed drying system. The fluid bed dryer would be thermally coupled with the fluidized bed incinerator. Thermal oil would transfer heat from the incinerator to the dryer, to provide all of the dryer's heating needs. The amount of sludge sent to the dryer would be based on the amount of heat available for drying. The dryer system would create dried granules that could be sold as a slow release fertilizer, applied to land, or used as fuel.

4.14.2 Incineration of Primary Sludge

Gravity-thickened primary sludge would be dewatered by centrifuge to 25 percent solids content and incinerated in a fluidized bed incinerator. A fluidized bed incinerator results in improved reliability, less operation and maintenance attention, reduced air emissions, and higher heat efficiency. The higher heat efficiency is a result of fluidized bed incinerators typically operating at much lower excess air rates than typical multiple hearth furnace operations. Refer to the description of Alternative 2 for information on fluidized bed incineration.

FIGURE 4-15
Process Flow Diagram: Alternative 14—Incineration and Drying



Advantages

- Class A product
- Recycling of solids and nutrients into a valuable end product
- Flexibility to incinerate or dry solids
- Volume reduction, and opportunities for regional solids management
- Waste heat capture eliminates need for fuel in dryer and reduces greenhouse gas emissions

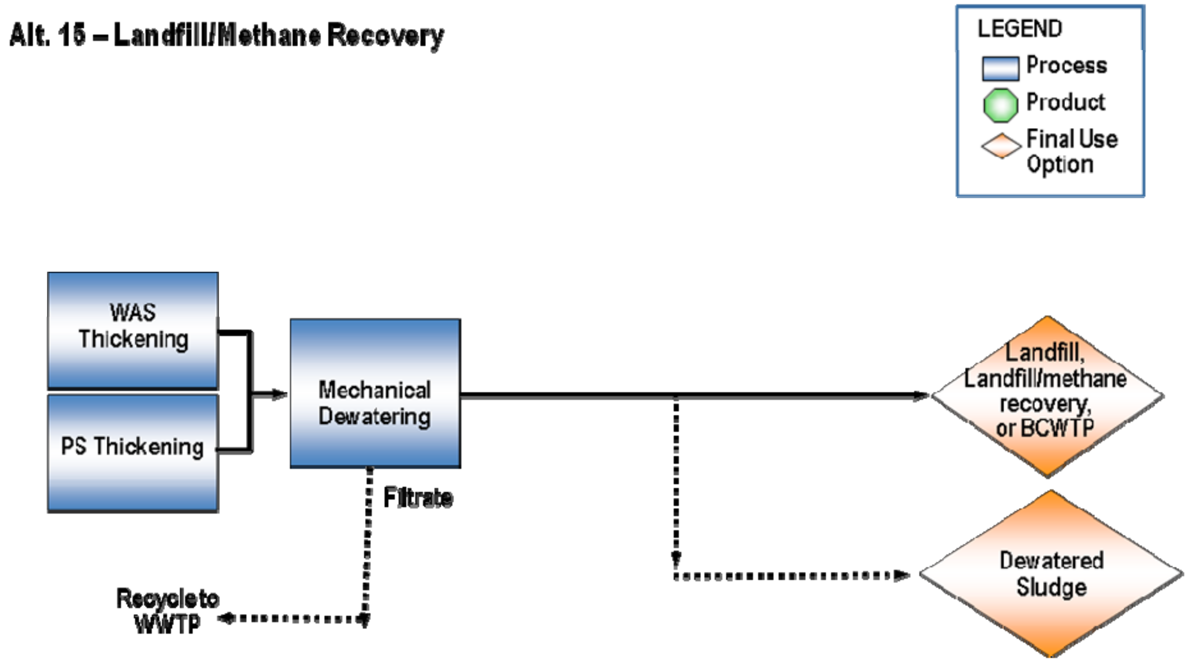
Disadvantages

- Waste heat is used for drying instead of offsetting building heating needs
- May not be able to process significant amounts of nonmunicipal solids such as meatpacker, agricultural, and food wastes. Some solids may adversely affect granule formation or cause safety issues in the dryer. Small amounts may be processed if they are homogenized with municipal solids
- Increased complexity because of the operation of an incinerator and dryer and the management of two separate solids streams/products
- Dryers are known to have potential safety issues
- Ash would likely be placed in a landfill instead of beneficially reused

4.15 Alternative 15—Landfill / Methane Recovery

Alternative 15 (Figure 4-16) would rely on a local landfill as the sole option for disposal. Biosolids could have beneficial uses at the landfill, such as enhancing methane production or, if stabilized, providing daily cover. Gravity-thickened primary solids and thickened waste activated solids would be dewatered to about 25 percent solids. Following dewatering, solids would be conveyed to a truck to be hauled to a landfill.

FIGURE 4-16
Process Flow Diagram: Alternative 15—Landfill/Methane Recovery



Advantages

- Simplest of all options
- Minimal capital and O&M costs, mainly for hauling and for tipping fees
- Possible beneficial use for the biosolids in the landfill
- Minimizes potential for public health concerns
- Few safety concerns associated with this option

Disadvantages

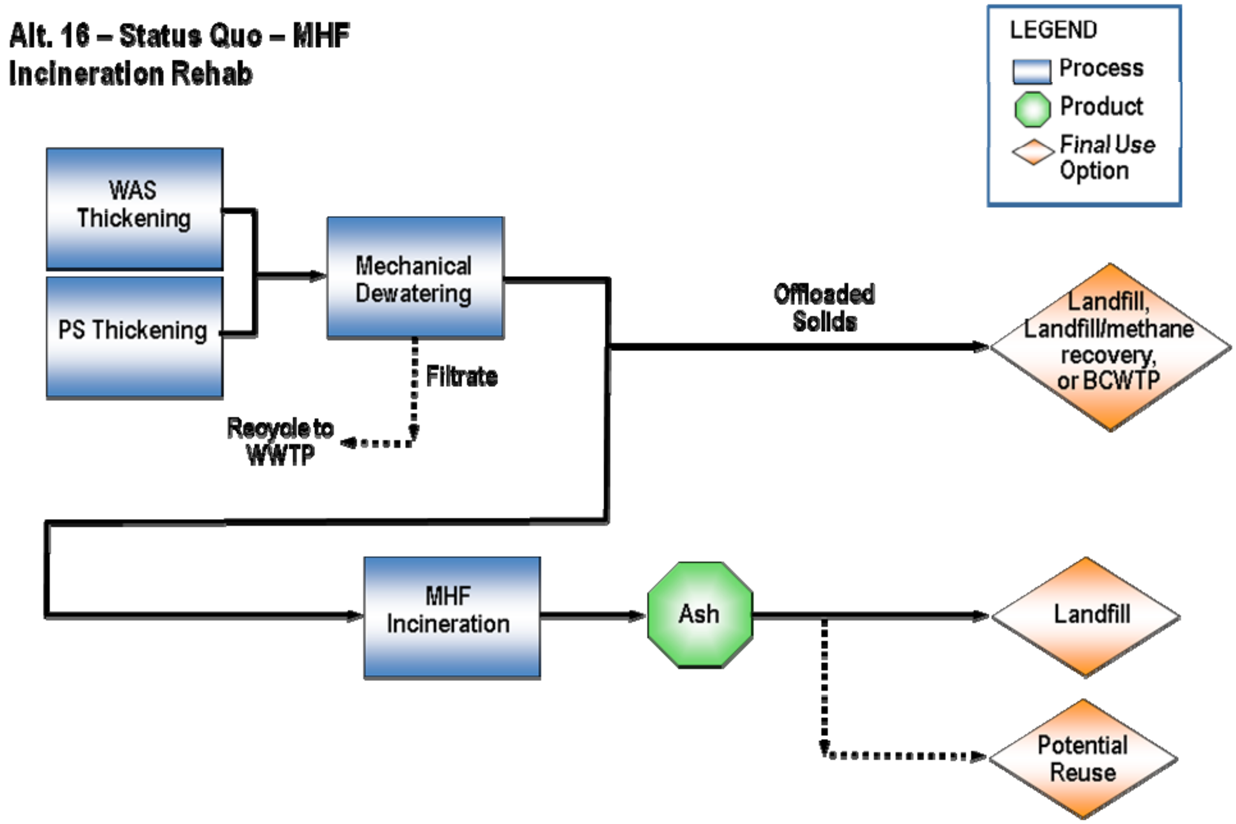
- Most likely the least sustainable of all options
- Cause landfills to reach capacity more quickly
- Landfilling costs are continuing to rise
- No volume reduction

4.16 Alternative 16—Status Quo: Rehabilitate MHF Incineration

Alternative 16 (Figure 4-17) would preserve the existing solids processing train. Currently, gravity-thickened primary solids and thickened waste activated solids are fed to belt filter presses at about 5 percent solids and dewatered to about 22 percent solids. The dewatered cake is then fed to the incinerators. The resulting ash is placed in a landfill.

The existing multiple hearth incinerators do not have sufficient capacity to handle future solids loads. The limited capacity is especially a concern when one incinerator must be taken offline for maintenance. During these maintenance periods, dewatered solids are offloaded directly to the landfill. In order to meet upcoming emissions requirements, the incinerators may have to be upgraded with emissions control systems.

FIGURE 4-17
Process Flow Diagram: Alternative 16—Status Quo: Rehabilitate MHF Incineration



The existing incineration system was installed in the 1970s and is nearing the end of its useful life. Significant rehabilitation is required in order to keep it operational for another 20 years. Also, increased capacity will need to be added in the future if offloading solids to the landfill becomes unacceptable.

Advantages

- Easy implementation with lowest capital cost
- Proven technology
- Ease of operation and maintenance; no training required
- Low O&M costs
- Volume reduction
- No public health concerns due to exposure with biosolids

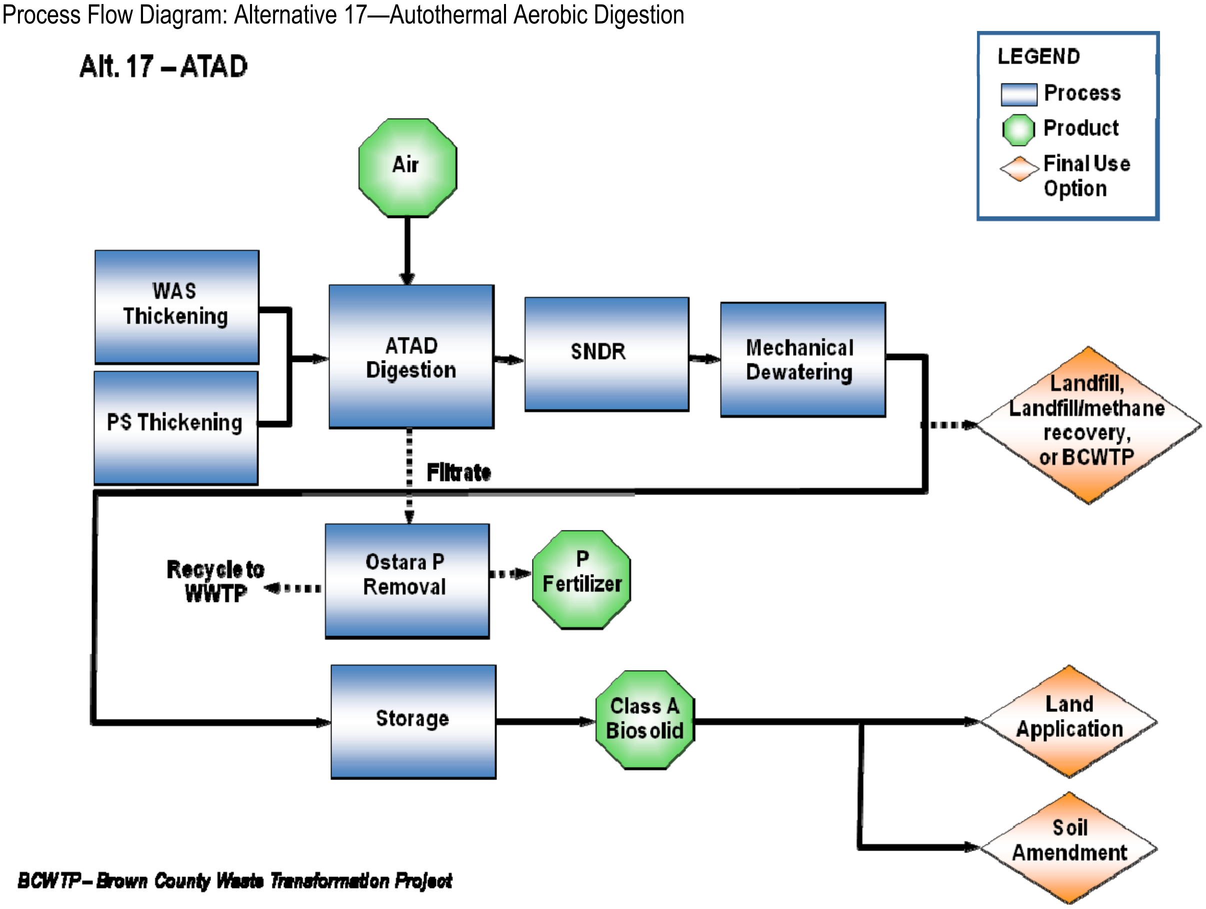
Disadvantages

- Outdated technology and aging equipment require significant O&M attention
- No capture of energy in biosolids
- Lower emissions quality
- Regulatory difficulty

4.17 Alternative 17—Autothermal Aerobic Digestion

In Alternative 17 (Figure 4-18), gravity-thickened primary solids and thickened waste activated solids would be fed at about 6 percent solids to thermophilic aerobic digesters.

FIGURE 4-18
Process Flow Diagram: Alternative 17—Autothermal Aerobic Digestion



Note: SNDR = Storage Nitrification Denitrification Reactor

The autothermal aerobic digestion (ATAD) process consists of insulated reactors, a volumetrically efficient (low air flow) aeration system, foam control devices, and transfer piping as required. The aerobic reactions in the digester release sufficient heat to raise the reactor temperature to the thermophilic range, generally from 56° to 65°C. The reactor is heated autothermally; that is, the organisms in the reactor produce the heat required for thermophilic reaction. To comply with the EPA's time and temperature requirements, the ATAD operates on a draw and fill cycle. Hold times based on time and temperature range from 4 to 20 hours. ATADs have been used in the U.S. almost exclusively to digest TWAS, thickened above 4 percent total solids. The second generation ATAD operates with a 10- to 15-day solids retention time and produces Class A biosolids.

ATAD digestion will reduce total solids by roughly 50 percent. This process does not produce methane because it is an aerobic process. The process produces carbon dioxide and ammonia because nitrifying organisms cannot survive at thermophilic temperatures. The solids content after digestion is about 3 percent. Digested solids are conditioned with polymer and dewatered to about 25 percent solids. The Class A dewatered cake would then be applied to land. Receiving soils would benefit from the nitrogen, phosphorus, and organic materials in the digested solids.

Nutrients would be extracted from the dewatering recycle process as described in Alternative 3.

Advantages

- Class A biosolids
- Potentially lower capital cost and land area requirement than anaerobic digestion
- Fifty percent volume reduction that could offset the transportation cost to move a 25 percent solids product

Disadvantages

- Few installations at this scale; most plants use less than 5 mgd
- Higher O&M cost than anaerobic digestion due to air requirement
- No biogas production
- Odor concerns

5. Alternatives Evaluation

CHAPTER 5

Alternatives Evaluation

5.1 Initial Screening

In Chapter 4, 17 alternatives were identified, but Alternative 7, Prepasteurization with Digestion, was eliminated because the technology was determined not to be mature, and it is not actively marketed by any vendors. Project team members scored the 16 remaining alternatives in the following categories (Refer to Appendix 5-1 for a description of the criteria):

- Life-cycle cost (present worth) weight: 25 percent
- Operations weight: 35 percent
- Social/community weight: 15 percent
- Environment weight: 25 percent

Figure 5-1 shows the results of scoring the 16 alternatives using the multi-attribute utility analysis (MUA). The three highest scoring alternatives were selected for further evaluation. Alternatives 1, 4 and 13 ranked fourth, fifth and sixth were dropped from further consideration, because they were very similar to the three highest ranked alternatives and provided no distinct advantages. Alternative 11, Conventional Composting, was chosen as a fourth alternative for evaluation because it scored fairly high (seventh) and offered some diversity from the remaining alternatives, its process differing substantially from the other alternatives. This decision is further justified because the alternatives ranked 4 through 7 had very close scores.

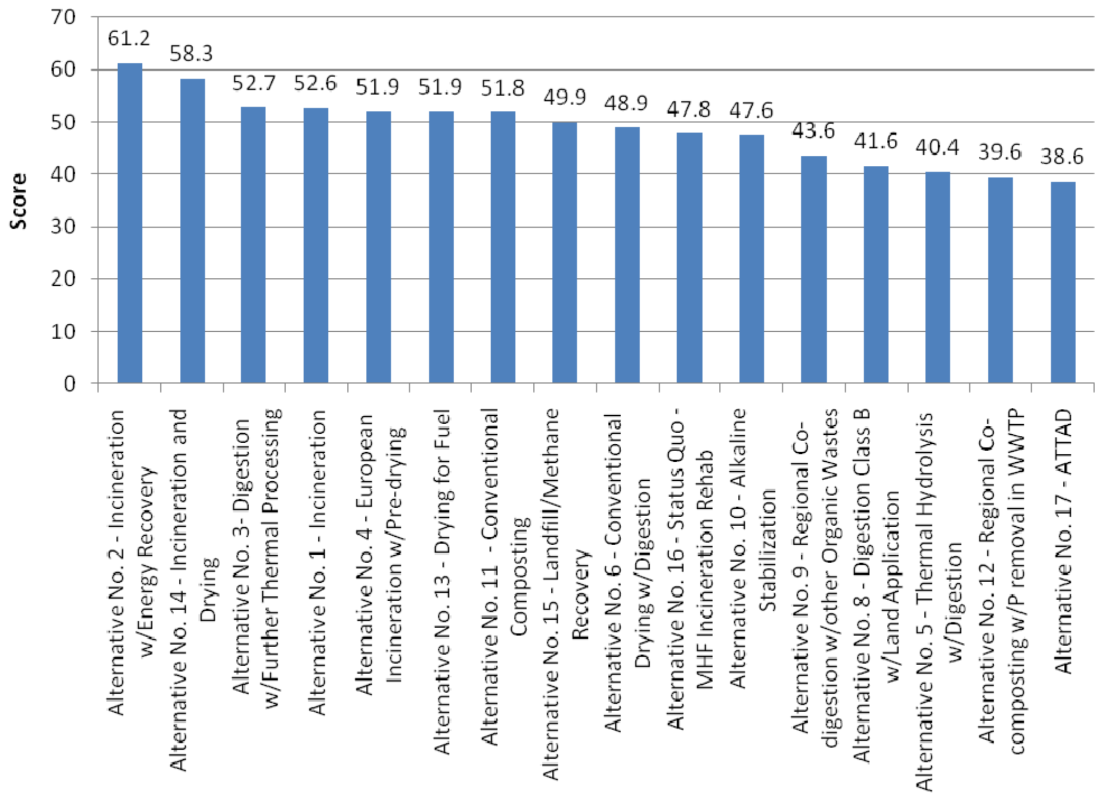
TABLE 5-1
Alternatives Selected for Detailed Evaluation

Alternative No.	Alternative
2	Incineration with Energy Recovery
3A	Digestion with Thermal Processing
3B	Digestion with Thermal Processing and Electrical Generation
11	Conventional Composting
14	Incineration with Drying
16	Rehabilitate Multiple Hearth Furnaces

Subsequent to the scoring exercise and submittal of the initial Solids Management Facility Plan to the WDNR in November 2010, several conditions changed, as addressed herein:

- GBMSD stakeholders requested that Alternative 16, Rehabilitate Multiple Hearth Furnaces, be reconsidered to attempt to identify a lower cost option.
- A modified version of Alternative 3, referred to as Alternative 3B, was added to the shortlist of alternatives. Alternative 3B is Digestion with Thermal Processing and Electrical Generation. Alternative 3 is now referred to as Alternative 3A.
- The flows and loads were refined to reflect reductions of loads from major industrial customers, a change in the planning period end date from 2028 to 2035, the most recent service area population projections, and other issues. See Appendix 2-2 for details.
- For alternatives 3A and 3B: Addition of codigestion of high strength industrial wastes to increase biogas production. See Appendix 5-2 for details.

FIGURE 5-1
Initial MUA Scoring Analysis of Alternatives



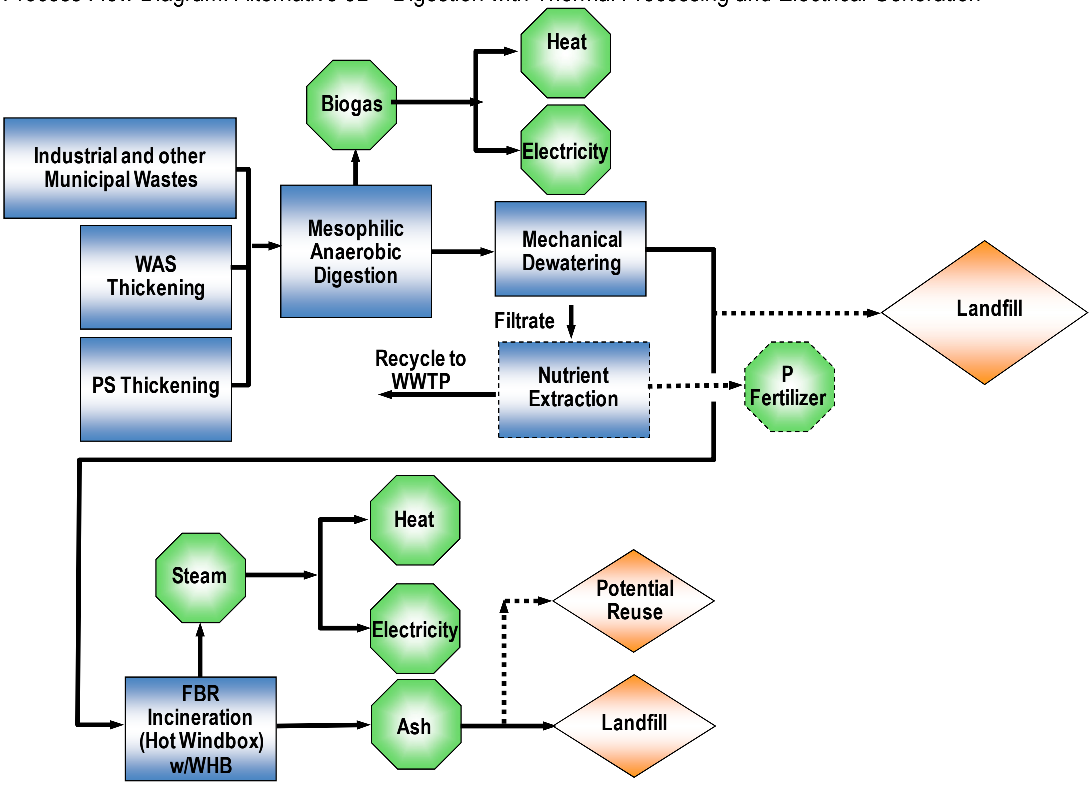
- For alternatives 3A and 3B: Defer the potential implementation of nutrient extraction and assume initially that iron salts would be used for struvite control. See Appendix 5-3 for details.
- Incorporation of the USEPA published the final SSI MACT rule which was published in March 2011. The air pollution controls required for Alternatives 2, 3A, 3B, and 16 reflect the final SSI MACT requirements.

Table 5-1 lists the six alternatives selected for further, detailed evaluation. This chapter summarizes the detailed evaluation of these six final alternatives. See the Refinement of Alternatives Technical Memorandum in Appendix 5-4 and Chapter 6 for additional information and details regarding the evaluation and Alternative 3B.

5.2 Alternative 3B—Digestion with Thermal Processing and Electrical Generation

Figure 5-2 is an overall, simplified process flow diagram for Alternative 3B, Digestion with Thermal Processing and Electrical Generation – the alternative that was added following the initial evaluation. Under Alternative 3B, thickened sludge would be digested, and the digested dewatered cake would be thermally oxidized. Energy would be recovered from the biogas produced in the digester and from the thermal oxidizer waste heat, as further described below. Primary sludge would be thickened in the existing gravity thickeners, and waste activated sludge would be thickened using the existing gravity belt thickeners.

FIGURE 5-2
Process Flow Diagram: Alternative 3B—Digestion with Thermal Processing and Electrical Generation



As with all alternatives, the gravity thickeners and TWAS pumps would be rehabilitated and odor control would be added to the gravity thickeners. See Chapter 6 for details regarding this. The combined thickened waste activated and primary sludge would be conveyed to storage tanks.

5.2.1 Digestion, Energy Recovery and Dewatering

The thickened sludge would be pumped to two mesophilic anaerobic digesters. The purpose of the digesters is to reduce sludge quantities and to produce biogas. The organic material in the sludges would be converted biologically to methane and carbon dioxide (biogas) in airtight reactors. The digesters would be completely mixed and operated under anaerobic conditions at 35° to 38°C. The biogas produced would be combusted in one or more internal combustion engines that would drive a generator to produce electricity. Waste heat from the engines could be used to heat the digesters. Wastes from other industrial sources, such as dairy wastes, would be digested along with municipal wastes to increase biogas production and electrical power generation. See the Codigestion Technical Memorandum (Appendix 5-2) for details. The digested sludge would be concentrated to about 25 percent solids. A nutrient extraction system could be added at some future time to produce a phosphorous fertilizer and prevent struvite formation on downstream equipment should iron addition prove to be too costly. See the Nutrient Extraction Technical Memorandum for details (Appendix 5-3).

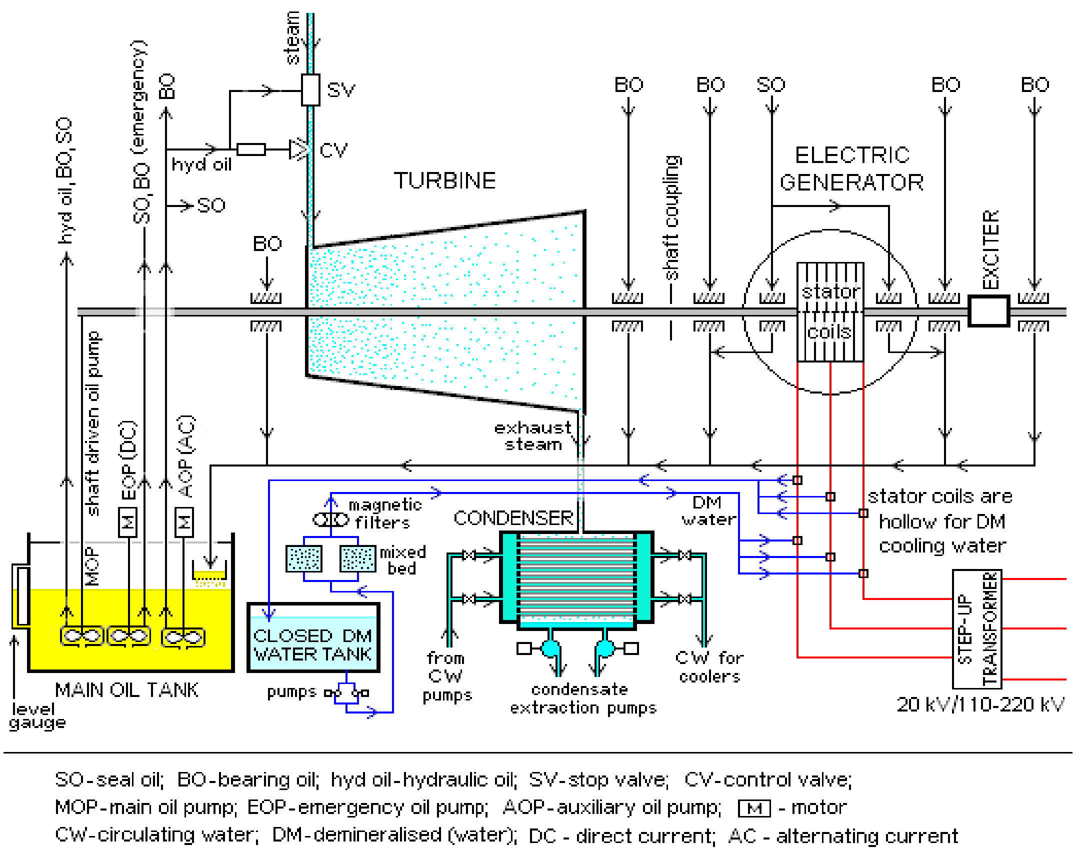
5.2.2 Incineration and Steam Turbine Power Generation

Digested, dewatered biosolids would be conveyed to a single fluidized bed incinerator. In a fluidized bed incinerator, unlike a multiple hearth incinerator, water flashes off and the sludge burns in one chamber. A fluidized bed incinerator is a cylindrical, vertically oriented, and refractory-lined steel shell that contains a sand bed and fluidized air diffusers called tuyeres. The bed expands to about 200 percent of its at-rest volume. The temperature of the bed is controlled between 1,400 and 1,500°F by injecting combustible materials into the sand bed. The residence time within the combustion zone is several seconds at 1,400 to 1,500°F. Ash is carried out the top of the furnace and removed by air pollution control devices. Feed is introduced to the furnace either above or directly into the bed. Airflow in the furnace is determined by several factors. Fluidizing and combustion airflow must be sufficient to expand the bed to a proper density but low enough to prevent biosolids from rising to and floating on the top of the bed.

A waste heat steam boiler would use waste heat from incineration to produce steam that could be used in a steam turbine to generate electricity, or the steam could be used for building heat. With current natural gas and electrical prices, it likely would be most economical to use steam for building heat in the winter and power generation in warmer months. This could change if the relative price of electrical power increases at a rate faster than that of natural gas. Figure 5-3 is a schematic of a steam turbine power generation system similar to the one that may be used. Power likely would be generated at 4160 volts.

Some of the major advantages and disadvantages of Alternative 3B are described below. See the multi-attribute utility analysis scoring matrix guide (Appendix 5-1) for a detailed comparison of attributes for all the alternatives.

FIGURE 5-3
Steam Turbine Generator System



Advantages

- Significantly reduced air emissions, as compared to the those from the existing multiple hearth furnace incinerators
- Low greenhouse gas emissions due to the high degree of energy recovery and minimal use of auxiliary fuel (natural gas)
- Proven technologies
- Low operating cost because of the high degree of energy recovery, especially if energy prices continue to rise in the future
- Ability to add nutrient extraction technology in the future to remove phosphorus from biosolids and produce a mineralized phosphorus fertilizer product
- Volume reduction in digestion reduces the size and cost of the thermal oxidation system

Disadvantages

- Capital cost is high because of multiple unit processes
- Ash would likely be landfilled instead of beneficially reused
- Operation of steam boiler likely will require a licensed operator

5.3 Alternative 16—Rehabilitate Multiple Hearth Furnaces

As noted, subsequent to submittal of the initial Solids Management Facility Plan to the WDNR in November 2010, GBMSD stakeholders requested that Alternative 16, Rehabilitate Multiple Hearth Furnaces, be reconsidered because it may be a lower cost alternative. In addition, in March 2011, after the plan was submitted to the WDNR, the USEPA published the final SSI MACT rule, which was determined to have significant impacts on the air pollution controls required for Alternative 16 (see MACT Technical Memorandum in Appendix 2-1 for more details). When the original evaluation of Alternative 16 was performed, it was uncertain as to what the air pollution control requirements would be. In Alternative 16, the solids facility would be completely rehabilitated, including incineration, plant building heat and waste heat boilers, dewatering, and building HVAC, and electrical and plumbing systems. New air pollution control would be installed to meet the final SSI MACT rule requirements. See the alternatives refinement technical memorandum (Appendix 5-4) for details regarding the rehabilitation of the existing solids facility.

5.4 Final Multi-attribute Utility Analysis

The remaining 6 alternatives were evaluated using the same approach as the initial screening of the 16 alternatives but in greater detail. Process descriptions, building plans, section drawings, and site layouts were developed, and process flow diagrams, solids balances, and energy balances were refined (see Appendix 5-4 and Appendix 5-5). The nonmonetary scoring process was expanded to include the attribute subcategories shown in Figure 5-4 to facilitate more detailed scoring. See Appendix 5-1 for additional details regarding the nonmonetary scoring process. The life-cycle cost estimates were also refined and are presented in Figure 5-5. Appendix 5-4 contains cost estimate details.

FIGURE 5-4
Objectives, Criteria, and Weightings Used for the Multi-attribute Utility Analysis

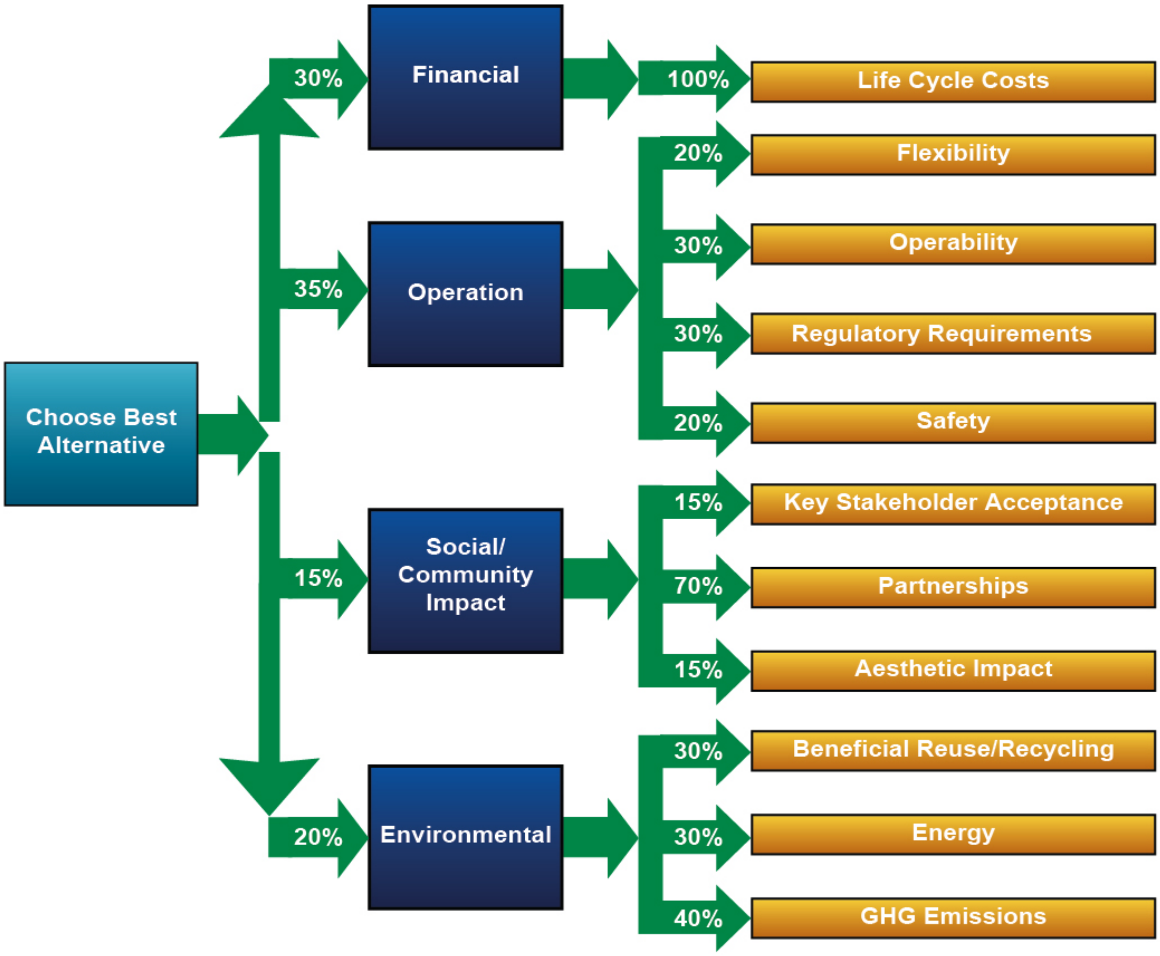
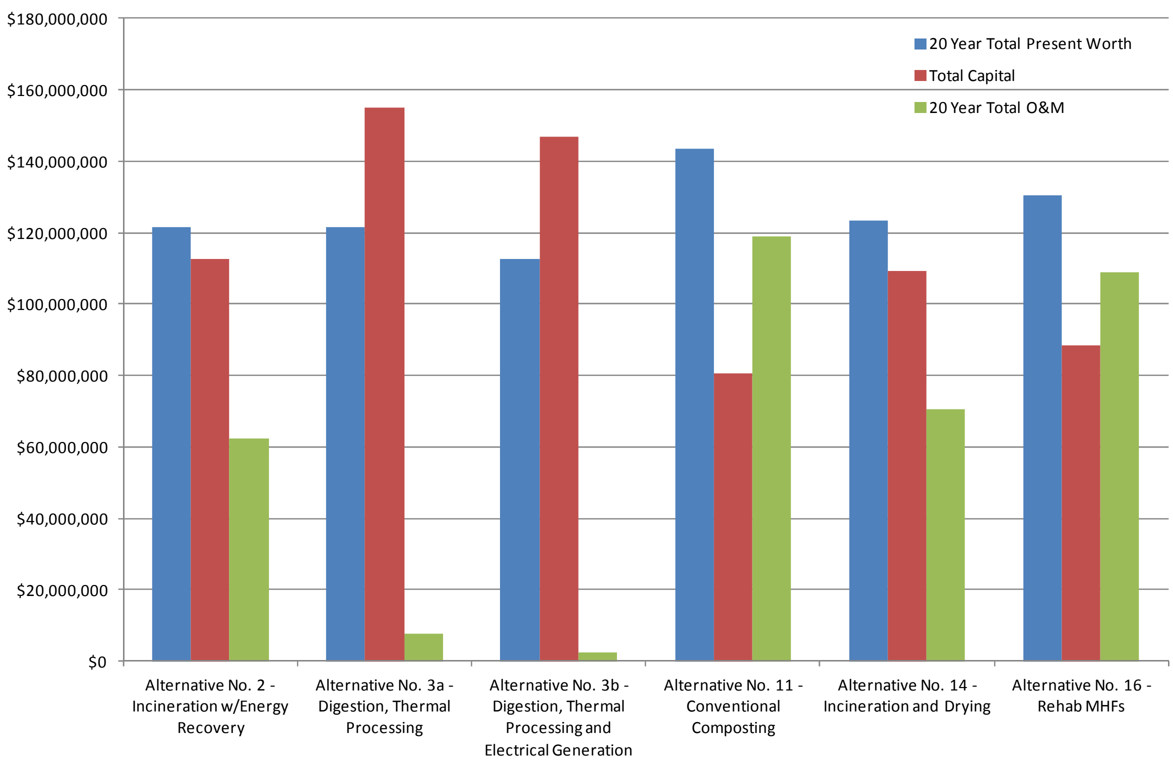


FIGURE 5-5
Comparison of Estimated Costs of Final Alternatives

	Alternatives					
	2	3A	3B	11	14	16
Capital Cost	$112,700,000	$154,900,000	$146,900,000	$80,600,000	$109,100,000	$88,400,000
Total Present Worth (40 year)	$180,200,000	$149,000,000	$134,600,000	$218,100,000	$187,800,000	$215,800,000
Total Present Worth (20-year w/ Salvage Value)	$121,500,000	$121,600,000	$112,600,000	$143,400,000	$123,500,000	$130,300,000
Annual O&M in 2015	$2,100,000	$700,000	$500,000	$3,500,000	$2,300,000	$3,300,000
Annual O&M in 2025	$2,900,000	$400,000	$200,000	$5,400,000	$3,300,000	$5,000,000
Annual O&M in 2035	$4,100,000	($100,000)	($520,000)	$8,700,000	$4,800,000	$7,700,000
Annual O&M in 2045	$5,800,000	($1,300,000)	($1,900,000)	$13,900,000	$7,000,000	$11,500,000
Annual O&M in 2055	$8,300,000	($3,600,000)	($4,600,000)	$22,800,000	$10,200,000	$17,300,000
20-Year Total O&M	$62,300,000	$7,500,000	$2,400,000	$119,000,000	$70,400,000	$108,800,000
40-Year Total O&M	$183,900,000	($23,800,000)	($42,800,000)	$417,000,000	$216,500,000	$350,200,000

Note: All costs are June 2011 dollars referenced to ENR CCI = 9104.



Project team members scored the six alternatives for each category shown in Figure 5-4. The non-renewable energy usage used to estimate energy costs and greenhouse gas emissions are shown in Figures 5-6 and 5-7 and were used to score the alternatives for the environmental attributes. The energy costs for some alternatives are negative because the alternative facility generates more energy than can be used in the solids facility. The excess energy can be utilized for other plant energy needs.

FIGURE 5-6
20-Year Energy Costs

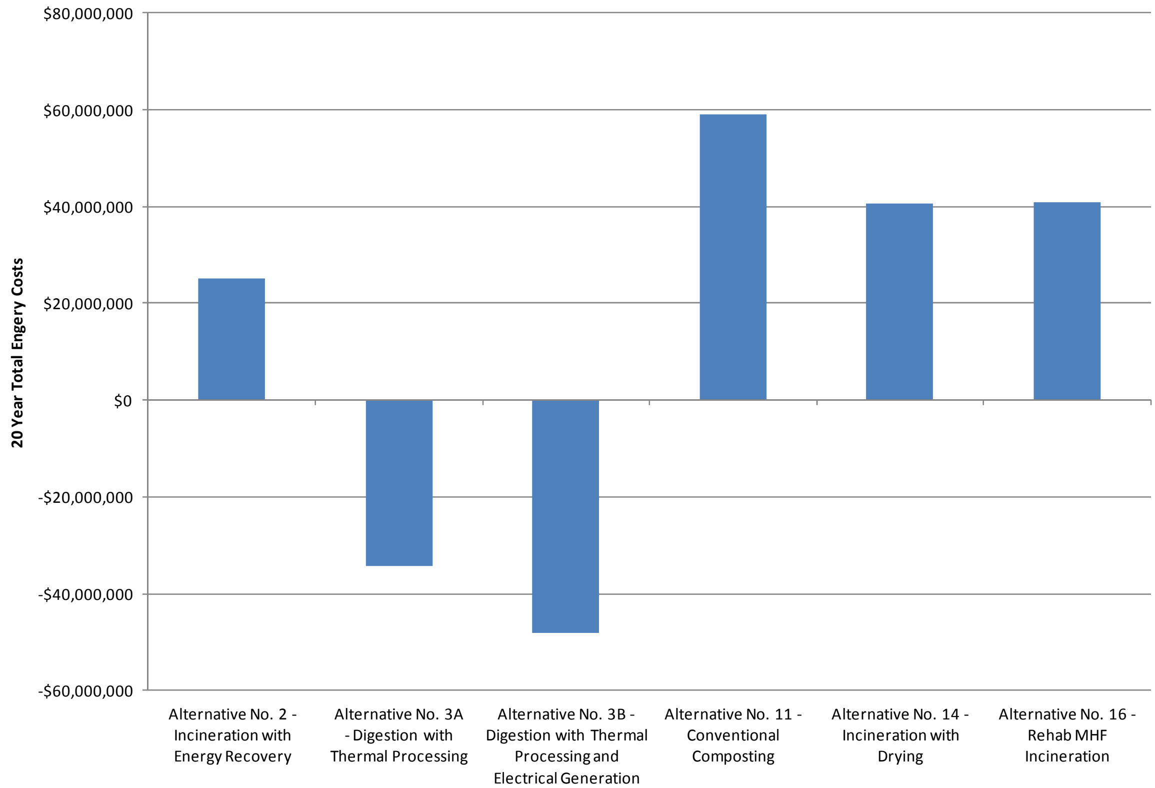
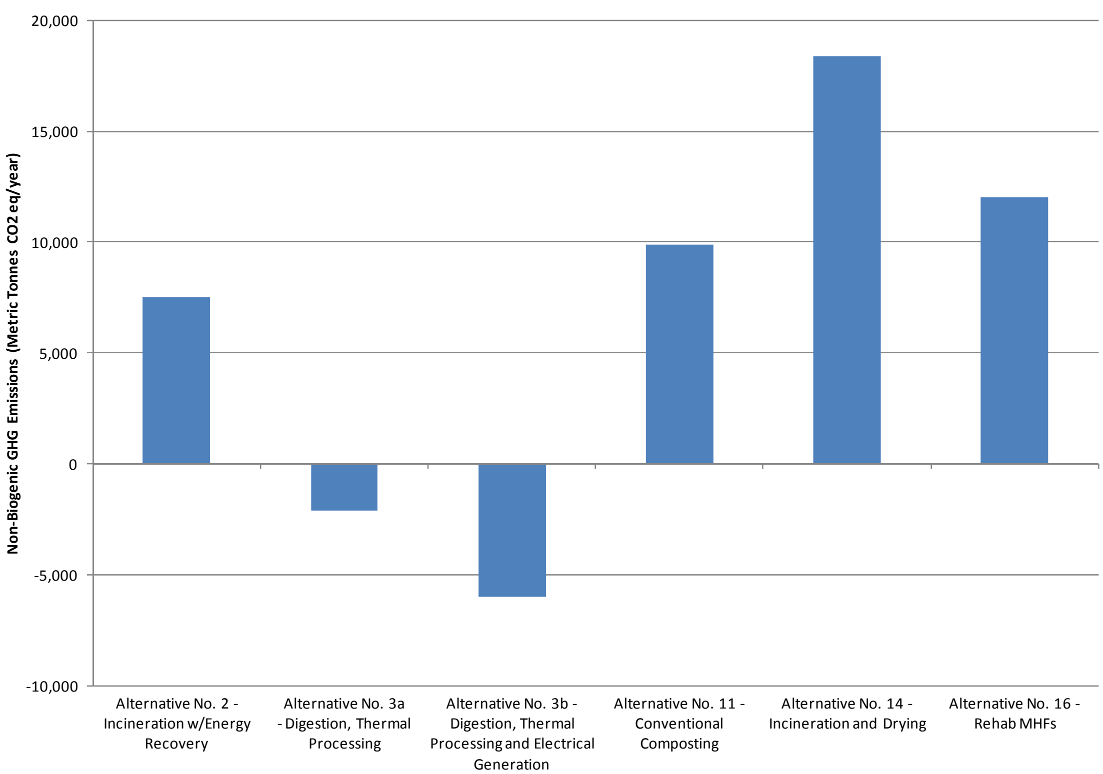


FIGURE 5-7
Greenhouse Gas Emissions



Greenhouse gas emissions from the six alternatives were estimated in terms of equivalent metric tons of carbon per year. The greenhouse gas emissions associated with the solids processes include direct emissions from the solids processes, such as the incinerators, boilers, and dryers, and indirect greenhouse emissions from the coal power plant that supplies electricity to GBMSD. Other indirect greenhouse gas emissions in the estimate include emissions from ancillary activities, such as trucking ash, chemicals, and pellets, and the energy used in the production of polymers.

Greenhouse gas emissions are classified as biogenic and nonbiogenic. Emissions from the combustion of digester gas and biosolids used for electricity, building heat, digester heating and drying pellets are classified as biogenic emissions. The reason they are biogenic is that the carbon-based diets of humans contribute to the production of the digester gas methane and biosolids cake that are the end products of wastewater treatment. The digester gas and biosolids cake combustion carbon emissions are taken up by food plants and other vegetation. Unlike, nonbiogenic, or man-made emissions from fossil fuel, this recycling of carbon results in no net increase in carbon emissions. Figure 5-7 compares the nonbiogenic greenhouse gas emissions from each alternative. The emission estimate reflects the fact that emissions may be avoided. For example, under Alternative 3A, emissions are avoided because it would supply a fertilizer produced using a biogenic fuel (waste heat from incineration), which would reduce the use of commercial fertilizers made using fossil fuels, and the emissions associated with their production.

Each alternative was described, noting advantages and disadvantages for each subcriterion, to ensure that team members were able to make an informed scoring decision (see nonmonetary descriptions in Appendix 5-1). Three categories—life-cycle cost, nonrenewable energy consumption, and nonbiogenic greenhouse gas emissions—were scored without input from the project team members because the scores were calculated using scales proportional to the cost, energy and emission values. The scores were averaged and the results are presented in Figure 5-8.

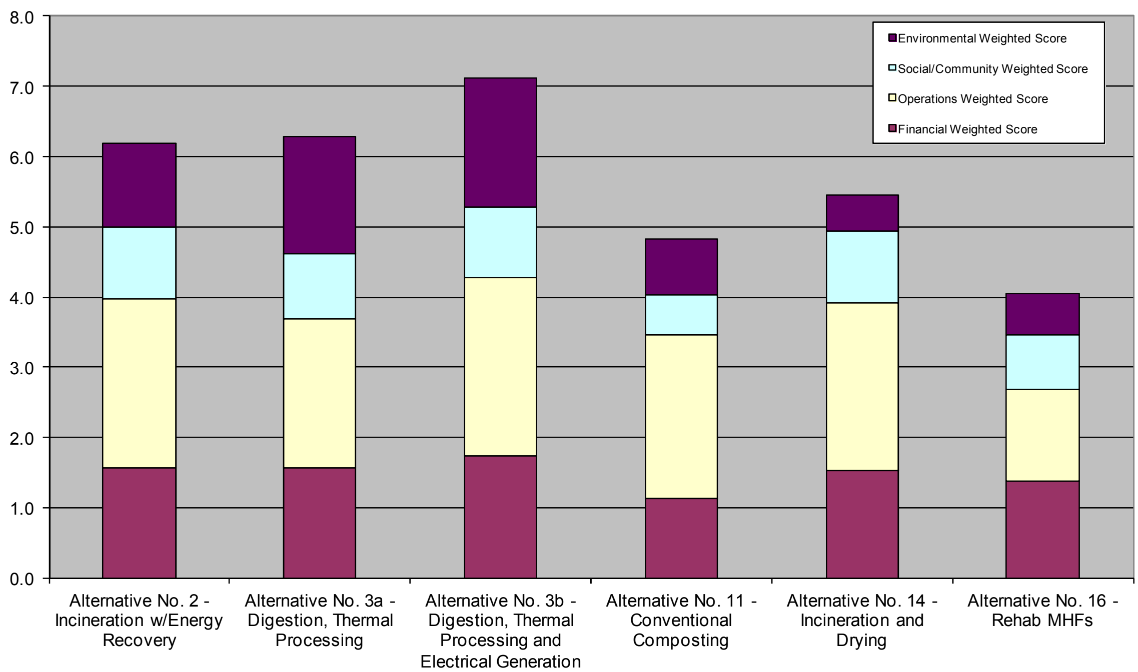
5.5 Alternative Selection

Using the multi-attribute scoring results to help inform their decision, the team selected Alternative 3B. Alternative 3B was selected because it is best aligned to the fundamental goals and objectives articulated in GBMSD's strategic plan that was used to develop the scoring attributes. Specifically, Alternative 3 was selected for the following reasons:

- Alternative 3B has the lowest 20-year life-cycle cost.
- Alternative 3B will reduce GBMSD's energy costs by an average of almost $4 million per year over 20 years for a total estimated savings of $82 million over 20 years.
- Alternative 3B will allow GBMSD to generate about 60 percent of its plant wide energy using renewable sources.
- Alternative 3B mitigates GBMSD's customer's exposure to the cost impacts of potential future increases in energy prices and greenhouse gas regulations.

FIGURE 5-8
Detailed Alternative Multi-attribute Scoring Results Summary

Alternative	Total Weighted Score	Financial	Operations	Social / Community	Environmental
2—Incineration with Energy Recovery	**6.2**	5.2	6.9	6.8	6.0
3A—Digestion with Thermal Processing	**6.3**	5.2	6.1	6.3	8.3
3B—Digestion with Thermal Processing and Electrical Generation	**7.1**	5.8	7.3	6.7	9.1
11—Conventional Composting	**4.8**	3.8	6.7	3.8	3.9
14—Incineration with Drying	**5.5**	5.1	6.8	6.9	2.5
16—Rehabilitate Multiple Hearth Furnaces	**4.1**	4.6	3.7	5.2	3.0



- Alternative 3B has the potential to generate revenue from selling renewable energy certificates (RECs). RECs are tradable, non-tangible energy commodities. REC's represent proof that electricity was generated from an eligible renewable energy resource that can be sold and traded and the owner of the REC can claim credit for purchasing renewable energy.
- Alternative 3B will reduce greenhouse gas emissions by about 22,000 metric tons/year of equivalent carbon dioxide, about equivalent to the annual emissions from 14,000 to 15,000 automobiles.
- Alternative 3B will reduce emissions of toxic air pollutants and air pollutants that form ozone (smog) by 50 to 90 percent. (Removal percents for individual compounds vary.)
- Alternative 3B will recover energy from industrial wastes in the codigestion process that otherwise typically would have been disposed of by applying on agricultural land, where wastes could run off or seep into rivers, streams, and groundwater.

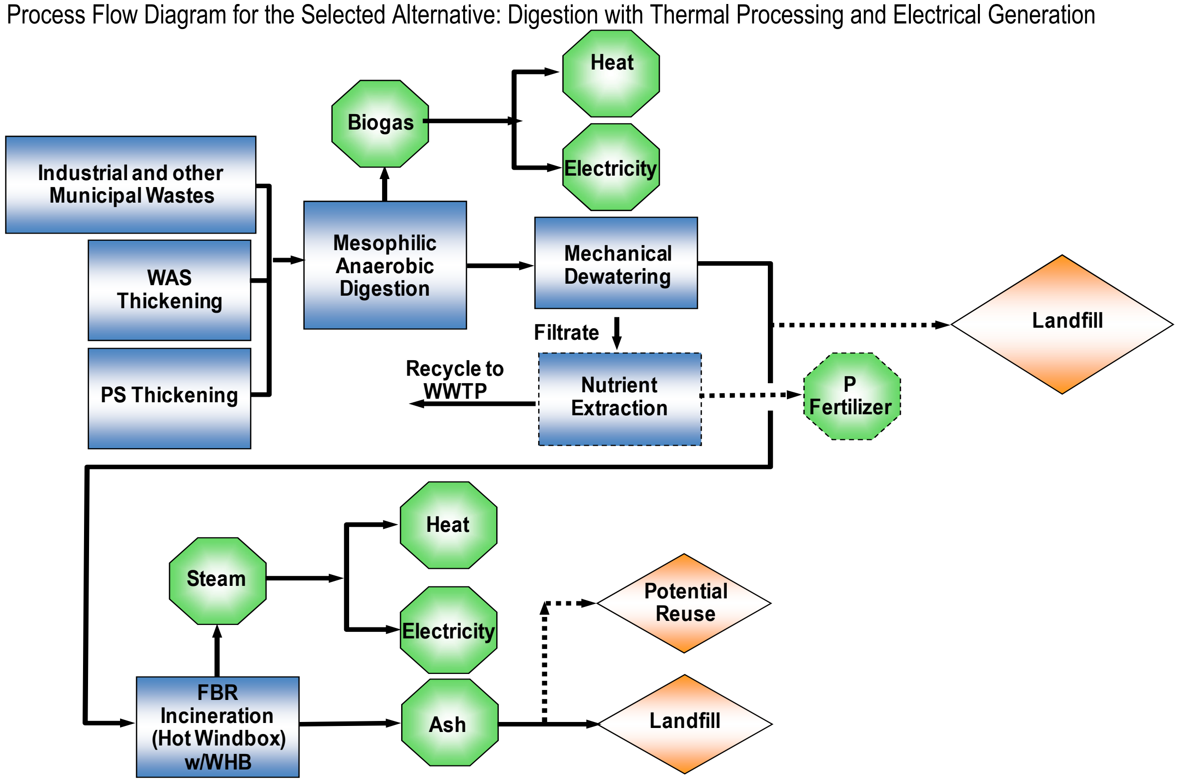
CHAPTER 6

Selected Alternative

6.1 Introduction

Alternative 3B, Digestion with Thermal Processing and Electrical Generation, is the selected alternative (Figure 6-1). This chapter refines the definition of the recommended facilities.

FIGURE 6-1
Process Flow Diagram for the Selected Alternative: Digestion with Thermal Processing and Electrical Generation



6.2 Solids Loadings

6.2.1 Review of Existing and Future Loadings

The projected solids loads presented in Chapter 3 were used to size the processes for the selected alternative. Table 6-1 lists the solids loadings used to size the system. It was assumed that the system would start up in 2015 and that the system would be sized for the projected 2035 loads. Table 6-1 also lists the refined solids loadings projections used to determine the size of the refined alternative facilities. Table 6-2 shows the estimated projected

TABLE 6-1
2035 Solids Loadings Projections for Sizing the Selected Alternative

Thickened solids to digestion	Avg. Day	51 dtpd
	Max. Month	64 dtpd
Digested, dewatered solids to incineration	Avg. Day	30 dtpd
	Max. Month	38 dtpd

solids loads at 2035 maximum month conditions and at 2035 average conditions. See the Updated Flows and Loads Technical Memorandum (Appendix 2-2) for the detailed methodology used for projecting the loads. As part of pre-design of the solids facilities, the solids loadings may be refined further to:

- Consider changes in actual loads and conditions that may have occurred since the solids projections were completed in July 2011.
- Consider adding additional capacity for future industrial loads that have not been identified. WDNR code would typically provide up to a 5 percent allowance for future unplanned industrial loads (NR 110.09).
- Review the assumption that industrial wastes that are codigested will add negligible solids. The solids added will depend upon the types of wastes that are codigested.

6.2.2 Codigestion

One goal of GBMSD's strategic plan is to be a regional provider of wastewater services. One way for that goal to be met is for GBMSD to process solids from industrial sources.

Codigestion of wastes was evaluated, and it was concluded that codigestion is feasible and would be cost-effective. See the Feasibility of Codigestion for Alternative 3 (Appendix 5-2) for details regarding the evaluation. It was concluded that while codigestion could have some adverse impacts on digester operation, the increased revenues from increased energy production and tipping fees will outweigh the potential disadvantages. Codigestion could increase biogas production by more than 50 percent. Implementing codigestion will increase the capital costs of Alternative 3B by about 5 percent because of the cost to increase the size of the digesters and biogas systems.

Several waste sources in northeastern Wisconsin are suitable and desirable for codigestion. The proximity of some sources to the GBF likely would allow GBMSD to negotiate a competitive tipping fee. The most suitable of the wastes available in large quantities are dairy wastes. Dairy wastes with the highest strength would be most desirable, largely because they would minimize the need to increase the digester size while significantly increasing biogas production. Dairy wastes are also desirable because they generally do not contain large amounts of solids or debris, which could add to handling costs. Chloride concentrations in some high-strength dairy wastes could inhibit the digestion process, but that could be mitigated by controlling the rate of waste addition or by prohibiting the codigestion of high chloride wastes.

Codigestion may be evaluated further during the predesign of the solids facility. This evaluation may include laboratory testing of wastes, continuing discussion with potential waste sources to better define waste characteristics and quantities, continued assessment of potential tipping fees, and evaluation of methods to mitigate potential problems such as foaming and chloride toxicity. This evaluation could then be used to further refine the size and features of the codigestion storage and handling facilities.

TABLE 6-2
Solids Balance for Selected Alternative

Description	Flow (gpm)	Flow (yd^3/day)	TSS (dry lb/day)	TSS (dtpd)	VSS (dry lb/day)	VSS (dtpd)	TSS (%)	VSS/TSS (%)
2035 Maximum Month Conditions								
Thickened primary sludge	71	N/A	51,660	26	38,745	19	6.1	75
Thickened waste activated sludge	134	N/A	75,600	38	68,040	34	4.7	90
Codigestate	57	N/A	—	—	—	—	—	—
Digested sludge (without codigestate)	204	N/A	78,262	39	57,787	29	3.2	74
Dewatered combined sludge	26	N/A	76,697	38	56,631	28	25.0	74
Centrate recycle	236	N/A	1,565	1	1,156	1	0.1	74
Cake to Incinerator	26	N/A	76,697	38	56,631	28	25.0	74
Ash	N/A	10.6	20,066	10	0	0	67.0	0
2035 Average Conditions								
Thickened primary sludge	56	N/A	41,000	21	30,750	15	6.1	75
Thickened waste activated sludge	106	N/A	60,000	30	54,000	27	4.7	90
Codigestate	57	N/A	—	—	—	—	—	—
Digested sludge (without codigestate)	162	N/A	62,113	31	45,863	23	3.2	74
Dewatered combined sludge	20	N/A	60,870	30	44,945	22	25.0	74
Centrate recycle	199	N/A	1,242	1	917	0	0.1	74
Cake to Incinerator	20	N/A	60,870	30	44,945	22	25.0	74
Ash	N/A	8.4	15,925	8	0	0	67.0	0

Note: It is assumed that suspended solids in codigested waste are negligible. This assumption may change depending upon the characteristics of codigested waste.

6.3 Description of Facilities

Appendix 6-1 contains process flow diagrams, site plans, and building plans for the refined, selected alternative. This section describes the facilities and summarizes some the design criteria used to size and configure the refined, selected alternative.

6.3.1 Digestion

Table 6-3 lists the conceptual criteria used to size the digesters. The geometry of the digesters can be evaluated and refined further in predesign. The digesters could become taller and narrower for more of a silo shape to reduce the footprint and to improve mixing. Biogas production rates are plant-specific and will likely vary from the assumed values. Refer to Appendix 5-2 regarding the methodology for estimating the volume of waste that could be codigested. Additional investigation will be done to refine the quantities and types of wastes that may be codigested, and the digester sizing will be refined during predesign to reflect the results of that investigation. Following the investigation, a design report will be prepared in accordance with WNDR requirements for digestion design that are summarized below.

TABLE 6-3
Conceptual Digester Sizing Criteria

Number of Digesters	2
Inside Diameter (ft)	107
Working depth (ft)	40
Volume, each (MG)	2.7
Volume, each (1,000 ft^3)	357.5
Total volume (MG)	5.4
Total volume (1,000 ft^3)	715
Codigested waste volume (gallons/day)	82,000
Codigested waste volatile solids (lb/day)	26,600
2035 maximum month solids loading rate for WAS (lb VS/1,000 cubic feet of digester volume)	170
2035 maximum month solids loading rate for primary sludge and codigested waste (lb VS/1,000 ft^3 of digester volume	240
2035 maximum month hydraulic retention time without codigestion (days)	18.2
2035 max month hydraulic retention time with codigestion (days)	14.2
Biogas production (ft^3/lb volatile solids reduction)	15

The Wisconsin Administrative Code regarding anaerobic digestion (NR 110.26(5)(b)1.) states that:

> The total digestion tank capacity shall be calculated based upon the factors indicated in sub. (1). If such calculations are not done, the following minimum requirements shall be met:
> a. A minimum detention time of 15 days at design flows shall be provided;
> b. Completely mixed digestion systems shall provide for intimate and effective mixing to prevent stratification and to assure homogeneity of digester content. The maximum

> system loading shall be 1.28 kilograms per cubic meter per day (80 pounds of volatile solids per 1,000 cubic feet of volume per day) in the digester.

NR 110.26(1) states:

> DESIGN REPORT. A design report shall be submitted in accordance with s. NR 110.15 (1). The report shall show calculations used to design the sludge facilities. Design of sludge handling facilities shall consider such factors as the volume of sludge generated, its percent solids and character, the degree of volatile solids reduction, sludge temperature, the degree or extent of mixing to be obtained, the sludge percent solids and characteristics after processing and the size of the installation with appropriate allowances for sludge and supernatant storage and energy requirements whenever such factors are appropriate for the design of the sludge processing facilities.

The digesters will have a detention time of slightly less than the code required 15 days during the 2035 maximum month condition. The conceptual loadings are greater than 80 lb VS/1,000 ft^3/day allowed by NR 110.26(5)(b)1.b. The following discussion provides preliminary justification for this higher loading rate. Additional information will be included in the design report

The object of the digestion system is to reduce the quantities of solids sent to incineration and to produce biogas. Biosolids will not be applied to land, and therefore the digestion system will not be designed specifically to meet the requirements of Part 503 Class B Biosolids. While the digesters will not comply with the maximum volatile solids loading rate required by NR 110.26(5)(b)1.b., they will meet the GBMSD desired volume reduction requirements and gas production rates. Based on other properly designed installations that used similar solids loadings rates, the digesters likely will produce Class B solids. Further, Manual of Practice No. 8 published by the Water Environment Federation recommends a design maximum month volatile solids loading rate of 170 lb VS/1,000 ft^3, equal to that used to size the GBMSD digesters. Some types of industrial wastes that may be codigested also can be loaded at higher rates than municipal solids.

Two digesters will be constructed, and both will be online during normal operations. A third redundant digester is not necessary because a digester with a modern, well-designed mixing system typically can operate for 10 to 15 years before it must be cleaned. When a digester does require cleaning, the digestion hydraulic retention time (HRT) could be reduced, some undigested cake could be landfilled, or both.

6.3.2 Biogas Utilization

Biogas produced by the digesters will be used in internal combustion engines to produce up to about 3.3 MW of electricity to be used at the GBF. Waste heat recovered from the engines will be used for digester heating and GBF building heating. Biogas will be cleaned to remove siloxanes, hydrogen sulfide, and other contaminants that could harm the engines.

6.3.3 Digestion Pretreatment

A potential refinement to the selected alternative is to pretreat the thickened sludge before digestion. Depending on the technology, pretreatment processes can provide the following potential benefits:

- Increased digester volatile solids reduction
- Decreased digested solids volumes
- Increased biogas production
- Production of a Class A biosolids
- Drier dewatered cake
- Ability to thicken solids sent to digestion to a higher solids content, thus reducing the required digester volumes

Sludge pretreatment technologies include Cambi, OpenCEL, and MicroSludge. Only Cambi has been proven commercially such that it can be recommended for GBMSD's application. Each pretreatment technology provides increased gas production and increased volatile solids destruction at low solids retention times, with some solids volume reduction. Unlike the other technologies, Cambi produces a Class A sludge and a significantly drier cake (up to 10 percent drier), and allows a thicker sludge (8 to 10 percent solids) to be sent to the digester, requiring less digester volume.

The cost to install Cambi now as part of the selected alternative was estimated to be more than the value of the benefits obtained, and the Cambi equipment would add complexity to operating and maintaining the system. Consequently, predesign will proceed without a digestion pretreatment process, but space for future installation of pretreatment will be included. Cambi could be one of the options considered in the future to handle increased loadings from non-GBMSD municipal wastewater solids or industrial loadings that have not yet been identified. The OpenCEL and MicroSludge technologies also could be evaluated in the future, for they may be proven commercially to the point that they are deemed feasible and reliable technologies for increasing biogas production.

6.3.4 Nutrient Extraction, Ammonia Recycle, and Struvite Control

The anaerobic digestion process used in Alternative 3B causes lysing of cells in waste activated sludge and degradation of organic solids in primary sludge. This results in ammonia production and release of soluble phosphorus. During dewatering, the soluble ammonia and phosphorus remain in the liquid and are recycled to the liquid treatment processes. The potential impacts of this recycle were evaluated.

The secondary treatment process will acclimate to the higher levels of ammonia in the dewatering recycle if the ammonia is recycled continuously. Recycled ammonia should not be a concern if the ammonia is not returned as a slug load. Solids can be stored over weekends and dewatered during the week without upsetting the nitrification process. However, operation with significantly longer solids storage times is not recommended without first testing or modeling the impacts on the liquid treatment process. For Alternative 3B, a centrate equalization tank should be provided to allow 24-hour continuous recycle. The tank is not necessary if the dewatering process is a 24/7 operation with continuous recycle. During predesign of the solids facilities, the impacts of ammonia recycle will be evaluated, including potential impacts of future anticipated effluent nitrogen regulations.

One option for managing recycled phosphorus is to use a nutrient extraction process to produce a phosphorus-rich product called struvite. The process will reduce recycled phosphorus by 90 percent or more while producing a fertilizer product that can be sold, and it prevents the damaging formation of struvite in digesters and downstream equipment and pipes. A second option for controlling phosphorus and preventing struvite formation is the use of ferric chloride. See Appendix 5-3 for a detailed summary of the evaluation of these two options.

The amount of struvite that will form in the digesters and the dose and cost of ferric chloride required to control it is difficult to predict with confidence because of the multiple variables affecting struvite formation and deposition. There is understanding of the fundamental reasons why some plants have more struvite problems than others but not sufficient understanding to predict accurately the level of struvite problems that GBMSD might experience. If the required ferric dose is near the lower range of what is reported at other plants, then ferric chloride will be the most cost-effective solution. However, if the required ferric dose is found to be higher than average, nutrient extraction would likely be more cost-effective than ferric chloride.

Installation of a nutrient extraction system will be deferred until after construction when some full-scale operating experience is gained with digestion to determine the actual ferric usage and costs. If struvite becomes an issue or ferric chloride usage is high, then nutrient extraction can be installed to address these issues. During design, comparison between ferric addition upstream and downstream of digestion will be done to determine a preferred approach. It may also be beneficial to experiment with adding ferric chloride to primary treatment. Ferric chloride could be used initially to prevent struvite formation, and the O&M budget would account for the potential cost of the ferric chloride. Space should be provided to include nutrient extraction in the future if it is found to be needed after operating the digestion system for a period of time. If actual ferric chloride costs approach or exceed the estimated annual cost (debt services plus O&M costs) of nutrient extraction, GBMSD will consider implementing nutrient extraction.

6.3.5 Dewatering

For cost estimating and building sizing purposes, it was assumed that centrifuges would be used for dewatering. It was assumed that the cake would be dewatered to 25 percent solids which would allow the incinerator to burn autogenously. During design, other methods of dewatering may be considered.

6.3.6 Thermal Processing

The incineration system is a single fluidized bed incinerator conceptually sized for 38 dtpd of dewatered cake with a solids content of 25 percent. Digested, dewatered biosolids would be conveyed to the incinerator. In a fluidized bed incinerator, unlike a multiple hearth incinerator, water flashes off and the sludge burns in one chamber. A fluidized bed incinerator is a cylindrical, vertically oriented, and refractory-lined steel shell that contains a sand bed and fluidized air diffusers called tuyeres. The bed expands to about 200 percent of its at-rest volume. The temperature of the bed is controlled to be 1,400 to 1,500°F by injecting combustible materials into the sand bed. The residence time within the combustion zone at these temperatures is several seconds. Ash is carried out the top of the furnace and removed by air pollution control devices. Feed is introduced to the furnace either above or directly into the bed. Airflow in the furnace is determined by several factors. Fluidizing and combustion airflow must be sufficient to expand the bed to a proper density but low enough to prevent biosolids from rising to and floating on the top of the bed.

A waste heat steam boiler would use waste heat from incineration to produce steam that could be used in a steam turbine to generate up to about 675 kW of electricity, or the steam could be used for building heat. With current natural gas and electrical prices, it likely would be most economical to use steam for building heat in the winter and power generation in warmer months. This could change if the relative price of electrical power increases at a rate faster than that of natural gas. The incineration system will be equipped with a fluidizing air blower, induced draft fan and an air pollution control system to meet regulatory requirements.

6.3.7 Incinerator Air Pollution Control

The USEPA published *Standards of Performance for New Stationary Sources and Emission Guidelines for Existing Sources: Sewage Sludge Incineration Units* (final rule, March 21, 2011).The rule, known as the SSI MACT rule, will affect existing and new incineration process trains developed as part of the *Solids Management Facility Plan.* See Appendix 2-1 for a detailed description of the rule and the evaluation of how the rule will impact air pollution control requirements for the selected alternative.

For the selected alternative, the SSI MACT rule applies only to emissions from the fluidized bed incinerators. The following air pollution control devices will be used to meet the SSI MACT rule for the fluidized bed incinerator:

- Ammonia or urea injection at the fluid bed reactor to control emissions of nitrogen oxides
- Multiple venturi/impingement wet scrubber with a wet electrostatic precipitator combination to control particulate matter, cadmium, lead, sulfur dioxide (caustic addition to scrubber may be required), and hydrogen chloride emissions
- Application of granular activated carbon mercury to control mercury emissions.

Other regulated pollutants include carbon monoxide and dioxins/furans. The fluidized bed reactor controls these pollutants through inherent combustion efficiency.

6.3.8 Gravity Thickening and Gravity Belt Thickening Improvements

This section describes the required improvements to the WAS and PS thickening systems. The total cost of improvements is $3.4 million (Table 6-4).

Gravity Belt System

The GBF has three gravity belt thickeners to thicken WAS. The thickeners and other ancillary systems were installed in the early 1990s and are in good condition, in part because only one of the three gravity belts historically has operated. However, the existing single stage TWAS progressive cavity pumps cannot provide the higher discharge pressure needed to convey a more concentrated TWAS longer distances. For planning and cost estimating purposes, it was assumed that three new TWAS two-stage progressing cavity pumps would be installed. The decision as to types of pumps will be finalized during predesign, in part because there may not be sufficient space to install two-stage progressing cavity pumps in the location of the existing TWAS pumps.

Gravity Thickening System

Two gravity thickeners were installed in the 1970s, two others in the early 1990s. The baffles and weirs in gravity thickener No. 2 were replaced in 2003. The mechanisms and all associated pumps for the two older gravity thickeners (Nos. 1 and 2) are aging and need to

be replaced, as do the baffles and weirs in Gravity Thickener 1. Scum from the primary and final clarifiers is pumped to the gravity thickeners and the combined scum from the gravity thickeners is pumped to the multiple hearth incinerators. The pumps and mechanisms for Gravity Thickeners 3 and 4 still have useful life and may not need to be replaced as part of the project. However, the cause of the excessive rotor and stator wear on the associated sludge pumps should be investigated, and the pumps should be replaced if needed.

TABLE 6-4
Thickening Improvements

Equipment		Cost (Description)
Thickened Sludge Pumps		
Number	4 (2 active, 2 standby)	$220,000 (Replace 4 pumps)
Type	Progressing cavity	
Thickened Sludge Pumps		
Number	3 (2 active, 1 standby)	$160,000 (Replace 3 pumps)
Type	Progressing cavity	
Thickened WAS Pumps		
Number	3	$160,000 (Replace 3 pumps)
Type	Progressing cavity	
Thickener Scum Pumps		
Number	3 (2 active, 1 standby)	$80,000 (Replace 3 pumps)
Type	Progressing cavity	
Thickener Scum Pumps		
Number	3 (2 active, 1 standby)	$80,000 (Replace 3 pumps)
Type	Progressing cavity	
Gravity Thickener Mechanisms		
Number	4	$1,000,000 (Replace 2 mechanisms and 1 set of baffles and weirs in GT#1)
Diameter	45 feet	
Odor Control		
Capacity	8,500 cfm	$1,700,000
Type	Biofilter with covers	
Total		**$3,400,000**

The gravity thickeners are currently used as fermentors to facilitate biological phosphorus removal and consequently, are a source of odors. For planning purposes, it is assumed they will be covered and that odorous air will be collected and treated in a control device such as a biofilter. It is recommended that odor control be implemented in the gravity thickeners if they continue to be operated as fermentors or if a future odor control study recommends controlling odors from the gravity thickeners. Table 6-4 lists the potential improvements to the thickening systems and their associated costs that could be included in the design.

6.3.9 Cost Estimate of Selected Alternative

Table 6-5 summarizes the cost estimate for the selected alternative.

The five levels of the American Academy of Cost Estimator cost opinions and their associated accuracies are shown in Figure 6-2. The centerline of Figure 6-2 represents probable construction cost. The costs includes a 25 percent contingency to account for items remaining to be defined and additional ancillary items identified as necessary during

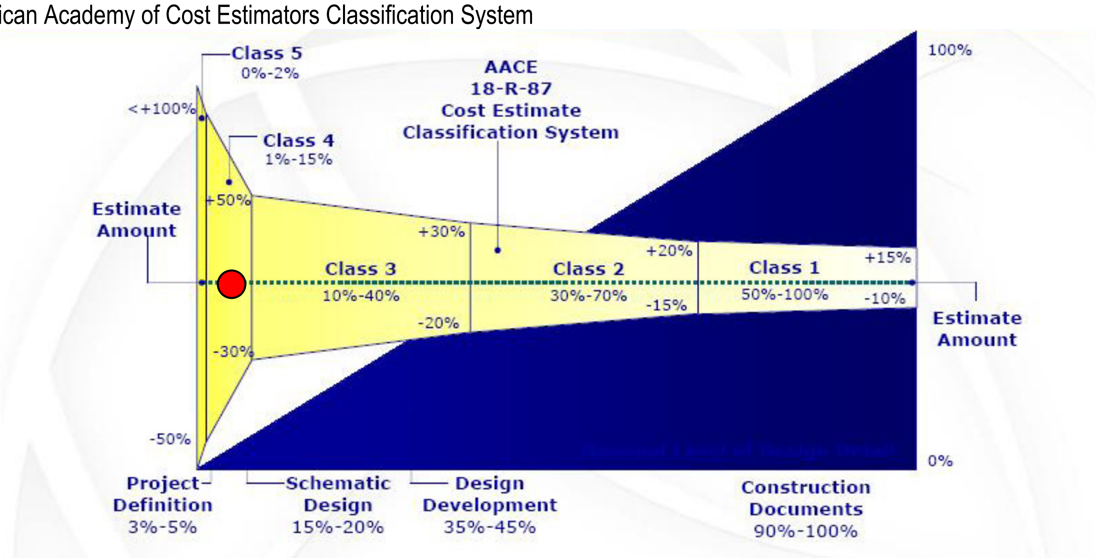
TABLE 6-5
Cost Estimate for Selected Alternative: Digestion with Thermal Processing and Electrical Generation

Item	Capital Cost
Anaerobic Digestion System	$35,900,000
Dewatering: Centrifuges and Polymer System	$13,600,000
Boilers and Cogeneration System	$20,800,000
Incinerator and Ancillary Systems	$57,368,000
Waste Heat Boiler and Steam Turbine System	$12,032,000
New Sludge Storage Tanks	$1,200,000
Demolition of Existing Solids Building	$1,600,000
Liquid and Dewatered Sludge Receiving and Storage	$1,100,000
Gravity Thickening and Gravity Belt Thickening Rehabilitation	$3,300,000
Initial Capital	**$146,900,000**

Note: All costs are June 2011 dollars referenced to ENR CCI: 9104

design. This contingency percentage is typical for this level of planning and design. That said, it is more likely that the eventual project cost will be nearer the opinion of probable cost (the centerline of the diagram, rather than the periphery). The red dot in Figure 6-2 shows the facilities plan capital cost opinion. At this level of project definition, the 90th percentile accuracy of the cost estimated is -20 to +40 percent.

FIGURE 6-2
American Academy of Cost Estimators Classification System



6.3.10 Impact on User Rates

GBMSD has constructed a strategic financial planning model to enable the evaluation of alternative capital program financing strategies in terms of systemwide rate implications and financial performance metrics. For this modeling, GBMSD cash flows were projected over a 20-year forecast period. Systemwide rate increases were specified to fund projected capital improvement expenditure requirements as well as prospective operations and maintenance expenses (incorporating expense impacts of new facilities). Alternative capital funding sources including low-interest loans from the State of Wisconsin, municipal revenue bond issues, and available reserves may be drawn upon in different proportions to manage rate increase requirements. All model scenarios were tested against key financial performance metrics (i.e., debt service coverage ratio, fund balance minimums) to ensure that resultant financial plans preserve and enhance the District's financial integrity.

Expenditures for design, equipment and facility construction of the selected alternative are scheduled between 2012 and 2016 and are estimated to cost $146.9 million (in 2011 dollars); other GBMSD capital requirements are projected to range between $9 million and $20 million in each year of the 15-year period until 2026 (with significant capital improvement requirements projected in the final 5 years of the forecast period for potential phosphorous removal upgrades to the District's treatment facilities).

Scheduled design and construction of the selected alternative in the 2012 to 2016 period will require increases in GBMSD revenue generation to support associated debt financing. Annual systemwide rate increases of 8 to 9.5 percent are therefore scheduled between 2012 and 2016, an additional rate increase of 6 percent is anticipated in 2017 (to accommodate debt service on bonds issued in 2016), with annual rate increases in the 3 to 4 percent range anticipated throughout the remainder of the 15 year period preceding the projected need to finance phosphorous removal upgrades. Though service revenues between 2011 and 2017 are projected to increase by approximately 45 percent during this period, increases in unit charges for individual billing determinants (i.e., flow, BOD, TSS) will vary based on cost-of-service allocations and policy-based rate adjustments that may mitigate bill impacts for selected user groups.

Appendix 1-1. GBF WPDES Permit

WPDES PERMIT

STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES

PERMIT TO DISCHARGE UNDER THE
WISCONSIN POLLUTANT DISCHARGE ELIMINATION SYSTEM

Green Bay Metropolitan Sewerage District

is permitted, under the authority of Chapter 283, Wisconsin Statutes, to discharge from a facility located in the East River Watershed (LF01) of the Lower Fox River Drainage Basin at

2231 North Quincy Street, Green Bay, Wisconsin

to

the Fox River near its mouth at the Bay of Green Bay in Lake Michigan

in accordance with the effluent limitations, monitoring requirements and other conditions set forth in this permit.

The permittee shall not discharge after the date of expiration. If the permittee wishes to continue to discharge after this expiration date an application shall be filed for reissuance of this permit, according to Chapter NR 200, Wis. Adm. Code, at least 180 days prior to the expiration date given below.

State of Wisconsin Department of Natural Resources
For the Secretary

By ____________________________
Joseph Graham
Wastewater Specialist

____
Date Permit Signed/Issued

PERMIT TERM: EFFECTIVE DATE - October 01, 2005 **EXPIRATION DATE - September 30, 2010**

TABLE OF CONTENTS

1 Influent Requirements

1.1 Sampling Point(s)

Sampling Point Designation	
Sampling Point Number	**Sampling Point Location, WasteType/Sample Contents and Treatment Description (as applicable)**
701	Influent, Fort James - Representative samples shall be collected at the Fort James flow meter station.
702	Influent, Proctor & Gamble - Representative samples shall be collected at the Proctor & Gamble flow meter station.
703	Influent, Metro - Municipal influent loading shall be calculated as follows. Two representative samples shall be collected: one from the headworks building, prior to screening and the addition of mill waste, and the second from the plant return stream. Results from the plant return sample analyses shall be subtracted, on a flow-weighted basis, from the headworks sample in order to calculate domestic influent results.
705	Influent, Calculated Combined - Representative influent loading to the facility shall be calculated by combining the monitoring results from sample points 701, 702, and 703. Results of chemical analyses shall be determined on a flow-weighted basis

1.2 Monitoring Requirements

The permittee shall comply with the following monitoring requirements.

1.2.1 Sampling Point 701 - Influent, Fort James; 702- Influent, Proctor & Gamble; 703- Influent, Metro

701, 702, & 703 - Monitoring Requirements and Limitations					
Parameter	**Limit Type**	**Limit and Units**	**Sample Frequency**	**Sample Type**	**Notes**
Flow Rate		MGD	Daily	Continuous	
BOD_5, Total		mg/L	Daily	24-Hr Flow Prop Comp	
Suspended Solids, Total		mg/L	Daily	24-Hr Flow Prop Comp	
Nitrogen, Ammonia (NH_3-N) Total		mg/L	Daily	24-Hr Flow Prop Comp	
pH Field		su	Daily	Grab	Not applicable at 703.
Cadmium, Total Recoverable		µg/L	Monthly	24-Hr Flow Prop Comp	See § 1.2.2.1
Chromium, Total Recoverable		µg/L	Monthly	24-Hr Flow Prop Comp	
Copper, Total Recoverable		µg/L	Monthly	24-Hr Flow Prop Comp	
Lead, Total Recoverable		µg/L	Monthly	24-Hr Flow Prop Comp	
Nickel, Total Recoverable		µg/L	Monthly	24-Hr Flow Prop Comp	
Zinc, Total Recoverable		µg/L	Monthly	24-Hr Flow Prop Comp	

701, 702, & 703 - Monitoring Requirements and Limitations					
Parameter	**Limit Type**	**Limit and Units**	**Sample Frequency**	**Sample Type**	**Notes**
Mercury, Total Recoverable		ng/L	Monthly	24-Hr Flow Prop Comp	See § 1.2.2.2

1.2.2 Sampling Point 705 - Influent, Calculated Combined

705 - Monitoring Requirements and Limitations					
Parameter	**Limit Type**	**Limit and Units**	**Sample Frequency**	**Sample Type**	**Notes**
Flow Rate		MGD	Daily	Calculated	
BOD_5, Total		mg/L	Daily	Calculated	
Suspended Solids, Total		mg/L	Daily	Calculated	
Nitrogen, Ammonia (NH_3-N) Total		mg/L	Daily	Calculated	
Cadmium, Total Recoverable		µg/L	Monthly	Calculated	See § 1.2.2.1
Chromium, Total Recoverable		µg/L	Monthly	Calculated	
Copper, Total Recoverable		µg/L	Monthly	Calculated	
Lead, Total Recoverable		µg/L	Monthly	Calculated	
Nickel, Total Recoverable		µg/L	Monthly	Calculated	
Zinc, Total Recoverable		µg/L	Monthly	Calculated	
Mercury, Total Recoverable		ng/L	Monthly	Calculated	See § 1.2.2.2

1.2.2.1 Metals Analyses

Samples shall be analyzed using a method which provides adequate sensitivity so that results can be quantified, unless not possible using the most sensitive approved method. Measurements of total metals and total recoverable metals shall be considered as equivalent.

1.2.2.2 Mercury Monitoring

The permittee shall collect and analyze all mercury samples according to the data quality requirements of ss. NR 106.145(9) and (10), Wisconsin Administrative Code. The limit of quantitation (LOQ) used for the effluent and field blank shall be less than 1.3 ng/L, unless the samples are quantified at levels above 1.3 ng/L. The permittee shall collect at least one mercury field blank for each set of mercury samples (a set of samples may include combinations of intake, influent, effluent or other samples all collected on the same day). The permittee shall report results of samples and field blanks to the Department on Discharge Monitoring Reports.

2 In-Plant Requirements

2.1 Sampling Point(s)

Sampling Point Designation	
Sampling Point Number	**Sampling Point Location, WasteType/Sample Contents and Treatment Description (as applicable)**
103	Field Blank - Sample point for reporting results of Mercury field blanks collected using standard sample handling procedures.

2.2 Monitoring Requirements and Limitations

The permittee shall comply with the following monitoring requirements and limitations.

2.2.1 Sampling Point 103 - Field Blank

Monitoring Requirements and Limitations					
Parameter	**Limit Type**	**Limit and Units**	**Sample Frequency**	**Sample Type**	**Notes**
Mercury, Total Recoverable		ng/L	Monthly	Blank	See § 2.2.1.1

2.2.1.1 Mercury Monitoring

The permittee shall collect and analyze all mercury samples according to the data quality requirements of ss. NR 106.145(9) and (10), Wisconsin Administrative Code. The limit of quantitation (LOQ) used for the effluent and field blank shall be less than 1.3 ng/L, unless the samples are quantified at levels above 1.3 ng/L. The permittee shall collect at least one mercury field blank for each set of mercury samples (a set of samples may include combinations of intake, influent, effluent or other samples all collected on the same day). The permittee shall report results of samples and field blanks to the Department on Discharge Monitoring Reports.

3 Surface Water Requirements

3.1 Sampling Point(s)

Sampling Point Designation	
Sampling Point Number	**Sampling Point Location, WasteType/Sample Contents and Treatment Description (as applicable)**
001	Effluent - Representative samples shall be collected downstream of the Parshall flumes for the North and South Complexes. Results of chemical analyses shall be reported on a flow-weighted basis. Fecal coliform samples shall be collected 20 feet upstream of the Parshall flume. Grab samples for pH and mercury shall be collected after dechlorination.
605	River Monitoring - Lower fox River data collected at the Rapid Croche Dam as reported by the Lower Fox River Discharger's Association used in the determination of the daily $CBOD_5$ wasteload allocation.
007	WLA Compliance Reporting - Sample point for determining compliance with $CBOD_5$ wasteload allocation for the discharge from sample point/outfall 001. These requirements are applicable from May 1 through October 31, each year.

3.2 Monitoring Requirements and Effluent Limitations

The permittee shall comply with the following monitoring requirements and limitations.

3.2.1 Sampling Point (Outfall) 001 - Effluent

Monitoring Requirements and Effluent Limitations					
Parameter	**Limit Type**	**Limit and Units**	**Sample Frequency**	**Sample Type**	**Notes**
Flow Rate		MGD	Daily	Continuous	
$CBOD_5$	Monthly Avg Weekly Avg	25 mg/L 40 mg/L	Daily	24-Hr Flow Prop Comp	$CBOD_5$ mass is limited from May – Oct. Mass reporting done under sample point 007, see § 3.2.3 for applicable limits.
Suspended Solids, Total	Monthly Avg Weekly Avg	30 mg/L 45 mg/L	Daily	24-Hr Flow Prop Comp	
BOD_5, Total		mg/L	Daily	24-Hr Flow Prop Comp	
pH (Minimum)	Daily Min	6.0 su	Daily	Continuous	
pH (Maximum)	Daily Max	9.0 su	Daily	Continuous	
Phosphorus, Total	Monthly Avg	1.0 mg/L	Daily	24-Hr Flow Prop Comp	
Nitrogen, Ammonia (NH_3-N) Total	Monthly Avg	15 mg/L (a)	Daily	24-Hr Flow Prop Comp	(a) Jan. - April
	Monthly Avg Weekly Avg	4.7 mg/L 13 mg/L (b)			(b) May - Sept.
	Monthly Avg Weekly Avg	14 mg/L 38 mg/L (c)			(c) October
	Monthly Avg	26 mg/L (d)			(d) Nov. - Dec.
Cadmium, Total Recoverable		µg/L	Monthly	24-Hr Flow Prop Comp	See § 3.2.1.1

Monitoring Requirements and Effluent Limitations					
Parameter	**Limit Type**	**Limit and Units**	**Sample Frequency**	**Sample Type**	**Notes**
Chromium, Total Recoverable		μg/L	Monthly	24-Hr Flow Prop Comp	See § 3.2.1.1
Copper, Total Recoverable		μg/L	Monthly	24-Hr Flow Prop Comp	
Lead, Total Recoverable		μg/L	Monthly	24-Hr Flow Prop Comp	
Nickel, Total Recoverable		μg/L	Monthly	24-Hr Flow Prop Comp	
Zinc, Total Recoverable		μg/L	Monthly	24-Hr Flow Prop Comp	
Mercury, Total Recoverable		ng/L	Monthly	Grab	See § 3.2.1.2
Fecal Coliform	Geometric Mean	400 #/100 ml	Weekly	Grab	Applies May - Sept.
Chlorine, Total Residual	Daily Max	38 μg/L	Daily	Grab	Monitoring required and limits apply whenever chlorine is used, see 3.2.1.3 for mass limit.
Bis(2-ethylhexyl)phthalate		μg/L	Once	24-Hr Flow Prop Comp	One sample before 10/01/2006.
Acute WET		TU_a	See Listed Qtr(s)	24-Hr Flow Prop Comp	The permittee shall perform WET tests during each of the calendar quarters specified in § 3.2.1.4
Chronic WET		rTUc	See Listed Qtr(s)	24-Hr Flow Prop Comp	

3.2.1.1 Metals Analysis

Samples shall be analyzed using a method which provides adequate sensitivity so that results can be quantified, unless not possible using the most sensitive approved method. Measurements of total metals and total recoverable metals shall be considered as equivalent.

3.2.1.2 Mercury Monitoring

The permittee shall collect and analyze all mercury samples according to the data quality requirements of ss. NR 106.145(9) and (10), Wisconsin Administrative Code. The limit of quantitation (LOQ) used for the effluent and field blank shall be less than 1.3 ng/L, unless the samples are quantified at levels above 1.3 ng/L. The permittee shall collect at least one mercury field blank for each set of mercury samples (a set of samples may include combinations of intake, influent, effluent or other samples all collected on the same day). The permittee shall report results of samples and field blanks to the Department on Discharge Monitoring Reports.

3.2.1.3 Applicable Mass Limit for Total Residual Chlorine

The applicable mass limit for Total Residual Chlorine is 30.4 pounds per day (daily maximum).

3.2.1.4 Whole Effluent Toxicity (WET) Testing

Primary Control Water: Fox River

Instream Waste Concentration (IWC): 9.1%

Dilution series: At least five effluent concentrations and dual controls must be included in each test.

- **Acute:** 100, 50, 25, 12.5, 6.25% and any additional selected by the permittee.
- **Chronic:** 100, 30, 10, 3, 1% and any additional selected by the permittee.

WET Testing Frequency: Tests are required during the following calendar quarters (Qtr.).

- **Acute & Chronic WET**

1st Qtr. 2006 (January 1 – March 31, 2006)

4th Qtr. 2007 (October 1 – December 31, 2007)

3rd Qtr. 2008 (July 1 – September 30, 2008)

2nd Qtr. 2009 (April 1 – June 30, 2009)

1st Qtr. 2010 (January 1 – March 31, 2010)

Reporting: The permittee shall report test results on the Discharge Monitoring Report form, and also complete the "Whole Effluent Toxicity Test Report Form" (Section 6, "*State of Wisconsin Aquatic Life Toxicity Testing Methods Manual, 2nd Edition*"), for each test. The original, complete, signed version of the Whole Effluent Toxicity Test Report Form shall be sent to the Biomonitoring Coordinator, Bureau of Watershed Management, 101 S. Webster St., P.O. Box 7921, Madison, WI 53707-7921, within 45 days of test completion.

Determination of Positive Results: An acute toxicity test shall be considered positive if the Toxic Unit – Acute (TU_a) is >1.0 for either species. The TU_a shall be calculated as follows: $TU_a = 100/LC_{50}$. An $LC_{50} \geq 100$ equals a TU_a of 1.0. A chronic toxicity test shall be considered positive if the Relative Toxic Unit - Chronic (rTU_c) is > 1.0 for either species. The rTU_c shall be calculated as follows: $rTU_c = IWC/IC_{25}$. An $IC_{25} \geq IWC$ equals an rTU_c of 1.0.

Additional Testing Requirements: Within 90 days of a test which showed positive results, the permittee shall submit the results of at least 2 retests to the Biomonitoring Coordinator on "Whole Effluent Toxicity Test Report Forms". The retests shall be completed using the same species and test methods specified for the original test (see the Standard Requirements section herein).

3.2.2 Sampling Point 605 - River Monitoring

Monitoring Requirements and Effluent Limitations					
Parameter	**Limit Type**	**Limit and Units**	**Sample Frequency**	**Sample Type**	**Notes**
WLA Previous Day River Flow		cfs	Daily	Gauge Station	May – Oct.
WLA Previous Day River Temp		deg F	Daily	Measure	May – Oct.
WLA Previous 4 Day Avg River Flow		cfs	Daily	Calculated	May – Oct.

3.2.3 Sampling Point (Outfall) 007 - WLA Compliance Reporting

Monitoring Requirements and Effluent Limitations					
Parameter	**Limit Type**	**Limit and Units**	**Sample Frequency**	**Sample Type**	**Notes**
WLA $CBOD_5$ Value		lbs/day	Daily	See Table	May – Oct. Values from Tables 1 - 4
WLA Adjusted Value		lbs/day	Daily	Calculated	May – Oct. [1.34 x WLA $CBOD_5$ Value]. Report applicable limit in this DMR column.
WLA $CBOD_5$ Discharged	Daily Max - Variable	lbs/day	Daily	Calculated	May – Oct. Daily mass discharged from outfall 001.
WLA 7 Day Sum Of WLA Values		lbs/day	Daily	Calculated	May – Oct. Report applicable limit in this DMR column.
WLA 7 Day Sum Of $CBOD_5$ Discharged	Daily Max - Variable	lbs/day	Daily	Calculated	May – Oct. 7-day mass discharged from outfall 001.

3.2.3.1 Wasteload Allocation Requirements:

Each year during the months of May through October, the discharge of CBOD5 from sample point/outfall 001 is limited to the following wasteload allocated water quality related effluent limitations in addition to the effluent limitations contained in section 3.2.1.

3.2.3.1.1 Definitions:

- *$CBOD_5$ Allocation*: Green Bay Metropolitan Sewerage District's allocation of $CBOD_5$ (pounds per day $CBOD_5$), as listed in Tables 1 through 4, represent water quality related effluent limitations. The flow and temperature conditions used to determine the $CBOD_5$ allocation for a given day are defined below.
- *Flow*: A representative measurement of flow is the previous four days average flow value derived daily from continuous river flow monitoring data for the Fox River collected at the Rapid Croche Dam as reported by the Lower Fox River Discharge Association.
- *Temperature*: A representative measurement of temperature is the daily average temperature value of the previous day derived from continuous river temperature monitoring data for the Fox River collected at the Rapid Croche Dam, as reported by the Lower Fox River Discharge Association.

3.2.3.1.2 Determination of Effluent Limitation:

For purposes of determining compliance with the wasteload allocated water quality related $CBOD_5$ effluent limitations, the following conditions shall be met:

- The sum of the actual daily discharges of $CBOD_5$ for any 7-consecutive-day period shall not exceed the sum of the daily $CBOD_5$ allocation values from Tables 1 through 4 for the same 7-consecutive-day period.
- For any one-day period, the actual discharge of $CBOD_5$ shall not exceed 1.34 times the $CBOD_5$ allocation value from Tables 1 through 4 for that day.

3.2.3.1.3 Monitoring Requirements:

The same 24-hour period shall be used for the collection of composite and continuous samples for river flow and temperature and all effluent characteristics listed in Table 3.2.1, including effluent flow and $CBOD_5$.

3.2.3.1.4 Reporting Requirements:

During the months of May through October inclusive the permittee shall report the following information:

- The daily average river flow value (cfs);
- The daily average river temperature value (^oF);
- The average of the previous 4 days river flow values (cfs);
- The daily $CBOD_5$ allocation value (lbs $CBOD_5$ per day from Tables 1 through 4);
- The daily adjusted $CBOD_5$ allocation value (1.34 x daily $CBOD_5$ allocation value).
- The actual discharge value of $CBOD_5$ (lbs/$CBOD_5$ per day);
- The sum of the daily $CBOD_5$ allocation values (lbs/$CBOD_5$) for each 7-consecutive-day period (present day allocation plus the 6 previous day's allocation); and
- The sum of the actual daily discharge values of $CBOD_5$ (lbs/$CBOD_5$) for each 7-consecutive-day period (present day discharge plus the 6 previous days discharge);

3.2.3.1.5 Tables 1 through 4. (Wasteload Allocation, May through October)

TABLE 1. WASTELOAD ALLOCATED VALUES IN LBS PER DAY OF $CBOD_5$
(River mile 7.3 to 0.0)

MAY

Temperature (previous day average in °F)	Flow at Rapide Croche Dam (previous four-day average in cfs)														
	750 OR LESS	751 TO 1000	1001 TO 1250	1251 TO 1500	1501 TO 1750	1751 TO 2000	2001 TO 2250	2251 TO 2500	2501 TO 2750	2751 TO 3000	3001 TO 3500	3501 TO 4000	4001 TO 5000	5001 TO 8000	8001 OR MORE
≥86	7439	7439	7439	7439	7439	7439	7439	7439	9882	12967	18576	27844	35420	35420	35420
82 TO 85	7439	7439	7439	7439	7439	7439	7439	8441	10925	13901	19274	28104	35420	35420	35420
78 TO 81	7439	7439	7439	7439	7439	7439	8290	10323	12795	15701	20859	29201	35420	35420	35420
74 TO 77	7439	7439	7439	7439	7439	8479	10304	12514	15106	18071	23212	31330	35420	35420	35420
70 TO 73	7439	7439	7439	7439	8670	10528	12719	15241	18083	21243	26566	34724	35420	35420	35420
66 TO 69	7439	7439	7439	8524	10658	13073	15764	18726	21953	25439	31142	35420	35420	35420	35420
62 TO 65	7439	7439	7700	10354	13236	16342	19663	23198	26941	30885	35420	35420	35420	35420	35420
58 TO 61	7439	7439	9276	12868	16630	20557	24642	28885	33274	35420	35420	35420	35420	35420	35420
54 TO 57	7439	7439	11630	16290	21064	25946	30927	35420	35420	35420	35420	35420	35420	35420	35420
50 TO 53	7439	9186	14988	20849	26767	32731	35420	35420	35420	35420	35420	35420	35420	35420	35420
46 TO 49	7439	12380	19573	26769	33960	35420	35420	35420	35420	35420	35420	35420	35420	35420	35420
42 TO 45	10762	16894	25613	34274	35420	35420	35420	35420	35420	35420	35420	35420	35420	35420	35420
≤41	15632	22958	33333	35420	35420	35420	35420	35420	35420	35420	35420	35420	35420	35420	35420

TABLE 2. WASTELOAD ALLOCATED EFFLUENT VALUES IN POUNDS PER DAY OF $CBOD_5$
(River mile 7.3 to 0.0)

JUNE

Temperature (previous day average in °F)	Flow at Rapide Croche Dam (previous four-day average in cfs)														
	750 OR LESS	751 TO 1000	1001 TO 1250	1251 TO 1500	1501 TO 1750	1751 TO 2000	2001 TO 2250	2251 TO 2500	2501 TO 2750	2751 TO 3000	3001 TO 3500	3501 TO 4000	4001 TO 5000	5001 TO 8000	8001 OR MORE
≥86	13818	12792	11646	10866	10434	10335	10557	11085	11901	12967	18576	27844	35420	35420	35420
82 TO 85	13068	12203	11285	10726	10512	10627	11057	11788	12804	13901	19274	28104	35420	35420	35420
78 TO 81	12057	11465	10929	10748	10901	11375	12158	13234	14585	15701	20859	29201	35420	35420	35420
74 TO 77	11281	10979	10851	11066	11613	12472	13630	15073	16785	18071	23212	31330	35420	35420	35420
70 TO 73	10738	10743	11047	11686	12646	13913	15472	17307	19403	21243	26566	34724	35420	35420	35420
66 TO 69	7439	7439	7439	8524	10658	13073	15764	18726	21953	25439	31142	35420	35420	35420	35420
62 TO 65	7439	7439	7700	10354	13236	16342	19663	23198	26941	30885	35420	35420	35420	35420	35420
58 TO 61	7439	7439	9276	12868	16630	20557	24642	28885	33274	35420	35420	35420	35420	35420	35420
54 TO 57	7439	7439	11630	16290	21064	25946	30927	35420	35420	35420	35420	35420	35420	35420	35420
50 TO 53	7439	9186	14988	20849	26767	32731	35420	35420	35420	35420	35420	35420	35420	35420	35420
46 TO 49	7439	12380	19573	26769	33960	35420	35420	35420	35420	35420	35420	35420	35420	35420	35420
42 TO 45	10762	16894	25613	34274	35420	35420	35420	35420	35420	35420	35420	35420	35420	35420	35420
≤41	15632	22958	33333	35420	35420	35420	35420	35420	35420	35420	35420	35420	35420	35420	35420

TABLE 3. WASTELOAD ALLOCATED EFFLUENT VALUES IN POUNDS PER DAY OF $CBOD_5$
(River mile 7.3 to 0.0)

JULY - AUGUST

Temperature (previous day average in °F)	Flow at Rapide Croche Dam (previous four-day average in cfs))														
	750 OR LESS	751 TO 1000	1001 TO 1250	1251 TO 1500	1501 TO 1750	1751 TO 2000	2001 TO 2250	2251 TO 2500	2501 TO 2750	2751 TO 3000	3001 TO 3500	3501 TO 4000	4001 TO 5000	5001 TO 8000	8001 OR MORE
≥86	13818	12792	11646	10866	10434	10335	10557	11085	11901	12995	15116	18769	25774	35420	35420
82 TO 85	13068	12203	11285	10726	10512	10627	11057	11788	12804	14090	16493	20502	28007	35420	35420
78 TO 81	12057	11465	10929	10748	10901	11375	12158	13234	14585	16201	19083	23703	32066	35420	35420
74 TO 77	11281	10979	10851	11066	11613	12472	13630	15073	16785	18752	22149	27429	35420	35420	35420
70 TO 73	10738	10743	11047	11686	12646	13913	15472	17307	19403	21748	25693	31679	35420	35420	35420
66 TO 69	10432	10759	11517	12604	14005	15703	17684	19934	22439	25184	29715	35420	35420	35420	35420
62 TO 65	10361	11028	12264	13821	15684	17837	20267	22958	25894	29061	34215	35420	35420	35420	35420
≤61	10524	11547	13285	15337	17686	20318	23219	26373	29764	33380	35420	35420	35420	35420	35420

TABLE 4. WASTELOAD ALLOCATED EFFLUENT VALUES IN POUNDS PER DAY OF $CBOD_5$
(River mile 7.3 to 0.0)

SEPTEMBER - OCTOBER

Temperature (previous day average in °F)	Flow at Rapide Croche Dam (previous four-day average in cfs)														
	0 TO 750	751 TO 1000	1001 TO 1250	1251 TO 1500	1501 TO 1750	1751 TO 2000	2001 TO 2250	2251 TO 2500	2501 TO 2750	2751 TO 3000	3001 TO 3500	3501 TO 4000	4001 TO 5000	5001 TO 8000	8001 OR MORE
≥86	7439	7439	7439	7439	8811	11224	13833	16613	19550	22620	27439	34151	35420	35420	35420
82 TO 85	7439	7439	7439	7561	9417	11486	13750	16186	18776	21502	25800	31819	35420	35420	35420
78 TO 81	7439	7439	7439	8667	10149	11844	13731	15793	18007	20356	24085	29342	35420	35420	35420
74 TO 77	7439	7547	8392	9486	10811	12347	14078	15979	18031	20219	23705	28635	35420	35420	35420
70 TO 73	7734	8208	9111	10267	11651	13245	15033	16991	19101	21342	24910	29946	35420	35420	35420
66 TO 69	7981	8649	9830	11259	12920	14790	16851	19083	21462	23977	27951	33524	35420	35420	35420
62 TO 65	8104	9118	10792	12717	14868	17229	19781	22500	25370	28373	33076	35420	35420	35420	35420
58 TO 61	8359	9870	12255	14887	17748	20816	24073	27500	31076	34781	35420	35420	35420	35420	35420
54 TO 57	8991	11151	14462	18019	21804	25797	29979	34326	35420	35420	35420	35420	35420	35420	35420
50 TO 53	10255	13215	17668	22368	27295	32427	35420	35420	35420	35420	35420	35420	35420	35420	35420
46 TO 49	12399	16309	22123	28179	34465	35420	35420	35420	35420	35420	35420	35420	35420	35420	35420
42 TO 45	15672	20686	28076	35420	35420	35420	35420	35420	35420	35420	35420	35420	35420	35420	35420
≤41	20328	26597	35420	35420	35420	35420	35420	35420	35420	35420	35420	35420	35420	35420	35420

4 Land Application Requirements

4.1 Sampling Point(s)

The discharge(s) shall be limited to land application of the waste type(s) designated for the listed sampling point(s) on Department approved land spreading sites or by hauling to another facility.

Sampling Point Designation	
Sampling Point Number	**Sampling Point Location, WasteType/Sample Contents and Treatment Description (as applicable)**
002	Incinerated Cake - Incineration of biosolids is regulated under the jurisdiction of US EPA Region 5 and subject to the requirements of 40 CFR part 503. While the State of Wisconsin has not been delegated authority for biosolids incineration, Form 3400-165 may be sent to the permittee each year and may be completed and returned to DNR, to satisfy federal reporting requirements. US EPA may also impose other 40 CFR part 503 requirements. For state reporting requirements submit form 3400-52, "Other Methods of Disposal or Distribution Report".
003	Future Land Application - This sample point is reserved for future land application of sludge. Monitoring requirements and limitations are applicable during any year that sludge is disposed by land application. Also applicable to landfill disposal.

4.2 Monitoring Requirements and Limitations

The permittee shall comply with the following monitoring requirements and limitations.

4.2.1 Sampling Point (Outfall) 003 - Future Land Application

Monitoring Requirements and Limitations					
Parameter	**Limit Type**	**Limit and Units**	**Sample Frequency**	**Sample Type**	**Notes**
Solids, Total		Percent	1 / 2 Months	Composite	List 1 Parameters, Total Solids and Metals. Monitoring only required for land application or landfilling. Limits applicable to land application.
Arsenic Dry Wt	Ceiling High Quality	75 mg/kg 41 mg/kg	1 / 2 Months	Composite	
Cadmium Dry Wt	Ceiling High Quality	85 mg/kg 39 mg/kg	1 / 2 Months	Composite	
Copper Dry Wt	Ceiling High Quality	4,300 mg/kg 1,500 mg/kg	1 / 2 Months	Composite	
Lead Dry Wt	Ceiling High Quality	840 mg/kg 300 mg/kg	1 / 2 Months	Composite	
Mercury Dry Wt	Ceiling High Quality	57 mg/kg 17 mg/kg	1 / 2 Months	Composite	
Molybdenum Dry Wt	Ceiling	75 mg/kg	1 / 2 Months	Composite	
Nickel Dry Wt	Ceiling High Quality	420 mg/kg 420 mg/kg	1 / 2 Months	Composite	
Selenium Dry Wt	Ceiling High Quality	100 mg/kg 100 mg/kg	1 / 2 Months	Composite	
Zinc Dry Wt	Ceiling High Quality	7,500 mg/kg 2,800 mg/kg	1 / 2 Months	Composite	
Radium 226 Dry Wt		pCi/g	1 / 2 Months	Composite	

Monitoring Requirements and Limitations					
Parameter	**Limit Type**	**Limit and Units**	**Sample Frequency**	**Sample Type**	**Notes**
Nitrogen, Total Kjeldahl		Percent	1 / 2 Months	Composite	List 2 Parameters, Nutrients. Monitoring only required for land application.
Nitrogen, Ammonium (NH_4-N) Total		Percent	1 / 2 Months	Composite	
Phosphorus, Total		Percent	1 / 2 Months	Composite	
Phosphorus, Water Extractable		Percent	1 / 2 Months	Composite	
Potassium, Total Recoverable		Percent	1 / 2 Months	Composite	
PCB Total Dry Wt	Ceiling High Quality	50 mg/kg 10 mg/kg	Once	Composite	Applicable only to land application. See § 4.2.1.5
Municipal Sludge Priority Pollutant Scan			Once	Composite	Applicable only to land application. See § 4.2.1.6

Other Sludge Requirements	
Sludge Requirements	**Sample Frequency**
List 3 Requirements – Pathogen Control: The requirements in List 3 shall be met prior to land application of sludge.	Bimonthly
List 4 Requirements – Vector Attraction Reduction: The vector attraction reduction shall be satisfied prior to, or at the time of land application as specified in List 4.	Bimonthly

4.2.1.1 List 2 Analysis

If the monitoring frequency for List 2 parameters is more frequent than "Annual" then the sludge may be analyzed for the List 2 parameters just prior to each land application season rather than at the more frequent interval specified.

4.2.1.2 Changes in Feed Sludge Characteristics

If a change in feed sludge characteristics, treatment process, or operational procedures occurs which may result in a significant shift in sludge characteristics, the permittee shall reanalyze the sludge for List 1, 2, 3 and 4 parameters each time such change occurs.

4.2.1.3 Multiple Sludge Sample Points (Outfalls)

If there are multiple sludge sample points (outfalls), but the sludges are not subject to different sludge treatment processes, then a separate List 2 analysis shall be conducted for each sludge type which is land applied, just prior to land application, and the application rate shall be calculated for each sludge type. In this case, List 1, 3, and 4 and PCBs need only be analyzed on a single sludge type, at the specified frequency. If there are multiple sludge sample points (outfalls), due to multiple treatment processes, List 1, 2, 3 and 4 and PCBs shall be analyzed for each sludge type at the specified frequency.

4.2.1.4 Sludge Which Exceeds the High Quality Limit

Cumulative pollutant loading records shall be kept for all bulk land application of sludge which does not meet the high quality limit for any parameter. This requirement applies for the entire calendar year in which any exceedance of Table 3 of s. NR 204.07(5)(c), is experienced. Such loading records shall be kept for all List 1 parameters for each site land applied in that calendar year. The formula to be used for calculating cumulative loading is as follows:

[(Pollutant concentration (mg/kg) x dry tons applied/ac) ÷ 500] + previous loading (lbs/acre) = cumulative lbs pollutant per acre

When a site reaches 90% of the allowable cumulative loading for any metal established in Table 2 of s. NR 204.07(5)(b), the Department shall be so notified through letter or in the comment section of the annual land application report (3400-55).

4.2.1.5 Sludge Analysis for PCBs

The permittee shall analyze the sludge for Total PCBs one time during the first year sludge is land applied. The results shall be reported as "PCB Total Dry Wt". Either congener-specific analysis or Aroclor analysis shall be used to determine the PCB concentration. The permittee may determine whether Aroclor or congener specific analysis is performed. Analyses shall be performed in accordance with Table EM in s. NR 219.04, Wis. Adm. Code and the conditions specified in Standard Requirements of this permit. PCB results shall be submitted by January 31, following the specified year of analysis.

4.2.1.6 Priority Pollutant Scan

The permittee shall analyze the sludge for the priority pollutants as specified in s. NR 215.03 (1-4), Wis. Adm. Code one time during the first year sludge is land applied. Results shall be reported on a dry weight basis.

4.2.1.7 Lists 3 and 4

List 3
PATHOGEN CONTROL FOR CLASS B SLUDGE
The permittee shall implement pathogen control as listed in List 3. The Department shall be notified of the pathogen control utilized and shall be notified when the permittee decides to utilize alternative pathogen control.
The following requirements shall be met prior to land application of sludge.

Parameter	Unit	Limit
Fecal Coliform*	MPN/gTS or CFU/gTS	2,000,000
OR, ONE OF THE FOLLOWING PROCESS OPTIONS		
Aerobic Digestion	Air Drying	
Anaerobic Digestion	Composting	
Alkaline Stabilization	PSRP Equivalent Process	

***** The Fecal Coliform limit shall be reported as the geometric mean of 7 discrete samples on a dry weight basis.

List 4
VECTOR ATTRACTION REDUCTION

The permittee shall implement any one of the vector attraction reduction options specified in List 4. The Department shall be notified of the option utilized and shall be notified when the permittee decides to utilize an alternative option. One of the following shall be satisfied prior to, or at the time of land application as specified in List 4.

Option	Limit	Where/When it Shall be Met
Volatile Solids Reduction	≥38%	Across the process
Specific Oxygen Uptake Rate	≤1.5 mg O_2/hr/g TS	On aerobic stabilized sludge
Anaerobic bench-scale test	<17 % VS reduction	On anaerobic digested sludge
Aerobic bench-scale test	<15 % VS reduction	On aerobic digested sludge
Aerobic Process	>14 days, Temp >40°C and Avg. Temp > 45°C	On composted sludge
pH adjustment	>12 S.U. (for 2 hours) and >11.5 (for an additional 22 hours)	During the process
Drying without primary solids	>75 % TS	When applied or bagged
Drying with primary solids	>90 % TS	When applied or bagged
Equivalent Process	Approved by the Department	Varies with process
Injection	-	When applied
Incorporation	-	Within 6 hours of application

5 Schedules of Compliance

5.1 Mercury Pollutant Minimization Program

The permittee shall implement a pollutant minimization program whenever, after the first 24 months of mercury monitoring, a mercury effluent limitation is necessary under the procedure in s. NR 106.145(2), Wis. Adm. Code. The first 24 months of monitoring includes all data collected by the permittee since October 2003.

Required Action	Date Due
Request Limit Determination: After one month of sampling under this permit, the permittee shall submit a summary of at least 12 monitoring results spaced out over a period of at least 24 months and shall request that the Department determine the need for an effluent limitation according to the requirements of s. NR 106.145(2). The Department will make the determination and notify the permittee, in writing, of the need for a limit with 90 days of such request. If the Department determines that an effluent limitation will NOT be necessary, the permittee need not follow subsequent steps in that schedule.	12/31/2005
Mercury Pollutant Minimization Program Plan: If the Department determines that an effluent limitation will be necessary, the permittee shall develop and submit to the Department a plan for a pollutant minimization program (PMP) that meets the requirements of s. NR 106.145(7), Wis. Adm. Code. Note: The Department will notify the permittee of acceptance of or comments on the proposed PMP. The permittee and the Department will then agree on what changes, if any will be made to the PMP. If the Department has not notified the permittee within 90 days of the Department's receipt of the PMP, the permittee may assume that the PMP has been accepted.	12/31/2006
Implement PMP Plan: The permittee shall implement the PMP as submitted or as amended by agreement of the permittee and the Department.	04/01/2007
Annual Status Reports: The permittee shall submit to the Department an annual status report on the progress of the PMP as required by s. NR 106.145(7), Wis. Adm. Code. Submittal of the first annual status report is required by the Date Due. Note: If the permittee wishes to apply for an alternative mercury effluent limitation, that application is due with the application for permit reissuance by 6 months prior to permit expiration. The permittee should submit or reference the PMP plan as updated by the Annual Status Report or more recent developments as part of that application.	12/31/2007
Annual Status Report: Submit an annual status report on progress of the PMP	12/31/2008
Annual Status Report: Submit an annual status report on progress of the PMP	12/31/2009

6 Standard Requirements

NR 205, Wisconsin Administrative Code: The conditions in ss. NR 205.07(1) and NR 205.07(2), Wis. Adm. Code, are included by reference in this permit. The permittee shall comply with all of these requirements. Some of these requirements are outlined in the Standard Requirements section of this permit. Requirements not specifically outlined in the Standard Requirement section of this permit can be found in ss. NR 205.07(1) and NR 205.07(2).

6.1 Reporting and Monitoring Requirements

6.1.1 Monitoring Results

Monitoring results obtained during the previous month shall be summarized and reported on a Department Wastewater Discharge Monitoring Report Form. This report form is to be returned to the Department no later than the date indicated on the form. The original and one copy of the Wastewater Discharge Monitoring Report Form shall be submitted to your DNR regional office. A copy of the Wastewater Discharge Monitoring Report Form shall be retained by the permittee. Sludge monitoring shall be reported on Characteristic Form 3400-49 by January 31, following the year any sludge analysis is performed.

If the permittee monitors any pollutant more frequently than required by this permit, the results of such monitoring shall be included in the calculations and reporting. The data shall be submitted on the Wastewater Discharge Monitoring Report Form or sludge reporting form.

The permittee shall comply with all limits for each parameter regardless of monitoring frequency. For example, monthly, weekly, and/or daily limits shall be met even with monthly monitoring. The permittee may monitor more frequently than required for any parameter.

Calculations for all limitations which require averaging of measurements shall utilize an arithmetic mean unless otherwise specified by the Department in this permit.

6.1.2 Sampling and Testing Procedures

Sampling and laboratory testing procedures shall be performed in accordance with Chapters NR 218 and NR 219, Wis. Adm. Code and shall be performed by a laboratory certified or registered in accordance with the requirements of ch. NR 149, Wis. Adm. Code. Groundwater sample collection and analysis shall be performed in accordance with ch. NR 140, Wis. Adm. Code. The analytical methodologies used shall enable the laboratory to quantitate all substances for which monitoring is required at levels below the effluent limitation. If the required level cannot be met by any of the methods available in NR 219, Wis. Adm. Code, then the method with the lowest limit of detection shall be selected. Additional test procedures may be specified in this permit.

6.1.3 Pretreatment Sampling Requirements

Sampling for pretreatment parameters (cadmium, chromium, copper, lead, nickel, zinc, and mercury) shall be done during a day each month when industrial discharges are occurring at normal to maximum levels. The sampling of the influent and effluent for these parameters shall be coordinated. All 24 hour composite samples shall be flow proportional.

6.1.4 Recording of Results

The permittee shall maintain records which provide the following information for each effluent measurement or sample taken:

- the date, exact place, method and time of sampling or measurements;
- the individual who performed the sampling or measurements;
- the date the analysis was performed;

- the individual who performed the analysis;
- the analytical techniques or methods used; and
- the results of the analysis.

6.1.5 Reporting of Monitoring Results

The permittee shall use the following conventions when reporting effluent monitoring results:

- Pollutant concentrations less than the limit of detection shall be reported as < (less than) the value of the limit of detection. For example, if a substance is not detected at a detection limit of 0.1 mg/L, report the pollutant concentration as < 0.1 mg/L.

- Pollutant concentrations equal to or greater than the limit of detection, but less than the limit of quantitation, shall be reported and the limit of quantitation shall be specified.

- For the purposes of reporting a calculated result, average or a mass discharge value, the permittee may substitute a 0 (zero) for any pollutant concentration that is less than the limit of detection. However, if the effluent limitation is less than the limit of detection, the department may substitute a value other than zero for results less than the limit of detection, after considering the number of monitoring results that are greater than the limit of detection and if warranted when applying appropriate statistical techniques.

6.1.6 Compliance Maintenance Annual Reports

Compliance Maintenance Annual Reports (CMAR) shall be completed using information obtained over each calendar year regarding the wastewater conveyance and treatment system. The CMAR shall be submitted by the permittee in accordance with ch. NR 208, Wis. Adm. Code, by June 30, each year on an electronic report form provided by the Department.

In the case of a publicly owned treatment works, a resolution shall be passed by the governing body and submitted as part of the CMAR, verifying its review of the report and providing responses as required. Private owners of wastewater treatment works are not required to pass a resolution; but they must provide an Owner Statement and responses as required, as part of the CMAR submittal.

A separate CMAR certification document, that is not part of the electronic report form, shall be mailed to the Department at the time of electronic submittal of the CMAR. The CMAR certification shall be signed and submitted by an authorized representative of the permittee. The certification shall be submitted by mail. The certification shall verify the electronic report is complete, accurate and contains information from the owner’s treatment works.

6.1.7 Records Retention

The permittee shall retain records of all monitoring information, including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation, copies of all reports required by the permit, and records of all data used to complete the application for the permit for a period of at least 3 years from the date of the sample, measurement, report or application. All pertinent sludge information, including permit application information and other documents specified in this permit or s. NR 204.06(9), Wis. Adm. Code shall be retained for a minimum of 5 years.

6.1.8 Other Information

Where the permittee becomes aware that it failed to submit any relevant facts in a permit application or submitted incorrect information in a permit application or in any report to the Department, it shall promptly submit such facts or correct information to the Department.

6.2 System Operating Requirements

6.2.1 Noncompliance Notification

- The permittee shall report the following types of noncompliance by a telephone call to the Department's regional office within 24 hours after becoming aware of the noncompliance:
  - any noncompliance which may endanger health or the environment;
  - any violation of an effluent limitation resulting from an unanticipated bypass;
  - any violation of an effluent limitation resulting from an upset; and
  - any violation of a maximum discharge limitation for any of the pollutants listed by the Department in the permit, either for effluent or sludge.

- A written report describing the noncompliance shall also be submitted to the Department's regional office within 5 days after the permittee becomes aware of the noncompliance. On a case-by-case basis, the Department may waive the requirement for submittal of a written report within 5 days and instruct the permittee to submit the written report with the next regularly scheduled monitoring report. In either case, the written report shall contain a description of the noncompliance and its cause; the period of noncompliance, including exact dates and times; the steps taken or planned to reduce, eliminate and prevent reoccurrence of the noncompliance; and if the noncompliance has not been corrected, the length of time it is expected to continue.

NOTE: Section 292.11(2)(a), Wisconsin Statutes, requires any person who possesses or controls a hazardous substance or who causes the discharge of a hazardous substance to notify the Department of Natural Resources **immediately** of any discharge not authorized by the permit. The discharge of a hazardous substance that is not authorized by this permit or that violates this permit may be a hazardous substance spill. To report a hazardous substance spill, call DNR's 24-hour HOTLINE at **1-800-943-0003**

6.2.2 Flow Meters

Flow meters shall be calibrated annually, as per s. NR 218.06, Wis. Adm. Code.

6.2.3 Raw Grit and Screenings

All raw grit and screenings shall be disposed of at a properly licensed solid waste facility or picked up by a licensed waste hauler. If the facility or hauler are located in Wisconsin, then they shall be licensed under chs. NR 500-536, Wis. Adm. Code.

6.2.4 Sludge Management

All sludge management activities shall be conducted in compliance with ch. NR 204 "Domestic Sewage Sludge Management", Wis. Adm. Code.

6.2.5 Prohibited Wastes

Under no circumstances may the introduction of wastes prohibited by s. NR 211.10, Wis. Adm. Code, be allowed into the waste treatment system. Prohibited wastes include those:

- which create a fire or explosion hazard in the treatment work;
- which will cause corrosive structural damage to the treatment work;
- solid or viscous substances in amounts which cause obstructions to the flow in sewers or interference with the proper operation of the treatment work;

- wastewaters at a flow rate or pollutant loading which are excessive over relatively short time periods so as to cause a loss of treatment efficiency; and
- changes in discharge volume or composition from contributing industries which overload the treatment works or cause a loss of treatment efficiency.

6.2.6 Unscheduled Bypassing

Any unscheduled bypass or overflow of wastewater at the treatment works or from the collection system is prohibited, and the Department may take enforcement action against a permittee for such occurrences under s. 283.89, Wis. Stats., unless:

- The bypass was unavoidable to prevent loss of life, personal injury, or severe property damage;
- There were no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate back-up equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass which occurred during normal periods of equipment downtime or preventive maintenance; and
- The permittee notified the Department as required in this Section.

Whenever there is an unscheduled bypass or overflow occurrence at the treatment works or from the collection system, the permittee shall notify the Department within 24 hours of initiation of the bypass or overflow occurrence by telephoning the wastewater staff in the regional office as soon as reasonably possible (FAX, email or voice mail, if staff are unavailable).

In addition, the permittee shall within 5 days of conclusion of the bypass or overflow occurrence report the following information to the Department in writing:

- Reason the bypass or overflow occurred, or explanation of other contributing circumstances that resulted in the overflow event. If the overflow or bypass is associated with wet weather, provide data on the amount and duration of the rainfall or snow melt for each separate event.
- Date the bypass or overflow occurred.
- Location where the bypass or overflow occurred.
- Duration of the bypass or overflow and estimated wastewater volume discharged.
- Steps taken or the proposed corrective action planned to prevent similar future occurrences.
- Any other information the permittee believes is relevant.

6.2.7 Scheduled Bypassing

Any construction or normal maintenance which results in a bypass of wastewater from a treatment system is prohibited unless authorized by the Department in writing. If the Department determines that there is significant public interest in the proposed action, the Department may schedule a public hearing or notice a proposal to approve the bypass. Each request shall specify the following minimum information:

- proposed date of bypass;
- estimated duration of the bypass;
- estimated volume of the bypass;
- alternatives to bypassing; and
- measures to mitigate environmental harm caused by the bypass.

6.2.8 Proper Operation and Maintenance

The permittee shall at all times properly operate and maintain all facilities and systems of treatment and control which are installed or used by the permittee to achieve compliance with the conditions of this permit. The wastewater treatment facility shall be under the direct supervision of a state certified operator as required in s. NR 108.06(2), Wis. Adm. Code. Proper operation and maintenance includes effective performance, adequate funding, adequate operator staffing and training as required in ch. NR 114, Wis. Adm. Code, and adequate laboratory and process controls, including appropriate quality assurance procedures. This provision requires the operation of back-up or auxiliary facilities or similar systems only when necessary to achieve compliance with the conditions of the permit.

6.3 Surface Water Requirements

6.3.1 Permittee-Determined Limit of Quantitation Incorporated into this Permit

For pollutants with water quality-based effluent limits below the Limit of Quantification (LOQ) in this permit, the LOQ calculated by the permittee and reported on the Discharge Monitoring Reports (DMRs) is incorporated by reference into this permit. The LOQ shall be reported on the DMRs, shall be the lowest quantifiable level practicable, and shall be no greater than the minimum level (ML) specified in or approved under 40 CFR Part 136 for the pollutant at the time this permit was issued, unless this permit specifies a higher LOQ.

6.3.2 Appropriate Formulas for Effluent Calculations

The permittee shall use the following formulas for calculating effluent results to determine compliance with average limits and mass limits:

Weekly/Monthly average concentration = the sum of all daily results for that week/month, divided by the number of results during that time period.

Weekly Average Mass Discharge (lbs/day): Daily mass = daily concentration (mg/L) x daily flow (MGD) x 8.34, then average the daily mass values for the week.

Monthly Average Mass Discharge (lbs/day): Daily mass = daily concentration (mg/L) x daily flow (MGD) x 8.34, then average the daily mass values for the month.

6.3.3 Visible Foam or Floating Solids

There shall be no discharge of floating solids or visible foam in other than trace amounts.

6.3.4 Percent Removal

During any 30 consecutive days, the average effluent concentrations of BOD_5 and of total suspended solids shall not exceed 15% of the average influent concentrations, respectively. This requirement does not apply to removal of total suspended solids if the permittee operates a lagoon system and has received a variance for suspended solids granted under NR 210.07(2), Wis. Adm. Code.

6.3.5 Fecal Coliforms

The limit for fecal coliforms shall be expressed as a monthly geometric mean.

6.3.6 Seasonal Disinfection

Disinfection shall be provided from May 1 through September 30 of each year. Monitoring requirements and the limitation for fecal coliforms apply only during the period in which disinfection is required. Whenever chlorine is used for disinfection or other uses, the limitations and monitoring requirements for residual chlorine shall apply. A dechlorination process shall be in operation whenever chlorine is used.

6.3.7 Total Residual Chlorine

Test methods for total residual chlorine, approved in ch. NR 219 - Table B, Wis. Adm. Code, normally achieve a limit of detection of about 20 to 50 micrograms per liter and a limit of quantitation of about 100 micrograms per liter. Reporting of test results and compliance with effluent limitations for chlorine residual and total residual halogens shall be as follows:

- Sample results which show no detectable levels are in compliance with the limit. These test results shall be reported on Wastewater Discharge Monitoring Report Forms as "< 100 µg/L". (Note: 0.1 mg/L converts to 100 µg/L)

- Samples showing detectable traces of chlorine are in compliance if measured at less than 100 µg/L, unless there is a consistent pattern of detectable values in this range. These values shall also be reported on Wastewater Discharge Monitoring Report Forms as "<100 µg/L." The facility operating staff shall record actual readings on logs maintained at the plant, shall take action to determine the reliability of detected results (such as re-sampling and/or calculating dosages), and shall adjust the chemical feed system if necessary to reduce the chances of detects.

- Samples showing detectable levels greater than 100 µg/L shall be considered as exceedances, and shall be reported as measured.

- To calculate average or mass discharge values, a "0" (zero) may be substituted for any test result less than 100 µg/L. Calculated values shall then be compared directly to the average or mass limitations to determine compliance.

6.3.8 Whole Effluent Toxicity (WET) Monitoring Requirements

In order to determine the potential impact of the discharge on aquatic organisms, static-renewal toxicity tests shall be performed on the effluent in accordance with the procedures specified in the *"State of Wisconsin Aquatic Life Toxicity Testing Methods Manual, 2nd Edition" (PUB-WT-797*, November 2004) as required by NR 219.04, Table A, Wis. Adm. Code). All of the WET tests required in this permit, including any required retests, shall be conducted on the *Ceriodaphnia dubia* and fathead minnow species. Receiving water samples shall not be collected from any point in contact with the permittee's mixing zone and every attempt shall be made to avoid contact with any other discharge's mixing zone.

6.3.9 Whole Effluent Toxicity (WET) Monitoring – ELS Absent Criteria

Effluent samples used in chronic fathead minnow tests may be modified to remove ammonia prior to testing, according to s. NR 106.36(2), Wis. Adm. Code, during periods when ammonia limits based on early life stage-absent criteria are in effect. For the Green Bay Metropolitan Sewerage District this provision is only applicable from October – December.

6.3.10 Whole Effluent Toxicity (WET) Identification

In the event of serious or repeated toxicity, the permittee may obtain approval from the Department to postpone retests in order to investigate the source(s) of toxicity. In order to postpone these tests, the permittee must provide the following information to the Department in writing, within 30 days of the end of the test which showed a positive result:

- a description of the investigation to be used to identify potential sources of toxicity. Treatment efficiency, housekeeping practices, and chemicals used in operation of the facility should be included in the investigation.

- who will conduct a toxicity identification evaluation (TIE), if required.

Once the above investigation has been completed, the permittee must conduct the postponed test(s) to demonstrate that toxicity has been reduced/eliminated.

6.4 Pretreatment Program Requirements

The permittee is required to operate an industrial pretreatment program as described in the program initially approved by the Department of Natural Resources including any subsequent program modifications approved by the Department, and including commitments to program implementation activities provided in the permittee's annual pretreatment program report, and that complies with the requirements set forth in 40 CFR Part 403 and ch. NR 211, Wis. Adm. Code. To ensure that the program is operated in accordance with these requirements, the following general conditions and requirements are hereby established:

6.4.1 Inventories

The permittee shall implement methods to maintain a current inventory of the general character and volume of wastewater that industrial users discharge to the treatment works and shall provide an updated industrial user listing annually and report any changes in the listing to the Department by March 31 of each year as part of the annual pretreatment program report required herein.

6.4.2 Regulation of Industrial Users

6.4.2.1 Limitations for Industrial Users:

The permittee shall develop, maintain, enforce and revise as necessary local limits to implement the general and specific prohibitions of the state and federal General Pretreatment Regulations.

6.4.2.2 Control Documents for Industrial Users (IUs)

The permittee shall control the discharge from each significant industrial user through individual discharge permits as required by s. NR 211.235, Wis. Adm. Code and in accordance with the approved pretreatment program procedures and the permittee's sewer use ordinance. The discharge permits shall be modified in a timely manner during the stated term of the discharge permits according to the sewer use ordinance as conditions warrant. The discharge permits shall include at a minimum the elements found in s. NR 211.235(1), Wis. Adm. Code and references to the approved pretreatment program procedures and the sewer use ordinance.

The permittee shall provide a copy of all newly issued, reissued, or modified discharge permits to the Department.

6.4.2.3 Review of Industrial User Reports, Inspections and Compliance Monitoring

The permittee shall require the submission of, receive, and review self-monitoring reports and other notices from industrial users in accordance with the approved pretreatment program procedures. The permittee shall randomly sample and analyze industrial user discharges and conduct surveillance activities to determine independent of information supplied by the industrial users, whether the industrial users are in compliance with pretreatment standards and requirements. The inspections and monitoring shall also be conducted to maintain accurate knowledge of local industrial processes, including changes in the discharge, pretreatment equipment operation, spill prevention control plans, slug control plans, and implementation of solvent management plans.

At least one time per year the permittee shall inspect and sample the discharge from each significant industrial user, or more frequently if so specified in the permittee's approved pretreatment program. At least once every 2 years the permittee shall evaluate whether each significant industrial user needs a slug control plan. If a slug control plan is needed, the plan shall contain at a minimum the elements specified in s. NR 211.235(4)(b), Wis. Adm. Code.

6.4.2.4 Enforcement and Industrial User Compliance Evaluation & Violation Reports

The permittee shall enforce the industrial pretreatment requirements including the industrial user discharge limitations of the permittee's sewer use ordinance. The permittee shall investigate instances of noncompliance by collecting and analyzing samples and collecting other information with sufficient care to produce evidence admissible in enforcement proceedings or in judicial actions. Investigation and response to instances of noncompliance shall be in accordance with the permittee's sewer use ordinance and approved Enforcement Response Plan.

The permittee shall make a semiannual report on forms provided or approved by the Department. The semiannual report shall include an analysis of industrial user significant noncompliance (i.e. the Industrial User Compliance Evaluation, also known as the SNC Analysis) as outlined in s.NR 211.23(1)(j), Wis. Adm. Code, and a summary of the permittee's response to all industrial noncompliance (i.e. the Industrial User Violation Report). The Industrial User Compliance Evaluation Report shall include monitoring results received from industrial users pursuant to s. NR 211.15(1)-(5), Wis. Adm. Code. The Industrial User Violation Report shall include copies of all notices of noncompliance, notices of violation and other enforcement correspondence sent by the permittee to industrial users, together with the industrial user's response. The Industrial User Compliance Evaluation and Violation Reports for the period January through June shall be provided to the Department by September 30 of each year and for the period July through December shall be provided to the Department by March 31 of the succeeding year, unless alternate submittal dates are approved.

6.4.2.5 Publication of Violations

The permittee shall publish a list of industrial users that have significantly violated the municipal sewer use ordinance during the calendar year, in the largest daily newspaper in the area by March 31 of the following year pursuant to s. NR 211.23(1)(j), Wis. Adm. Code. A copy of the newspaper publication shall be provided as part of the annual pretreatment report specified herein.

6.4.2.6 Multijurisdictional Agreements

The permittee shall establish agreements with all contributing jurisdictions as necessary to ensure compliance with pretreatment standards and requirements by all industrial users discharging to the permittee's wastewater treatment system. Any such agreement shall identify who will be responsible for maintaining the industrial user inventory, issuance of industrial user control mechanisms, inspections and sampling, pretreatment program implementation, and enforcement.

6.4.3 Annual Pretreatment Program Report

The permittee shall evaluate the pretreatment program, and submit the Pretreatment Program Report to the Department on forms provided or approved by the Department by March 31 annually, unless an alternate submittal date is approved. The report shall include a brief summary of the work performed during the preceding calendar year, including the numbers of discharge permits issued and in effect, pollution prevention activities, number of inspections and monitoring surveys conducted, budget and personnel assigned to the program, a general discussion of program progress in meeting the objectives of the permittee's pretreatment program together with summary comments and recommendations.

6.4.4 Pretreatment Program Modifications

- Future Modifications: The permittee shall within one year of any revisions to federal or state General Pretreatment Regulations submit an application to the Department in duplicate to modify and update its approved pretreatment program to incorporate such regulatory changes as applicable to the permittee. Additionally, the Department or the permittee may request an application for program modification at any time where necessary to improve program effectiveness based on program experience to date.

- Modifications Subject to Department Approval: The permittee shall submit all proposed pretreatment program modifications to the Department for determination of significance and opportunity for comment in accordance with the requirements and conditions of s. NR 211.27, Wis. Adm. Code. Any substantial proposed program modification shall be subject to Department public noticing and formal approval prior to implementation. A substantial program modification includes, but is not limited to, changes in enabling legal authority to administer and enforce pretreatment conditions and requirements; significant changes in program administrative or operational procedures; significant reductions in monitoring frequencies; significant reductions in program resources including personnel commitments, equipment, and funding levels; changes (including any relaxation) in the local limitations for substances enforced and applied to users of the sewerage treatment works; changes in treatment works sludge disposal or management practices which impact the pretreatment program; or program modifications which increase pollutant loadings to the treatment works. The Department shall use the procedures outlined in s. NR 211.30, Wis. Adm. Code for review and approval/denial of proposed pretreatment program modifications. The permittee shall comply with local public participation requirements when implementing the pretreatment program.

6.4.5 Program Resources

The permittee shall have sufficient resources and qualified personnel to carry out the pretreatment program responsibilities as listed in ss. NR 211.22 and NR 211.23, Wis. Adm. Code.

6.5 Land Application Requirements

6.5.1 Sludge Management Program Standards And Requirements Based Upon Federally Promulgated Regulations

In the event that new federal sludge standards or regulations are promulgated, the permittee shall comply with the new sludge requirements by the dates established in the regulations, if required by federal law, even if the permit has not yet been modified to incorporate the new federal regulations.

6.5.2 General Sludge Management Information

The General Sludge Management Information Form 3400-48 shall be submitted with your WPDES permit application. This form shall also be updated and submitted prior to any significant sludge management changes.

6.5.3 Sludge Samples

All sludge samples shall be collected at a point and in a manner which will yield sample results which are representative of the sludge being tested, and collected at the time which is appropriate for the specific test.

6.5.4 Less Frequent Sludge Monitoring

Less frequent sludge monitoring may be requested in writing to the Department. Granting such a request requires a permit modification.

6.5.5 Land Application Characteristic Report

Each report shall consist of a Characteristic Form 3400-49 and Lab Report, unless approval for not submitting the lab reports has been given. Both reports shall be submitted by January 31 following each year of analysis.

The permittee shall use the following convention when reporting sludge monitoring results: Pollutant concentrations less than the limit of detection shall be reported as < (less than) the value of the limit of detection. For example, if a substance is not detected at a detection limit of 1.0 mg/kg, report the pollutant concentration as < 1.0 mg/kg .

All results shall be reported on a dry weight basis.

6.5.6 Monitoring and Calculating PCB Concentrations in Sludge

When sludge analysis for "PCB, Total Dry Wt" is required by this permit, the PCB concentration in the sludge shall be determined as follows.

Either congener-specific analysis or Aroclor analysis shall be used to determine the PCB concentration. The permittee may determine whether Aroclor or congener specific analysis is performed. Analyses shall be performed in accordance with the following provisions and Table EM in s. NR 219.04, Wis. Adm. Code.

- EPA Method 1668 may be used to test for all PCB congeners. If this method is employed, all PCB congeners shall be delineated. Non-detects shall be treated as zero. The values that are between the limit of detection and the limit of quantitation shall be used when calculating the total value of all congeners. All results shall be added together and the total PCB concentration by dry weight reported. **Note**: It is recognized that a number of the congeners will co-elute with others, so there will not be 209 results to sum.
- EPA Method 8082A shall be used for PCB-Aroclor analysis and may be used for congener specific analysis as well. If congener specific analysis is performed using Method 8082A, the list of congeners tested shall include at least congener numbers 5, 18, 31, 44, 52, 66, 87, 101, 110, 138, 141, 151, 153, 170, 180, 183, 187, and 206 plus any other additional congeners which might be reasonably expected to occur in the particular sample. For either type of analysis, the sample shall be extracted using the Soxhlet extraction (EPA Method 3540C) (or the Soxhlet Dean-Stark modification) or the pressurized fluid extraction (EPA Method 3545A). If Aroclor analysis is performed using Method 8082A, clean up steps of the extract shall be performed as necessary to remove interference and to achieve as close to a limit of detection of 0.11 mg/kg as possible. Reporting protocol, consistent with s. NR 106.07(6)(e), should be as follows: If all Aroclors are less than the LOD, then the Total PCB Dry Wt result should be reported as less than the highest LOD. If a single Aroclor is detected then that is what should be reported for the Total PCB result. If multiple Aroclors are detected, they should be summed and reported as Total PCBs. If congener specific analysis is done using Method 8082A, clean up steps of the extract shall be

performed as necessary to remove interference and to achieve as close to a limit of detection of 0.003 mg/kg as possible for each congener. If the aforementioned limits of detection cannot be achieved after using the appropriate clean up techniques, a reporting limit that is achievable for the Aroclors or each congener for the sample shall be determined. This reporting limit shall be reported and qualified indicating the presence of an interference. The lab conducting the analysis shall perform as many of the following methods as necessary to remove interference:

3620C - Florisil	3611B - Alumina
3640A - Gel Permeation	3660B - Sulfur Clean Up (using copper shot instead of powder)
3630C - Silica Gel	3665A - Sulfuric Acid Clean Up

6.5.7 Land Application Report

Land Application Report Form 3400-55 shall be submitted by January 31, following each year non-exceptional quality sludge is land applied. Non-exceptional quality sludge is defined in s. NR 204.07(4), Wis. Adm. Code.

6.5.8 Other Methods of Disposal or Distribution Report

The permittee shall submit Report Form 3400-52 by January 31, following each year sludge is hauled, landfilled, incinerated, or when exceptional quality sludge is distributed or land applied.

6.5.9 Approval to Land Apply

Bulk non-exceptional quality sludge as defined in s. NR 204.07(4), Wis. Adm. Code, may not be applied to land without a written approval letter or Form 3400-122 from the Department unless the Permittee has obtained permission from the Department to self approve sites in accordance with s. NR 204.06 (6), Wis. Adm. Code. Analysis of sludge characteristics is required prior to land application. Application on frozen or snow covered ground is restricted to the extent specified in s. NR 204.07(3) (l), Wis. Adm. Code, and is not allowed once 180 day storage is provided.

6.5.10 Soil Analysis Requirements

Each site requested for approval for land application must have the soil tested prior to use. Each approved site used for land application must subsequently be soil tested such that there is at least one valid soil test in the four years prior to land application. All soil sampling and submittal of information to the testing laboratory shall be done in accordance with UW Extension Bulletin A-2100. The testing shall be done by the UW Soils Lab in Madison or Marshfield, WI or at a lab approved by UW. The test results including the crop recommendations shall be submitted to the DNR contact listed for this permit, as they are available. Application rates shall be determined based on the crop nitrogen recommendations and with consideration for other sources of nitrogen applied to the site.

6.5.11 Land Application Site Evaluation

For non-exceptional quality sludge, as defined in s. NR 204.07(4), Wis. Adm. Code, a Land Application Site Evaluation Form 3400-53 shall be submitted to the Department for the proposed land application site. The Department will evaluate the proposed site for acceptability and will either approve or deny use of the proposed site. The permittee may obtain permission to approve their own sites in accordance with s. NR 204.06(6), Wis. Adm. Code.

6.5.12 Class B Sludge: Fecal Coliform Limitation

Compliance with the fecal coliform limitation for Class B sludge shall be demonstrated by calculating the geometric mean of at least 7 separate samples. (Note that a Total Solids analysis must be done on each sample). The geometric mean shall be less than 2,000,000 MPN or CFU/g TS. Calculation of the geometric mean can be done using one of the following 2 methods.

Method 1:
Geometric Mean = $(X_1 \times X_2 \times X_3 \ldots \times X_n)^{1/n}$
Where X = Coliform Density value of the sludge sample, and where n = number of samples (at least 7)

Method 2:
Geometric Mean = antilog$[(X_1 + X_2 + X_3 \ldots + X_n) \div n]$
Where X = $\log_{10}$ of Coliform Density value of the sludge sample, and where n = number of samples (at least 7)
Example for Method 2

Sample Number	Coliform Density of Sludge Sample	$\log_{10}$
1	6.0×10^5	5.78
2	4.2×10^6	6.62
3	1.6×10^6	6.20
4	9.0×10^5	5.95
5	4.0×10^5	5.60
6	1.0×10^6	6.00
7	5.1×10^5	5.71

The geometric mean for the seven samples is determined by averaging the $\log_{10}$ values of the coliform density and taking the antilog of that value.
(5.78 + 6.62 + 6.20 + 5.95 + 5.60 + 6.00 + 5.71) ÷ 7 = 5.98
The antilog of 5.98 = 9.5×10^5

6.5.13 Class B Sludge - Vector Control: Injection

No significant amount of the sewage sludge shall be present on the land surface within one hour after the sludge is injected.

6.5.14 Class B Sludge - Vector Control: Incorporation

Class B sludge shall be incorporated within 6 hours of surface application, or as approved by the Department.

6.5.15 Landfilling of Sludge

General: Sewage sludge may not be disposed of in a municipal solid waste landfill unless the landfill meets the requirements of chs. NR 500 to 536, Wis. Adm. Code, and is an approved facility as defined in s. 289.01(3), Wis. Stats. Any facility accepting sewage sludge shall be approved by the Department in writing to accept sewage sludge. Disposal of sewage sludge in a municipal solid waste landfill shall be in accordance with ss. NR 506.13 and 506.14. Sewage sludge may not be disposed of in a surface disposal unit as defined in s. NR 204.03(62).

Approval: The permittee shall obtain approval from the Department prior to the disposal of sludge at a Wisconsin licensed landfill.

6.5.16 Sludge Landfilling Reports

The permittee shall report the volume of sludge disposed of at any landfill facility on Form 3400-52. The permittee shall include the name and address of the landfill, the Department license number or other state's designation or license number for all landfills used during the report period and a letter of acceptability from the landfill owner. In addition, any permittee utilizing landfills as a disposal method shall submit to the Department any test results used to indicate acceptability of the sludge at a landfill. Form 3400-52 shall be submitted annually by January 31, following each year sludge is landfilled.

6.5.17 Sludge Incineration Reports

The permittee shall report the volume of sludge combusted at an on-site incinerator on Form 3400-52. Submittal of Form 3400-52 is required annually by January 31, following each year sludge is incinerated.

6.5.18 Land Application of Sludge Which Contains Elevated Levels of Radium-226

When contributory water supplies exceed 2 pci per liter of Radium 226, monitoring for Radium 226 in sludge is required. Sludge containing Radium 226 shall be land applied in accordance with the requirements in s. NR 204.07(3)(n), Wis. Adm. Code.

7 Summary of Reports Due

FOR INFORMATIONAL PURPOSES ONLY

Description	**Date**	**Page**
Mercury Pollutant Minimization Program - Request Limit Determination	December 31, 2005	15
Mercury Pollutant Minimization Program - Mercury Pollutant Minimization Program Plan	December 31, 2006	15
Mercury Pollutant Minimization Program - Implement PMP Plan	April 1, 2007	15
Mercury Pollutant Minimization Program – Annual Status Reports	December 31, 2007	15
Mercury Pollutant Minimization Program - Annual Status Report	December 31, 2008	15
Mercury Pollutant Minimization Program - Annual Status Report	December 31, 2009	15
Compliance Maintenance Annual Reports (CMAR)	by June 30, each year	17
Industrial User Compliance Evaluation and Violation Reports	Semiannual	23
Pretreatment Program Report	Annually	24
General Sludge Management Information Form 3400-48	prior to any significant sludge management changes	25
Characteristic Form 3400-49 and Lab Report	by January 31 following each year of analysis	25
Land Application Report Form 3400-55	by January 31, following each year non-exceptional quality sludge is land applied	26
Report Form 3400-52	by January 31, following each year sludge is hauled, landfilled, incinerated, or when exceptional quality sludge is distributed or land applied	26
Wastewater Discharge Monitoring Report Form	no later than the date indicated on the form	16

All submittals required by this permit shall be submitted to the Northeast Region, 2984 Shawano Avenue, P.O. Box 10448, Green Bay, WI 54307-0448, except as follows. Report forms shall be submitted to the address printed on the report form. Any facility plans or plans and specifications for municipal, industrial pretreatment and non industrial wastewater systems shall be submitted to the Regional Plan Reviewer (as designated at www.dnr.state.wi.us/org/water/wm/consultant.htm). Any construction plans and specifications for industrial wastewater systems shall be submitted to the Bureau of Watershed Management, P.O. Box 7921, Madison, WI 53707-7921.

WPDES Permit No. WI-0023787-07-0

WISCONSIN
DEPT. OF NATURAL RESOURCES

RECEIVED
APR 21 2006
CITY OF DE PERE
WASTEWATER TREATMENT PLANT

WPDES PERMIT

STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES

PERMIT TO DISCHARGE UNDER THE
WISCONSIN POLLUTANT DISCHARGE ELIMINATION SYSTEM

City of De Pere

is permitted, under the authority of Chapter 283, Wisconsin Statutes, to discharge from a facility located in Brown County at
315 Leonard St., De Pere, Wisconsin
to

the Fox River in the East River Watershed (LF01) of the Lower Fox River Drainage Basin in the Lake Michigan Basin

in accordance with the effluent limitations, monitoring requirements and other conditions set forth in this permit.

The permittee shall not discharge after the date of expiration. If the permittee wishes to continue to discharge after this expiration date an application shall be filed for reissuance of this permit, according to Chapter NR 200, Wis. Adm. Code, at least 180 days prior to the expiration date given below.

State of Wisconsin Department of Natural Resources
For the Secretary

By ______________________
Joseph Graham
Wastewater Specialist

April 19, 2006
Date Permit Signed/Issued

PERMIT TERM: EFFECTIVE DATE - May 01, 2006 **EXPIRATION DATE - March 31, 2011**

TABLE OF CONTENTS

1 Influent Requirements

1.1 Sampling Point(s)

Sampling Point Designation	
Sampling Point Number	**Sampling Point Location, WasteType/Sample Contents and Treatment Description (as applicable)**
701	Influent: Representative samples shall be taken at the raw sewage pump station prior to the addition of any sidestreams.

1.2 Monitoring Requirements

The permittee shall comply with the following monitoring requirements.

1.2.1 Sampling Point 701 - Influent

Monitoring Requirements and Limitations					
Parameter	**Limit Type**	**Limit and Units**	**Sample Frequency**	**Sample Type**	**Notes**
Flow Rate		MGD	Daily	Continuous	
BOD_5, Total		mg/L	5/Week	24-Hr Flow Prop Comp	
Suspended Solids, Total		mg/L	5/Week	24-Hr Flow Prop Comp	
Cadmium, Total Recoverable		µg/L	Monthly	24-Hr Flow Prop Comp	See § 1.2.1.1.
Chromium, Total Recoverable		µg/L	Monthly	24-Hr Flow Prop Comp	
Copper, Total Recoverable		µg/L	Monthly	24-Hr Flow Prop Comp	
Lead, Total Recoverable		µg/L	Monthly	24-Hr Flow Prop Comp	
Nickel, Total Recoverable		µg/L	Monthly	24-Hr Flow Prop Comp	
Zinc, Total Recoverable		µg/L	Monthly	24-Hr Flow Prop Comp	
Mercury, Total Recoverable		ng/L	Monthly	24-Hr Flow Prop Comp	See § 1.2.1.2.

1.2.1.1 Sample Analysis

Samples shall be analyzed using a method which provides adequate sensitivity so that results can be quantified, unless not possible using the most sensitive approved method.

1.2.1.2 Mercury Monitoring

The permittee shall collect and analyze all mercury samples according to the data quality requirements of ss. NR 106.145(9) and (10), Wisconsin Administrative Code. The limit of quantitation (LOQ) used for the effluent and field blank shall be less than 1.3 ng/L, unless the samples are quantified at levels above 1.3 ng/L. The permittee shall collect at least one mercury field blank for each set of mercury samples (a set of samples may include combinations of intake, influent, effluent or other samples all collected on the same day). The permittee shall report results of samples and field blanks to the Department on Discharge Monitoring Reports.

2 In-Plant Requirements

2.1 Sampling Point(s)

Sampling Point Designation	
Sampling Point Number	**Sampling Point Location, WasteType/Sample Contents and Treatment Description (as applicable)**
110	Field Blank - Sample point for reporting results of Mercury field blanks collected using standard sample handling procedures.

2.2 Monitoring Requirements and Limitations

The permittee shall comply with the following monitoring requirements and limitations.

2.2.1 Sampling Point 110 - Field Blank

Monitoring Requirements and Limitations					
Parameter	**Limit Type**	**Limit and Units**	**Sample Frequency**	**Sample Type**	**Notes**
Mercury, Total Recoverable		ng/L	Monthly	Blank	See § 2.2.1.1.

2.2.1.1 Mercury Monitoring

The permittee shall collect and analyze all mercury samples according to the data quality requirements of ss. NR 106.145(9) and (10), Wisconsin Administrative Code. The limit of quantitation (LOQ) used for the effluent and field blank shall be less than 1.3 ng/L, unless the samples are quantified at levels above 1.3 ng/L. The permittee shall collect at least one mercury field blank for each set of mercury samples (a set of samples may include combinations of intake, influent, effluent or other samples all collected on the same day). The permittee shall report results of samples and field blanks to the Department on Discharge Monitoring Reports.

3 Surface Water Requirements

3.1 Sampling Point(s)

Sampling Point Designation	
Sampling Point Number	**Sampling Point Location, WasteType/Sample Contents and Treatment Description (as applicable)**
001	Effluent: Representative composite samples shall be taken from the gravity filter building wet well, and grab samples shall be taken from the disinfection basin discharge.

3.2 Monitoring Requirements and Effluent Limitations

The permittee shall comply with the following monitoring requirements and limitations.

3.2.1 Sampling Point (Outfall) 001 - Effluent

Monitoring Requirements and Effluent Limitations					
Parameter	**Limit Type**	**Limit and Units**	**Sample Frequency**	**Sample Type**	**Notes**
$CBOD_5$	Weekly Avg Monthly Avg	18 mg/L 9.0 mg/L	5/Week	24-Hr Flow Prop Comp	
Suspended Solids, Total	Weekly Avg Monthly Avg	20 mg/L 10 mg/L	5/Week	24-Hr Flow Prop Comp	
Phosphorus, Total	Monthly Avg	1.0 mg/L	5/Week	24-Hr Flow Prop Comp	
Nitrogen, Ammonia (NH_3-N) Total	Daily Max Monthly Avg.	34 mg/L 27 mg/L (a)	5/Week	24-Hr Flow Prop Comp	(a) Jan. - Mar.
	Daily Max Monthly Avg	34 mg/L 24 mg/L (b)			(b) April
	Monitor Only	mg/L (c)			(c) May – Oct., See § 3.2.1.1.
	Daily Max Monthly Avg	34 mg/L 31 mg/L (d)			(d) Nov. & Dec.
pH Field	Daily Min Daily Max	6.0 su 9.0 su	Daily	Grab	
Cadmium, Total Recoverable		µg/L	Monthly	24-Hr Flow Prop Comp	See § 3.2.1.2.
Chromium, Total Recoverable		µg/L	Monthly	24-Hr Flow Prop Comp	
Copper, Total Recoverable		µg/L	Monthly	24-Hr Flow Prop Comp	
Lead, Total Recoverable		µg/L	Monthly	24-Hr Flow Prop Comp	
Nickel, Total Recoverable		µg/L	Monthly	24-Hr Flow Prop Comp	
Zinc, Total Recoverable		µg/L	Monthly	24-Hr Flow Prop Comp	
Mercury, Total Recoverable		ng/L	Monthly	Grab	See § 3.2.1.3.

Monitoring Requirements and Effluent Limitations					
Parameter	**Limit Type**	**Limit and Units**	**Sample Frequency**	**Sample Type**	**Notes**
Fecal Coliform	Geometric Mean	400 #/100 ml	Weekly	Grab	May - Sept.
Chlorine, Total Residual	Daily Max	38 µg/L	Daily	Grab	Monitoring required and limits apply whenever chlorine is used. Mass limit specified in § 3.2.1.4.
Acute WET		TU_a	See Listed Qtr(s)	24-Hr Flow Prop Comp	The permittee shall perform WET testing as specified in § 3.2.1.5.
Chronic WET		rTU_c			

3.2.1.1 Continue to Optimize Removal of Ammonia

Ammonia limits are not included for the months of May through October in accordance with the exceptions contained in s. NR 106.33(2). During these months, the wastewater treatment plant shall continue to be operated in a manner that optimizes removal of ammonia within the design capabilities of the wastewater treatment plant.

3.2.1.2 Sample Analysis

Samples shall be analyzed using a method which provides adequate sensitivity so that results can be quantified, unless not possible using the most sensitive approved method.

3.2.1.3 Mercury Monitoring

The permittee shall collect and analyze all mercury samples according to the data quality requirements of ss. NR 106.145(9) and (10), Wisconsin Administrative Code. The limit of quantitation (LOQ) used for the effluent and field blank shall be less than 1.3 ng/L, unless the samples are quantified at levels above 1.3 ng/L. The permittee shall collect at least one mercury field blank for each set of mercury samples (a set of samples may include combinations of intake, influent, effluent or other samples all collected on the same day). The permittee shall report results of samples and field blanks to the Department on Discharge Monitoring Reports.

3.2.1.4 Applicable Mass Limit for Total Residual Chlorine

The applicable mass limit for Total Residual Chlorine is 11 pounds per day (daily maximum).

3.2.1.5 Whole Effluent Toxicity (WET) Testing

Primary Control Water: Fox River from a point upstream of outfall 001 and any other known discharge.

Instream Waste Concentration (IWC): 12%

Dilution series: At least five effluent concentrations and dual controls must be included in each test.

- **Acute:** 100, 50, 25, 12.5, 6.25% and any additional selected by the permittee.
- **Chronic:** 100, 30, 10, 3, 1% and any additional selected by the permittee.

WET Testing Frequency: Tests are required during the following quarters (Qtr.).

Acute & Chronic WET

3rd Qtr. 2006 (July 1 – September 30, 2006)

4th Qtr. 2007 (October 1 – December 31, 2007)

3rd Qtr. 2008 (July 1 – September 30, 2008)

2nd Qtr. 2009 (April 1 – June 30, 2009)

1st Qtr. 2010 (January 1 – March 31, 2010)

Reporting: The permittee shall report test results on the Discharge Monitoring Report form, and also complete the "Whole Effluent Toxicity Test Report Form" (Section 6, "*State of Wisconsin Aquatic Life Toxicity Testing Methods Manual, 2nd Edition*"), for each test. The original, complete, signed version of the Whole Effluent Toxicity Test Report Form shall be sent to the Biomonitoring Coordinator, Bureau of Watershed Management, 101 S. Webster St., P.O. Box 7921, Madison, WI 53707-7921, within 45 days of test completion. The original Discharge Monitoring Report (DMR) form and one copy shall be sent to the contact and location provided on the DMR by the required deadline.

Determination of Positive Results: An acute toxicity test shall be considered positive if the Toxic Unit - Acute (TU_a) is greater than 1.0 for either species. The TU_a shall be calculated as follows: If $LC_{50} \geq 100$, then $TU_a = 1.0$. If LC_{50} is < 100, then $TU_a = 100 \div LC_{50}$. A chronic toxicity test shall be considered positive if the Relative Toxic Unit - Chronic (rTU_c) is greater than 1.0 for either species. The rTU_c shall be calculated as follows: If $IC_{25} \geq IWC$, then $rTU_c = 1.0$. If $IC_{25} < IWC$, then $rTU_c = IWC \div IC_{25}$.

Additional Testing Requirements: Within 90 days of a test which showed positive results, the permittee shall submit the results of at least 2 retests to the Biomonitoring Coordinator on "Whole Effluent Toxicity Test Report Forms". The retests shall be completed using the same species and test methods specified for the original test (see the Standard Requirements section herein).

4 Land Application Requirements

4.1 Sampling Point(s)

The discharge(s) shall be limited to land application of the waste type(s) designated for the listed sampling point(s) on Department approved land spreading sites or by hauling to another facility.

Sampling Point Designation	
Sampling Point Number	**Sampling Point Location, WasteType/Sample Contents and Treatment Description (as applicable)**
002	Incinerated Cake: Incineration of biosolids is regulated under the jurisdiction of US EPA Region 5 and subject to the requirements of 40 CFR 503. While the State of Wisconsin has not been delegated authority for biosolids incineration, Form 3400-165 may be sent to the permittee each year and may be completed and returned to DNR, to satisfy federal reporting requirements. US EPA may also impose other 40 CFR part 503 requirements. For state reporting requirements submit form 3400-52, "Other Methods of Disposal or Distribution Report".
003	Future Land App. or Landfill - This sample point is reserved for future land application of sludge. Monitoring requirements and limitations are applicable during any year that sludge is disposed by land application. Also applicable to landfill disposal.

4.2 Monitoring Requirements and Limitations

The permittee shall comply with the following monitoring requirements and limitations.

4.2.1 Sampling Point (Outfall) 003 - Future Land App. or Landfill

Monitoring Requirements and Limitations					
Parameter	**Limit Type**	**Limit and Units**	**Sample Frequency**	**Sample Type**	**Notes**
Solids, Total		Percent	1/ 2 Months	Composite	List 1 Parameters, Total Solids and Metals. Monitoring required for land application or landfilling. Limits only applicable to land application.
Arsenic Dry Wt	Ceiling High Quality	75 mg/kg 41 mg/kg	1/ 2 Months	Composite	
Cadmium Dry Wt	Ceiling High Quality	85 mg/kg 39 mg/kg	1/ 2 Months	Composite	
Copper Dry Wt	Ceiling High Quality	4,300 mg/kg 1,500 mg/kg	1/ 2 Months	Composite	
Lead Dry Wt	Ceiling High Quality	840 mg/kg 300 mg/kg	1/ 2 Months	Composite	
Mercury Dry Wt	Ceiling High Quality	57 mg/kg 17 mg/kg	1/ 2 Months	Composite	
Molybdenum Dry Wt	Ceiling	75 mg/kg	1/ 2 Months	Composite	
Nickel Dry Wt	Ceiling High Quality	420 mg/kg 420 mg/kg	1/ 2 Months	Composite	
Selenium Dry Wt	Ceiling High Quality	100 mg/kg 100 mg/kg	1/ 2 Months	Composite	
Zinc Dry Wt	Ceiling High Quality	7,500 mg/kg 2,800 mg/kg	1/ 2 Months	Composite	

Monitoring Requirements and Limitations					
Parameter	**Limit Type**	**Limit and Units**	**Sample Frequency**	**Sample Type**	**Notes**
Radium 226 Dry Wt		pCi/g	1/ 2 Months	Composite	List 1 – Not required after the public water utilities begin using Lake Michigan.
Nitrogen, Total Kjeldahl		Percent	1/ 2 Months	Composite	List 2 Parameters, Nutrients. Monitoring only required for land application.
Nitrogen, Ammonium (NH_4-N) Total		Percent	1/ 2 Months	Composite	
Phosphorus, Total		Percent	1/ 2 Months	Composite	
Phosphorus, Water Extractable		Percent	1/ 2 Months	Composite	
Potassium, Total Recoverable		Percent	1/ 2 Months	Composite	
PCB Total Dry Wt	Ceiling High Quality	50 mg/kg 10 mg/kg	Once	Composite	Applicable only to land application. See § 4.2.1.5
Municipal Sludge Priority Pollutant Scan			Once	Composite	Applicable only to land application. See § 4.2.1.6

Other Sludge Requirements	
Sludge Requirements	**Sample Frequency**
List 3 Requirements – Pathogen Control: The requirements in List 3 shall be met prior to land application of sludge.	BiMonthly
List 4 Requirements – Vector Attraction Reduction: The vector attraction reduction shall be satisfied prior to, or at the time of land application as specified in List 4.	BiMonthly

4.2.1.1 List 2 Analysis

If the monitoring frequency for List 2 parameters is more frequent than "Annual" then the sludge may be analyzed for the List 2 parameters just prior to each land application season rather than at the more frequent interval specified.

4.2.1.2 Changes in Feed Sludge Characteristics

If a change in feed sludge characteristics, treatment process, or operational procedures occurs which may result in a significant shift in sludge characteristics, the permittee shall reanalyze the sludge for List 1, 2, 3 and 4 parameters each time such change occurs.

4.2.1.3 Multiple Sludge Sample Points (Outfalls)

If there are multiple sludge sample points (outfalls), but the sludges are not subject to different sludge treatment processes, then a separate List 2 analysis shall be conducted for each sludge type which is land applied, just prior to land application, and the application rate shall be calculated for each sludge type. In this case, List 1, 3, and 4 and PCBs need only be analyzed on a single sludge type, at the specified frequency. If there are multiple sludge sample points (outfalls), due to multiple treatment processes, List 1, 2, 3 and 4 and PCBs shall be analyzed for each sludge type at the specified frequency.

4.2.1.4 Sludge Which Exceeds the High Quality Limit

Cumulative pollutant loading records shall be kept for all bulk land application of sludge which does not meet the high quality limit for any parameter. This requirement applies for the entire calendar year in which any exceedance of Table 3 of s. NR 204.07(5)(c), is experienced. Such loading records shall be kept for all List 1 parameters for each site land applied in that calendar year. The formula to be used for calculating cumulative loading is as follows:

[(Pollutant concentration (mg/kg) x dry tons applied/ac) ÷ 500] + previous loading (lbs/acre) = cumulative lbs pollutant per acre

When a site reaches 90% of the allowable cumulative loading for any metal established in Table 2 of s. NR 204.07(5)(b), the Department shall be so notified through letter or in the comment section of the annual land application report (3400-55).

4.2.1.5 Sludge Analysis for PCBs

The permittee shall analyze the sludge for Total PCBs one time during the first year sludge is land applied. The results shall be reported as "PCB Total Dry Wt". Either congener-specific analysis or Aroclor analysis shall be used to determine the PCB concentration. The permittee may determine whether Aroclor or congener specific analysis is performed. Analyses shall be performed in accordance with Table EM in s. NR 219.04, Wis. Adm. Code and the conditions specified in Standard Requirements of this permit. PCB results shall be submitted by January 31, following the specified year of analysis.

4.2.1.6 Priority Pollutant Scan

The permittee shall analyze the sludge for the priority pollutants as specified in s. NR 215.03 (1-4), Wis. Adm. Code one time during the first year sludge is land applied. Results shall be reported on a dry weight basis.

4.2.1.7 Lists 3 and 4

List 3
PATHOGEN CONTROL FOR CLASS B SLUDGE
The permittee shall implement pathogen control as listed in List 3. The Department shall be notified of the pathogen control utilized and shall be notified when the permittee decides to utilize alternative pathogen control.
The following requirements shall be met prior to land application of sludge.

Parameter	Unit	Limit
Fecal Coliform*	MPN/gTS or CFU/gTS	2,000,000
OR, ONE OF THE FOLLOWING PROCESS OPTIONS		
Aerobic Digestion	Air Drying	
Anaerobic Digestion	Composting	
Alkaline Stabilization	PSRP Equivalent Process	

* The Fecal Coliform limit shall be reported as the geometric mean of 7 discrete samples on a dry weight basis.

List 4
VECTOR ATTRACTION REDUCTION

The permittee shall implement any one of the vector attraction reduction options specified in List 4. The Department shall be notified of the option utilized and shall be notified when the permittee decides to utilize an alternative option. One of the following shall be satisfied prior to, or at the time of land application as specified in List 4.

Option	Limit	Where/When it Shall be Met
Volatile Solids Reduction	≥38%	Across the process
Specific Oxygen Uptake Rate	≤1.5 mg O_2/hr/g TS	On aerobic stabilized sludge
Anaerobic bench-scale test	<17 % VS reduction	On anaerobic digested sludge
Aerobic bench-scale test	<15 % VS reduction	On aerobic digested sludge
Aerobic Process	>14 days, Temp >40°C and Avg. Temp > 45°C	On composted sludge
pH adjustment	>12 S.U. (for 2 hours) and >11.5 (for an additional 22 hours)	During the process
Drying without primary solids	>75 % TS	When applied or bagged
Drying with primary solids	>90 % TS	When applied or bagged
Equivalent Process	Approved by the Department	Varies with process
Injection	-	When applied
Incorporation	-	Within 6 hours of application

5 Schedules of Compliance

5.1 Mercury Pollutant Minimization Program

The permittee shall implement or continue a pollutant minimization program whenever, after the first 24 months of mercury monitoring, a mercury effluent limitation is necessary under the procedure in s. NR 106.145(2), Wis. Adm. Code. In the interim, the permittee is encouraged to continue ongoing mercury reduction efforts and to report the status of implementing those efforts annually.

Required Action	Date Due
Request Limitation Determination: After completion of the first 24 months of sampling under this permit, the permittee shall submit a summary of at least 12 monitoring results spaced over a period of at least 24 months and request that the Department make a preliminary determination of the need for effluent limitations according to the requirements of s. NR 106.145(2), Wis. Adm. Code. If the Department's determination under s. NR 106.145(2) shows that an effluent limitation is NOT necessary, the permittee shall not be required to follow subsequent steps in this schedule. Monitoring for mercury shall continue as required elsewhere in this permit. Note: The Department will make the determination and notify the permittee in writing within 90 days of such request.	04/30/2008
Mercury Pollutant Minimization Program Plan: If the Department's determination under s. NR 106.145(2) shows that an effluent limitation is necessary, the permittee shall amend their March 19, 2002 Mercury Pollution Program to meet the requirements of a pollutant minimization program (PMP) as specified in s. NR 106.145(7), Wis. Adm. Code. The amended plan shall be submitted by the date due. Note: The Department will notify the permittee of acceptance of or comments on the proposed PMP. The permittee and the Department will then agree on what changes, if any will be made to the PMP. If the Department has not notified the permittee within 90 days of the Department's receipt of the PMP, the permittee may assume that the PMP has been accepted.	03/31/2009
Implement the Mercury Pollutant Minimization Program: The permittee shall implement the PMP as submitted or as amended by agreement of the permittee and the Department.	07/01/2009
Annual Status Reports: Each year by March 31, the permittee shall submit to the Department an annual status report on the progress of the PMP as required by s. NR 106.145(7), Wis. Adm. Code. Submittal of the first annual status report is required by the Date Due. Note: If the permittee wishes to apply for an alternative mercury effluent limitation, that application is due with the application for permit reissuance by 6 months prior to permit expiration. The permittee should submit or reference the PMP plan as updated by the Annual Status Report or more recent developments as part of that application.	03/31/2010

6 Standard Requirements

NR 205, Wisconsin Administrative Code: The conditions in ss. NR 205.07(1) and NR 205.07(2), Wis. Adm. Code, are included by reference in this permit. The permittee shall comply with all of these requirements. Some of these requirements are outlined in the Standard Requirements section of this permit. Requirements not specifically outlined in the Standard Requirement section of this permit can be found in ss. NR 205.07(1) and NR 205.07(2).

6.1 Reporting and Monitoring Requirements

6.1.1 Monitoring Results

Monitoring results obtained during the previous month shall be summarized and reported on a Department Wastewater Discharge Monitoring Report Form. This report form is to be returned to the Department no later than the date indicated on the form. The original and one copy of the Wastewater Discharge Monitoring Report Form shall be submitted to your DNR regional office. A copy of the Wastewater Discharge Monitoring Report Form shall be retained by the permittee. Sludge monitoring shall be reported on Characteristic Form 3400-49 by January 31, following the year any sludge analysis is performed.

If the permittee monitors any pollutant more frequently than required by this permit, the results of such monitoring shall be included in the calculations and reporting. The data shall be submitted on the Wastewater Discharge Monitoring Report Form or sludge reporting form.

The permittee shall comply with all limits for each parameter regardless of monitoring frequency. For example, monthly, weekly, and/or daily limits shall be met even with monthly monitoring. The permittee may monitor more frequently than required for any parameter.

Calculations for all limitations which require averaging of measurements shall utilize an arithmetic mean unless otherwise specified by the Department in this permit.

6.1.2 Sampling and Testing Procedures

Sampling and laboratory testing procedures shall be performed in accordance with Chapters NR 218 and NR 219, Wis. Adm. Code and shall be performed by a laboratory certified or registered in accordance with the requirements of ch. NR 149, Wis. Adm. Code. Groundwater sample collection and analysis shall be performed in accordance with ch. NR 140, Wis. Adm. Code. The analytical methodologies used shall enable the laboratory to quantitate all substances for which monitoring is required at levels below the effluent limitation. If the required level cannot be met by any of the methods available in NR 219, Wis. Adm. Code, then the method with the lowest limit of detection shall be selected. Additional test procedures may be specified in this permit.

6.1.3 Pretreatment Sampling Requirements

Sampling for pretreatment parameters (cadmium, chromium, copper, lead, nickel, zinc, and mercury) shall be done during a day each month when industrial discharges are occurring at normal to maximum levels. The sampling of the influent and effluent for these parameters shall be coordinated. All 24 hour composite samples shall be flow proportional.

6.1.4 Recording of Results

The permittee shall maintain records which provide the following information for each effluent measurement or sample taken:

- the date, exact place, method and time of sampling or measurements;
- the individual who performed the sampling or measurements;
- the date the analysis was performed;

- the individual who performed the analysis;
- the analytical techniques or methods used; and
- the results of the analysis.

6.1.5 Reporting of Monitoring Results

The permittee shall use the following conventions when reporting effluent monitoring results:

- Pollutant concentrations less than the limit of detection shall be reported as < (less than) the value of the limit of detection. For example, if a substance is not detected at a detection limit of 0.1 mg/L, report the pollutant concentration as < 0.1 mg/L.

- Pollutant concentrations equal to or greater than the limit of detection, but less than the limit of quantitation, shall be reported and the limit of quantitation shall be specified.

- For the purposes of reporting a calculated result, average or a mass discharge value, the permittee may substitute a 0 (zero) for any pollutant concentration that is less than the limit of detection. However, if the effluent limitation is less than the limit of detection, the department may substitute a value other than zero for results less than the limit of detection, after considering the number of monitoring results that are greater than the limit of detection and if warranted when applying appropriate statistical techniques.

6.1.6 Compliance Maintenance Annual Reports

Compliance Maintenance Annual Reports (CMAR) shall be completed using information obtained over each calendar year regarding the wastewater conveyance and treatment system. The CMAR shall be submitted by the permittee in accordance with ch. NR 208, Wis. Adm. Code, by June 30, each year on an electronic report form provided by the Department.

In the case of a publicly owned treatment works, a resolution shall be passed by the governing body and submitted as part of the CMAR, verifying its review of the report and providing responses as required. Private owners of wastewater treatment works are not required to pass a resolution; but they must provide an Owner Statement and responses as required, as part of the CMAR submittal.

A separate CMAR certification document, that is not part of the electronic report form, shall be mailed to the Department at the time of electronic submittal of the CMAR. The CMAR certification shall be signed and submitted by an authorized representative of the permittee. The certification shall be submitted by mail. The certification shall verify the electronic report is complete, accurate and contains information from the owner's treatment works.

6.1.7 Records Retention

The permittee shall retain records of all monitoring information, including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation, copies of all reports required by the permit, and records of all data used to complete the application for the permit for a period of at least 3 years from the date of the sample, measurement, report or application. All pertinent sludge information, including permit application information and other documents specified in this permit or s. NR 204.06(9), Wis. Adm. Code shall be retained for a minimum of 5 years.

6.1.8 Other Information

Where the permittee becomes aware that it failed to submit any relevant facts in a permit application or submitted incorrect information in a permit application or in any report to the Department, it shall promptly submit such facts or correct information to the Department.

6.2 System Operating Requirements

6.2.1 Noncompliance Notification

- The permittee shall report the following types of noncompliance by a telephone call to the Department's regional office within 24 hours after becoming aware of the noncompliance:
  - any noncompliance which may endanger health or the environment;
  - any violation of an effluent limitation resulting from an unanticipated bypass;
  - any violation of an effluent limitation resulting from an upset; and
  - any violation of a maximum discharge limitation for any of the pollutants listed by the Department in the permit, either for effluent or sludge.

- A written report describing the noncompliance shall also be submitted to the Department's regional office within 5 days after the permittee becomes aware of the noncompliance. On a case-by-case basis, the Department may waive the requirement for submittal of a written report within 5 days and instruct the permittee to submit the written report with the next regularly scheduled monitoring report. In either case, the written report shall contain a description of the noncompliance and its cause; the period of noncompliance, including exact dates and times; the steps taken or planned to reduce, eliminate and prevent reoccurrence of the noncompliance; and if the noncompliance has not been corrected, the length of time it is expected to continue.

NOTE: Section 292.11(2)(a), Wisconsin Statutes, requires any person who possesses or controls a hazardous substance or who causes the discharge of a hazardous substance to notify the Department of Natural Resources **immediately** of any discharge not authorized by the permit. The discharge of a hazardous substance that is not authorized by this permit or that violates this permit may be a hazardous substance spill. To report a hazardous substance spill, call DNR's 24-hour HOTLINE at **1-800-943-0003**

6.2.2 Flow Meters

Flow meters shall be calibrated annually, as per s. NR 218.06, Wis. Adm. Code.

6.2.3 Raw Grit and Screenings

All raw grit and screenings shall be disposed of at a properly licensed solid waste facility or picked up by a licensed waste hauler. If the facility or hauler are located in Wisconsin, then they shall be licensed under chs. NR 500-536, Wis. Adm. Code.

6.2.4 Sludge Management

All sludge management activities shall be conducted in compliance with ch. NR 204 "Domestic Sewage Sludge Management", Wis. Adm. Code.

6.2.5 Prohibited Wastes

Under no circumstances may the introduction of wastes prohibited by s. NR 211.10, Wis. Adm. Code, be allowed into the waste treatment system. Prohibited wastes include those:

- which create a fire or explosion hazard in the treatment work;
- which will cause corrosive structural damage to the treatment work;
- solid or viscous substances in amounts which cause obstructions to the flow in sewers or interference with the proper operation of the treatment work;

- wastewaters at a flow rate or pollutant loading which are excessive over relatively short time periods so as to cause a loss of treatment efficiency; and
- changes in discharge volume or composition from contributing industries which overload the treatment works or cause a loss of treatment efficiency.

6.2.6 Unscheduled Bypassing

Any unscheduled bypass or overflow of wastewater at the treatment works or from the collection system is prohibited, and the Department may take enforcement action against a permittee for such occurrences under s. 283.89, Wis. Stats., unless:

- The bypass was unavoidable to prevent loss of life, personal injury, or severe property damage;
- There were no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate back-up equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass which occurred during normal periods of equipment downtime or preventive maintenance; and
- The permittee notified the Department as required in this Section.

Whenever there is an unscheduled bypass or overflow occurrence at the treatment works or from the collection system, the permittee shall notify the Department within 24 hours of initiation of the bypass or overflow occurrence by telephoning the wastewater staff in the regional office as soon as reasonably possible (FAX, email or voice mail, if staff are unavailable).

In addition, the permittee shall within 5 days of conclusion of the bypass or overflow occurrence report the following information to the Department in writing:

- Reason the bypass or overflow occurred, or explanation of other contributing circumstances that resulted in the overflow event. If the overflow or bypass is associated with wet weather, provide data on the amount and duration of the rainfall or snow melt for each separate event.
- Date the bypass or overflow occurred.
- Location where the bypass or overflow occurred.
- Duration of the bypass or overflow and estimated wastewater volume discharged.
- Steps taken or the proposed corrective action planned to prevent similar future occurrences.
- Any other information the permittee believes is relevant.

6.2.7 Scheduled Bypassing

Any construction or normal maintenance which results in a bypass of wastewater from a treatment system is prohibited unless authorized by the Department in writing. If the Department determines that there is significant public interest in the proposed action, the Department may schedule a public hearing or notice a proposal to approve the bypass. Each request shall specify the following minimum information:

- proposed date of bypass;
- estimated duration of the bypass;
- estimated volume of the bypass;
- alternatives to bypassing; and
- measures to mitigate environmental harm caused by the bypass.

6.2.8 Proper Operation and Maintenance

The permittee shall at all times properly operate and maintain all facilities and systems of treatment and control which are installed or used by the permittee to achieve compliance with the conditions of this permit. The wastewater treatment facility shall be under the direct supervision of a state certified operator as required in s. NR 108.06(2), Wis. Adm. Code. Proper operation and maintenance includes effective performance, adequate funding, adequate operator staffing and training as required in ch. NR 114, Wis. Adm. Code, and adequate laboratory and process controls, including appropriate quality assurance procedures. This provision requires the operation of back-up or auxiliary facilities or similar systems only when necessary to achieve compliance with the conditions of the permit.

6.3 Surface Water Requirements

6.3.1 Permittee-Determined Limit of Quantitation Incorporated into this Permit

For pollutants with water quality-based effluent limits below the Limit of Quantification (LOQ) in this permit, the LOQ calculated by the permittee and reported on the Discharge Monitoring Reports (DMRs) is incorporated by reference into this permit. The LOQ shall be reported on the DMRs, shall be the lowest quantifiable level practicable, and shall be no greater than the minimum level (ML) specified in or approved under 40 CFR Part 136 for the pollutant at the time this permit was issued, unless this permit specifies a higher LOQ.

6.3.2 Appropriate Formulas for Effluent Calculations

The permittee shall use the following formulas for calculating effluent results to determine compliance with average limits and mass limits:

Weekly/Monthly average concentration = the sum of all daily results for that week/month, divided by the number of results during that time period.

Weekly Average Mass Discharge (lbs/day): Daily mass = daily concentration (mg/L) x daily flow (MGD) x 8.34, then average the daily mass values for the week.

Monthly Average Mass Discharge (lbs/day): Daily mass = daily concentration (mg/L) x daily flow (MGD) x 8.34, then average the daily mass values for the month.

6.3.3 Visible Foam or Floating Solids

There shall be no discharge of floating solids or visible foam in other than trace amounts.

6.3.4 Percent Removal

During any 30 consecutive days, the average effluent concentrations of BOD_5 and of total suspended solids shall not exceed 15% of the average influent concentrations, respectively. This requirement does not apply to removal of total suspended solids if the permittee operates a lagoon system and has received a variance for suspended solids granted under NR 210.07(2), Wis. Adm. Code.

6.3.5 Fecal Coliforms

The limit for fecal coliforms shall be expressed as a monthly geometric mean.

6.3.6 Seasonal Disinfection

Disinfection shall be provided from May 1 through September 30 of each year. Monitoring requirements and the limitation for fecal coliforms apply only during the period in which disinfection is required. Whenever chlorine is used for disinfection or other uses, the limitations and monitoring requirements for residual chlorine shall apply. A dechlorination process shall be in operation whenever chlorine is used.

6.3.7 Total Residual Chlorine

Test methods for total residual chlorine, approved in ch. NR 219 - Table B, Wis. Adm. Code, normally achieve a limit of detection of about 20 to 50 micrograms per liter and a limit of quantitation of about 100 micrograms per liter. Reporting of test results and compliance with effluent limitations for chlorine residual and total residual halogens shall be as follows:

- Sample results which show no detectable levels are in compliance with the limit. These test results shall be reported on Wastewater Discharge Monitoring Report Forms as "< 100 µg/L". (Note: 0.1 mg/L converts to 100 µg/L)

- Samples showing detectable traces of chlorine are in compliance if measured at less than 100 µg/L, unless there is a consistent pattern of detectable values in this range. These values shall also be reported on Wastewater Discharge Monitoring Report Forms as "<100 µg/L." The facility operating staff shall record actual readings on logs maintained at the plant, shall take action to determine the reliability of detected results (such as re-sampling and/or calculating dosages), and shall adjust the chemical feed system if necessary to reduce the chances of detects.

- Samples showing detectable levels greater than 100 µg/L shall be considered as exceedances, and shall be reported as measured.

- To calculate average or mass discharge values, a "0" (zero) may be substituted for any test result less than 100 µg/L. Calculated values shall then be compared directly to the average or mass limitations to determine compliance.

6.3.8 Whole Effluent Toxicity (WET) Monitoring Requirements

In order to determine the potential impact of the discharge on aquatic organisms, static-renewal toxicity tests shall be performed on the effluent in accordance with the procedures specified in the *"State of Wisconsin Aquatic Life Toxicity Testing Methods Manual, 2nd Edition" (PUB-WT-797*, November 2004) as required by NR 219.04, Table A, Wis. Adm. Code). All of the WET tests required in this permit, including any required retests, shall be conducted on the *Ceriodaphnia dubia* and fathead minnow species. Receiving water samples shall not be collected from any point in contact with the permittee's mixing zone and every attempt shall be made to avoid contact with any other discharge's mixing zone.

6.3.9 Whole Effluent Toxicity (WET) Identification

In the event of serious or repeated toxicity, the permittee may obtain approval from the Department to postpone retests in order to investigate the source(s) of toxicity. In order to postpone these tests, the permittee must provide the following information to the Department in writing, within 30 days of the end of the test which showed a positive result:

- a description of the investigation to be used to identify potential sources of toxicity. Treatment efficiency, housekeeping practices, and chemicals used in operation of the facility should be included in the investigation.

- who will conduct a toxicity identification evaluation (TIE), if required.

Once the above investigation has been completed, the permittee must conduct the postponed test(s) to demonstrate that toxicity has been reduced/eliminated.

6.4 Pretreatment Program Requirements

The permittee is required to operate an industrial pretreatment program as described in the program initially approved by the Department of Natural Resources including any subsequent program modifications approved by the Department, and including commitments to program implementation activities provided in the permittee's annual pretreatment program report, and that complies with the requirements set forth in 40 CFR Part 403 and ch. NR 211, Wis. Adm. Code. To ensure that the program is operated in accordance with these requirements, the following general conditions and requirements are hereby established:

6.4.1 Inventories

The permittee shall implement methods to maintain a current inventory of the general character and volume of wastewater that industrial users discharge to the treatment works and shall provide an updated industrial user listing annually and report any changes in the listing to the Department by March 31 of each year as part of the annual pretreatment program report required herein.

6.4.2 Regulation of Industrial Users

6.4.2.1 Limitations for Industrial Users:

The permittee shall develop, maintain, enforce and revise as necessary local limits to implement the general and specific prohibitions of the state and federal General Pretreatment Regulations.

6.4.2.2 Control Documents for Industrial Users (IUs)

The permittee shall control the discharge from each significant industrial user through individual discharge permits as required by s. NR 211.235, Wis. Adm. Code and in accordance with the approved pretreatment program procedures and the permittee's sewer use ordinance. The discharge permits shall be modified in a timely manner during the stated term of the discharge permits according to the sewer use ordinance as conditions warrant. The discharge permits shall include at a minimum the elements found in s. NR 211.235(1), Wis. Adm. Code and references to the approved pretreatment program procedures and the sewer use ordinance.

The permittee shall provide a copy of all newly issued, reissued, or modified discharge permits to the Department.

6.4.2.3 Review of Industrial User Reports, Inspections and Compliance Monitoring

The permittee shall require the submission of, receive, and review self-monitoring reports and other notices from industrial users in accordance with the approved pretreatment program procedures. The permittee shall randomly sample and analyze industrial user discharges and conduct surveillance activities to determine independent of information supplied by the industrial users, whether the industrial users are in compliance with pretreatment standards and requirements. The inspections and monitoring shall also be conducted to maintain accurate knowledge of local industrial processes, including changes in the discharge, pretreatment equipment operation, spill prevention control plans, slug control plans, and implementation of solvent management plans.

At least one time per year the permittee shall inspect and sample the discharge from each significant industrial user, or more frequently if so specified in the permittee's approved pretreatment program. At least once every 2 years the permittee shall evaluate whether each significant industrial user needs a slug control plan. If a slug control plan is needed, the plan shall contain at a minimum the elements specified in s. NR 211.235(4)(b), Wis. Adm. Code.

6.4.2.4 Enforcement and Industrial User Compliance Evaluation & Violation Reports

The permittee shall enforce the industrial pretreatment requirements including the industrial user discharge limitations of the permittee's sewer use ordinance. The permittee shall investigate instances of noncompliance by collecting and analyzing samples and collecting other information with sufficient care to produce evidence admissible in enforcement proceedings or in judicial actions. Investigation and response to instances of noncompliance shall be in accordance with the permittee's sewer use ordinance and approved Enforcement Response Plan.

The permittee shall make a semiannual report on forms provided or approved by the Department. The semiannual report shall include an analysis of industrial user significant noncompliance (i.e. the Industrial User Compliance Evaluation, also known as the SNC Analysis) as outlined in s.NR 211.23(1)(j), Wis. Adm. Code, and a summary of the permittee's response to all industrial noncompliance (i.e. the Industrial User Violation Report). The Industrial User Compliance Evaluation Report shall include monitoring results received from industrial users pursuant to s. NR 211.15(1)-(5), Wis. Adm. Code. The Industrial User Violation Report shall include copies of all notices of noncompliance, notices of violation and other enforcement correspondence sent by the permittee to industrial users, together with the industrial user's response. The Industrial User Compliance Evaluation and Violation Reports for the period January through June shall be provided to the Department by September 30 of each year and for the period July through December shall be provided to the Department by March 31 of the succeeding year, unless alternate submittal dates are approved.

6.4.2.5 Publication of Violations

The permittee shall publish a list of industrial users that have significantly violated the municipal sewer use ordinance during the calendar year, in the largest daily newspaper in the area by March 31 of the following year pursuant to s. NR 211.23(1)(j), Wis. Adm. Code. A copy of the newspaper publication shall be provided as part of the annual pretreatment report specified herein.

6.4.2.6 Multijurisdictional Agreements

The permittee shall establish agreements with all contributing jurisdictions as necessary to ensure compliance with pretreatment standards and requirements by all industrial users discharging to the permittee's wastewater treatment system. Any such agreement shall identify who will be responsible for maintaining the industrial user inventory, issuance of industrial user control mechanisms, inspections and sampling, pretreatment program implementation, and enforcement.

6.4.3 Annual Pretreatment Program Report

The permittee shall evaluate the pretreatment program, and submit the Pretreatment Program Report to the Department on forms provided or approved by the Department by March 31 annually, unless an alternate submittal date is approved. The report shall include a brief summary of the work performed during the preceding calendar year, including the numbers of discharge permits issued and in effect, pollution prevention activities, number of inspections and monitoring surveys conducted, budget and personnel assigned to the program, a general discussion of program progress in meeting the objectives of the permittee's pretreatment program together with summary comments and recommendations.

6.4.4 Pretreatment Program Modifications

- Future Modifications: The permittee shall within one year of any revisions to federal or state General Pretreatment Regulations submit an application to the Department in duplicate to modify and update its approved pretreatment program to incorporate such regulatory changes as applicable to the permittee. Additionally, the Department or the permittee may request an application for program modification at any time where necessary to improve program effectiveness based on program experience to date.

- Modifications Subject to Department Approval: The permittee shall submit all proposed pretreatment program modifications to the Department for determination of significance and opportunity for comment in accordance with the requirements and conditions of s. NR 211.27, Wis. Adm. Code. Any substantial proposed program modification shall be subject to Department public noticing and formal approval prior to implementation. A substantial program modification includes, but is not limited to, changes in enabling legal authority to administer and enforce pretreatment conditions and requirements; significant changes in program administrative or operational procedures; significant reductions in monitoring frequencies; significant reductions in program resources including personnel commitments, equipment, and funding levels; changes (including any relaxation) in the local limitations for substances enforced and applied to users of the sewerage treatment works; changes in treatment works sludge disposal or management practices which impact the pretreatment program; or program modifications which increase pollutant loadings to the treatment works. The Department shall use the procedures outlined in s. NR 211.30, Wis. Adm. Code for review and approval/denial of proposed pretreatment program modifications. The permittee shall comply with local public participation requirements when implementing the pretreatment program.

6.4.5 Program Resources

The permittee shall have sufficient resources and qualified personnel to carry out the pretreatment program responsibilities as listed in ss. NR 211.22 and NR 211.23, Wis. Adm. Code.

6.5 Land Application Requirements

6.5.1 Sludge Management Program Standards And Requirements Based Upon Federally Promulgated Regulations

In the event that new federal sludge standards or regulations are promulgated, the permittee shall comply with the new sludge requirements by the dates established in the regulations, if required by federal law, even if the permit has not yet been modified to incorporate the new federal regulations.

6.5.2 General Sludge Management Information

The General Sludge Management Form 3400-48 shall be completed and submitted prior to any significant sludge management changes.

6.5.3 Sludge Samples

All sludge samples shall be collected at a point and in a manner which will yield sample results which are representative of the sludge being tested, and collected at the time which is appropriate for the specific test.

6.5.4 Land Application Characteristic Report

Each report shall consist of a Characteristic Form 3400-49 and Lab Report, unless approval for not submitting the lab reports has been given. Both reports shall be submitted by January 31 following each year of analysis.

The permittee shall use the following convention when reporting sludge monitoring results: Pollutant concentrations less than the limit of detection shall be reported as < (less than) the value of the limit of detection. For example, if a substance is not detected at a detection limit of 1.0 mg/kg, report the pollutant concentration as < 1.0 mg/kg .

All results shall be reported on a dry weight basis.

6.5.5 Monitoring and Calculating PCB Concentrations in Sludge

When sludge analysis for "PCB, Total Dry Wt" is required by this permit, the PCB concentration in the sludge shall be determined as follows.

Either congener-specific analysis or Aroclor analysis shall be used to determine the PCB concentration. The permittee may determine whether Aroclor or congener specific analysis is performed. Analyses shall be performed in accordance with the following provisions and Table EM in s. NR 219.04, Wis. Adm. Code.

- EPA Method 1668 may be used to test for all PCB congeners. If this method is employed, all PCB congeners shall be delineated. Non-detects shall be treated as zero. The values that are between the limit of detection and the limit of quantitation shall be used when calculating the total value of all congeners. All results shall be added together and the total PCB concentration by dry weight reported. **Note**: It is recognized that a number of the congeners will co-elute with others, so there will not be 209 results to sum.
- EPA Method 8082A shall be used for PCB-Aroclor analysis and may be used for congener specific analysis as well. If congener specific analysis is performed using Method 8082A, the list of congeners tested shall include at least congener numbers 5, 18, 31, 44, 52, 66, 87, 101, 110, 138, 141, 151, 153, 170, 180, 183, 187, and 206 plus any other additional congeners which might be reasonably expected to occur in the particular sample. For either type of analysis, the sample shall be extracted using the Soxhlet extraction (EPA Method 3540C) (or the Soxhlet Dean-Stark modification) or the pressurized fluid extraction (EPA Method 3545A). If Aroclor analysis is performed using Method 8082A, clean up steps of the extract shall be performed as necessary to remove interference and to achieve as close to a limit of detection of 0.11 mg/kg as possible. Reporting protocol, consistent with s. NR 106.07(6)(e), should be as follows: If all Aroclors are less than the LOD, then the Total PCB Dry Wt result should be reported as less than the highest LOD. If a single Aroclor is detected then that is what should be reported for the Total PCB result. If multiple Aroclors are detected, they should be summed and reported as Total PCBs. If congener specific analysis is done using Method 8082A, clean up steps of the extract shall be performed as necessary to remove interference and to achieve as close to a limit of detection of 0.003 mg/kg as possible for each congener. If the aforementioned limits of detection cannot be achieved after using the appropriate clean up techniques, a reporting limit that is achievable for the Aroclors or each congener for the sample shall be determined. This reporting limit shall be reported and qualified indicating the presence of an interference. The lab conducting the analysis shall perform as many of the following methods as necessary to remove interference:

3620C - Florisil	3611B - Alumina
3640A - Gel Permeation	3660B - Sulfur Clean Up (using copper shot instead of powder)
3630C - Silica Gel	3665A - Sulfuric Acid Clean Up

6.5.6 Land Application Report

Land Application Report Form 3400-55 shall be submitted by January 31, following each year non-exceptional quality sludge is land applied. Non-exceptional quality sludge is defined in s. NR 204.07(4), Wis. Adm. Code.

6.5.7 Other Methods of Disposal or Distribution Report

The permittee shall submit Report Form 3400-52 by January 31, following each year sludge is hauled, landfilled, incinerated, or when exceptional quality sludge is distributed or land applied.

6.5.8 Approval to Land Apply

Bulk non-exceptional quality sludge as defined in s. NR 204.07(4), Wis. Adm. Code, may not be applied to land without a written approval letter or Form 3400-122 from the Department unless the Permittee has obtained permission from the Department to self approve sites in accordance with s. NR 204.06 (6), Wis. Adm. Code. Analysis of sludge characteristics is required prior to land application. Application on frozen or snow covered ground is restricted to the extent specified in s. NR 204.07(3) (l), Wis. Adm. Code.

6.5.9 Soil Analysis Requirements

Each site requested for approval for land application must have the soil tested prior to use. Each approved site used for land application must subsequently be soil tested such that there is at least one valid soil test in the four years prior to land application. All soil sampling and submittal of information to the testing laboratory shall be done in accordance with UW Extension Bulletin A-2100. The testing shall be done by the UW Soils Lab in Madison or Marshfield, WI or at a lab approved by UW. The test results including the crop recommendations shall be submitted to the DNR contact listed for this permit, as they are available. Application rates shall be determined based on the crop nitrogen recommendations and with consideration for other sources of nitrogen applied to the site.

6.5.10 Land Application Site Evaluation

For non-exceptional quality sludge, as defined in s. NR 204.07(4), Wis. Adm. Code, a Land Application Site Evaluation Form 3400-53 shall be submitted to the Department for the proposed land application site. The Department will evaluate the proposed site for acceptability and will either approve or deny use of the proposed site. The permittee may obtain permission to approve their own sites in accordance with s. NR 204.06(6), Wis. Adm. Code.

6.5.11 Class B Sludge: Fecal Coliform Limitation

Compliance with the fecal coliform limitation for Class B sludge shall be demonstrated by calculating the geometric mean of at least 7 separate samples. (Note that a Total Solids analysis must be done on each sample). The geometric mean shall be less than 2,000,000 MPN or CFU/g TS. Calculation of the geometric mean can be done using one of the following 2 methods.

Method 1:

Geometric Mean = $(X_1 \times X_2 \times X_3 \ldots \times X_n)^{1/n}$

Where X = Coliform Density value of the sludge sample, and where n = number of samples (at least 7)

Method 2:

Geometric Mean = antilog$[(X_1 + X_2 + X_3 \ldots + X_n) \div n]$

Where X = $\log_{10}$ of Coliform Density value of the sludge sample, and where n = number of samples (at least 7)

Example for Method 2

Sample Number	Coliform Density of Sludge Sample	$\log_{10}$
1	6.0×10^5	5.78
2	4.2×10^6	6.62
3	1.6×10^6	6.20
4	9.0×10^5	5.95
5	4.0×10^5	5.60
6	1.0×10^6	6.00
7	5.1×10^5	5.71

The geometric mean for the seven samples is determined by averaging the $\log_{10}$ values of the coliform density and taking the antilog of that value.

$(5.78 + 6.62 + 6.20 + 5.95 + 5.60 + 6.00 + 5.71) \div 7 = 5.98$ The antilog of $5.98 = 9.5 \times 10^5$

6.5.12 Class B Sludge - Vector Control: Incorporation

Class B sludge shall be incorporated within 6 hours of surface application, or as approved by the Department.

6.5.13 Landfilling of Sludge

General: Sewage sludge may not be disposed of in a municipal solid waste landfill unless the landfill meets the requirements of chs. NR 500 to 536, Wis. Adm. Code, and is an approved facility as defined in s. 289.01(3), Wis. Stats. Any facility accepting sewage sludge shall be approved by the Department in writing to accept sewage sludge. Disposal of sewage sludge in a municipal solid waste landfill shall be in accordance with ss. NR 506.13 and 506.14. Sewage sludge may not be disposed of in a surface disposal unit as defined in s. NR 204.03(62).

Approval: The permittee shall obtain approval from the Department prior to the disposal of sludge at a Wisconsin licensed landfill.

6.5.14 Sludge Landfilling Reports

The permittee shall report the volume of sludge disposed of at any landfill facility on Form 3400-52. The permittee shall include the name and address of the landfill, the Department license number or other state's designation or license number for all landfills used during the report period and a letter of acceptability from the landfill owner. In addition, any permittee utilizing landfills as a disposal method shall submit to the Department any test results used to indicate acceptability of the sludge at a landfill. Form 3400-52 shall be submitted annually by January 31, following each year sludge is landfilled.

6.5.15 Sludge Incineration Reports

The permittee shall report the volume of sludge combusted at an on-site incinerator on Form 3400-52. Submittal of Form 3400-52 is required annually by January 31, following each year sludge is incinerated.

6.5.16 Land Application of Sludge Which Contains Elevated Levels of Radium-226

When contributory water supplies exceed 2 pci per liter of Radium 226, monitoring for Radium 226 in sludge is required. Sludge containing Radium 226 shall be land applied in accordance with the requirements in s. NR 204.07(3)(n), Wis. Adm. Code.

7 Summary of Reports Due

FOR INFORMATIONAL PURPOSES ONLY

Description	Date	Page
Mercury Pollutant Minimization Program - Request Limitation Determination	April 30, 2008	10
Mercury Pollutant Minimization Program - Mercury Pollutant Minimization Program Plan	March 31, 2009	10
Mercury Pollutant Minimization Program - Implement the Mercury Pollutant Minimization Program	July 1, 2009	10
Mercury Pollutant Minimization Program - Annual Status Reports	March 31, 2010	10
Compliance Maintenance Annual Reports (CMAR)	by June 30, each year	12
Industrial User Compliance Evaluation and Violation Reports	Semiannual	18
Pretreatment Program Report	Annually	18
General Sludge Management Form 3400-48	prior to any significant sludge management changes	19
Characteristic Form 3400-49 and Lab Report	by January 31 following each year of analysis	19
Land Application Report Form 3400-55	by January 31, following each year non-exceptional quality sludge is land applied	20
Report Form 3400-52	by January 31, following each year sludge is hauled, landfilled, incinerated, or when exceptional quality sludge is distributed or land applied	20
Wastewater Discharge Monitoring Report Form	no later than the date indicated on the form	11

All submittals required by this permit shall be submitted to the Northeast Region, 2984 Shawano Avenue, P.O. Box 10448, Green Bay, WI 54307-0448, except as follows. Report forms shall be submitted to the address printed on the report form. Any facility plans or plans and specifications for municipal, industrial pretreatment and non industrial wastewater systems shall be submitted to the Regional Plan Reviewer (as designated at www.dnr.state.wi.us/org/water/wm/consultant.htm). Any construction plans and specifications for industrial wastewater systems shall be submitted to the Bureau of Watershed Management, P.O. Box 7921, Madison, WI 53707-7921.

GBMSD | 2009 Strategic Plan

Cleaning Water Today for Tomorrow's Generations

Collaborative Regional Leadership, Education, and Sustainability

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Strategic Planning Team Members

Commissioners

Daniel J. Alesch

Kathryn Hasselblad

Thomas P. Meinz

Denise Scheberle

Christopher Zabel

Management Team

Tom Sigmund, Leader

Bill Angoli

Dan Busch

Debbie Cawley

Judi Christ

Jeff Czypinski

Mike Erschnig

Lisa Evenson

Paul Kaster

John Kennedy

Mike Kersten

Dave Lefebvre

Pete McCarthy

Mike Pierner

Brian Vander Loop

Tim Woodworth

COMMISSIONERS' MESSAGE

Throughout our 78-year history, the Green Bay Metropolitan Sewerage District (GBMSD) has served its regional communities and industrial users through high quality wastewater conveyance and treatment services that have supported economic development while protecting area water resources. In doing so, we have taken great care to be good stewards of the public resources with which we have been entrusted. We have also made every attempt to support a culture of quality, innovation, and customer service. As Commissioners, we have had the privilege to see GBMSD become an industry leader in the delivery of cost-effective, reliable wastewater treatment services to our community. We are extraordinarily proud of the innovation, fortitude, and commitment of GBMSD's entire staff – and gratified to know that we have built a strong foundation to effectively deliver needed environmental services for future generations.

Today we face unprecedented economic and environmental challenges. Regional industries have been impacted by changing market conditions and the liquidity and credit market crisis. Despite the exceptional performance of our wastewater treatment system, improvement in regional water resource quality continues to be elusive. This is in large part due to nonpoint source pollutants. We recognize our local responsibilities to ensure the sustainability of the resources we use. In addition, we recognize that wastewater treatment systems throughout the region will require substantial re-investment in the coming decades.

Given the rapidly changing nature of the conditions under which we deliver services, GBMSD elected to develop a Strategic Plan to help us proactively manage these challenges. In setting the tone for our strategic planning, we've emphasized the importance of regional collaboration, leadership, education, and sustainability.

Collaboration – we recognize that we face regional challenges and that we can accomplish more and perform more efficiently through collective action.

Leadership – we recognize that as one of the largest environmental service providers in the region, we have both the resources and the responsibility to be proactive, manage risks, and promote innovation.

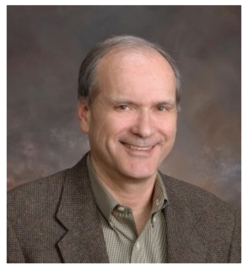
Education – we recognize that our most daunting issues require us to challenge the status quo and broaden our collective appreciation for the complexities of environmental stewardship.

Sustainability – we recognize that we have profound responsibilities to oversee the economic, environmental, and social impacts of our resource use.

We believe these precepts will enable us to build on the solid foundation that we have established over our first 78 years to meet the challenges facing current and future generations. We are confident that together, we will evolve and expand GBMSD's role to support sustainable economic development within the communities we serve. We offer this Strategic Plan as one of our first steps toward opening the exchange of new ideas as we develop a strategy for success.

Daniel J. Alesch

Kathryn Hasselblad



Thomas P. Meinz

Denise Scheberle

Christopher Zabel

MESSAGE FROM THE EXECUTIVE DIRECTOR

Tom Sigmund

STRATEGIC PLAN GOALS

- *SUPPORT ECONOMIC DEVELOPMENT*
- *EXCEPTIONAL CAREER DEVELOPMENT OPPORTUNITIES*
- *ENVIRONMENTAL STEWARDSHIP/ EDUCATION*
- *DIVERSE QUALITY SERVICES*

GBMSD has established a comprehensive strategic planning process to guide our work and direct our future initiatives. I would like to share with you my motivations for engaging in this process and its outcomes, and perhaps most importantly, to solicit your input and assistance in charting our future course.

Since coming to GBMSD in June 2007, I have been singularly impressed with its Commissioners, Management Team, staff, and customers. Our organization is committed to the delivery of cost-effective, high-quality environmental services – and our customers and communities graciously recognize and value our contributions. With this in mind, there are two fundamental drivers for establishing a formal, interactive strategic planning process. First, as noted by our Commissioners, we face unprecedented economic and environmental challenges. If we are to continue to deliver environmental services successfully, we need to address the issues before us proactively. Second, with our solid foundation of effective service delivery and stewardship of public resources, I believe we can do more to serve our region in the coming years.

Guided by GBMSD Commissioners' themes of collaboration, leadership, education, and sustainability, we conducted a strategic planning process designed to identify strategic investments that will define new directions for GBMSD. We have been deliberate in our efforts and yet still anticipate the need to modify plans to address stakeholder concerns, regulatory changes, and market dynamics. Four strategic initiatives were formulated:

Regional Municipal Environmental Services – Through tailored partnerships, provide environmental services to other municipalities not currently served by GBMSD.

Watershed Based Planning – Develop and advance implementation of a watershed planning framework to more cost-effectively address regional water quality.

In-District Sustainability – Implement an internal sustainability program that integrates economy, ecology, and equity into daily decisions, policies, and practices to ensure a prosperous and healthy future for today's and tomorrow's generations.

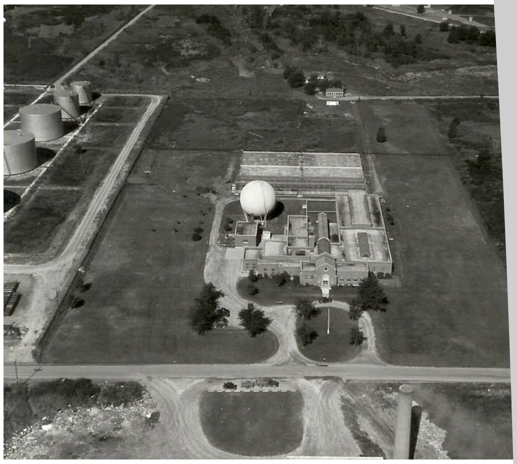
Risk-Based Asset Management – Develop an asset renewal and replacement program to minimize the life-cycle costs of GBMSD capital assets at acceptable levels of service and risk.

Collectively, these initiatives reflect a new approach to GBMSD's role in the region. Whereas, we have built our reputation for excellence largely through a 78-year history of quiet, focused development and operation of a centralized wastewater system; we believe that future service will require a more expansive view. Our future lies in working with our customers, regulators, and regional stakeholders to align our activities and services to meet the emerging challenges of the day. We recognize that to collaborate and to lead, we must first listen. In presenting this Strategic Plan, I ask for your input in mapping the best possible future for GBMSD and the region we serve.

HISTORY

GBMSD was formed in 1931 to address the significant pollution in local waterways. In fact, the rivers were so polluted that despite the Great Depression, concerned citizens raised approximately $1.8 million to construct a wastewater treatment facility. In 1935, the City of Green Bay and Towns of Allouez and Preble opened the area's first wastewater treatment facility, treating 2.5 million gallons per day (mgd). Soon afterward, with area growth and the desire for cleaner water, other municipalities joined GBMSD. In 1955, secondary treatment[1] was added and treatment capacity was increased to 22 mgd to accommodate this new growth. Also during the 1950s, the process of separating storm sewers and sanitary sewers began so treatment could be applied to the more concentrated wastes.

With the passing of the Clean Water Act in 1972, GBMSD constructed a new, more effective wastewater treatment facility. In 1975, with the help of State and Federal grants, GBMSD opened a state-of-the-art wastewater treatment facility; the first in the country to simultaneously treat municipal and paper mill wastewater. In 1992, the facility was expanded to meet new stringent effluent regulations for ammonia, with the addition of two aeration basins, two clarifiers, improved solids handling, and dechlorination. GBMSD acquired a treatment facility and interceptors from the City of De Pere in 2008, and today GBMSD serves over 219,000 residents within a 285 square mile area through 85 miles of interceptors. Municipal customers of GBMSD include: the Cities of Green Bay and De Pere; the Villages of Allouez, Ashwaubenon, Bellevue, Hobart, Howard, Luxemburg, Pulaski, and Suamico; and the Towns of Green Bay, Humboldt, Lawrence, Ledgeview, Pittsfield, Red River, and Scott. GBMSD also serves two contract customers – Georgia-Pacific Consumer Products LP, and Procter & Gamble Paper Products Company. Combined, on average, the two wastewater treatment facilities treat approximately 39 mgd with an annual operating budget of approximately $25 million.



Green Bay Facility, 1935

GBMSD PERFORMANCE AWARDS

Green Bay Facility

- 2007, 2008 NACWA[2] Platinum Award
- 2000, 2003 - 2006 NACWA Gold Award
- 2001, 2002 NACWA Silver Award
- 2005 Environmental Protection Agency Region 5 O&M Award

De Pere Facility

- 2008 NACWA Gold Award
- 2007 NACWA Silver Award

Green Bay Facility, 2008

De Pere Facility, 2008

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[1] Secondary treatment is designed to substantially degrade the organic content of wastewater containing human waste, food waste, soaps, detergent, etc., whereas primary treatment is largely associated with separation of solid content from the liquid stream.

[2] National Association of Clean Water Agencies (NACWA) is a national organization that is involved with the protection of water quality.

MISSION STATEMENT

The Mission of the Green Bay Metropolitan Sewerage District is to promote public health and welfare through the collection, treatment, and reclamation of wastewater, while assessing stable, competitive rates. In conjunction with others, the organization will encourage pollution prevention and support programs to help ensure that water contaminated by human activity is returned clean to the environment.

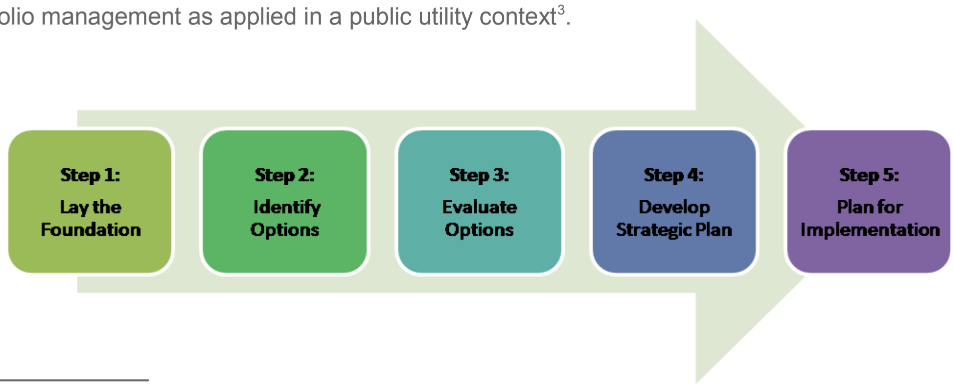
STRATEGIC PLAN PURPOSE

The purpose of the Strategic Plan is to document and communicate GBMSD's direction for its community of internal and external stakeholders. The Strategic Plan charts GBMSD's course into the future. It describes how GBMSD will ensure operations continue to be successful and identifies opportunities that will enhance the organization and the communities it serves.

The Strategic Plan is intended to be one of many steps toward engaging regional stakeholders in navigating GBMSD's future course. With this plan and future updates, it hopes to enhance the awareness and understanding of the services GBMSD provides and the activities in which it is engaged. Whether considering new approaches to solids management, advocating for more effective watershed management, or sponsoring educational events in its communities, GBMSD is committed to effective communication and engagement with its stakeholders. Moreover, GBMSD is committed to transparency and careful stewardship of the public resources with which it has been entrusted.

STRATEGIC PLANNING PROCESS

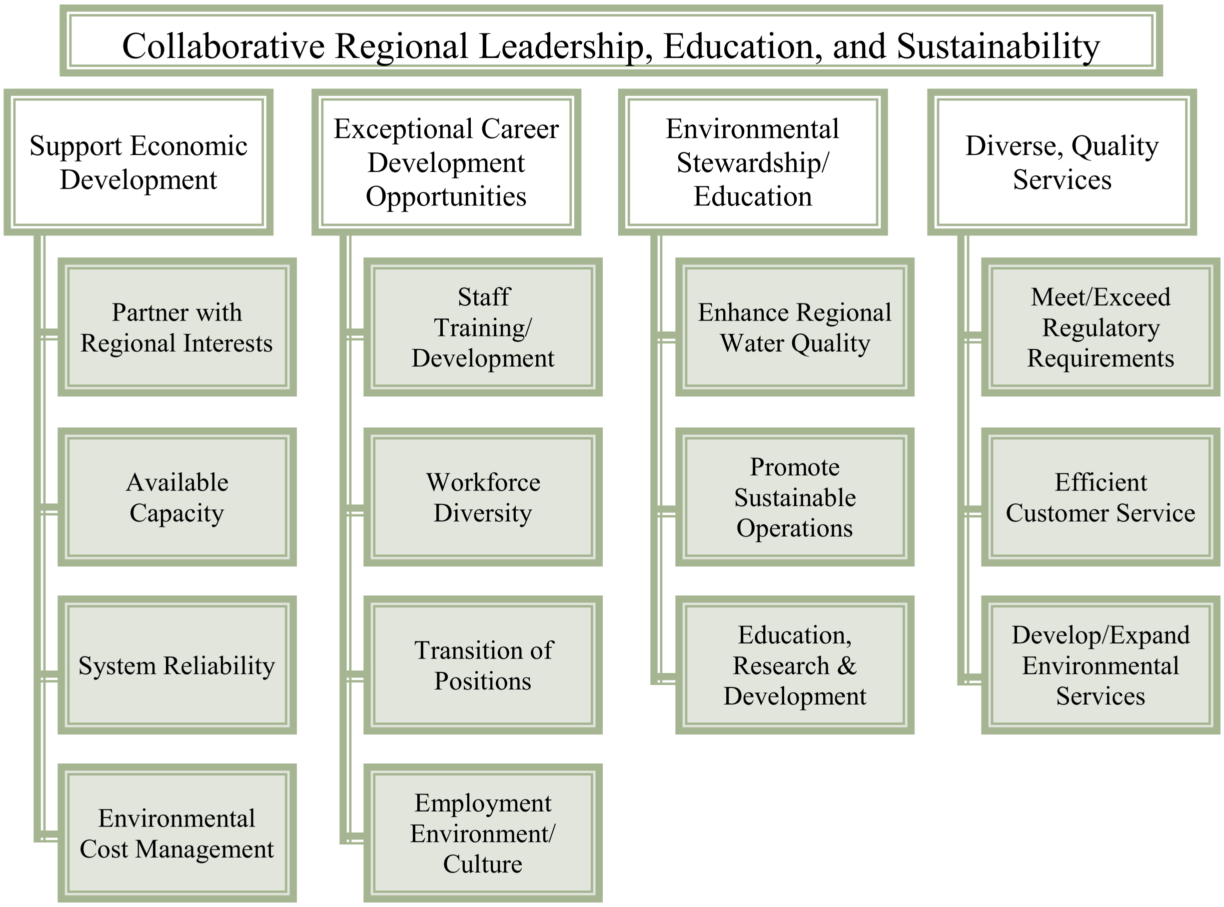
GBMSD's strategic planning process was designed to ensure that resource allocations are appropriately aligned with fundamental goals and objectives. The strategic planning process followed a simple, practical, five-step approach (illustrated below) that employed the principles of portfolio management as applied in a public utility context[3].



[3]This process is documented in the 2003 American Water Works Association Research Foundation report: *Development of a Strategic Planning Process* (AwwaRF Report No. 90957).

STRATEGIC PLANNING PROCESS

The portfolio management framework casts GBMSD's resource allocation decisions as strategic investments. In this respect, it is incumbent upon GBMSD's decision makers to ensure that allocations of scarce resources achieve the highest returns at acceptable levels of service and risk. In the public utility context, these returns are broadly defined to include financial, environmental, and social benefits. For GBMSD specifically, returns on resource allocations are assessed in terms of the extent to which they advance GBMSD toward accomplishment of its goals and objectives. Accordingly, as part of the first step of the strategic planning process, GBMSD Commissioners and Management Team members identified organizational goals and objectives, as summarized in the figure below:



Particularly noteworthy among these goals and objectives is that Collaborative Regional Leadership, Education, and Sustainability is considered an overarching philosophy encompassing all GBMSD activities. Further, each fundamental goal involves considerable interaction with regional stakeholders. This is stated explicitly by objectives like "Partner with Regional Interests." However, even the more internally focused goals related to career development opportunities contemplate working with local training, education, and employment agencies.

Once GBMSD's goals and objectives were defined, potential strategic investments were identified by assessing the strategic opportunities and challenges discussed below. The ranking and selection of 14 candidate strategic investments reflected GBMSD's assessment of which resource allocations will enable it to most effectively and efficiently meet its established goals and objectives. In doing so, the strategic investment portfolio reflects a proactive approach to the prevailing opportunities and challenges that characterize environmental services delivery in northeast Wisconsin.

STRATEGIC OPPORTUNITIES AND CHALLENGES

GBMSD has enjoyed a long tradition of success in delivering high-quality, low cost wastewater treatment and collection services to its established service area. GBMSD looks forward to building on this foundation and extending and expanding its environmental service offerings to facilitate sustainable economic development in northeast Wisconsin. In doing so, GBMSD has undertaken a clear-eyed assessment of both the opportunities and challenges that will likely characterize the landscape of future operations. These generally may be categorized as pertaining to future regulations and service imperatives, opportunities to advance regional collaboration, and measures to ensure the continuing exceptional character and quality of GBMSD's human and physical resources.

Regulatory Issues

GBMSD has an outstanding record of performance in delivery of wastewater transmission and treatment services. Despite highly variable loads to the treatment facilities, in terms of both wastewater flows and contributed pollutant strengths, GBMSD has consistently performed well within requirements of Wisconsin Department of Natural Resources permits related to its effluent discharges. However, because of the poor quality of regional receiving waters, including the Bay of Green Bay itself, GBMSD anticipates that a number of alternative regulations may come to bear on permitted wastewater dischargers within the region.

Perhaps the most significant prospective water quality regulations relate to potential phosphorus discharge limits. For GBMSD facilities, these regulations could require plant upgrades costing in the hundreds of millions of dollars; for other communities in the region, equally substantial additional costs may be imposed. Similarly, heightened concerns related to climate change may bring about new regulations and reporting requirements for GBMSD's incineration facilities. More generally, GBMSD anticipates that environmental regulations related to water quality and solids management will continue to become increasingly stringent, potentially imposing significant costs of compliance, but also affording new opportunities to extend and expand GBMSD service offerings.

Regional Collaboration

In part because of prospective regulatory changes, GBMSD's proactive evaluation of the future landscape for environmental service delivery in northeast Wisconsin suggests that now, perhaps more than ever before, unique opportunities exist for collaboration among regional stakeholders. Prospective regulatory requirements will strain GBMSD's physical resources and technical expertise; other communities in the region may be similarly challenged. Rising costs and changing workforce demographics will remain significant issues for GBMSD for the foreseeable future; other communities in the region are likely to be similarly impacted by these industry-wide trends. Yet at the same time, GBMSD believes that these challenges may provide new avenues to form collaborative partnerships founded on solid business principles. These partnerships may range from the development of informal agreements to effect exchanges of technical expertise and/or training, to execution of inter-jurisdictional agreements for GBMSD operation of selected regional facilities.

STRATEGIC OPPORTUNITIES AND CHALLENGES

Regional Collaboration

Partnerships may also come in the form of collective advocacy for sensible water quality regulation; joint collection and evaluation of environmental performance data (e.g., water quality measures, greenhouse gas emissions); or new methods for delivery of support services (e.g., information technology, billing, and customer service). Of utmost importance, GBMSD approaches these opportunities with a commitment to collaboration, adherence to sound business principles, and the recognition that each partnership is unique and must be carefully structured to ensure mutual benefit.

Asset Management and Human Resources

GBMSD is not insulated from the industry-wide trends relating to human and physical resources that characterize wastewater utilities throughout the United States. A significant share of its critical infrastructure assets were originally placed in service over 30 years ago. Asset renewal and replacement needs represent a significant share of its current and projected costs. Accordingly, GBMSD has undertaken asset management initiatives to minimize the life-cycle costs of assets while delivering desired service levels at acceptable levels of risk. These initiatives represent a new risk management approach to GBMSD's ownership of capital assets – one that recognizes the implications of its aging infrastructure.

Similarly, GBMSD recognizes the implications of its aging employee population and evolving workforce management issues. Succession planning, to ensure continuity of service and retention of employee knowledge, is of paramount importance as 39% of its employee population will be eligible for retirement over the next 5 to 10 years. Moreover, it recognizes the need for career paths to provide attractive opportunities for an increasingly diverse, technologically savvy pool of potential future employees. GBMSD is implementing training programs, defining new career paths, and making strategic investments to ensure GBMSD remains a place of rewarding employment and public service.

In summary, GBMSD's strategic investments were developed to address proactively the realities of the changing landscape in which it operates – both the opportunities and the challenges. GBMSD believes that these changes afford its current and future customers the ability to benefit from a collaborative, regional approach to environmental service delivery.

STRATEGIC INVESTMENT PORTFOLIO

GBMSD's strategic investment portfolio reflects the ranking and synthesis of numerous alternatives that were suggested through a series of interactive work sessions with both Commissioners and the Management Team. These strategic investment options focus efforts on the most significant opportunities and challenges, without compromising delivery of high-quality environmental services.

Regional Municipal Environmental Services

Communities throughout northeast Wisconsin are expected to face increasingly stringent regulations related to wastewater discharges to receiving waters. As for GBMSD, these regulations may impose significant facility upgrade requirements and challenge the technical expertise of facility operators. These emerging challenges, however, may also afford new opportunities to realize economies of scale in service delivery and more fully leverage the technical expertise at GBMSD.

This strategic investment option contemplates GBMSD's provision of wastewater treatment and collection services to other municipalities in the region beyond its existing service area. These services would be tailored to respond to individual community goals and objectives. Whereas some communities may elect to have GBMSD assume responsibility for operation and maintenance of their facilities, others may seek to have GBMSD provide technical support related to specific processes or regulatory requirements. Situations similar to the De Pere system integration may enable communities to obtain value for existing system assets and relief from future service delivery obligations. Perhaps most importantly, GBMSD's strategic investment seeks to establish partnerships with regional municipalities to promote economical and efficient delivery of environmental services.

Watershed Based Planning

Recent trends in water resource management have reflected an increasing recognition that a holistic, watershed-based perspective is required to accomplish and sustain water quality improvements. Regulation of point source discharges without complementary management of nonpoint source pollutant loadings will not only frustrate environmental stewardship objectives but also lead to sub-optimal resource allocations. Unfortunately, the current regulatory framework does not accommodate this watershed management perspective, and potential point source regulations may impose significant new costs on Publicly Owned Treatment Works. In response to similar conditions elsewhere in the United States, progressive wastewater utilities have promoted collaborative approaches to development of whole watershed planning protocols.

STRATEGIC INVESTMENT PORTFOLIO

This strategic investment option involves having GBMSD work with other major Wisconsin wastewater utilities, regional water resource stakeholders, and local, state, and federal agencies to foster the development of a whole watershed planning framework. Some specific attributes of this collaboration would include:

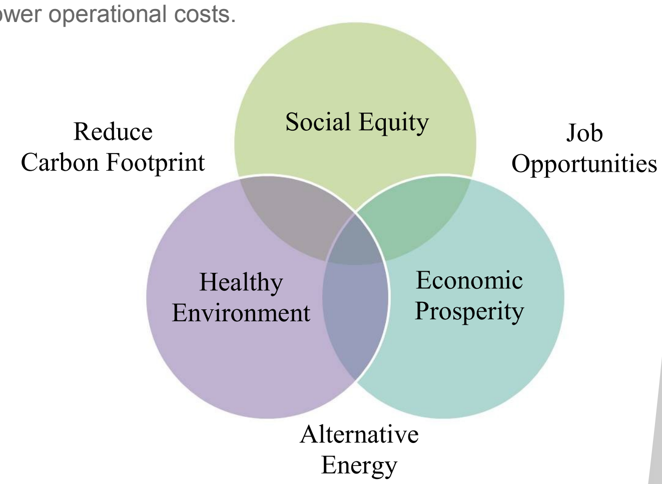
- Defining protocols for pollutant discharge credit calculations and for exchanges of credits. Calculation protocols will address measurement issues, relevant time periods, permitting procedures, and other issues. Trading protocols will define exchange ratios and options for trading between point source dischargers, and trading between point source and nonpoint source pollutant contributors.

- Engaging agricultural interests in discussions and demonstration pilot projects to better define pollutant reduction potential and associated costs, to more fully understand the cost structures of respective parties, and to collaborate in developing mutually beneficial opportunities.

- Working with the Wisconsin Department of Natural Resources and regional water resource interests (e.g., utility districts and municipalities, academic institutions, non-governmental environmental organizations) to promote and maintain "best science" as a basis for prioritization of water quality investments.

In-District Sustainability

GBMSD's goals and objectives speak to the importance of sustainability in the implementation of future programs and conduct of its operations. As a major environmental services provider in the region, GBMSD will lead by example in developing internal policies, practices, and solutions that balance economic, environmental, and community needs, while ensuring the opportunity for future generations to meet their needs. GBMSD will use education and innovation to develop a sustainability program that enhances its decision-making process to improve operational performance, reduce its carbon/water footprint, and engage its workforce. GBMSD will bridge the gap between declining ecosystems and diminishing resources by providing leadership on sustainability issues and setting an example for communities and other organizations to follow. Projects or project components that are anticipated to yield environmental sustainability benefits include operational improvements that reduce greenhouse gas emissions, conserve energy, reduce waste, improve staff's health and safety, and lower operational costs.



STRATEGIC INVESTMENT PORTFOLIO

In terms of specific projects and operating protocols that can yield sustainability benefits, perhaps the most significant opportunities involve alternatives to enhance solids management operations and/or convert solids to bio-fuels or other marketable products. Solids management, currently featuring incineration of dewatered wastewater sludge, represents GBMSD's single most significant energy demand and source of greenhouse gas emissions. Facing the potential for increasingly stringent solids management regulations, aging assets (incinerators were installed in the mid-1970s), and loads associated with integration of the De Pere facilities, GBMSD has initiated a comprehensive solids management study. The scope of this effort will address not only opportunities to enhance the environmental performance of GBMSD's current and planned facilities, but also methods to develop solids management services that may be offered to other communities and wastewater generators in the region.

Risk-Based Asset Management

Consistent with nationally recognized attributes of effective water sector utilities[4], GBMSD recognizes that asset management is critical to delivering cost-effective, high quality, and reliable service. Asset management is an integrated optimization process for "managing infrastructure assets to minimize the total cost of owning and operating them, while continuously delivering the service levels customers desire, at acceptable levels of risk."[5] Though GBMSD historically has ensured that its infrastructure assets are well-maintained, renewed, and replaced as needed to deliver reliable service like most of the water utility sector, its efforts have not methodically focused on minimizing lifecycle costs related to defined service levels or based on assessment of risks.

Significant developments throughout the industry afford important opportunities to enhance GBMSD's asset management practices. Standard procedures for asset condition assessments and risk evaluation have been promulgated and disseminated. Increasingly powerful software tools are available to facilitate record keeping on asset characteristics, maintenance histories, and performance attributes. Accordingly, GBMSD will elevate its asset management practices by implementing successful tools and techniques tailored to its asset inventory and operating conditions.


[4] See, for example, Recommendations for a Water Utility Sector Management Strategy: A Final Report Submitted by the Effective Utility Management Steering Committee to the Collaborating Organizations – March 30, 2007, American Public Works Association, American Water Works Association, Association of Metropolitan Water Agencies, National Association of Clean Water Agencies, National Association of Water Companies, U.S. Environmental Protection Agency, Water Environment Federation Managing Public Infrastructure Assets, AMSA, AMWA, WEF, AWWA, 2001

[5] Managing Public Infrastructure Assets, AMSA, AMWA, WEF, AWWA, 2001

IMPLEMENTATION AND UPDATE

GBMSD has initiated implementation of components of its strategic investment portfolio. The following describes what has been accomplished to date for each initiative.

Watershed Based Planning:

- Working with a statewide municipal utility group on nutrient limit regulations
- Working with federal, state, and county agencies and educational institutions on the development of a total maximum daily load and education outreach for the lower Fox River basin
- Contact with non-governmental environmental organizations to identify common areas of interest

Regional Municipal Environmental Services:

- Working as part of the Brown County Waste Transformation initiative to identify regional solids and agricultural waste management options
- Identified potential municipal service offerings

In-District Sustainability:

- Identified and implemented “low hanging fruit” sustainability projects (e.g. paper reduction)
- Energy evaluation and recommended alternatives for energy conservation on lighting, heating/cooling, wastewater treatment equipment, (e.g. pumps, monitors, mixers, and generators)
- Solids Management Plan – evaluate future alternatives for solids handling and disposal
- In-District Sustainability Study

Risk-based Asset Management:

- Asset condition assessment
- Accounting-based asset management inventory and value
- Long-term planning for renewal and replacement of aging assets

As a wastewater utility that has been out of the public eye, GBMSD has recently been engaging its stakeholders on new and future initiatives. In the past year, GBMSD has met with stakeholders one-on-one, held its first annual update meeting, surveyed customers, published external newsletters, and commissioned a stakeholder advisory group for input on a future capital investment project.

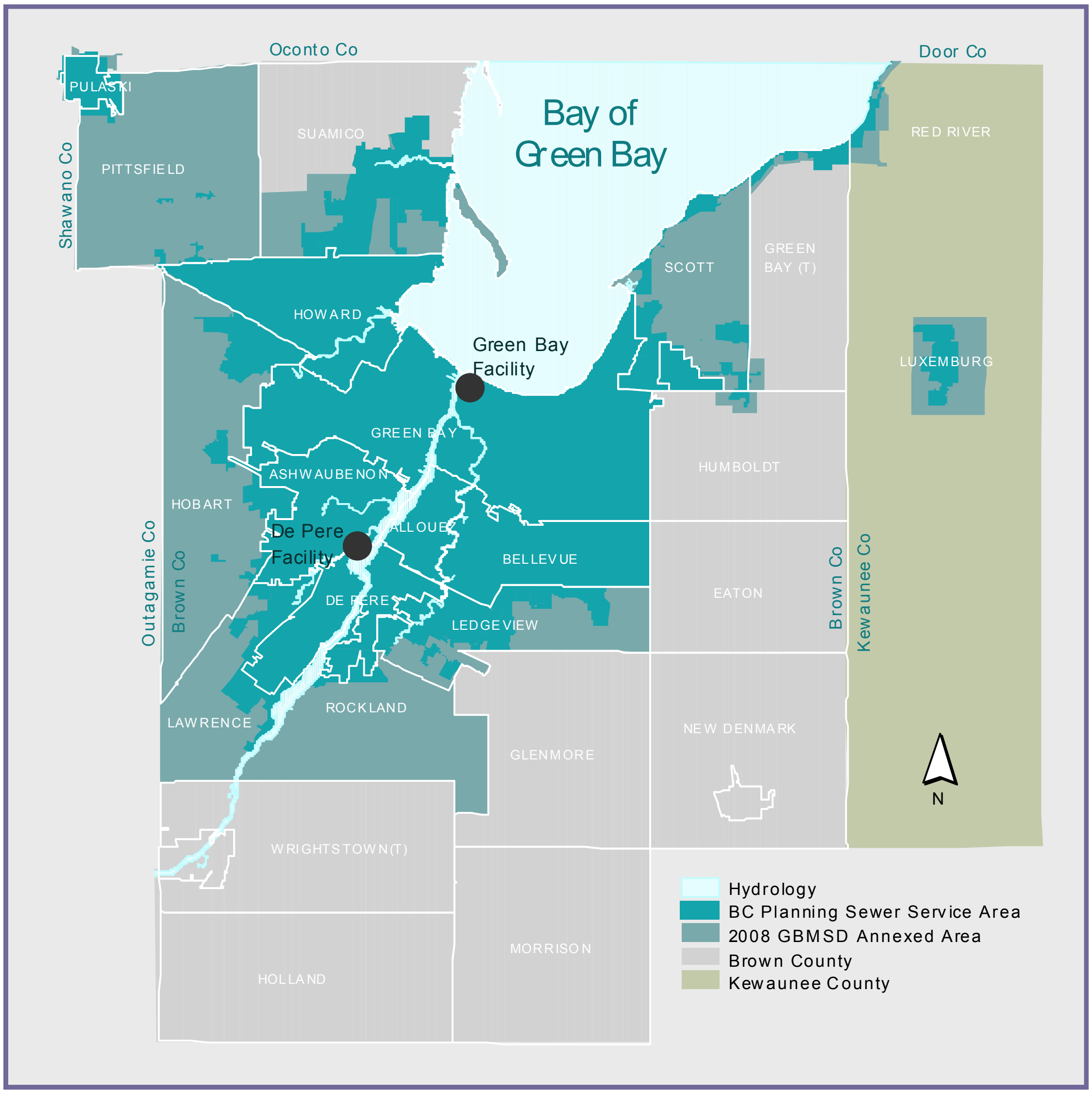
A key part of this Strategic Plan will be to conduct an annual review of each strategic initiative and update its progress. Through reviewing where GBMSD is relative to its benchmarks, the plan will be modified to reflect actual progress, current conditions, and future needs. GBMSD will update the Strategic Plan as part of its annual report.

GBMSD'S COMMITMENT

GBMSD is committed to transparency and effective stewardship of the public resources with which it has been entrusted. Accordingly, provided on GBMSD's website at www.gbmsd.org is general information on its organizational structure, financial performance, and operations. This information is evidence that GBMSD is a significant economic actor in the region – with $222 million in asset investment and annual revenues of $23.1 million – and it recognizes and takes seriously the responsibilities of its role in the region. Over the last decade, GBMSD has established a strong foundation of efficiency and effectiveness of its operations. Today, GBMSD is well positioned to build on that foundation as it implements the strategic investments described herein. GBMSD will remain committed to the effectiveness and efficiency that has served its community so well to date, and to the openness and transparency that is at the center of the regional collaborations to which it aspires.

Photographed left to right: Commission President Daniel Alesch, Commission Secretary Kathryn Hasselblad, Commissioner Tom Meinz, Commissioner Chris Zabel, Commissioner Denise Scheberle, Executive Director Tom Sigmund.

GBMSD SERVICE AREA



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Impact of SSI MACT Standards on the Selection of Alternatives

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DATE: August 18, 2011

Introduction

The United States Environmental Agency (USEPA) published *Fact Sheet: Standards of Performance for New Stationary Sources and Emission Guidelines for Existing Sources: Sewage Sludge Incineration Units* (final rule, March 21, 2011).The rule, known as the SSI MACT rule, will affect existing and new incineration process trains developed as part of the Solids Management Facility Plan. This memorandum provides an overview of the rule, analyses of the impacts the rule will have on the multiple hearth furnaces and the three alternatives that include incineration, and estimates the cost impacts on each alternative. Specifically, it addresses the following alternatives:

- Existing multiple hearth incinerators without major rehabilitation
- Existing solids system rehabilitation alternative (Alternative 16)
- Alternative 2—Incineration with Energy Recovery
- Alternative 3—Digestion with Further Thermal Processing
- Alternative 14—Incineration and Drying

Overview of the SSI MACT Rule

General

The Clean Air Act Amendments (CAAA) of 1990 lists sewage sludge (biosolids) incinerators under Section 112 (National Emission Standards for Hazardous Air Pollutants) and Section 129 (Rules for Solid Waste Combustion) as source categories. In January 1997, USEPA indicated in the *Federal Register* that biosolids incinerators would be delisted from Section 112 of the CAA and regulated under Section 129 of the CAA. However, based on recommendations and data analysis results submitted by the Industrial Combustion Coordinated Rulemaking advisory committee under the Federal Advisory Committee Act, USEPA issued its final rulemaking on November 15, 2000, that sewage sludge incinerators will not be regulated as a category under Section 129 of the CAA.

Confirming its earlier announcement of January 1997, USEPA announced changes to the maximum achievable control technology (MACT) standards that affect biosolids incinerators favorably. Section 112 (c) of the CAAA of 1990 had listed sewage sludge incinerators (SSI) under the source category Waste Treatment and Disposal. This required

USEPA to develop MACT standards for publicly owned treatment works. After evaluating the emissions information available, including testing conducted since the initial listing in June 1992, USEPA concluded that the SSI source category does not have any sources with the potential to emit hazardous air pollutants at a level approaching major source levels. Therefore, USEPA deleted SSI from the §112 source category list effective February 12, 2002. See 67 *Federal Register* 6521, 6523 (February 12, 2002). In June 2006, USEPA published a notice reconsidering the issue of whether SSI should be excluded from regulation under §129. On January 22, 2007, USEPA confirmed its earlier decision to exclude regulation of SSI under Other Solid Waste Incinerators of §129.

In June 2002, USEPA listed SSI under §§112(c)(3) and 112(k)(3)(B)(ii) as an area source category, with promulgation. USEPA was due to promulgate standards for SSI under the area source category in June 2009. Regulations under the area source category allow USEPA to require the use of generally acceptable control technology, which is less stringent than the mandatory MACT for §§129 and 112 source categories.

On June 28, 2006, USEPA issued a notice of reconsideration on whether sewage sludge incinerators would be considered "other solid waste incinerators" under §129 of the CAA. USEPA previously had decided to regulate sewage sludge incinerators under §112 of the CAA, as sewage sludge almost exclusively comes from publicly owned treatment works rather than commercial or industrial establishments or the general public. In 2007, the U.S. Court of Appeals for the District of Columbia Circuit vacated and remanded the 2005 Commercial and Industrial Solid Waste Incineration definition rule.

On June 4, 2010, a proposed rule was published identifying nonhazardous secondary materials that are solid waste. The significance of the rule is that the combustion units that use materials identified as solid waste would be considered solid waste incinerators and subject to regulation under §129 of the CAA. The rule required USEPA to publish new source performance standards for new sources and emission guidelines for existing sources. The emission limitations proposed under this section would be at least as stringent as those promulgated under §112.

On February 21, 2011, USEPA released New Source Performance Standards and emission guidelines for new and existing SSI units, collectively referred to as the SSI MACT Rule. The SSI MACT Rule was officially published on March 21, 2011, with an effective date of May 20, 2011. The new standards are a significant improvement over the originally proposed standards, particularly for multiple hearth incinerators. All existing SSIs must be in compliance with the new requirements no later than May 21, 2016, but the exact compliance date will vary.

Standards of Performance for New Sewage Sludge Incineration Units

The performance requirements for new sewage sludge incinerators are promulgated in Code of Federal Regulations, Title 40 Part 60 Subpart LLLL (40 CFR 60 Subpart LLLL), Standards of Performance for New Sewage Sludge Incineration Units. This subpart defines separate emission limits for multiple hearth incinerators and fluidized bed incinerators (Table 1). USEPA does not define emission control technologies that may be needed to achieve the emission limits. The performance standards apply to new SSI units that commenced construction after October 14, 2010.

TABLE 1
Emission Limits for New Sewage Sludge Incinerators

Pollutant	Engineering Units	Multiple Hearth Incinerator Emission Limits	Fluidized Bed Incinerator Emission Limits
Particulate matter	mg/dscm @ 7% O_2	60	9.6
Hydrogen chloride	ppmvd @ 7% O_2	1.2	0.24
Carbon monoxide	ppmvd @ 7% O_2	52	27
Dioxins/furans (total mass basis)	ng/dscm @ 7% O_2	0.045	0.013
Dioxins/furans (toxic equivalency basis)	ng/dscm @ 7% O_2	0.0022	0.0044
Mercury	mg/dscm @ 7% O_2	0.15	0.0010
Oxides of nitrogen	ppmvd @ 7% O_2	210	30
Sulfur dioxide	ppmvd @ 7% O_2	26	5.3
Cadmium	mg/dscm @ 7% O_2	0.0024	0.0011
Lead	mg/dscm @ 7% O_2	0.0035	0.00062
Fugitive ash handling		No visible emissions for > 5% of hour	No visible emissions for > 5% of hour

An SSI unit becomes subject to the emission limits for new SSI if it is modified after September 21, 2011. This means that if it undergoes a physical change (excluding routine maintenance and repairs) after this date that does one of the following: results in an increase in emissions of one of the pollutants regulated by the SSI MACT Rule; or contributes to a cumulative cost from all changes over the life of the SSI unit that exceed 50 percent of the original cost of the SSI unit (with all costs updated to today’s dollars).

Sources may demonstrate compliance either using stack testing or through continuous emission monitors or continuous automated sampling systems. If sources demonstrate compliance using stack testing, they must establish operating limits during the stack tests and meet those operating limits any time sewage sludge is in the combustion chamber. These operating limits are unique to the type of control device used and correlate with the performance of the device. Sources must install continuous monitoring systems (generally continuous parametric monitoring systems) to demonstrate compliance with the operating limits. Sources demonstrating compliance with continuous emission monitors do not need to establish operating limits.

Sources must conduct initial and annual performance evaluations of continuous monitoring systems, including continuous emission monitors, continuous automated sampling systems, and continuous parametric monitoring systems, and perform regular calibration and other quality control/quality assurance procedures. Sources also must do the following:

- Meet operator training requirements.
- Conduct initial and annual inspections of pollution control equipment.
- Submit site-specific monitoring plans for all required systems.

All publicly owned treatment works that use incineration will be subject to the requirements under Title V of the Clean Air Act. Clean water agencies operating an SSI that do not have a Title V permit will have to apply for a permit in accordance with the following deadlines. An application must be submitted by March 21, 2012, if the unit already is operating on March 21, 2011. If the unit is not yet operating on March 21, 2011, the application is due within 1 year of the unit commencing operation. The Green Bay Facility has a Title V permit that will need to be updated to incorporate the new standards.

New SSI units will need to complete training and qualification procedures by the later of 6 months after unit startup, or the date before an employee assumes operating responsibility or supervision responsibility.

Emission Guidelines and Compliance Times for Existing Sewage Sludge Incineration Units

The emission guidelines for SSIs are promulgated in Code of Federal Regulations, Title 40 Part 60 Subpart MMMM, Emission Guidelines and Compliance Times for Existing Sewage Sludge Incineration Units. This subpart defines separate emission guidelines for multiple hearth incinerators and fluid bed incinerators. Table 2 summarizes the guidelines. USEPA does not define emission control technologies that may be needed to achieve the emission guidelines.

TABLE 2
Emission Guidelines for Existing Sewage Sludge Incinerators

Pollutant	Engineering Units	Multiple Hearth Incinerator Emission Limits	Fluidized Bed Incinerator Emission Limits
Particulate matter	mg/dscm @ 7% O_2	80	18
Hydrogen chloride	ppmvd @ 7% O_2	1.2	0.51
Carbon monoxide	ppmvd @ 7% O_2	3800	64
Dioxins/furans (total mass basis)	ng/dscm @ 7% O_2	5.0	1.2
Dioxins/furans (toxic equivalency basis)	ng/dscm @ 7% O_2	0.32	0.10
Mercury	mg/dscm @ 7% O_2	0.28	0.037
Oxides of nitrogen	ppmvd @ 7% O_2	220	150
Sulfur dioxide	ppmvd @ 7% O_2	26	15
Cadmium	mg/dscm @ 7% O_2	0.095	0.0016
Lead	mg/dscm @ 7% O_2	0.30	0.0074
Fugitive ash handling		No VE observed for > 5% of hour	No VE observed for > 5% of hour

The state or local air permitting agency would enforce the emission guidelines. Subpart MMMM includes a model rule that must be added to the agencies State Implementation Plan (SIP) by March 21, 2012. Upon review and approval of the revised plan, the state or local agency would issue air permits and enforce the emission limits. Existing SSI units must comply by the earlier of March 21, 2016, or 3 years from the effective date of USEPA's approval of the SIP. This means that the multiple hearth incinerators at the Green Bay

Facility will be required to comply with the new emission guidelines before a new solids facility could be constructed. It has been tentatively estimated that it would take 5 years to design, construct and start up a new incineration facility. Assuming that design of the new solids facilities would begin in late 2011, the new facilities would be operational in late 2016, beyond the date when the existing facility must comply with the new guidelines.

An existing SSI must submit a Title V application on the earlier of 1 year after the effective date of an approved SIP; 1 year after the effective date of an approved FIP; or March 21, 2014. The Green Bay Facility has a Title V permit that will need to be updated to incorporate the new standards.

An SSI must complete operator training by the later of the final compliance date specified in the SIP (likely 3 years from the date the SIP is approved); 6 months after unit startup; or 6 months after an employee assumes operating or supervision responsibility.

Impact Assessment of SSI MACT Rule

The SSI MACT rule may require each alternative that includes incineration to include additional process control (such as combustion control) and air pollution control not included in the final draft Solids Management Facility Plan submitted to the WDNR in November 2010. Each section describes the alternative, the incineration process train, including air pollution control devices and assesses whether additional controls are required to meet the SSI MACT and what they should be.

Existing Multiple Hearth Incinerators

This section describes the multiple hearth incinerators and assesses their potential to comply with the SSI MACT rule. There are two multiple hearth incineration systems installed at the Green Bay Facility. Each includes a multiple hearth furnace (MHF), a multiple venture/impingement scrubber, and an induced draft fan. Each MHF is equipped with an emergency bypass damper that opens when the induced draft fan automatically shuts down in response to a number of operational situations. The MHFs were installed in 1974 and were refurbished circa 2006. The MHFs have nearly reached their capacity and now require considerable operation and maintenance. Both incinerators need to be operational most of the time to process the combined solids from both the Green Bay Facility and the De Pere Facility. Stack tests were conducted on each MHF in 2007. The 2007 stack test results are compared to the emission guidelines to determine the potential to comply with the SSI MACT rule. As subsequently discussed, additional, supplementary stack testing was done in 2011.

Stack Test Results

Stack tests were conducted on MHF No. 1 May 29 through 31, 2007 and on MHF No. 2 on April 24, 25, and 30, 2007. Emission rates for the pollutants regulated in the SSI MACT rule were converted to the appropriate engineering units and reference condition, typically milligrams/dry standard cubic meter at 7 percent oxygen. Table 3 summarizes the emission rates and compares them to the emission guidelines. Based on the emission test results, only the emission limits for NO_x would be exceeded for both MHFs. However, the mercury emission test results are questionable as explained below.

TABLE 3
Comparison of MHF Emissions at the Green Bay Facility to MACT Standards for Existing MHF Sludge Incinerators

Pollutant	Engineering Units	Emission Limits	MHF No. 1 Emissions	MHF No. 2 Emissions
Particulate matter	mg/dscm @ 7% O_2	80	19	21
Hydrogen chloride	ppmvd @ 7% O_2	1.2	0.23	0.46
Carbon monoxide	ppmvd @ 7% O_2	3800	657	1758
Dioxins/furans (total mass basis)	ng/dscm @ 7% O_2	5	0.04	0.23
Dioxins/furans (toxic equivalency basis)	ng/dscm @ 7% O_2	0.32	0.000012	0.0015
Mercury*	mg/dscm @ 7% O_2	0.28	0.000005	0.00006
Oxides of nitrogen	ppmvd @ 7% O_2	220	***419***	***418***
Sulfur dioxide	ppmvd @ 7% O_2	26	5.5	10.2
Cadmium	mg/dscm @ 7% O_2	0.095	0.003	0.004
Lead	mg/dscm @ 7% O_2	0.3	0.007	0.006
Opacity		N/A		

Note: Results in ***bold*** exceed limits.
*GBMSD is performing additional mercury stack testing
Emissions based on MHF April/May 2007 stack testing

NO_x Compliance. Additional stack testing should be conducted to determine whether combustion system modifications could be implemented to reduce NO_x emissions and verify that emissions of other pollutants have not increased. The additional testing could be added to any future scheduled incinerator stack testing. Should NO_x emissions not be reduced below the limit, GBMSD may need to install NO_x abatement and follow the increments of progress methodology in the SSI MACT rule. Depending on the schedule for construction of the new solids facilities and EPA approval of the WDNR's regulations, these modifications may need to be done before construction of new solids facilities.

Mercury Emissions. The reported mercury stack testing emissions are extremely low because most of the test runs reported non-detection. This is unusual for an SSI. GBMSD staff reviewed stack testing sampling and analytical methodologies and results and found no reason to suspect error. Following the April 14, 2011, workshop, GBMSD staff compiled historical mercury influent, effluent, ash, plant recycle and dewatered cake concentrations. An evaluation of the data indicated that less than 1 percent of the total mercury mass in the effluent at the Green Bay and De Pere facilities is found consistently in the ash and about 1 to 2 percent of the total mercury influent is found in the effluent. This indicates that the only remaining outlet for the influent mercury is the incinerator stack emissions, and 98 to 99 percent of the influent mercury would typically be expected to be emitted from the stack which is consistent with what has been observed at other municipal incinerator facilities. Using this assumption and considering mercury influent data, mercury emissions measured during the stack testing should have been significantly higher. The low emissions of mercury measured in the 2007 stack testing cannot readily be explained. Recent stack testing done in May of 2011 appeared to show that incinerator stack mercury emissions were of an order of magnitude that would be expected given the historical influent mercury concentrations. This recent testing provides further evidence that the 2007 stack testing was an anomaly.

The peak influent mercury mass from GBMSD's monthly data from 2002 through 2010 was used to estimate mercury emissions by assuming that 100 percent of the influent mercury mass is emitted from the MHFs. Using this method and the peak historical mercury concentrations, 2035 projected average flows, and assuming two incinerators in operation, the peak incinerator stack emissions were estimated to be 0.13 mg/dscm at 7 percent oxygen. This is significantly less than the SSI MACT standard of 0.28 mg/dscm at 7 percent oxygen, meaning the MHFs would be in compliance using this mass balance method. Table 4 lists the data used to estimate the mercury emissions.

TABLE 4
Data Used to Estimate Peak Mercury Emissions for Existing MHFs

	Hg (μg/L)	Hg (mg/L)	Flow (mgd)	Hg (mg/day)
Green Bay Influent (not including P&G)	0.42	0.0004	28.4	45,362
De Pere Influent	0.32	0.0003	9.2	11,143
Procter & Gamble	0.07	0.0001	4.5	1,200
Total				57,706

Note: Using data in table, Hg emissions estimated to be 0.13 mg/dscm @ 7% oxygen.

Flows are 2035 averages.

Peak Hg concentrations from monthly data for 2002–2010.

Air flow assumed = 693,484 dscm/day

Air flow from average air flow from 2007 stack test report for Incinerator no. 1 in 2007.

Assumes Hg emissions are from one incinerator operated at 10,000 lbs/hr water and 22% cake solids and that one incinerator receives 67% of the total solids. An incinerator can operated at higher capacity which may result in higher emissions.

Existing Solids System Rehabilitation (Alternative 16)

This subsection describes the air pollution control devices required to meet the SSI MACT rule if the MHFs are rehabilitated. The MHFs have nearly reached their capacity and require considerable operation and maintenance. Both incinerators need to be operational most of the time to process the combined solids from both the Green Bay and De Pere plants.

A report by Black and Veatch dated June 14, 2011 estimated that, to date, rehabilitation costs have cumulatively amounted to 21 percent of the original value of the MHF system. The report concluded that when an additional $4.2 million is expended on MHF rehabilitation, the SSI MACT rule would be triggered. Each MHF and other ancillary systems would require extensive rehabilitation to extend operational life 20 to 40 years. As described in the draft *Refinements of Alternatives* Technical Memorandum (July 1, 2011), rehabilitation would be extensive and would trigger designation as a modification under the SSI MACT rule because the cost of the rehabilitation would easily exceed the $4.2 million threshold identified in the report.

Table 5 compares 2007 stack test results with emission limits for new (rehabilitated) MHFs. Based on 2007 stack test results, controls would be required for carbon monoxide, nitrogen oxides, cadmium, and lead. The following control devices are recommended:

- Ammonia or urea injection at the MHF outlet to control emissions of nitrous oxides. However, control of nitrous oxide from MHFs has not been done before and additional, more costly controls may be needed. Additional engineering is required to determine the most appropriate type of controls.
- Multiple venturi/impingement wet scrubber with a wet electrostatic precipitator combination to control cadmium and lead emissions.

TABLE 5
Comparison of MHF Emissions from the Green Bay Facility to MACT Standards Assuming MHFs are Rehabilitated

Pollutant		Engineering Units	Emission Limits	Emissions MHF 1	Emissions MHF 2
Particulate matter	PM	mg/dscm @ 7% O_2	60	19	21
Hydrogen chloride	HCl	ppmvd @ 7% O_2	1.2	0.23	0.46
Carbon monoxide	CO	ppmvd @ 7% O_2	52	***657***	***1,758***
Dioxins/furans (total mass basis)	CDD/CDF, TMB	ng/dscm @ 7% O_2	0.045	0.04	***0.23***
Dioxins/furans (toxic equivalency basis)	CDD/CDF, TEQ	ng/dscm @ 7% O_2	0.0022	0.000012	0.0015
Mercury	Hg	mg/dscm @ 7% O_2	0.15	0.000005	0.00006
Oxides of nitrogen	NO_x	ppmvd @ 7% O_2	210	***419***	***418***
Sulfur dioxide	SO_2	ppmvd @ 7% O_2	26	5.5	10.2
Cadmium	Cd	mg/dscm @ 7% O_2	0.0024	***0.003***	***0.004***
Lead	Pb	mg/dscm @ 7% O_2	0.0035	***0.007***	***0.006***
Opacity			N/A		

Note: Results in **bold** exceed limits.

- Regenerative thermal oxidizer to control carbon monoxide emissions. The oxidizer would be installed downstream of the wet electrostatic precipitator and equipped with low nitrogen oxide burners.

Mercury Controls

Using the influent mercury mass balance method explained previously the peak incinerator stack emissions were estimated to be 0.13 mg/dscm at 7 percent oxygen. This is only slightly less than the SSI MACT standard for rehabilitated ("new") MHFs of 0.15 mg/dscm at 7 percent oxygen. Even though the estimated peak mercury emissions do not exceed the SSI MACT standards, it is recommended that a granular activated carbon mercury emission control system be installed for the following reasons if the MHFs are rehabilitated:

- The true peak mercury emissions are likely higher than those estimated. While the peak mercury emissions were estimated based on a fairly large dataset (~100 points), use of additional future data could result in higher estimated peaks.
- The MACT rule requires that emissions comply with the standards at all times and does not allow *any* exceedances of the standards. The difference between the peak mercury emissions based on historical data and the MACT standard would not provide sufficient protection against future potential exceedances of the mercury standard, which are reported as deviations.
- Should deviations lead to violations, fines for violating the MACT standards under the Clean Air Act are significant—up to $25,000 per day.
- GBMSD is committed to 100 percent regulatory compliance. Its management philosophy and operations principles minimize the risk of violating regulatory mandates.

Emergency Bypass

Use of the MHF emergency bypass could result in MACT SSI regulatory compliance issues because as explained below in more detail, the MACT emission standards apply at all times even when the emergency bypass is open. If power to the MHF ID fan is lost, the scrubber water supply is lost or other operational situations arise, the emergency bypass damper opens to allow gases to be exhausted upstream of the air pollution control train. The damper is typically required to be opened a few times per year. A June 10, 2011 memorandum from SEH addressed this issue by estimating the levels of uncontrolled emissions from the emergency bypass. The memorandum concluded that when the emergency bypass damper was operated, emission levels of particulate matter, hydrogen chloride, carbon monoxide, nitrogen oxides, and sulfur dioxide would exceed the SSI MACT standards for modified/new MHFs. The opening of the bypass damper would be a described as a “deviation” according the regulations if it results in a release of emissions above the emission limits and standards and/or operation outside the operating limits (see definitions below).

The SSI regulations (40 CFR 60.4861; see attachment) would allow emissions from the emergency bypass to exceed MACT standards if it can be proven that the bypass was caused by a malfunction. The preamble of the SSI regulations defines a malfunction as:

> … any sudden, infrequent, and not reasonably preventable failure of air pollution control equipment, process equipment, or process to operate in a normal or usual manner. Failures that are caused in part by poor maintenance or careless operation are not malfunctions…

Emission limits apply at all times that sludge is in the combustion chamber including periods of malfunction (40 CFR 4860). However, a source may present an “affirmative defense” to attempt to avoid penalties and enforcement actions that regulators may enact due to an emission violation that would occur due to a malfunction that led to the emergency bypass opening. This in essence says that a source is guilty of a violation until the source can prove otherwise and the burden of proof is on the source.

Opening of the bypass damper may or may not be a malfunction and is open to interpretation. All deviations, including any caused by malfunctions must be reported. A violation is an action by the regulatory agency to a deviation. The agency issues a violation for actions contrary to the operating permit. Along with a violation are civil penalties which the owner/operator must pay unless the owner/operator can establish an affirmative defense. Although the rule specifically addresses affirmative defense for malfunction, the definition does not limit affirmative defense to malfunctions. In summary, a deviation, including a deviation due to a malfunction, can lead to a violation of the permit. A deviation or deviation due to a malfunction are event that occur that cause conditions to be different than permit conditions. A violation of the permit conditions is an action taken by the regulatory agency in response to a deviation.

Attachment A defines several, specific requirements that must be included in an affirmative defense that must be submitted to regulators. The attachment describes how a source must prove that that the bypass could not have been prevented through better design, more careful planning, better maintenance and operation and other conditions. The regulations could be interpreted as requiring that an affirmative defense be submitted each and every time use of the emergency bypass causes an emission violation.

As part of the required revised GBMSD Title V Operating Permit, a revised Compliance Assurance Monitoring (CAM) plan will likely need to be developed which describes how the facility will be in compliance with the SSI emission limits during normal, start-up, shut-down and malfunctions. If the emergency bypass dampers open and excess emissions are released, one of the first issues that would have to be addressed is was CAM plan followed.

In summary, use of the emergency bypass dampers that results in emissions that exceed the standards would be a deviation and could be deemed to be a violation. Based on the affirmative defense provision, it would not be a violation if GBMSD can prove through submitting detailed documentation to the regulators that the use of the emergency bypass damper could not be avoided. However, there is a significant risk that the regulators may interpret the affirmative defense in such a way that results in declaring that the bypass was avoidable. GBMSD would be dependent on the regulators interpretations of the rules. If the regulators ruled that the exceedance were avoidable, then GBMSD would be in violation of the MACT standards and subject to potential significant enforcement actions and penalties under the Clean Air Act.

For reference, the following are definitions from each rule, although similar may have specific words or phrases that are slightly different.

As defined in Subpart LLLL - Standards of Performance for New Sewage Sludge Incineration Units, 40 CFR 60.4930 and Subpart MMMM – Emission Guidelines and Compliance Times for Existing Sewage Sludge Incineration Units, 40 CFR 60.5250 :

Affirmative defense means, in the context of an enforcement proceeding, a response or defense put forward by a defendant, which the defendant has the burden of proof, and the merits of which are independently and objectively evaluated in a judicial or administrative proceeding.

Deviation means any instance in which an affected source subject to this subpart, or an owner or operator of such a source:

(1) Fails to meet any requirement or obligation established by this subpart, including but not limited to any emission limit, operating limit, or operator qualification and accessibility requirements.

(2) Fails to meet any term or condition that is adopted to implement an applicable requirement in this subpart and that is included in the operating permit for any affected source required to obtain such a permit.

Malfunction means any sudden, infrequent, and not reasonably preventable failure of an air pollution control and monitoring equipment, process equipment, or a process to operate in a normal or usual manner. Failures that are caused, in part, by poor maintenance or careless operation are not malfunctions.

Alternative 2—Incineration with Energy Recovery

This subsection describes Alternative 2 from the facility plan and assesses the air pollution control devices required to meet the SSI MACT rule. Gravity-thickened primary solids and thickened waste activated solids would be dewatered to about 25 percent solids. The dewatered cake would be fed to the fluidized bed incinerators. Each incinerator would be equipped with a waste heat recovery boiler, and electrical power would be generated by a turbine that uses incinerator waste heat.

The following air pollution control devices are recommended to meet the SSI MACT rule for new fluidized bed incinerators:

- Multiple venturi/impingement wet scrubber with a wet electrostatic precipitator combination to control particulate matter, cadmium, lead, sulfur dioxide (caustic addition to scrubber may be required), and hydrogen chloride emissions

- Ammonia or urea injection at the fluid bed reactor to control emissions of nitrogen oxides

Other regulated pollutants include carbon monoxide and dioxins/furans. The FBI controls these pollutants through inherent combustion efficiency. It will control nitrogen oxide emissions to about 60 ppmvd, which is higher than the emission limit, requiring the nitrogen oxide controls listed above.

Mercury Controls

As noted, using a mass balance, the peak incinerator stack emissions were estimated to be 0.13 mg/dscm at 7 percent oxygen. This exceeds the new FBI SSI MACT standard threshold of standard of 0.001 mg/dscm at 7 percent oxygen. To meet the SSI MACT standard for mercury, installation of a granular activated carbon mercury emission control system is recommended.

Alternative 3—Digestion with Further Thermal Processing

This subsection describes Alternative 3 and assesses air pollution control devices required to meet the SSI MACT rule. Gravity-thickened primary and thickened waste activated sludges would be fed to the digesters at about 6 percent solids. Digested solids would be dewatered to about 25 percent solids. Following dewatering, part of the solids would be conveyed and fed to a heat dryer. The balance of the solids would be fed to the fluidized bed incinerator. The incineration and drying processes would be thermally coupled such that the dryer would use waste heat from the incinerator to produce a dried granular product. The thermal needs of the dryer would be matched with the waste heat available from the incinerator, with two-thirds of the solids incinerated and one-third dried.

The SSI MACT rule applies only to emissions from the fluidized bed incinerators. The following air pollution control devices are recommended to meet the SSI MACT rule for new fluidized bed incinerators:

- Ammonia or urea injection at the fluid bed reactor to control emissions of nitrogen oxides
- Multiple venturi/impingement wet scrubber with a wet electrostatic precipitator combination to control particulate matter, cadmium, lead, sulfur dioxide (caustic addition to scrubber may be required), and hydrogen chloride emissions

Other regulated pollutants include carbon monoxide and dioxins/furans. The fluidized bed reactor controls these pollutants through inherent combustion efficiency. The reactor will also control emissions of nitrogen oxide to about 60 ppmvd, which is higher than the emission limit, requiring the nitrogen oxide controls listed above.

Mercury Controls

As noted, using a mass balance, the peak incinerator stack emissions were estimated to be 0.13 mg/dscm at 7 percent oxygen. This exceeds the new SSI MACT standard threshold of standard of 0.001 mg/dscm at 7 percent oxygen. To meet the SSI MACT standard for mercury, a granular activated carbon mercury emission control system is recommended.

Alternative 14—Incineration and Drying

This subsection describes Alternative 14 and assesses additional air pollution control devices required to meet the SSI MACT rule. Alternative 14 consists of drying part of the solids stream and incinerating the remainder. The amount of sludge sent to drying would be such that the dryer heating demand is matched with the waste heat available from the incinerator. Thermal oil would transfer heat from the incinerator to the dryer to provide all the dryer's heating needs. The amount of sludge sent to the dryer would be based on the amount of heat available for drying.

The SSI MACT rule applies only to emissions from fluidized bed incinerators. The following air pollution control devices are recommended to meet the SSI MACT rule for new fluid bed incinerators:

- Ammonia or urea injection at the fluid bed reactor to control emissions of nitrogen oxides
- Multiple venturi/impingement wet scrubber with a wet electrostatic precipitator combination to control particulate matter, cadmium, lead, sulfur dioxide (caustic addition to scrubber may be required), and hydrogen chloride emissions

Other regulated pollutants include carbon monoxide and dioxins/furans. The fluidized bed reactor controls these pollutants through inherent combustion efficiency. The reactor will also control emission of nitrogen oxides to about 60 ppmvd, which is higher than the emission limit, requiring the nitrogen oxide controls listed above.

Mercury Controls

As noted, using a mass balance, the peak incinerator stack emissions were estimated to be 0.13 mg/dscm at 7 percent oxygen. This exceeds the new FBI SSI MACT standard threshold of standard of 0.001 mg/dscm at 7 percent oxygen. To meet the SSI MACT standard for mercury, a granular activated carbon mercury emission control system is recommended.

Estimated Cost of Air Pollution Control

Table 6 lists the estimated cost of the air pollution control equipment recommended to meet the SSI MACT standards for each alternative. These cost estimates will be incorporated into the amended Solid Management Facility Plan.

TABLE 6
Air Pollution Control Equipment Cost Estimate To Meet SSI MACT Standards

Alternative	Capital Cost	Annual O & M Cost
Alternative 2	$11,100,000	$111,000
Alternative 3	$7,800,000	$78,000
Alternative 14	$8,700,000	$87,000
Alternative 16 (rehabilitate MHFs)	$20,200,000	$385,960

Note: Capital costs include construction, engineering, and GBMSD administration costs.ENR Construction Cost Index of 9027 (April 2011).

The costs for Alternative 16 includes the cost of new building to house the pollution control equipment. During predesign, locating the equipment in the space currently occupied by the belt presses or the Zimpro process could be considered.

For Alternative 16, an air pollution control train is required for each of the 2 MHFs.

Boiler MACT Standards

On February 21, 2011, the USEPA finalized a rule that will reduce emissions of toxic air pollutants from existing and new industrial, commercial, and institutional boilers at area source facilities. An area source facility emits or has the potential to emit less than 10 tons per year of any single air toxic or less than 25 tons per year of any combination of air toxics. The Green Bay Facility is an area source.

The final rule is applicable to boilers at area source facilities that burn coal, oil, or biomass, or nonwaste materials, but not to boilers that burn only gaseous fuels or any solid waste. The boilers use natural gas or incinerator waste heat as a fuel. The boilers used in future solids facilities would use natural gas, biogas (digester gas), or incinerator waste heat. Because none of the existing or future boilers burn or will burn coal, oil, or biomass, the boiler emission rules likely are not applicable. However, this should be verified during the air permitting process for any new or modified facility.

Attachment A

§ 60.4860 Do the emission limits, emission standards, and operating limits apply during periods of startup, shutdown, and malfunction?

The emission limits and standards apply at all times and during periods of malfunction. The operating limits apply at all times that sewage sludge is in the combustion chamber (*i.e.,* until the sewage sludge feed to the combustor has been cut off for a period of time not less than the sewage sludge incineration residence time).

§ 60.4861 How do I establish an affirmative defense for exceedance of an emission limit or standard during malfunction?

In response to an action to enforce the numerical emission standards set forth in paragraph § 60.4845, you may assert an affirmative defense to a claim for civil penalties for exceedances of emission limits that are caused by malfunction, as defined in § 60.2. Appropriate penalties may be assessed, however, if you fail to meet your burden of proving all of the requirements in the affirmative defense. The affirmative defense shall not be available for claims for injunctive relief.

(a) To establish the affirmative defense in any action to enforce such a limit, you must timely meet the notification requirements in paragraph (b) of this section, and must prove by a preponderance of evidence that the conditions in paragraphs (a)(1) through (a)(9) of this section are met.

(1) The excess emissions meet:

(i) Were caused by a sudden, infrequent, and unavoidable failure of air pollution control and monitoring equipment, process equipment, or a process to operate in a normal or usual manner, and

(ii) Could not have been prevented through careful planning, proper design or better operation and maintenance practices, and

(iii) Did not stem from any activity or event that could have been foreseen and avoided, or planned for, and

(iv) Were not part of a recurring pattern indicative of inadequate design, operation, or maintenance, and (2) Repairs were made as expeditiously as possible when the applicable emission limits were being exceeded. Off-shift and overtime labor were used, to the extent practicable to make these repairs, and

(3) The frequency, amount and duration of the excess emissions (including any bypass) were minimized to the maximum extent practicable during periods of such emissions, and

(4) If the excess emissions resulted from a bypass of control equipment or a process, then the bypass was unavoidable to prevent loss of life, personal injury, or severe property damage, and

(5) All possible steps were taken to minimize the impact of the excess emissions on ambient air quality, the environment and human health, and

(6) All emissions monitoring and control systems were kept in operation if at all possible consistent with safety and good air pollution control practices, and

(7) All of the actions in response to the excess emissions were documented by properly signed, contemporaneous operating logs, and

(8) At all times, the affected facility was operated in a manner consistent with good practices for minimizing emissions, and

(9) A written root cause analysis has been prepared the purpose of which is to determine, correct, and eliminate the primary causes of the malfunction and the excess emissions resulting from the malfunction event at issue. The analysis shall also specify, using best monitoring methods and engineering judgment, the amount of excess emissions that were the result of the malfunction.

(b) The owner or operator of the SSI unit experiencing an exceedance of its emission limit(s) during a malfunction, shall notify the Administrator by telephone or facsimile (fax) transmission as soon as possible, but no later than 2 business days after the initial occurrence of the malfunction, if it wishes to avail itself of an affirmative defense to civil penalties for that malfunction. The owner or operator seeking to assert an affirmative defense shall also submit a written report to the Administrator within 45 days of the initial occurrence of the exceedance of the standard in § 60.4845 to demonstrate, with all necessary supporting documentation, that it has met the requirements set forth in paragraph (a) of this section. The owner or operator may seek an extension of this deadline for up to 30 additional days by submitting a written request to the Administrator before the expiration of the 45 day period. Until a request for an extension has been approved by the Administrator, the owner or operator is subject to the requirement to submit such report within 45 days of the initial occurrence of the exceedance.

Update Flows and Loads

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DATE: August 5, 2011

Executive Summary

The flows and loads for the year 2028 projected in the *Solids Management Facility Plan* (November 2010) were based on data available at the time the project began in 2008. Since 2008, some conditions that affect loadings have changed. In addition, with delays in the project schedule, it is now estimated that construction of the solids facilities would not be completed until 2015, and assuming a 20-year planning period, that now requires that 2035 projected flows and loads be used instead of 2028. This memorandum presents the revised, recommended flows and load projections that use the most recent conditions and projects loads to 2035 that will be used for comparison of solids management alternatives.

Table 1 compares the 2035 projected thickened solids load used in the November 2010 facility plan, and the updated recommended projected solids loadings. The updated projection is lower than the previous projection.

TABLE 1
Total Average and Peak Month Thickened Sludge Loadings to Solids Processing

	Average (dtpd)	Peak Month (dtpd)
Original 2035 Projected (Table 6-1, *Solids Management Facility Plan*)	67	85
Revised 2035 Recommended Projections	51	64
Original 2015 Projected (Table 6-1, *Solids Management Facility Plan*)	53	66
Revised 2015 Recommended Projections	47	59

Use of the revised 2035 solids projections results in the solids system being sized for a peak month thickened sludge load of 64 dry tons per day (dtpd) compared to the facility plan recommendation of 85 dtpd. The following individual decreases are the reason for the overall lower projections:

- About 8 dtpd due to the loss of Georgia-Pacific contracted loads
- About 5 dtpd due to use of new, lower Procter & Gamble maximum loads instead of contracted loads
- About 2 dtpd due to reduction in JBS Green Bay load based on a JBS Green Bay request

- About 6 dtpd due to use of the most recent flows and loads data and population projections and other refinements to methods in projecting future growth rate

Based on projections provided by industries in a GBMSD survey, the projected loads from each of the 7 major industries that provide more than 1 percent of GBMSD revenue will be flat throughout the planning period. It is assumed that current loads from residential, commercial and smaller industries will increase in proportion to the projected increase in population. The Brown County Planning Department estimates that population in the GBMSD service area will increase by about 1 percent per year for the next 20 years.

It is recommended that the thickened solids loadings at the Green Bay Facility (GBF) continue to be tracked and trended and that the data be used to potentially update flows and loads during the solids facility predesign.

The methodology and assumptions used to develop these refined loadings are described below.

Revised Flow and Load Projections

Original Projections

Tables 2 and 3 are copies of Table 3-3 and 3-4 from the *Solids Management Facility Plan.* Industrial flows and loads from Thilmany and Sonoco in the De Pere Facility (DPF) service area were assumed to remain constant and were based on data from 2001 to 2006. The Fox River Fiber flow and load were based on data from 2006 through July 2008. Flows and loads for Georgia-Pacific and Procter & Gamble were based on 2008 contracted amounts. The other major industries discharging to the GBF—American Foods Group, Bay Valley Foods, and JBS Green Bay—were not projected separately from the municipal wastewater. Commercial and residential flows and loads were assumed to increase according to projections developed during the Facilities Plan for Regional Wastewater Management in the South Service Area.

Revised Projections

The following changes and assumptions were incorporated into the revised flow and load projections for 2035:

- Georgia-Pacific discontinued its wastewater discharge in 2010; therefore, this contribution was removed from the 2035 design loads. Georgia-Pacific was a significant contributor with a contracted BOD limit of 16,000 lb/day and TSS of 5,000 lb/day.
- EcoFibre is not in operation and was not include in the 2028 or 2035 projections.
- The Procter & Gamble projected load has decreased. Procter & Gamble recently requested maximum desired loads much lower than the contracted limits previously used.
- JBS Green Bay load had decreased 50 percent since 2008. JBS Green Bay advised GBMSD to use the 2010 data for design purposes.
- The original flow and load estimates assumed that flows and loads would remain constant from the following major industries: Georgia–Pacific, Procter & Gamble, Fox River Fiber, Thilmany, and Sonoco.

TABLE 2
2028 Flows and Loads with Mill Waste Transfer from the DPF

	Flow (mgd)	BOD (lb/day)	SS (lb/day)	WAS (lb/day)	PSD (lb/day)
DPF					
Residential/commercial					
Maximum month	13.7	16,770	26,850		
Average	8.3	10,500	21,810		
Industrial (excluding mill waste force main)					
Maximum month	2.0	14,930	5,880		
Average	1.6	11,270	2,720		
Total Metro Waste (residential/commercial plus industrial, excluding mill waste force main)					
Maximum month	15.7	31,700	32,730		
Average	9.9	21,770	24,530		
Mill Waste Force Main (to GBF)					
Maximum month	1.1	17,210	2,130		
Average	1.1	16,090	1,090		
Mill Waste Force Main to De Pere Aeration Basins					
Maximum month	0.1	1,460	180		
Average	0	0	0		
Metro Waste transfer from DPF to GBF					
Maximum month	3.6	7,250	7,490		
Average	3.6	7,920	8,920		
Total Influent (metro waste plus mill waste force main minus transfer to GBF)					
Maximum month	12.2	25,910	25,420	***33,620***	
Average	6.3	13,850	15,610	***19,090***	
GBF					
Metro Waste (residential/ commercial and other industries)					
Maximum month	35.40	46,960	50,470		
Average	28.50	39,460	42,060		
Mill Waste (contracted paper mills)					
Maximum Month	4.90	23,300	19,100		
Average	4.50	20,500	16,200		
Metro Waste transfer from De Pere to Green Bay					
Maximum month	3.6	7,250	7,490		
Average	3.6	7,920	8,920		
Mill Waste Force Main (to GBF)					
Maximum month	1.06	17,210	2,130		
Average	1.06	16,090	1,090		

TABLE 2
2028 Flows and Loads with Mill Waste Transfer from the DPF

	Flow (mgd)	BOD (lb/day)	SS (lb/day)	WAS (lb/day)	PSD (lb/day)
Total Influent (metro waste plus mill waste plus transfer from De Pere)					
Maximum month	45.0	94,720	79,190	**76,720**	**75,200**
Average	37.6	83,970	68,270	**65,050**	**63,110**
De Pere WAS Pumped from De Pere to GBF					
Maximum month	0.5[a]			***33,620***	
Average	0.3[a]			***19,090***	
Total WAS to be Processed at GBF					
Maximum month	1.7[a]			**110,340**	
Average	1.3[a]			**84,140**	

Source: Table 3-3, *Final Draft Solids Facility Plan* (November 2010)

Note: The information in this table was derived from the *Facilities Plan for Regional Wastewater Management in the South Service Area* .

[a]WAS flows assume 0.8% solids content

TABLE 3
2028 Flows and Loads With Mill Waste Transfer from the DPF

	2028 Average, lb/day (dtpd)	**2028 Maximum Month, lb/day (dtpd)**
Primary sludge (~1% TS)	63,110 (31.6)	75,200 (37.6)
Thickened PSD (~6% TS)	**56,800 (28.4)**	**67,680 (33.8)**
De Pere pumped WAS (~1% TS)	19,090 (9.5)	33,620 (16.8)
Green Bay WAS (~1% TS)	65,050 (32.5)	76,720 (38.4)
WAS processed (~1% TS)	84,140 (42.1)	110,340 (55.2)
Thickened WAS (~6% TS)	**67,310 (33.7)**	**88,270 (44.1)**
Total Thickened Sludge to Dewatering (~6% TS)	**124,110 (62.1)**	**155,950 (78.0)**

Source: Table 3-4, *Final Draft Solids Facility Plan* (November 2010)

In these revised projections, the flows and loads were based on forecasts requested from major industries. The major industries are: Procter & Gamble, Fox River Fiber, Thilmany, Sonoco, American Foods Group, Bay Valley Foods, and JBS Green Bay. For the industries that responded, their forecasts were used. Overall, the responses indicated the loads from the major industries would be approximately flat. For industries that did not respond, it was assumed that their flows and loads remained constant.

Table 4 compares the assumptions used in the 2028 solids projections with those used for the 2035 solids projections. Table 5 shows the past and estimated future populations of villages, towns and cities that lie partially or wholly within the GBMSD sewer service area. Based on these data, developed by the Brown County Planning Department, the population within the GBMSD sewer service area is forecast to increase at an annual rate of about 1 percent. In addition, to provide a historical perspective, from 1980 to 2010, the actual Brown County population increased at an annual rate of 1.1 percent.

TABLE 4
Comparison of Assumptions for Previous 2028 Solids Projections and Revise 2035 Solids Projections

2028 Solids Projection Assumptions	2035 Solids Projection Assumptions
2028 commercial and residential flows and loads for GBF and DPF were obtained from the 2006 Facilities Plan for Regional Wastewater Management in the South Service Area (based on 2001–2006 data).	Population projections were obtained from Brown County. The population projections indicate approximately a 1 percent annual population growth through 2030, a rate assumed to continue through 2035.
Industrial loads based on 2001–2006 data, except for Georgia-Pacific and Procter & Gamble, which were based on contracted limits. DPF and GBF major industrial loads were assumed to remain constant while residential, small industry and commercial loads increased at a rate estimated in the 2006 Facilities Plan for Regional Wastewater Management in the South Service Area.	2035 commercial/residential/small industry loads were projected by using these loads from May 2010 to May 2011 and then assuming a 1 percent annual increase to match population growth. Additionally, 20 percent of the forecasted population for the Town of Rockland was assumed to be added to the GBMSD service area by 2035. Major industrial loads were based on 2008–2010 data with the average from these 3 years adjusted based on industry forecasts. Industries that did not respond to the request for forecasts were assumed to remain constant. The result was that major industrial loads are projected to be flat through the planning period.
Georgia-Pacific and Procter & Gamble were assumed to discharge at their full 2008 contracted limits.	Georgia-Pacific load was assumed to be zero because of the shutdown in 2010. Procter & Gamble design load was recently obtained from Procter & Gamble. This design load is significantly lower (about 75 percent) than the previously contracted load.
A spreadsheet model was used to determine WAS and PSD production at the GBF based on the 2028 loads	A spreadsheet model was used to determine WAS and PSD production at the GBF based on the 2035 loads. The model was validated using actual solids data from the time period following startup of the interplant WAS pipeline. Use of the data following the pipeline startup reduces the number of measurement points, better reflects actual current system performance and therefore increases the accuracy of the data.
An Excel-based treatment plant simulator was used to determine WAS production at the DPF based on the 2028 loads	An Excel-based treatment plant simulator was used to determine WAS production at the DPF based on the 2035 loads. The model was validated using actual solids data from the time period following startup of the interplant WAS pipeline. Use of the data following the pipeline startup reduces the number of measurement points, better reflects actual current system performance and therefore increases the accuracy of the data.

Tables 6 and 7 show the 2035 projected flows and loads that are based on the assumptions stated in Table 4. Peak month total solids to the GBF solids facility are based on a peak month to average ratio of 1.26, the same peaking factor used in the *Solids Management Facility Plan* that was based on data from the *Facilities Plan for Regional Wastewater Management in the South Service Area.* Peak month influent loads are for informational purposes and were not used to determine peak month total solids.

Sources of Solids

Figures 1 and 2 show the sources of solids to the GBF solids processing system for average loadings. Commercial, small industry, and residential loads (TSS and BOD) account for three-fourths of the solids (51 percent from GBF, 24 percent from DPF), and major industrial loads account for the remaining one-fourth. Fox River Fiber is the most significant industrial contributor (almost 30 percent of the major industrial contribution) followed by Procter & Gamble, Thilmany and JBS Green Bay (each about 15 percent of the industrial load).

TABLE 5
Population Projections, 2000–2030, Brown County (Revisions to 2008 Release)

Municipality Name	Census		Projection			
	2000	2010	2015	2020	2025	2030
T Eaton	1,414	1,551	1,790	1,913	2,027	2,132
T Glenmore	1,187	1,252	1,362	1,419	1,471	1,515
T Green Bay	1,772	1,929	2,278	2,456	2,625	2,779
T Holland	1,339	1,452	1,595	1,668	1,736	1,795
T Humboldt	1,338	1,435	1,538	1,592	1,640	1,680
T Lawrence	1,548	2,437	3,220	3,620	4,005	4,367
T Ledgeview	3,363	4,626	6,131	6,894	7,627	8,319
T Morrison	1,651	1,711	1,813	1,868	1,915	1,953
T New Denmark	1,482	1,548	1,676	1,726	1,770	1,806
T Pittsfield	2,433	2,574	2,804	2,920	3,024	3,112
T Rockland	1,522	1,654	1,996	2,167	2,329	2,479
T Scott	3,138	3,543	4,359	4,769	5,160	5,522
T Wrightstown	2,013	2,192	2,468	2,609	2,739	2,856
V Allouez	15,443	15,403	15,611	15,747	15,822	15,823
V Ashwaubenon	17,634	17,649	18,366	18,761	19,082	19,312
V Bellevue	11,828	14,042	18,229	20,355	22,394	24,308
V Denmark	1,958	2,055	2,256	2,377	2,488	2,587
V Hobart	5,090	5,686	6,624	7,104	7,557	7,969
V Howard *	13,546	15,545	19,050	20,837	22,538	24,116
V Pulaski *	3,013	3,268	3,842	4,141	4,422	4,681
V Suamico	8,686	10,621	13,950	15,639	17,261	18,786
V Wrightstown *	1,934	2,348	3,011	3,350	3,675	3,979
C De Pere	20,559	22,356	25,805	27,578	29,237	30,742
C Green Bay	102,767	104,101	108,481	110,899	112,879	114,313
Brown County	**226,658**	**240,978**	**268,255**	**282,409**	**295,423**	**306,931**
Projected Annualized Population Growth			**1.1%**	**1.03%**	**0.91%**	**0.77%**

*The municipality crosses the county boundary.
T=Town of
V=Village of
C = City of

TABLE 6
2035 Average Flows and Loads with Mill Waste Transfer from the DPF

	Flow (mgd)	BOD (lb/day)	SS (lb/day)	WAS (lb/day)	PSD (lb/day)
DPF					
Residential/commercial	8.1	7,226	16,561		
Thilmany	1.1	7,334	579		
Sonoco	0.1	4,415	1,406		
Total Influent (residential/commercial plus industrial)	9.2	18,985	18,546	***24,592***	
GBF					
JBS Green Bay	1.0	4,792	3,312		
American Foods Group	0.5	3,922	1,295		
Bay Valley Foods	0.2	2,549	686		
Metro Waste (residential/commercial and other industries)	25.6	29,832	35,835		
Procter & Gamble	4.5	1,400	3,000		
Mill Waste (FRF) Force Main (to GBF)	1.0	19,457	1,063		
Total Influent (metro waste plus mill waste plus transfer from De Pere)	32.9	61,952	45,190	**50,470**	**45,470**
De Pere WAS Pumped from De Pere to GBF	0.4[a]			***24,592***	
Total WAS to be Processed at GBF	1.3[a]			**75,062**	
GBF + DPF	42.1	80,937	63,736		

Industrial loads are based on May 2010 – April 2011 data. Major industrial loads were assumed to remain constant to the year 2035. Residential/Commercial/small industrial loads are based on May 2010 – April 2011 data plus 1% estimated growth to the year 2035.

No metro waste assumed to be transferred from DPF to GBF.

All FRF mill waste assumed to be pumped to GBF.

Georgia-Pacific East and EcoFibre loads assumed to be zero. Not included in table.

[a]WAS flows assume 0.8% solids content

TABLE 7
2035 Design Solids Loading

	2035 Average, lb/day (dtpd)	**2035 Maximum Month, lb/day (dtpd)**
Total Raw Sludge to Thickening	**120,532 (60.3)**	
Primary sludge (~1% TS)	45,470 (22.7)	
Thickened PSD (~6% TS)	**40,923 (20.5)**	
De Pere pumped WAS (~1% TS)	24,592 (12.3)	
Green Bay WAS (~1% TS)	50,470 (25.2)	
WAS processed (~1% TS)	75,062 (37.5)	
Thickened WAS (~6% TS)	**60,050 (30.0)**	
Total Thickened Sludge to Dewatering (~6% TS)	**100,973 (50.5)**	**127,226 (63.6)**

FIGURE 1
Sources of Solids for 2035 Loadings

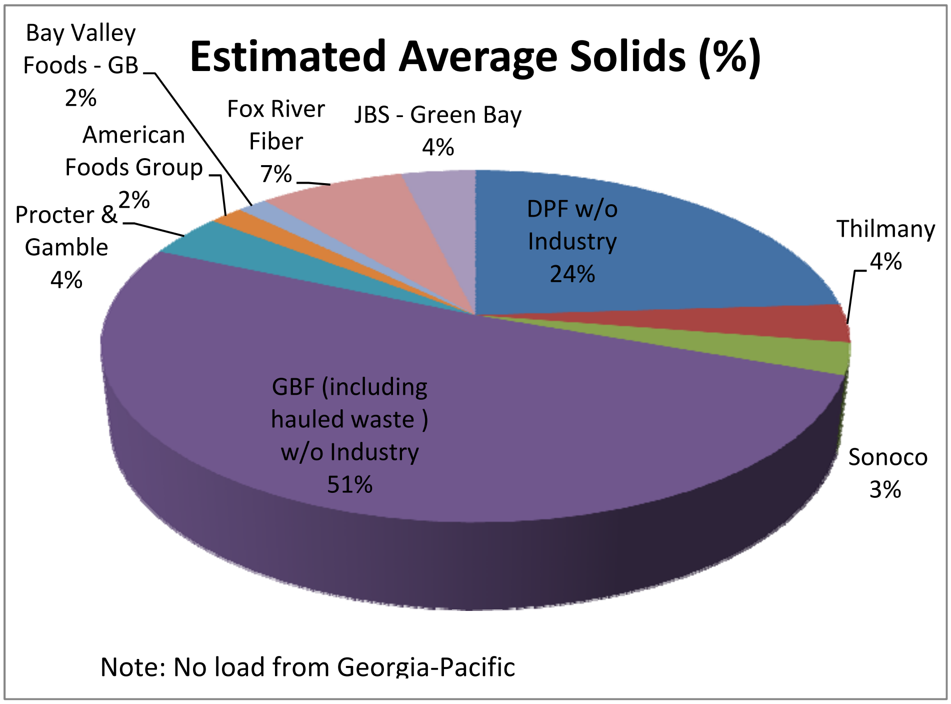
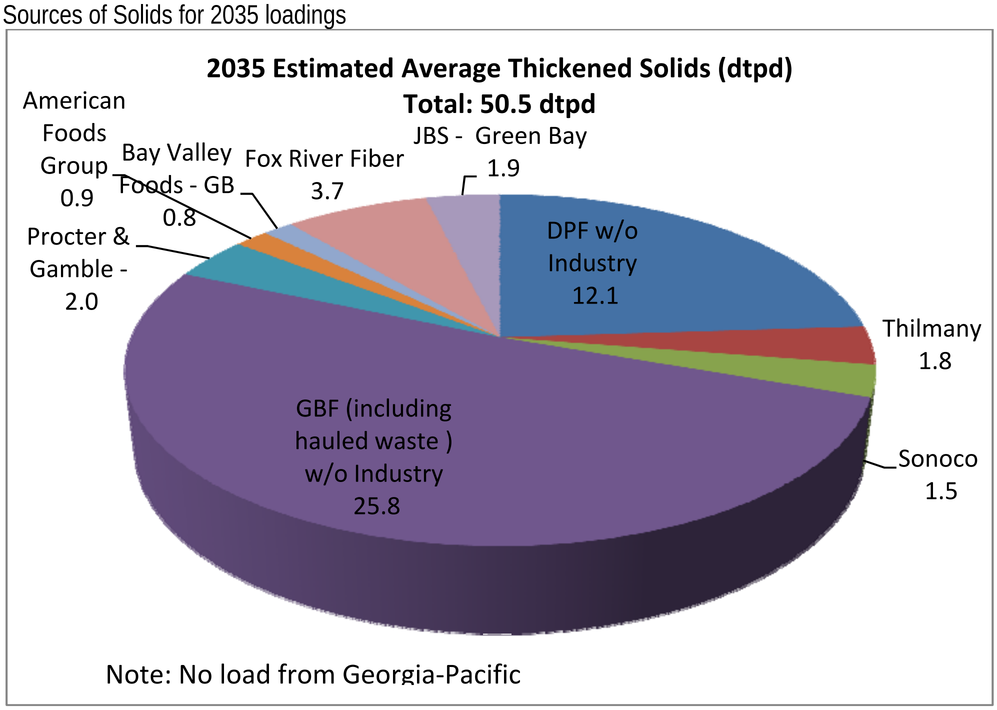


FIGURE 2
Sources of Solids for 2035 loadings



Comparison of Original and Updated Flow and Loads

The 2035 projected flows and loads are lower than the previous projected flows and loads presented in the *Solids Management Facility Plan.* This is due to the loss of Georgia-Pacific, reduction in Procter & Gamble load, reduction in JBS Green Bay load, and other adjustments made including using the most recent (May 2010–April 2011) industrial and municipal loads data as the new baseline rather than the older baseline data originally used. Table 8 lists the May 2010 through April 2011 loads to each treatment plant and the loads from major industries used as the new baseline for estimating 2035 loads. Tables 9 and 10 compare the 2028 projected loads from the *Solids Management Facility Plan* and the revised 2035 projected loads.

TABLE 8
Actual Average Loads (May 1, 2010–April 30, 2011)

	BOD (lb/day)	TSS (lb/day)
Green Bay Facility Total	47,001	34,214
De Pere Facility Total	22,153	15,282
Total GBMSD Service Area	69,154	49,497
Green Bay Facility—hauled waste (2008–2010)	3,648	2,896
American Foods Group	3,565	1,177
Bay Valley Foods	2,549	686
Fox River Fiber[a]	19,457	1,063
Georgia-Pacific East[b]	0	0
JBS Green Bay	4,792	3,312
Procter & Gamble	1,494	2,905
Thilmany	7,344	579
Sonoco	4,415	1,406
Total Industrial Contribution	**47,264**	**14,024**

Note: All loads (except GBF hauled waste) based on actual data from May 2010 through April 2011, the period following startup of the WAS interplant pipeline.

[a]Fox River Fiber redirected wastewater flow into a newly constructed force main in January 18, 2010.

[b]Georgia-Pacific East– discontinued flow to GBMSD on December 12, 2009.

TABLE 9
2028 Projected Average

Source	BOD (lb/day)	TSS (lb/day)	
Green Bay Facility	Not used	Not used	
Green Bay Facility—hauled waste	Not used	Not used	
GBF total influent minus Georgia-Pacific and Procter & Gamble	63,470	52,070	
Georgia-Pacific	16,000	5,000	
Procter & Gamble	4,500	11,200	
De Pere Facility	13,850	15,610	
Total GBMSD Service Area	**97,820**	**83,880**	
Significant Industries			
Fox River Fiber[a]	16,090	1,090	
JBS Green Bay	n/a	n/a	
Procter & Gamble	4,500	11,200	
Georgia-Pacific East[b]	16,000	5,000	
Thilmany	6,680	690	
American Foods Group	n/a	n/a	n/a
Sonoco	0.10	3,660	1,630
Bay Valley Foods—GB	n/a	n/a	n/a
Total Industrial Contribution	**7.1**	**46,930**	**19,610**

Source: Table 3-3, *Solids Management Facility Plan.*

[a]Fox River Fiber redirected wastewater flow into a newly constructed force main in January 18, 2010.

[b]Georgia-Pacific East discontinued flow to GBMSD on December 12, 2009.

TABLE 10
Updated 2035 Average Projected Loads

Source	BOD (lb/day)	TSS (lb/day)
Green Bay Facility Total	61,952	45,190
De Pere Facility Total	18,985	18,546
Total GBMSD Service Area	80,937	63,736
Green Bay Facility—hauled waste	4,632	3,677
American Foods Acme	3,922	1,295
Bay Valley Foods	2,549	686
Fox River Fiber[a]	19,457	1,063
Georgia-Pacific East[b]	0	0
JBS Green Bay	4,792	3,312
Procter & Gamble	1,400	3,000
Thilmany	7,344	579
Sonoco	4,415	1,406
Total Industrial Contribution	**48,511**	**15,018**

Note: All projected loads (except GBF hauled waste) use actual data from May 2010 through April 2011 as the baseline, the period following startup of the WAS interplant pipeline. Industrial loads except as noted below were assumed to stay constant through 2035. Residential/commercial/small industrial loads were projected based on 1% annual growth through 2035. American Foods Group load was increased 10% per request. Procter & Gamble load was provided by Procter & Gamble.

[a]Fox River Fiber redirected wastewater flow into a newly constructed force main in January 18, 2010 and all the waste assumed to be directed to GBF.

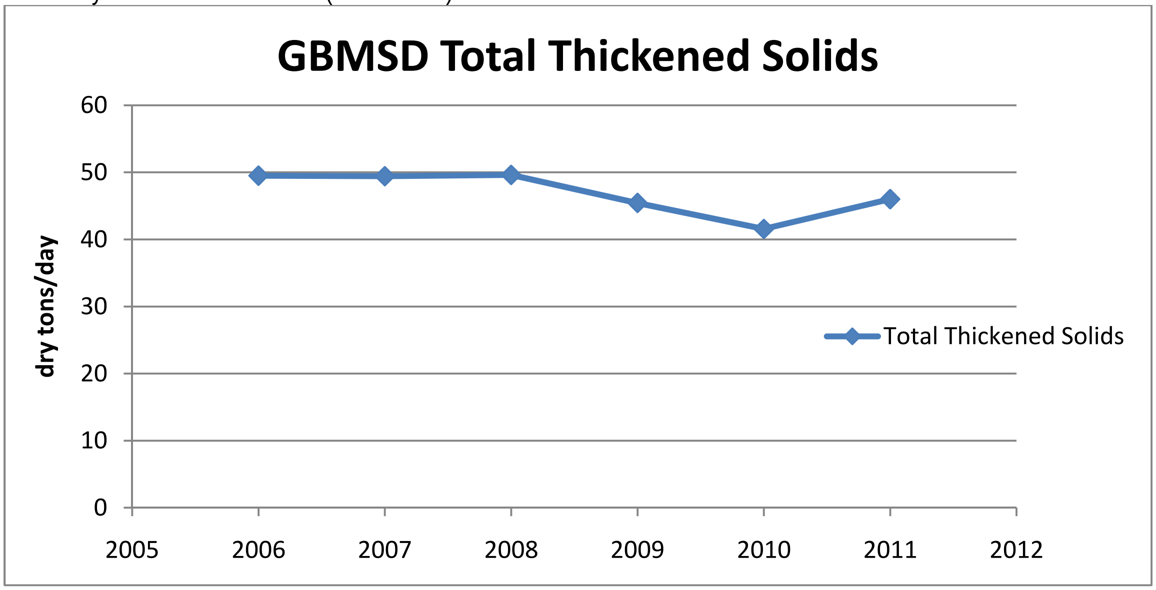
[b]Georgia-Pacific East discontinued flow to GBMSD on December 12, 2009.

Recent Decreases in Loadings and Solids

Since the original projections were done at the beginning of the project in 2008, flows and loads have decreased for several reasons. Figure 3 shows that the actual total thickened solids loads has decreased by about 4 dtpd, or 8 percent from 2008 to May 2011. The 4 dtpd decrease is likely due primarily to the following events:

- January 2008—Eco Fiber began operating intermittently in 2008
- June 2008—Georgia-Pacific East shut down one paper machine (~0.5 dtpd decrease)
- January 2009—Eco Fiber shut down except for showing operation to potential buyer (~1 dtpd decrease)
- January 2010—Georgia-Pacific East shut down (~1 dtpd decrease)
- 2010—JBS Green Bay load has decreased by 25 percent from 2008 average (~1 dtpd decrease)
- Procter & Gamble TSS load has decreased 25 percent from 2008 (~0.5 dtpd decrease)

FIGURE 3
2006–May 2011 Total Thickened (GBF + DPF) Solids Trend



Other normal variations in loads have occurred that could have contributed to the load changes. Also, it should be noted that the JBS Green Bay pretreatment system was shut down for 4 to 5 months in 2009, resulting in about a 2 to 4 dtpd increase when averaged over the year.

The recent decrease in loads was confirmed by reviewing multiple data sources—influent loadings, cake quantities incinerator ash, and other data—to confirm the magnitude of the decrease. Again, Figure 3 shows a decrease in total thickened solids of about 8 percent which can be compared to Figure 4 which shows an 11 percent decrease in influent solids from 2008 to 2010 and an 8 percent decrease in influent BOD confirming that solids have decreased.

Figure 5 shows the GBF and DPF thickened solids data based on several different sources (WAS, TPSD, cake, ash data). The unthickened solids, data were used to estimate thickened solids by making assumptions for capture rate in thickening. The cake data were used to estimate thickened solids by making assumptions for the capture rate in dewatering. The ash data were used to estimate thickened solids by making assumptions for water content in ash, volatility of cake, and dewatering capture rate. The various data sources agree relatively well, and show a general decrease in solids at the GBF from 2008 to May 2011. Figure also shows that as expected, the actual thickened solids (BFP feed) at GBF increased about 10 to 12 dtpd in 2010–2011 due to the addition of DPF following the pipeline startup in May 2010.

Figure 6 shows the combined GBF and DPF thickened solids estimates. This figure shows that total thickened solids has decreased somewhat in the past 3 years. The most accurate trend line in the figure should be the one derived from the unthickened WAS and TPSD data because it relies completely on measured data—flow and solids concentrations. The other trend lines required assumptions be made about parameters such as ash moisture content and dewatering solids capture. The WAS and TPSD data indicate about an 8 dptd decrease from 2008 to 2010 followed by a recent increase in the first part of 2011. Use of other data show a slightly different amount of decrease but the trends show good agreement, which helps confirm the recent trends and also provides confirmation of the loading rates.

FIGURE 4
Total Influent Load Trend (2008–2010) (GBF + DPF)

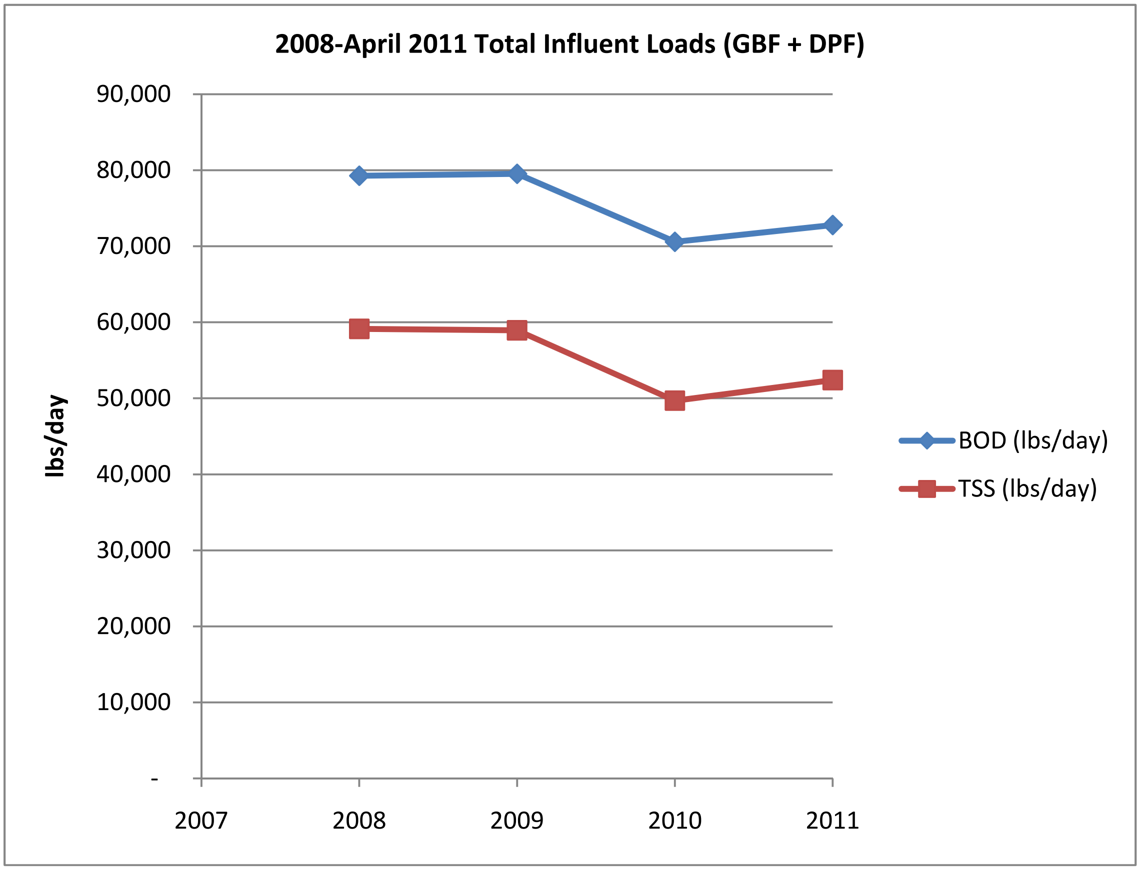


FIGURE 5
GBF and DPF Thickened Solids Production Estimated from Various Data Sources (2008–2011)

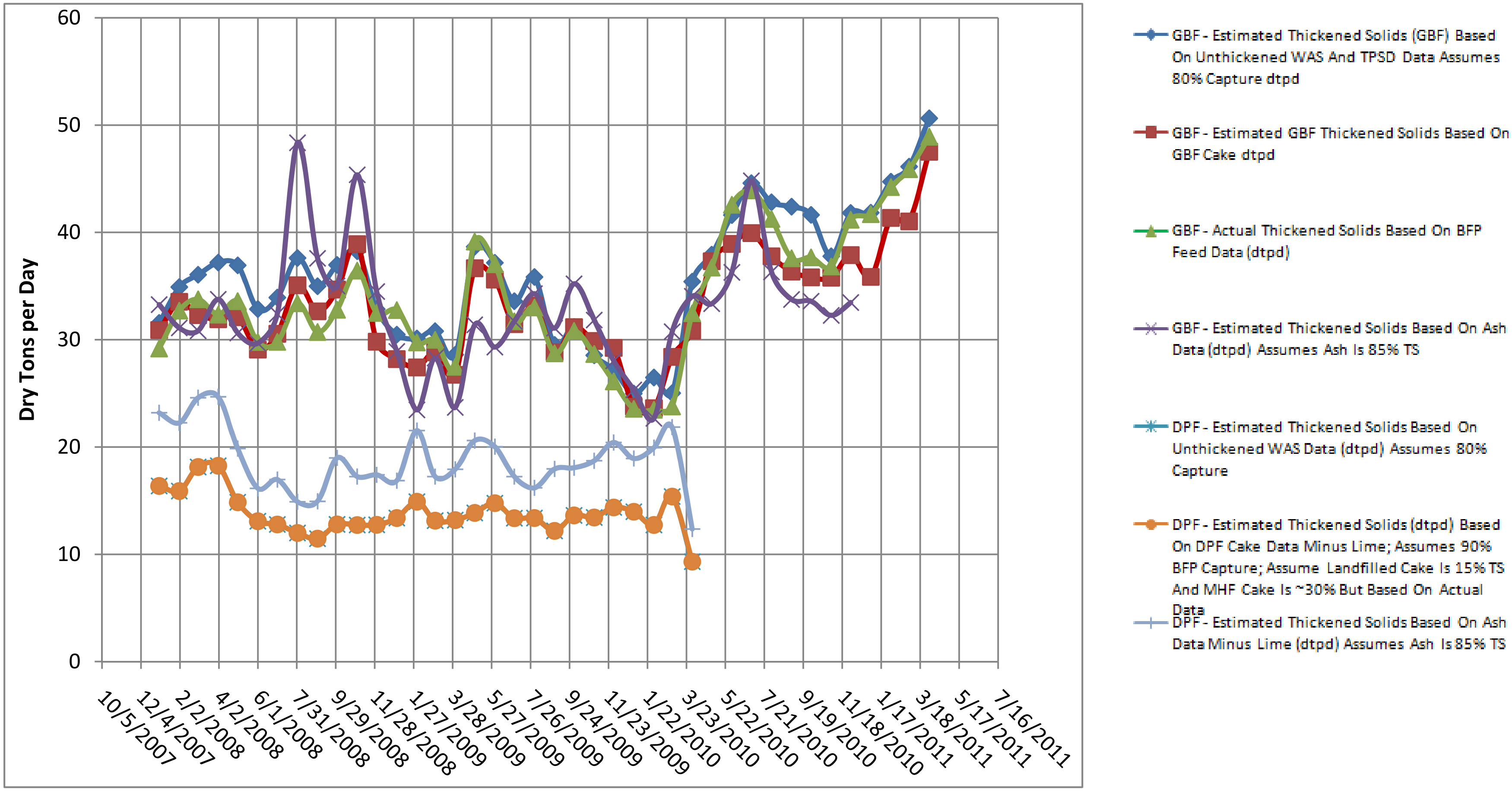
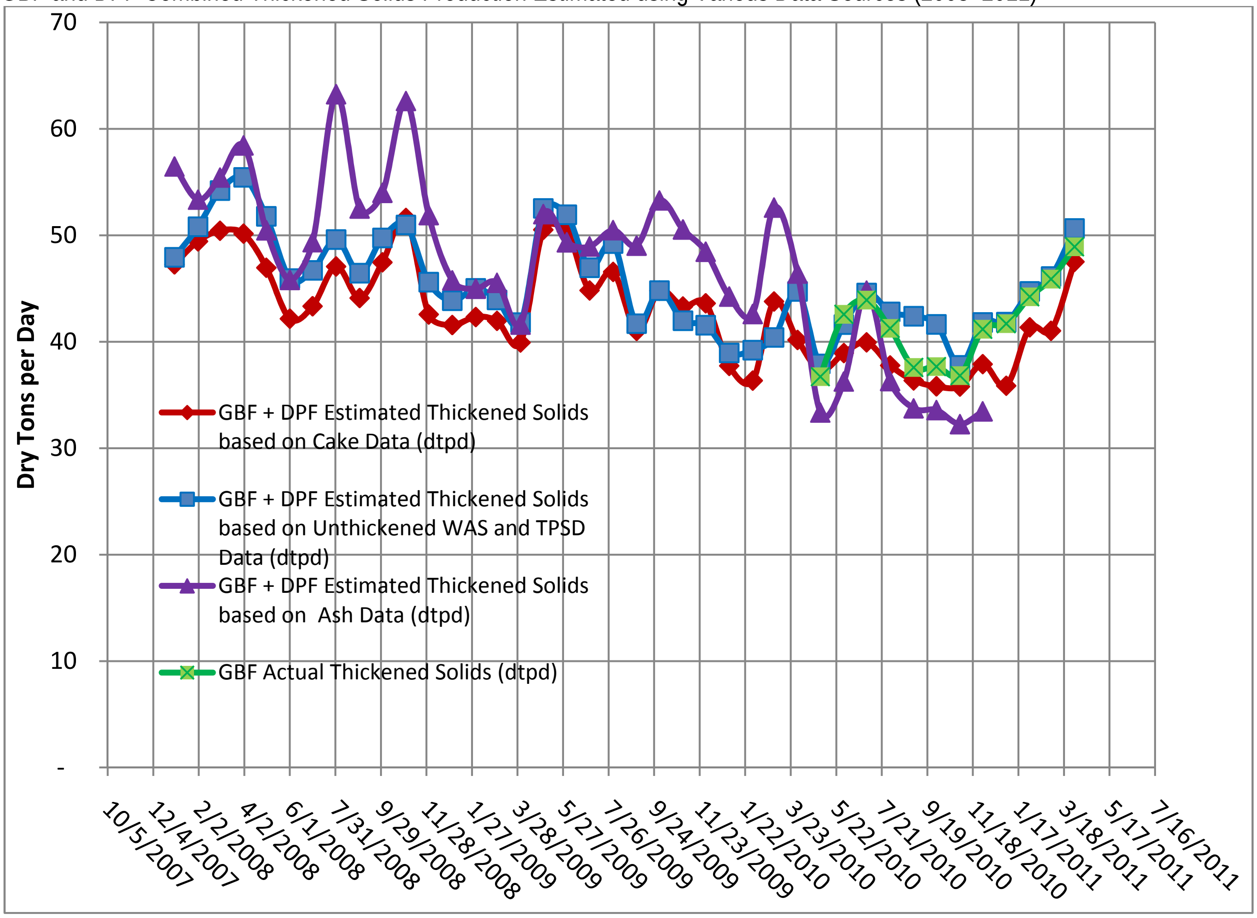


FIGURE 6
GBF and DPF Combined Thickened Solids Production Estimated using Various Data Sources (2008–2011)



Conclusions and Recommendations

Table 11 compares the 2035 projected thickened solids load used in the November 2010 facility plan to the updated projected solids loadings. The revised projection is lower than the previous projections.

TABLE 11
Total Average and Peak Month Thickened Sludge Loadings to Solids Processing

	Average (dtpd)	Peak Month (dtpd)
Original 2035 Projected (Table 6-1, *Solids Management Facility Plan*)	67	85
Revised 2035 Recommended Projections	51	64
Original 2015 Projected (Table 6-1, *Solids Management Facility Plan*)	53	66
Revised 2015 Recommended Projections	47	59

Use of the revised 2035 solids projections presented in this memorandum would result in the solids system being sized for a peak month thickened sludge load of 64 dry tons per day (dtpd) compared to the November 2010 Solids Management Facility Plan recommendation of 85 dtpd. The following decreases contribute to the overall 21 dtpd decrease:

- About 8 dtpd due to the loss of Georgia-Pacific contracted loads
- About 5 dtpd due to use of new, lower Procter & Gamble maximum loads instead of contracted loads
- About 2 dtpd due to reduction in JBS Green Bay load based on discussions with JBS Green Bay
- About 6 dtpd due to use of the most recent flows and loads data and population projections and other refinements to methods in projecting future growth rate

Based on projections provided by industries in a GBMSD survey, the projected loads from the 7 major industries that provide more than 1 percent of GBMSD revenue will be flat throughout the planning period. It is assumed that current loads from residential, commercial, and smaller industries will increase in proportion to the projected increase in population. The Brown County Planning Department estimates that population in the GBMSD service area will increase by about 1 percent annually for the next 20 years.

It is recommended that the GBF thickened solids loadings continue to be tracked and trended and that the data be used to update flows and loads during the solids facility predesign. In addition, during predesign, it is recommended that GBMSD consider adding additional capacity for industrial loads that have not yet been identified. Doing so is allowed under NR 110.09 which states in part:

> This additional allowance for future unplanned industrial flow shall not normally exceed 5% (or 10% for towns with less than 10,000 population) of the total design flow of the treatment works exclusive of the allowance or 25% of the total industrial flow (existing plus documented future), whichever is greater.

Green Bay Metropolitan Sewerage District
Solids Management Facilities Plan
Alternative Evaluation Framework

Objectives, Criteria, Performance Indices and Scales

INTRODUCTION

Fundamental steps in GBMSD's Solids Management Facilities Plan process involve the use of formal and rigorous evaluation techniques to screen and ultimately select a recommended alternative for implementation. These techniques require careful delineation of GBMSD objectives, criteria and performance measures to be used for alternatives evaluation. Based on a synthesis of input provided by GBMSD staff and external stakeholders, and largely affirmed by the GBMSD Commissioners, the following objectives, criteria and performance metrics have been developed for GBMSD's prospective alternatives evaluation. This synthesis involved a reconciliation of comments and suggestions offered by different stakeholders. A brief review of linkages between comments provided by key stakeholders and the defined evaluation framework is provided in the Appendix. In addition, the synthesis refined the evaluation framework to ensure objectives and criteria are non-redundant, independent, and comprehensive – as required for effective scoring and ranking of alternatives.

FUNDAMENTAL OBJECTIVES

Fundamental objectives define what the alternatives are intended to accomplish and indicate how relative performance of alternatives may be measured. For the GBMSD Solids Management facilities, four objectives were defined:

- **Financial:** Minimize the 20-year lifecycle costs of alternative implementation – operating, capital[1], and net revenues or costs associated with reuse, product sales, or disposal.

- **Operations:** Define a solids management system that safely performs at desired service levels [2] and enables incremental expansion[3] and re-alignment of process configurations under variable flow and load conditions and external facility availability.

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[1] Includes all capitalized expenditure in lifecycle of the asset including permitting, design, construction, rehabilitation and salvage values.

[2] Threshold values for service levels are meeting current regulatory requirements. Desired service levels are related to compliance with potential future regulatory changes.

[3] Incremental expansion and process configuration enable alternatives to limit incidence of idle assets that may be specified to achieve desired redundancy.

- **Social/Community Impacts:** Promote stakeholder/community acceptance and support of solids management system alternative through stakeholder/community partnering and education and limitation of adverse aesthetic impacts.

- **Environmental:**[4] Minimize the solids management system's impacts on the environment by maximizing beneficial reuse/recycling, and minimizing energy consumption and green house gas emissions (e.g., climate change impacts, ground water impacts and metal contaminates).

CRITERIA

Given the four fundamental objectives for the GBMSD solids management system, specific criteria that define specific bases for evaluation of the performance of the candidate solids system alternatives were delineated. By definition, strong performance relative to the stated criteria is indicative of accomplishment of the stated objective. Criteria for evaluation of the GBMSD solids management alternatives are as follows:

1. **Financial**

    a. **Lifecycle costs:**[5] Net present values of all capital, operating, maintenance, reuse, and disposal costs, less any revenue from product sales over a 20-year period using a five percent discount rate.

    b. **Solids Disposal Costs:** Diversify GBMSD's revenue, and offset solids disposal costs from sales of products of the solids management system.

2. **Operations**

    a. **Flexibility:** A system that features process trains that enables incremental expansion and re-alignment of process configurations to address changing waste loads, regulations, operating conditions or availability of external facilities (e.g., landfill).

    b. **Operability:** A solids management system that mitigates prevailing operating risks by featuring facility configurations and operating protocols for which operator training and expertise is readily available.

    c. **Future regulatory requirements:** A solids management system that facilitates complying with or exceeding currently anticipated future regulations.

    d. **Safety:** A solids management system that enables staff to perform operations with limited, mitigated risks to personnel, public health and property damage

---

[4] All screened alternatives, as a threshold condition, will meet all current regulatory requirements.

[5] Additional criteria to be considered for alternative short-list selection could include ratepayer impacts addressing the "slope" of rate increases associated with lifecycle costs.

3. **Social/Community Impacts**

   a. **Partnerships:** A solids management system that positions GBMSD to engage interested regional partners - in terms of regional contributions to waste streams and/or reuse options and educational/sustainability initiatives.

   b. **Aesthetic impact:** Projected performance of alternatives in terms of noise level, odor and visual impacts both for on-site and remote facilities.

   c. **Key stakeholder (political, community, staff) acceptance:** The solids management system is recognized as a community asset providing services consistent with community values and opportunities for staff training and development.

4. **Environmental**[6]

   a. **Beneficial Reuse/Recycling:** The solids management system's ability to reuse or recycle solids generated by the facility.

   b. **Non-renewable Energy**: Amount of non-renewable energy consumed by the solids management system

   c. **GHG Emissions**: Green House Gas emissions from the solids management system expressed as equivalent carbon in accordance with recognized protocols.

PERFORMANCE MEASURES AND SCALES:

Evaluation of the available solids management system alternatives was accomplished by scoring the anticipated performance of the alternatives in terms of the criteria listed above and thereby their anticipated contributions to the solids management plan objectives. Provided in the table below are the principal performance measures for each criteria.[7]

No.	Criteria	Performance Measure
1. Financial		
a.	Lifecycle Costs	Net present value of lifecycle costs using 20 year forecast period, baseline cost estimation scenario, and five percent discount rate
2. Operations		
a.	Flexibility	Ability to reconfigure process trains through modular components.
b.	Operability	Track record of prior performance (e.g., years of successful operation), relative complexity of

[6] All screened alternatives, as a threshold condition, will meet all current regulatory requirements.
[7] Ranges of performance for each criterion are provided in the Appendix delineating Performance Scales.

		facility configuration, and staff training requirements.
c.	Future Regulatory Requirements	Requirements to enable system to accommodate compliance with potential regulations related to reducing GHGs, EPA air pollution control, or solids re-use/disposal regulations requiring Class A treatment and reduction in solids metals or other compounds.
d.	Safety	Based on industry experience safety records relative to risks of significant hazard.
3. Social / Community Impacts		
a.	Partnerships	Stakeholder perception of relative extent to which alternative will enable shared dedication of resources, risks and returns regionally.
b.	Aesthetic Impacts	Projected performance of alternatives in terms of noise level, odor and visual impacts both for on-site and remote facilities.
c.	Key stakeholder (political, community, staff) acceptance	Indices of key stakeholder scoring in terms of advancing community goals and enabling staff training and environmental education opportunities
4. Environmental		
a.	Beneficial Reuse/Recycling	Percentage of solids that may be reused or recycled under projected loading conditions.
b.	Non-renewable Energy	Amount of non-renewable energy, consumed under projected loading conditions.
c.	GHG Emissions	Green House Gas emissions of the solids management system expressed as equivalent carbon in accordance with recognized protocols.

EVALUATION PROCESS:

These Objectives and Criteria were employed in a multi-step evaluation process designed to ensure that the selected GBMSD solids management system alternative yields the highest net benefits, defined in terms of contributions to the stated Objectives. The multi-step process may be briefly summarized as follows:

1. Scoring of 16 pre-screened alternatives using performance scales (see Appendix) and objective weights based on stakeholder input:

Financial (30%) | Operations (35%) | Social / Community (15%) | Environmental (20%)

2. Test robustness of resultant rankings of top alternatives applying alternative weights

3. Select a short list of alternatives for more detailed evaluation (e.g., refined cost estimates, facility layouts, and process flow diagrams.)
4. Scoring and ranking of short list alternatives to support recommendation of selected alternative.

APPENDIX I

GBMSD SOLIDS MANAGEMENT FACILITIES PLAN

Alternatives Evaluation: Performance Scales

1. **Financial:** Minimize the lifecycle costs of alternative implementation – operating, capital[8], and net revenues or costs associated with reuse, product sales, or disposal.

   a. **Lifecycle costs:**[9] Net present values of all capital, operating, maintenance, reuse, and disposal costs, less any revenue from product sales over a 20-year period using a 5 percent discount rate.

Score	Description of Performance
0	Net present value of projected life cycle costs for base case scenario exceed $210 million
1	Net present value of projected life cycle costs for base case scenario range between $202 and $210 million
2	Net present value of projected life cycle costs for base case scenario range between $194 and $202 million
3	Net present value of projected life cycle costs for base case scenario range between $186 and $194 million
4	Net present value of projected life cycle costs for base case scenario range between $178 and $186 million
5	Net present value of projected life cycle costs for base case scenario range between $170 and $178 million
6	Net present value of projected life cycle costs for base case scenario range between $162 and $170 million
7	Net present value of projected life cycle costs for base case scenario range between $154 and $162 million
8	Net present value of projected life cycle costs for base case scenario range between $146 and $154 million
9	Net present value of projected life cycle costs for base case scenario range between $138 and $146 million
10	Net present value of life cycle costs for base case scenario are less than $138 million

[8] Includes all capitalized expenditure in lifecycle of asset including permitting, design, construction, rehabilitation and salvage values.

[9] Additional criteria to be considered for alternative short-list selection could include ratepayer impacts addressing the "slope" of rate increases associated with lifecycle costs.

- Provided above, for illustrative purposes, is a complete “natural scale” wherein the scoring of alternatives is unambiguously defined by incremental measures of lifecycle costs.

2. **Operations:** Define a solids management system[10] that safely performs at desired service levels [11] and enables incremental expansion[12] and re-alignment of process configurations under variable flow and load conditions.

    a. **Flexibility:** A system that features process trains that enables incremental expansion and re-alignment of process configurations to address changing waste loads, regulations, operating conditions or availability of external facilities (e.g., landfill).

Score	Description of Performance
0	The solids management system is not modular or sufficiently flexible without retrofit to adapt to more stringent regulations, variances from design loadings, or changes in availability of external facilities (e.g., landfill).
5	Solids management system may be expanded in with modular units with limited advance system configuration and will enable compliance with current and proposed regulations under foreseeable variances in future loads or changes in availability of external facilities.
10	The solids management system is fully modular and capable of being adaptable to meet future changing needs or changes in availability of external facilities

    b. **Operability:** A solids management system that mitigates prevailing operating risks by featuring facility configurations and operating protocols for which operator training and expertise is readily available.

Score	Description of Performance
0	The solids management system consists of a relatively high number of process subsystems (based on subject matter expert judgment), and/or has not been proven at a scale similar to GBMSD.
5	The solids management system consists of a number of process

[10] Consider inclusion of “advancing state-of the art” (innovation) in industry as criteria for final alternative selection.
[11] Threshold values for service levels are meeting of current regulatory requirements; desired service levels related to compliance with potential future regulatory changes.
[12] Incremental expansion and process configuration enable alternatives to limit incidence of idle assets that may be specified to achieve desired redundancy.

	subsystems of which some of the subsystems have been proven at a scale similar to GBMSD.
10	The solids management system consists of a limited number of process subsystems each of which have been proven at a scale similar to GBMSD to rarely fail when operated by staff with the training and expertise typical of the wastewater industry.

c. **Future regulatory requirements:** A solids management system that facilitates compliance with or exceeding currently anticipated future regulations

Score	Description of Performance
0	Alternative does not provide for compliance with potential regulations related to reducing GHGs, EPA air pollution control regulations, or solids re-use/disposal regulations requiring Class A treatment and reduction in solids metals or other compounds.
5	Alternative provides for compliance with regulations viewed by subject matter experts as approximately 50% likely to be promulgated.
10	Alternative provides for full compliance with all proposed (by EPA and NGOs) regulations related to reducing GHGs, EPA incinerator/solids air pollution control regulations, or solids re-use/disposal regulations requiring Class A treatment and reduction in solids metals or other compounds.

d. **Safety:** A solids management system that enables staff to perform operations with limited, mitigated risks to personnel, public health and property damage.

Score	Description of Performance
0	Solids management system does **not** have specific design features and operating protocols to mitigate identified safety and security risks (defined as product of likelihood and consequences of occurrence).
5	Solids management system has specific design features and operating protocols to reduce identified safety and security risks (defined as product of likelihood and consequences of occurrence) **to levels consistent with current industrial safety practices.**
10	Solids management system **has** design features and operating protocols to effectively eliminate all identified safety and security risks (defined as product of likelihood and consequences of occurrence).

3. **Social/Community Impacts:** Promote stakeholder/community acceptance and support of solids management system alternative through stakeholder/community partnering and education and limited adverse aesthetic impacts.

   a. **Partnerships:** The solids management system positions GBMSD to engage potential interested regional partners - both in terms of regional contributions to waste streams and/or reuse options and educational/sustainability initiatives.

Score	Description of Performance
0	The solids management system has no regional partnerships. The system is operational without support or cooperation of potentially impacted parties in the region.
5	The solids management system may engender some regional partnerships. The system is operational with some support and shared resources of potentially impacted parties in the region.
10	The solids management system has full regional partnering as manifested by significant load contributions from agricultural or other regional municipal users, and regional collaboration on environmental / sustainability education activities. The system involves shared dedication of resources among regional partners with established interests in economic, social, and environmental returns.

   b. **Aesthetic impact[13]:** Projected performance of alternatives in terms of noise level, odor and visual impacts both for on-site and remote facilities.

Score	Description of Performance
0	Projected system performance would involve noise, odor and/or visual impacts of on-side or remote facilities that community is anticipated to grade as “very unappealing” at all times.
5	Projected system performance would involve limited noise, odor and/or visual impacts of on-site or remote facilities that community is anticipated to grade as “acceptable or not unappealing” no less than 95% of the time.
10	The solids management system has a positive community and economic impact to the area and no noise, odor or visual impact issues are identified.

[13] Specific performance attributes related to noise, odors and visual impacts of individual alternatives may be employed in final screening step. In general, aesthetic impacts may be mitigated with additional expenditures (e.g., scrubbers, enhanced architectural features, etc).

c. **Key stakeholder (political, community, staff) acceptance:**[14] The solids management system is recognized as a community asset providing services consistent with community values and opportunities for staff training and development.

Score	Description of Performance
0	Solids management system does not address expressed community values as indicated by stakeholder input / surveys or provide staff training and development opportunities.
5	Solids management system addresses 40-60 percent of the most important expressed community values as indicated by stakeholder input / surveys or provides some staff training and development opportunities.
10	Solids management system is deemed to fully address expressed community values as indicated by stakeholder input / surveys and provide significant staff training and development opportunities.

4. **Environmental:**[15] Minimize the solids management system's impacts on the environment by maximizing beneficial reuse/recycling, minimizing energy consumption, and green house gas emissions (e.g., climate change impacts, ground water impacts and metal contaminants).

a. **Beneficial Reuse/Recycling:** The solids management system's ability to reuse or recycle solids generated by the facility.

Score	Description of Performance
0	Solids management system is able to reuse or recycle 0% of solids generated.
5	Solids management system is able to reuse or recycle 50% of solids generated.
10	Solids management system is able to reuse or recycle 100% of solids generated.

b. **Non-renewable Energy**: Amount of non-renewable energy consumed by the solids management system.

Score	Description of Performance
0	Non-renewable energy consumption in excess of 170,000 MBtu per annum under projected loads
5	Non-renewable energy consumption in excess of 95,000 MBtu per annum

[14] A critical aspect of stakeholder acceptance under all alternatives is expressed satisfaction with decision-process and absence of alternatives that violate expressed community values.

[15] All screened alternatives, as a threshold condition, will meet all current regulatory requirements.

	under projected loads
10	Non-renewable energy consumption less than 20,000 MBtu per annum under projected loads

c. **GHG Emissions:**[16] Minimize emissions of GHGs in terms of carbon equivalent emissions.

Score	Description of Performance
0	Non-Biogenic Carbon equivalent emissions in excess of 20,000 metric tonnes CO2eq per annum under projected loads.
5	Non-Biogenic Carbon equivalent emissions less than 10,000 metric tonnes CO2eq per annum under projected loads.
10	Non-Biogenic Carbon equivalent emissions less than 0 metric tonnes CO2eq per annum under projected loads.

[16] For screening of 16 alternatives, in the absence of GHG emission estimates, existing correlation between energy consumption and GHG emissions enabled scoring of Energy criterion. GHG emission estimates were prepared for final alternative screening and used this criterion.

APPENDIX II

GBMSD SOLIDS MANAGEMENT FACILITIES PLAN

Alternatives Evaluation: Linkages of Stakeholder Identified Criteria Concepts to Evaluation Framework

The development of the Objectives, Criteria and Performance Measures outlined in the Alternatives Evaluation Framework represents the synthesis of input of various key stakeholders (including GBMSD Commissioners, selected community representatives, and GBMSD staff) and subject matter experts. As demonstrated by the table below, the alternative evaluation framework addresses and reflects the perspectives and suggestions offered by stakeholders while ensuring that the resultant evaluation framework enables mathematically valid scoring and ranking of alternatives. Validity requires that the defined objectives and criteria be non-redundant, independent and comprehensive.

Stakeholder Suggested Criteria	Linkage to Evaluation Framework
1. Financial	
System Longevity	As a threshold condition, all specified systems were configured and cost estimates prepared assuming a minimum lifecycle of 20 years
Various Descriptors for System Costs: sum total operational costs, O&M costs, effective costs, capital costs, initial cost, operating costs, product, energy costs, regulatory compliance costs, rate to customers.	Lifecycle cost estimates provide for a comprehensive representation of system costs including operating and capital components, net of product sales revenues. As a threshold condition, all alternatives enable regulatory compliance. Lifecycle costs are also an indicator of long-term rate impacts and considered in final screening. This was supplemented by specific rate projections for the final screened alternatives.
Partnership	Explicitly included as criteria 3.a. – and reflected in net lifecycle cost estimates and associated rates.
Regional Waste Stream Benefits	As above, most notable partnerships may be those involving regional waste contributors.
Beneficial Reuse	Explicitly addressed as criteria 4.a.
2. Operations	
Sustainability	Financial sustainability addressed by lifecycle cost focus; sustainability of operations addressed in Operations criteria – (a. Flexibility, b. Operability,

	c. Future regulatory req.), and environmental sustainability addressed in criteria 4 (a. Beneficial Reuse, b. Energy, c. GHG emissions)
Scalability	Explicitly addressed in criteria 32a. – Flexibility that references modular expansion.
Construction Impacts	All alternatives, as a threshold condition, may be constructed with relatively limited impact to GBMSD facilities or operations.
Operational (safety, staffing, and training)	Explicitly addressed in Operations criteria (a. Flexibility, b. Operability, c. Safety)
Process Flexibility	Explicitly addressed in Operations criteria (a. Flexibility)
Expandable	Explicitly addressed in criteria 2.a. – Flexibility that references modular expansion.
Efficient operation	Largely addressed by Financial criteria relating to lifecycle costs but also in Operations criteria relating to Flexibility and Operability
Independent	Explicitly addressed by Operations criteria (2.a. Flexibility) in language related to availability of external facilities
Highly Reliable	All alternatives design assumptions required a high level of reliability. Explicitly addressed by Operations criteria related to Flexibility and Operability.
Location/Setting	All alternatives contemplate use of existing GBMSD sites and/or readily available locations that will consider acceptable levels of odor, noise and aesthetics
3. Social / Community Impacts	
Public Education	Partnerships criteria (3.a.) contemplates both loading and community education partnering
System is Safe	Explicitly addressed in Operations criteria (a. Flexibility, b. Operability, c. Safety)
Technical Reliability	All alternatives design assumptions required a high level of reliability. Operations criteria related to Flexibility and Operability.
Risk of Success	Explicitly addressed in Operations criteria (a. Flexibility, b. Operability, c. Safety)
Organizationally Feasible	All alternatives may be implemented with limited changes in organizational alignments. Addressed further by Operability criteria (2.b.) and input of staff for Stakeholder Acceptance criteria (3.c.)
Security	Explicitly addressed in Operations criteria (2.d.

	Safety).
Public/Social Impact	All Social / Community criteria intended to address these impacts, perceptions/acceptance explicitly addressed in criteria 3. b. and c.
Economic Impact	Financial/economical impacts explicitly addressed in criteria 1.a
4. Environmental	
Permit-ability	Permits may be obtained for all 16 candidate alternatives as a threshold condition.
Short-term Environmental Compliance	Ability to achieve environmental compliance for all ***current*** regulations was a threshold condition for alternatives screening.
Low impact to Other GBMSD Processes	All alternatives, as a threshold condition, may be implemented with relatively limited impact to other GBMSD processes.
Timely	All alternatives, as a threshold condition, may be implemented within similar time frames and within period required for regulatory compliance.
Environmentally Sound	Explicitly addressed in Objective 4: Environmental
Carbon Footprint	Explicitly addressed in criteria 4.b. – Non-renewable Energy
Environmental Footprint	See above – most environmental impacts associated with GHG emissions and/or beneficial reuse opportunities and criteria 4.b.
Fossil Fuel Use	Explicitly addressed in criteria 4.b. – Non-renewable Energy
Public Health and Safety	Explicitly addressed in criteria 2.d. Safety

Financial	Operations					
Life-Cycle costs	**Flexibility**	**Expandability**	**Operability**	**Future Regulatory Requirements**	**Safety**	**Autonomy**
Alternative 2—Incineration with Energy Recovery						
Third highest 40-year net present worth and capital cost.	Landfilling dewatered sludge is the backup. Depends on landfilling unless another use for all the ash is identified. Dewatered cake could be hauled to the landfill as a backup.	A single, large incinerator limits flexibility. More smaller units could be installed for added flexibility, but cost would increase. More incinerator units could be added in the future if other regional solids sources are identified, but the cost to do so is relatively high.	High degree of operability because of GBMSD's experience with incineration. Fluidized bed incinerators require less maintenance and operator attention than multiple hearth furnaces.	Less susceptible to future residuals management regulations, because end product (ash) is not land applied. System would be designed to meet new SSI MACT standards. Legal challenges could change MACT requirements and changes if enacted would more likely decrease control requirements than increase them.	Inherent safety risk due to the high temperatures present in the process (1,500°F), but with the proper safety policies and procedures, the fluidized bed incinerator has proven safe. Fluidized bed incineration is expected to be slightly lower risk than multiple hearth incineration because the system is sealed to prevent operator exposure. The sealed vessel can be designed with screens to prevent contact with hot surfaces by personnel. In a multiple hearth incinerator, there is a slightly greater risk of a hot gas escaping at doors and viewing windows.	Landfill acceptance of ash is not expected to be an issue, although price of disposal could rise.
Alternative 3A—Digestion with Thermal Processing						
Second lowest 40-year net present worth and highest capital cost.	Has flexibility to dry, incinerate, or landfill. Also can land apply Class B solids after digestion, although that would require development of a land application program. The incinerator and dryer would be sized for only part of the solids, and therefore, the incinerator/dryer system does not have 100% redundancy.	The digesters are fairly modular. If future, additional solids sources are identified and digesters reach capacity, a digester can be added. Incinerator and dryer are moderately modular because each is sized smaller than Alt 2. Each is sized for less than half the total capacity and because capacity is less due to reduction in solids by digestion.	GBMSD staff does not have experience operating digesters or dryers. The fluidized bed incinerator should improve operability over that of multiple hearth furnaces. Having digestion, incineration, and drying will be the most complex of the four alternatives.	Less susceptible to residuals management regulations, because the end products pellets are Class A and the ash will likely be landfilled. System would be designed to meet new SSI MACT standards. Legal challenges could change MACT requirements and changes if enacted would more likely decrease control requirements than increase them.	Refer to Alt. 2 regarding fluidized bed incineration. Sludge drying presents risk of explosion, although dryer manufacturers and design engineers have improved safety based on lessons learned from fires and explosions at operating facilities. Even with design improvements and safety devices, some risk remains, both in the dryer and with processing and handling outside the dryer. A primary risk is the accumulation of fines into dust piles that can ignite. Indirect dryers are assumed to be lower risk than direct dryers, primarily because there is typically less pre- and post-processing of dried product, thereby reducing the potential for buildup of fines. There is some risk of fire and explosions posed by the presence, storage, and combustion of biogas from the digester, although proper safety precautions and design can mitigate risk.	Primarily depends on landfill acceptance of ash. Acceptance is not expected to be an issue, although price of disposal could rise. Finding a market for pellets is not expected to be difficult in the long term, although it could take time to develop and there is some uncertainty in the price that can be obtained for the pellets.
Alternative 3B—Digestion with Thermal Processing and Electrical Generation						
Lowest 40-year net present worth and second highest capital cost.	Has flexibility to incinerate, or landfill. Also can land apply Class B solids after digestion, although that would require development of a land application program.	The digesters are fairly modular. If future, additional solids sources are identified and digesters reach capacity, a digester can be added. A single, large incinerator is sized for all solids, thus limiting modularity.	GBMSD staff does not have experience operating digesters or steam turbine power generation. Steam turbine may required that licensed operator be present at all times. The fluidized bed incinerator should improve operability over that of multiple hearth furnaces. Having digestion, incineration, and steam turbine generation processes will be somewhat complex.	Less susceptible to residuals management regulations, because the ash likely will be landfilled. System would be designed to meet new SSI MACT standards. Legal challenges could change MACT requirements and changes, if enacted, would more likely decrease control requirements than increase them.	Refer to Alt. 2 regarding the fluidized bed incinerator. Some risk of fire and explosions is posed by the presence, storage, and combustion of biogas from the digester, although proper safety precautions and design can mitigate risk.	Primarily depends on landfill acceptance of ash. Acceptance of ash is not expected to be an issue, although price of disposal could rise.

Financial	Operations					
Life-Cycle costs	**Flexibility**	**Expandability**	**Operability**	**Future Regulatory Requirements**	**Safety**	**Autonomy**
Alternative 11—Conventional Composting						
Second highest 40-year net present worth and lowest capital cost.	Does not provide flexibility to manage solids by alternative means except for landfill backup. Because there are multiple composting bays and agitators, there is a high degree of redundancy. About 24 composting bays and 4 agitators are expected. Maintenance on one bay at a time could be accommodated with minimal effect on capacity. Maintenance on an agitator could be accommodated 16 of 24 hours each day without affecting operation. (Agitators are assumed to operate during one 8-hour shift per day.)	Composting is very modular, and additional incrementally sized facilities could be constructed. Some or all of the amendment and product storage could be located remotely from composting, curing, and ancillary operations as necessary to provide additional space for expansion of active composting operations.	GBMSD staff is unfamiliar with process. Not complex, but operation includes a significant amount of labor for material transfer with front-end loaders and O&M of large grinding and mixing equipment, which does require new skills to be learned.	Less susceptible to residuals management regulations because the compost end product is Class A. Will very likely not require a federal air permit, but WDNR/Clean Air Act could regulate odors as a nuisance or H_2S as a toxic in the future.	Operation of front-end loaders near plant personnel presents risk to pedestrians and vehicle operators. Some risks to personnel associated with operating the tub grinder can be minimized with a horizontal style grinder and the mixer used for mixing dewatered solids and yard waste. Ammonia release in the active composting area can pose a breathing risk, but this can be controlled by isolating the air space in the composting bays from the loading and unloading area—a standard design practice assumed for this plan— and by not entering the compost bays for maintenance when compost is being agitated.	The primary reliance issue is a continuous, reliable source of amendment. It is assumed the City of Green Bay will give GBMSD its yard waste and that woody amendment would be purchased to supplement this. Developing a market to sell the compost will take time to establish. The price that can be attained for the compost is uncertain.
Alternative 14—Incineration and Thermal Drying						
Third lowest 40-year net present worth and fourth highest capital cost.	Has flexibility to dry, incinerate, or landfill. Similar to Alt. 3A except without the flexibility added by digestion. Redundancy: Can process part of the solids when the dryer or incinerator is out. Landfill is backup.	Incinerator and dryer are less modular than Alt. 3 because the dryer/incinerator is larger. However it is more modular than Alternative 2 because of the smaller size of incinerator/dryer that each handles only a part of the solids.	GBMSD staff does not have experience operating dryers. Fluidized bed incinerators require less maintenance and operator attention than multiple hearth furnaces.	Less susceptible to residuals management regulations because end product is Class A and the ash will likely be landfilled. The system would be designed to meet new SSI MACT standards. Legal challenges could change MACT requirements, and changes, if enacted, would more likely decrease control requirements than increase them.	Refer to Alt. 2 regarding the fluidized bed incinerator. Refer to Alt. 3 regarding the drying.	Primary reliances are landfill acceptance of ash and a market for the pellets. Primarily must depend on landfill acceptance of ash. Acceptance is not expected to be an issue, although price of disposal could rise. Finding a market for the pellets is not expected to be difficult in the long term, although it could take time to develop, and there is some uncertainty in the price that can be obtained for the pellets.
Alternative 16—Rehabilitate Multiple Hearth Furnaces						
Highest 40-year net present worth and second lowest capital cost.	Two incinerators provide some redundancy but not sufficient capacity for processing peak loads. Landfilling dewatered sludge is the backup.	Two incinerators provide some flexibility and redundancy, but peak loadings exceed capacity of the two incinerators, and landfilling is required during peak loading periods. Could add more incinerator units in the future, but capital cost would increase significantly.	GBMSD staff has many years of experience operating multiple hearth furnaces, but multiple hearth furnaces require significantly more operator attention than current incineration technology (fluidized beds).	The system would be designed to be retrofitted to meet new SSI MACT standards. Legal challenges could change MACT requirements. If enacted, changes would more likely decrease control requirements than increase them.	Inherent safety risk due to the high temperatures is present in the process, but with the proper safety policies and procedures multiple hearth furnaces have proven safe. Fluidized bed incineration is expected to be slightly lower risk than multiple hearth incineration because the system is sealed to prevent operator exposure. In a multiple hearth incinerator, there is a slightly greater risk of a hot gas escaping at doors and viewing windows.	Landfill acceptance of ash is not expected to be an issue, although price of disposal could rise. Must depend on landfills to accept wet dewatered cake during peak loadings and more landfills are refusing to accept wet cake.

Social/Community Impact			Environmental		
Partnerships	**Aesthetic impact**	**Key Stakeholder (political, community, staff) Acceptance**	**Beneficial Reuse/Recycling**	**Energy**	**GHG Emissions**
Alternative 2—Incineration with Energy Recovery					
Some limited capacity for processing non-GBMSD wastes if peak capacity or capacity reserved for future growth is used.	Could be better than existing incineration facility by incorporating plume suppression. Incineration destroys almost all odors.	Unknown how stakeholders will perceive continued incineration. Can be considered green/sustainable because it recovers some energy from the biosolids and produces a safe end product. However does not provide a beneficial byproduct unless a ash is reused.	Ash will be landfilled unless a beneficial use is identified. However, some preliminary, potential ash beneficial reuses have been identified.	Captures heat energy in the winter and produces renewable/green electricity in the summer. About 33% of energy available in the solids is captured for heating during winter. During summer, about 11% of the energy in the solids is captured in the form of renewable electricity.	Greenhouse gases result primarily because of the thermal oxidation of solids in the incinerator, although the gases are biogenic rather than from fossil fuel (nonbiogenic). Heat captured from incinerator will reduce natural gas used for heating, resulting in nonbiogenic (fossil fuel) greenhouse gas emission reduction. Uses a steam turbine from May to October to convert steam energy to electricity. Use of this renewable electricity will replace part of the coal powered electricity otherwise used and also reduce nonbiogenic greenhouse gas emissions.
Alternative 3A—Digestion with Thermal Processing					
Will facilitate significant regional partnerships with sources of codigested wastes by processing their wastes into beneficial products. Solids from other municipalities could be processed at relatively low cost and yield marketable end products (biogas, electricity, pellet fertilizer). Digesters will help homogenize and degrade solids to make them more amenable to drying and incineration giving this alternative an advantage for the range of waste that can be accepted. In addition, digester gas produced from the addition of other non-GBMSD solids would help lower marginal cost of handling solids. Potential impacts on dried pellet quality must be considered because of drying. Fibrous or nondigestable material may pass through digestion and affect drying (or incineration although less sensitive than drying). Because of digestion, this alternative also provides the flexibility to remove phosphorus from the solids using a nutrient recovery process to produce a valuable mineral fertilizer pellet.	Could be better than existing incineration system by incorporating plume suppression. Incineration and thermal oxidizers destroy almost all odors from incinerators and dryers. Leakage of digester gas could add a small amount of odor (small compared to the existing plant odors), although this could be mitigated through advanced digester gas pressure controls.	Stakeholders likely will consider this to be the greenest option because it recovers the most energy from both digestion and incineration and yields safe, valuable end products.	Will recycle part of the solids into a valuable fertilizer product. The remaining solids will be converted to ash that will be landfilled unless a beneficial use is identified. However, some preliminary, potential ash beneficial reuses have been identified. Nutrient extraction can be added in the future to produce a phosphorus based fertilizer.	Recovers the most energy from solids of any alternative. Depending on conditions, about 50% of the energy in the solids is captured in biogas (~40%) and heat for the dryer (~10%). Another ~16% could be recovered if pellets are burned as a fuel source, but this would come at the expense of beneficial use as a soil fertilizer. About ~40% of the energy available in the solids is converted to biogas in the digesters. The gas can then be used to produce electricity in engine generators. The waste heat can be used for digester and space heating, or the biogas could be used in boilers for digester and space heating, or the biogas could be used to supplement sludge drying. When biogas is burned in internal combustion engine generators, up to ~37% of its energy is converted to electricity and ~40% recovered in the form of heat, for digester and space heating in the winter.	Greenhouse gas emissions result from the thermal oxidation of the solids in the incinerator and combustion of biogas from the digesters. However, both emission sources are biogenic (non–fossil fuel). Heat captured from engine generators will reduce natural gas used for heating, resulting in non biogenic greenhouse gas emission reduction. Electricity produced in the IC engine generators will offset fossil fuel based electricity resulting in further non biogenic greenhouse gas emission reduction. This alternative also could in the future receive credit for carbon sequestration due to land application of pellets, but only a small fraction of the carbon in the pellets is likely to remain in the soil after 100 years.
Alternative 3B—Digestion with Thermal Processing and Electrical Generation					
Will facilitate significant regional partnerships with sources of codigested wastes by processing their wastes into beneficial products. Also, solids from other municipalities could be processed at relatively low cost with production of marketable end products (biogas, electricity). Digesters will help homogenize and degrade solids to make them more amenable to incineration giving this alternative an advantage for the range of waste that can be accepted. Digester gas produced from the addition of other non-GBMSD solids would help lower marginal cost of handling solids. Fibrous or nondigestable material may pass through digestion to incineration. This alternative, because of digestion, also provides the flexibility in the future to remove phosphorus from the solids using a nutrient recovery process to produce a valuable mineral fertilizer pellet.	Could be better than existing incineration system by incorporating plume suppression. Incineration destroys almost all odors from incinerators. Leakage of digester gas could add a small amount of odor (small compared to the existing plant odors) although this could be mitigated through advanced digester gas pressure controls.	Stakeholders likely will consider this to be the second greenest option because it recovers the energy from both digestion and incineration, but there is somewhat less energy recovery than with Alternative 3A. No beneficial reuse of solids that occurs in the alternatives that produce dried pellets.	All solids will be converted to ash that will be landfilled unless a beneficial use can be found. Some preliminary beneficial reuses of ash have been identified. Nutrient extraction can be added in the future to produce a phosphorus based fertilizer.	Recovers the second greatest amount energy from solids of all the alternatives. Depending on conditions, about 40% of the energy in the solids is captured in biogas, and heat from the incinerator is used for generating electrical power in a steam turbine. About 40% of the energy available in the solids is converted to biogas in the digesters. The gas can then be used to produce electricity in engine generators. The waste heat can be used for digester and space heating, or the biogas could be used in boilers for digester and space heating, or the biogas could be used to supplement sludge drying. When biogas is burned in internal combustion engine generators, up to ~37% of its energy is converted to electricity and ~40% recovered in the form of heat, for digester and space heating in the winter.	Greenhouse gas emissions due to the thermal oxidation of the solids in the incinerator and combustion of biogas from the digesters. However, both emission sources are biogenic (non–fossil fuel). Heat captured from engine generators will reduce the natural gas needed for heating, resulting in nonbiogenic greenhouse gas emission reduction. Electricity produced in the IC engine generators will offset fossil fuel based electricity resulting in further nonbiogenic greenhouse gas emission reduction.

Social/Community Impact			Environmental		
Partnerships	**Aesthetic impact**	**Key Stakeholder (political, community, staff) Acceptance**	**Beneficial Reuse/Recycling**	**Energy**	**GHG Emissions**
Alternative 11—Conventional Composting					
Could facilitate regional partnerships. Solids from other municipalities could be processed at low additional cost, but more yard waste or other amendment will be required to compost additional solids. This may require partnering to transfer yard waste composting operations from neighboring municipalities to supply GBMSD for co-composting with GBMSD and regional solid. It will also require purchase of alternative amendments such as wood waste. The costs assumed for composting of GBMSD solids assumed the City of Green Bay would give its yard waste (leaves, grass) to GBMSD at no charge and GBMSD would purchase wood waste. See Alt. 2 regarding available capacity between facility sizing and initial avg. loads. Very flexible alternative to accept nonmunicipal solids. Almost any organic material can be added to this process, however, odor potential from some nonmunicipal solids could be an issue.	Visually the buildings will be large metal buildings with an agricultural or warehouse-like appearance. Curing processes would be inside a building, and air would be ventilated to an odor control system. Odors are controlled by enclosing the handling and mixing dewatered solids with yard waste area, the active composting area, which releases significant ammonia, and curing, which can release some residual odors. Odorous air from enclosed areas is discharged to an odorous air biofilter. Even with odor control, there will be some fugitive odors and odors not completely treated in the biofilter. Total odor from composting is likely to add odors equal to or less than those from the existing plant. Covered amendment and finished compost storage, which is included in the cost, will prevent moisture addition and thereby limit biological activity and associated odors, although these areas will not be completely enclosed.	The public generally is familiar with composting, and it likely has a positive image. Stakeholders may consider this a greener option because there is no burning of solids and no fuel is consumed for drying, and because it yields a safe valuable product. Almost any organic material can be added to the process, but odors may be a concern with some waste materials.	All solids would be turned into a valuable soil amendment product assuming that market can be established.	There is no energy recovery from composting. Energy is consumed aerating the compost and in the fuel used for front end loaders and other vehicles.	Direct fossil fuel usage is relatively low and results from relatively continuous operation of front end loaders, intermittent use of a tub grinder and other equipment, and heating of some building spaces. Electricity is consumed by blowers that aerate compost and by other mechanical equipment. Could receive future GHG credit for carbon sequestration because of the land application of compost, but only a small fraction of the carbon in the compost is likely to remain in the soil after 100 years.
Alternative 14—Incineration and Thermal Drying					
Could facilitate regional partnerships. Similar to Alts. 3A and #B regarding ability to accept regional waste but without the benefit of the homogenization from digestion.	Could be better than existing incineration facility if plume suppression installed. T	Stakeholders would likely perceive this to be less green than Alts. 3A and 3B because of lower energy production and greater energy consumption, but it shares some of the same benefits as Alts. 3A and 3B.	Will recycle part of the solids into a valuable fertilizer product. The remaining solids will be converted to ash that likely will be landfilled unless a beneficial use is identified.	Energy from incinerator used to dry pellets. Unlike Alternatives 3A and 3B, no energy is recovered through the production of biogas.	See Alt. 3A except that without the digestion process there will be higher greenhouse gas emissions.
Alternative 16 -Rehabilitate Multiple Hearth Furnaces					
No capacity available for processing other wastes because of inability of incinerators to process peak loadings.	Incineration destroys almost all odors. Plume suppression could be added in the future, but it is not included in rehabilitation costs.	Unknown how stakeholders will perceive continued incineration. May not be considered green/sustainable because it recovers limited energy from the biosolids and produces a safe end product. However does not provide a beneficial byproduct unless a ash is reused.	Ash and cake (during peak loadings) will be landfilled unless a beneficial use is identified. However, some preliminary, potential ash beneficial reuses have been identified.	Captures some heat energy in the winter and no energy in the summer.	Greenhouse gases result primarily because of the thermal oxidation of solids in the incinerator although the gases are biogenic rather than from fossil fuel (nonbiogenic). Greenhouse gas emissions from multiple hearth furnaces are significantly greater than emissions from fluidized bed incinerators. Heat captured from incinerator will reduce natural gas used for heating, resulting in nonbiogenic (fossil fuel) greenhouse gas emission reduction.

Appendix 5-2. Feasibility of Codigestion for Alternative 3 TM

Feasibility of Codigestion for Alternative 3

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Introduction

Direct addition of high-strength organic wastes and municipal wastewater to anaerobic digesters, referred to as codigestion, is a growing industry trend primarily because it can increase biogas production. Codigestion is the simultaneous digestion of a homogenous mix of two or more substrates. Most commonly, a majority volume of a main substrate (such as municipal sludge) is mixed and digested together with smaller amounts of one or more additional substrates. This memorandum evaluates the feasibility, cost effectiveness, advantages, and disadvantages of codigesting wastes for Alternative 3, Digestion with Further Thermal Processing, of the Solids Management Facility Plan.

Codigestion of solids with other organics may significantly increase biogas production beyond the municipal waste only gas production rate estimates used in the base case system sizing for Alternative 3. The most beneficial wastes for codigestion have high chemical oxygen demand content and are highly degradable (carbohydrates, sugars). Digestion of agricultural waste (manure) also was considered, but agricultural waste likely would require costly transportation and separate digestion facilities. In addition, it has a lower organic content than other wastes, resulting in low biogas production. For these reasons, digestion of agricultural wastes was not evaluated. The potential for GBMSD processing agricultural wastes could have nonmonetary benefits, such as reduction of nonpoint source pollution and greater greenhouse gas reduction. The possibility of digesting agricultural wastes could be addressed during predesign.

Codigestion of fat, oil, and grease (FOG) that could be collected from restaurants and other sources was not evaluated because it was believed that there would be competition in the Green Bay area for collecting such waste and because it would take somewhat more costly facilities to handle and process the waste. The possibility of codigesting FOG could be reconsidered during predesign.

Waste Source Survey

A survey was conducted to determine potential industrial and commercial waste sources that may be most suitable for codigestion to increase biogas production. About 35 industrial and commercial waste sources were contacted by phone and letter to identify available quantities of waste and the potential suitability of the wastes for codigestion at the Green Bay Facility (GBF) and to ascertain the reliability, consistency, availability, and suitability of the waste and its potential to increase biogas production. Of the 35 industrial and commercial waste sources contacted, 8 completed surveys and 7 were determined to be unsuitable for codigestion because of the small scale of operation or lack of interest in participating. The remaining sources did not respond to multiple requests. Table 1 summarizes the survey results. As discussed below, the responses indicate that viable sources for codigestion exist in Northeast Wisconsin.

Information Provided by A&B Leist Trucking

Following completion of the initial survey, GBMSD staff arranged a meeting with Al Leist, the owner of A&B Leist Trucking Company, which specializes in collecting, transporting, and disposing of wastes from dairy and cheese industries in Northeast Wisconsin. The meeting was intended to help provide additional insights into the market for wastes that GBMSD may desire to codigest. Mr. Leist provided the following information about the dairy/cheese waste disposal industry and his business:

- The company collects, transports, and disposes of mostly dairy waste from milk and cheese producers in Northeast Wisconsin and covers 5 or 6 counties within an 50 to 60 mile radius of the GBF.
- Most of the wastes collected are land applied. Because the company does not handle wastes that contain fecal material, the WDNR allows it to apply wastes to land during the winter.
- The company hauled about 24,000 truckloads last year with a total volume of about 140 million gallons. Trucks typically have a capacity of 5,500 gallons, and the volumes they can haul sometimes limited by weight because the high-strength wastes are often dense (~10 pounds per gallon).
- Generally two types of waste are handled and disposed of separately: Low strength waste typically is applied to land. High-strength waste can be costly to land apply because of the 170 lb/acre limit on chlorides for land application. The high-strength waste is sometimes discharged to a sanitary sewer or the influent of a wastewater treatment plant. Because of high charges from wastewater utilities, disposal of high-strength waste is much more costly than disposal of low strength wastes.
- Monthly data are submitted to the WDNR for waste concentrations for chlorides, BOD, TS, TSS, TKN, K, pH, N, and P.
- Customers include Land O'Lakes, Belgioioso, and Trega Foods.
- Because some facilities have no waste processing onsite and only a small volume of storage, collection is required 6 or 7 days per week.
- Appleton had processed dairy waste for codigestion. At times it caused digester upsets, likely because of high chloride concentrations.
- Dairy waste typically is 4 to 8 percent total solids (TS), with most of the solids in the dissolved form. Whey waste is about 20 percent TS.
- Chlorides often increase with increasing BOD, although some wastes have high BOD and low chlorides.

TABLE 1
Survey Results

Company	Waste Type	Waste Production	Distance from GBF	Current Method of Disposal	Current Cost of Disposal	Frequency of Production
Agropur, Luxemburg	Dairy processing	30,000 gallons/day	18.3 miles	Land application	—	7 days/week
AK Pizza Crust	Pizza dough	27 tons/day	5.2 miles	Sold for income	Sold for income	—
Belgioioso Cheese, Inc.[a]	Wash water	300,000 gallons/day	11.4 miles	Land application	$0.015/gallon	7 days/ week
Dean Foods/Morning Glory Dairy	Milk processing	14,000 gallons/day	11.7 miles	Land application	—	7 days/week
Graf Creamery	Wash water	8,500 gallons/day	29.2 miles	Land application	$0.015-$0.020/gallon	7 days/week
JBS, Green Bay	Meat processing	25 wet tons/day	4.7 miles	Land application/ anaerobic digestion	$3.00/ton + transport	48 hours/week
Seroogy's Chocolates	Chocolate	< 10 wet pounds/day	7.2 miles	Landfill	—	28 to 35 hours/week
TNT Crust	Wash water	2,947 gallons/day	2.5 miles	Municipal sewer	Typical municipal sewer charges	20 hours/week

[a] Belgioioso receives revenue from the sale of whey (~$3,000/truckload)

- Waste production at dairy facilities is fairly consistent and predictable. Wastes contain few large suspended solids or debris. Wastes have BOD concentrations ranging from 10,000 to 200,000 mg/L. Chloride content typically is 1,200 to 1,400 mg/L but can be as high as 40,000 mg/L in wastes from brine specialty cheese production.
- Some dairy businesses in Sheboygan haul their waste to Indiana for digestion. It could be more cost-effective to haul the wastes to GBMSD.

Waste Characterization and Biogas Production

To help determine which waste sources may be most suitable for codigestion, the sources were categorized into three groups based on their waste quality and digestibility (Table 2):

- Easy to digest with high solids and volatile solids (VS) content
- Available in large quantities with moderate suitability for codigestion
- Difficult to digest

TABLE 2
Categories of Waste Sources

Category	Waste Source/Type
Easy to digest	Salad dressing, other condiments Fruits and vegetables processing/canning
Available in large quantities, moderately suitable for codigestion	Dairy products Cheese processing
Difficult to digest	Meat packing waste Slaughterhouse waste

Table 3 shows the characteristics of the wastes of the sources that responded to the survey, including an estimate of potential biogas production.

Competition for Wastes

There is a recent growing trend for municipal wastewater treatment utilities and industries to collect wastes and digest them to produce biogas and/or produce other products that can be sold. As this occurs, competition for the wastes could be created, which could decrease the fees that GBMSD may receive for the wastes. Because a significant part of the cost of waste disposal is often trucking costs, GBMSD would likely receive the highest fees for those waste sources located closest to the GBF. For example, wastewater treatment plants operated by Sheboygan and Stevens Point have codigestion programs and could likely offer the waste sources that are closer to their plants a lower disposal fee than GBMSD.

Sanimax is a potential competitor for wastes that could be codigested. Sanimax is one of North America's leading waste reclamation companies with 15 locations in Canada, the U.S., and Mexico, including a facility in Green Bay. Sanimax began its business in rendering—a long-practiced form of waste reclamation. Today, Sanimax is a leading supplier of ingredients for agriculture and animal nutrition and a source of animal hides

TABLE 3
Summary of Waste Characteristics and Biogas Production Potential of Survey Respondents

Producer	Type of Waste Stream	Waste Production	TS (%)	BOD (mg/L)	Estimated Biogas Production	Nitrogen Content	pH
Agropur, Luxemburg	Dairy Processing	30,000 gpd	—	30,000–50,000	84,000–140,000 ft^3/day 18,400–30,800 MBTU/year	—	—
AK Pizza Crust	Pizza Dough	27 tons/day	50	n/a	n/a	n/a	n/a
Belgioioso Cheese, Inc.	Wash water	300,000 gpd	—	5,000–15,000	n/a	150 mg/L	6.5–7.5
Dean Foods/Morning Glory Dairy	Milk Processing	14,000 gpd	0.97	6,000–75,000	8,000–100,000 ft^3/day 2,000–21,000 MBTU/year	1,000 mg/L	> 6
Graf Creamery	Wash water	8,500 gpd	224 mg/L	—	n/a	62.1 mg/L	8
JBS, Green Bay	Meat Processing	25 wet tons/day	24	—	n/a	10,256 mg/kg organic N	7–8
Seroogy's Chocolates	Chocolate	< 10 wet pounds/day	—	—	n/a	—	—
TNT Crust	Wash water	2,947 gpd	—	—	n/a	—	—

and skins. Based on phone conversations between Sanimax, GBMSD, and CH2M HILL staff, the Green Bay Sanimax facility collects animal slaughtering wastes; FOG from restaurants; and dead animals. It collects FOG from throughout the state and processes it into biodiesel at its facilities in DeForest (Madison) and South Saint Paul, Minnesota. Sanimax also collects waste vegetables from Wal-Mart throughout the state and upper Michigan. Sanimax does not, however, process the types of liquefied high-strength wastes that GBMSD would desire for codigestion and, therefore, is not in competition with GBMSD for those wastes.

The fees charged by municipal wastewater treatment facilities for codigested wastes vary widely depending on several factors including waste strength and other characteristics, distance from the source, and competition for the wastes. Fees vary from $0.01 to $0.05 per gallon and higher. Some municipal wastewater utilities do not receive a fee but rather pay sources for very high-strength wastes that result in significant increases in biogas. The limited results from the survey show that sources near GBMSD pay $0.015 to $0.03 per gallon to dispose of wastes through land application. Depending on trucking costs, GBMSD may be able to expect similar fees.

To better estimate what sources near GBMSD would be willing to pay for waste disposal, it is recommended that GBMSD continue discussion with those sources. The actual price would not be known until GBMSD would negotiate the price and terms and conditions with sources. Other public and private entities not yet known may be evaluating the feasibility of digesting wastes, recovering energy, and generating revenues that could create competition for wastes. If Alternative 3 were selected, additional investigation of that issue should be done to help better assess the potential competition.

Advantages of Codigestion

Codigestion offers the following advantages:

- Increases biogas production which can significantly reduce costs through generation of additional electrical power and recovery of heat and would help mitigate the impacts of future increases in energy prices on GBMSD.
- Provides potential revenue through tipping fees paid by waste sources.
- For wastes with poor fluid dynamics that are difficult to handle, codigestion allows materials to be digested much easier because of homogenization with the more dilute municipal sludge substrate. This allows materials to be digested that otherwise would be land applied or landfilled.
- Provides a means of disposal that could be lower in cost than other disposal methods and allow recovery of renewable energy.

Potential Disadvantages of Codigestion

Codigestion has been cited in the literature and practice as one of the causes of digester foaming. However, there have been numerous causes of digester foaming cited in the literature and there is not agreement on the causes and methods for controlling. The amount of foam that could be potentially formed would be dependent upon the type and quantity of codigested wastes. It is known that proper acclimation, steady loading, and proper mixing and heating will help control foaming and other problems that could be caused by codigestion. In addition, codigestion of some types of wastes could result in grit and debris accumulation. Codigestion could cause odor problems if the codigested materials were not contained properly. The impact of codigestion on dewatering operations is highly dependent on the type and quantities of materials that are codigested.

Codigestion will result in some increased ammonia, phosphorus, and BOD entering the liquid treatment system through the dewatering centrate recycle. It is important that the recycle stream be operated continuously to allow the biomass to acclimate and prevent shock loadings that may pass through the system. The recycled BOD and ammonia associated with the codigested material should not be a concern in the liquid treatment system, as long as the recycle stream is fairly consistent. Phosphorus added to the system by codigested wastes could result in the need to use additional, relatively small, quantities of ferric chloride for phosphorus removal.

Future private and public entities may develop systems to use wastes to produce energy. This could potentially create competition that could lower tipping fees. However, GBMSD would likely have an advantage over private entities because the GBMSD system, unlike a privately owned system, would have fix costs that may not necessarily have to be considered when setting tipping fees.

Impact of Chlorides

Some constituents in wastes that are codigested could be toxic to the digestion process. One constituent that is known to be contained in some dairy wastes is chlorides. Dairy wastes are a likely candidate for codigestion because they are commonly available in northeast Wisconsin. The subsequent discussion addresses the issue of chlorides in dairy wastes potentially being toxic to the digestion process.

McCarty and McKinney (1961)[1] found that cations (introduced as acetate or chlorine salts) can be inhibitory to anaerobic digestion at high concentrations. They found that the divalent cations (Ca++ and Mg++) were the least toxic followed by the monovalent cations (Na+ and K+), and ammonia (NH_4+) was the most toxic. They also found that cations are much more toxic if added as a slug load than when added slowly over a period of time. The toxicity of a slug loading of sodium can be eliminated by the addition of calcium or magnesium. They called this effect salt antagonism.

McCarty (1964)[2] presents a detailed summary of anaerobic processes, including a thorough discussion of toxicity and preventing toxicity. This paper provides the following methods to control toxicity:

- Remove toxic material from waste.
- Dilute below toxic threshold.
- Form insoluble complex or precipitate.
- Antagonize toxicity with another material.

TABLE 4
Stimulatory and Inhibitory Concentrations of Light Metal Cations

Cation	Stimulatory (mg/L)	Moderately Inhibitory (mg/L)	Strongly Inhibitory (mg/L)
Sodium	100–200	3,500–5,500	8,000
Potassium	200–400	2,500–4,500	12,000
Calcium	100–200	2,500–4,500	8,000
Magnesium	75–150	1,000–1,500	3,000

McCarty (1964) determined cation toxicity concentrations, as shown in Table 4. The concentrations listed as stimulatory are those that are desirable and will permit maximum efficiency of the process. Concentrations listed as moderately inhibitory are those that normally can be tolerated but require some acclimation by the microorganisms. When introduced suddenly, these concentrations can retard the digestion process significantly for periods ranging from a few days to more than a week. Concentrations listed as strongly inhibitory are those that normally retard the process to such an extent that the efficiency is quite low, and the time required for effective treatment may be excessively long. These concentrations normally are undesirable for successful anaerobic treatment. If an inhibitory concentration of one cation is present in a waste, the inhibition can be significantly reduced if an antagonistic ion is present or is added to the waste. Sodium and potassium are the best antagonists for this purpose and are most effective if present at the stimulatory concentrations listed in the table. Higher concentrations are not as effective and could increase toxicity.

Preliminary data show that some Green Bay area dairy wastes with BOD levels of about 100,000 mg/L typically have chloride levels of 1,200 to 1,400 mg/L, which by itself is below digestion inhibitory levels, and that dilution would decrease the concentrations. Some specialty brine cheese process wastes may have chloride levels of about

[1] Perry L. McCarty and Ross E. McKinney. 1961. "Salt Toxicity in Anaerobic Digestion." *Journal Water Pollution Control Federation*. Vol. 33, No. 4 (April): 399-415.

[2] P. L. McCarty. 1964. "Anaerobic Waste Treatment Fundamentals." *Public Works* 95(9): 107–12; (10): 123–26; (11): 91-94; (12): 95–99.

40,000 mg/L. The brine cheese waste and other high chloride wastes would likely have to be diluted, digested in limited quantities, or not be allowed to be codigested.

It has been found that 7,000 mg/L of sodium may significantly retard anaerobic treatment. If 300 mg/L of potassium is added, retardation may be reduced by 80 percent. If 150 mg/L of calcium is added, the inhibition may be completely eliminated. However, if calcium were added in the absence of potassium, there would be no beneficial effect at all. Use of additives such as this would require further research and pilot testing.

Impact of Codigestion on Alternatives Cost Analysis

As discussed, codigestion would reduce costs through energy recover and tipping fees and an estimate of these cost reductions was done. While the waste survey did not result in a complete list of potential wastes for codigestion, a reasonable scenario for codigestion was developed based on the limited results of the survey. The example scenario developed assumed that wastes from two sources that supplied waste data—Dean Foods and Agropure—would be codigested. In addition, it was assumed that an additional 38,000 gallons of similar dairy type wastes would also be codigested. Table 5 summarizes the assumed volumes and characteristics of the wastes that would be codigested.

TABLE 5
Codigestion Wastes

Source	Flow (gpd)	BOD (mg/L)	COD (mg/L)	Volatile Solids (%)	VS (lb/day
Dean Foods	14,000	40,000	80,000	90%	1,051
Agropure	30,000	40,000	80,000	90%	11,259
Other similar dairy wastes	38,000	40,000	80,000	90%	14,261
Total	**82,000**				**26,571**

The digestion system proposed for Alternative 3 consists of two digesters with an internal combustion engine cogeneration system to produce renewable electricity and heat to offset natural gas usage. The following describes the potential modifications required to Alternative 3 to allow for codigestion.

Biogas Production

Potential energy production estimates were determined for the dairy wastes assumed a waste (BOD) concentration of 40,000 mg/L and BOD to chemical oxygen demand (COD) ratio of 0.5. Assuming 350 liters of methane per kilogram of COD at 35° Celsius[3] and that 70 percent of the COD is converted to biogas, the energy from the biogas produced from codigested wastes would be about 9 MBtu/hr. This would be an increase of about 50 to 55 percent from the biogas that would be produced if only GBMSD wastes were digested. The estimate is reasonable in part because other municipal treatment plants have increased biogas production from 30 to more than 100 percent when they have implemented codigestion programs. Examples of these plants are subsequently discussed.

[3] Daniel H. Zitomer, Prasoon Adhikari, Craig Heisel, and Dennis Dineen. 2008. “Municipal Anaerobic Digesters for Co-digestion, Energy Recovery, and Greenhouse Gas Reductions.” *Water Environment Research*. 80(3) March.

Gas Handling and Power Generation

The capacity of the biogas handling/cleaning system and internal combustion engine/ heat recovery systems would have to be increased proportionately to the projected increase in biogas production that would result from codigestion. Although the size of the systems would increase, the number of units of equipment needed would not. Because of this and economies of scale, the increase in costs for increasing the size of the systems would increase less than the proportional increase in biogas production.

Digester Size

To handle the additional waste that would be codigested, the digesters will need to be made larger. The diameter of the two digesters in the original Solids Management Facility Plan was 115 feet with a 40-foot depth. If the same sizing criteria were used for the revised lower flows and loads, the digester diameter would be reduced to about 102 feet. To codigest the additional wastes, the digester diameters would be increased from 102 feet to 110 feet. A solids loading rate of 0.17 lb of VS ft^3/day was assumed for TWAS and 0.24 lb of VS ft^3/day for primary sludge and codigested waste. The digester hydraulic residence time was also estimated, and the solids loading rate governed the digester sizing. The loading rate, sizing, and gas production will likely vary depending upon codigested waste characteristics. It is recommended that bench-scale, and possibly full-scale pilot, testing be done as part of the facility predesign to select the final digester sizing and loadings.

Incinerator and Dryer Size

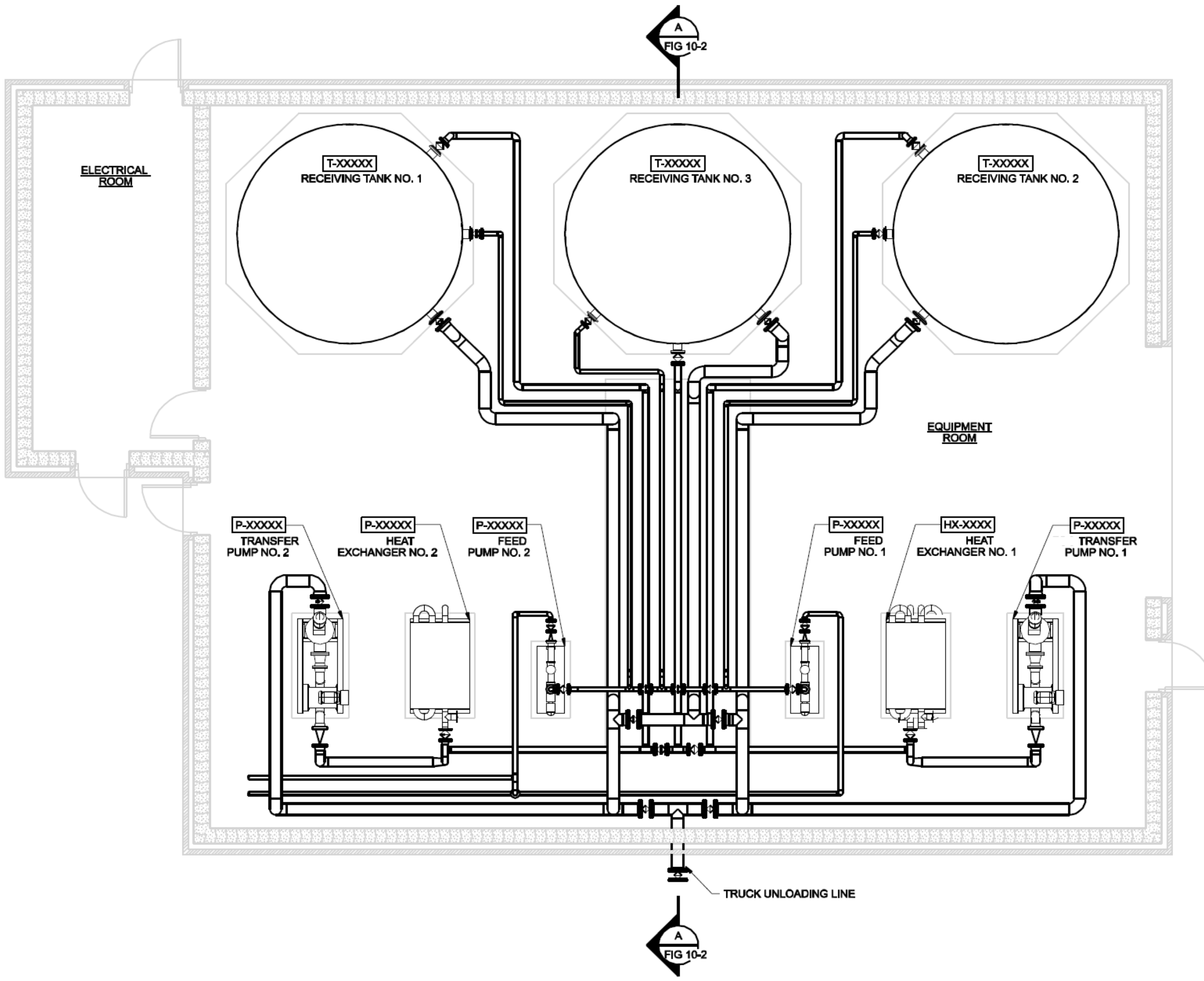
Because the suspended solids and ash content of dairy wastes typically is low, it is expected that there would be a negligible increase in digested sludge, and therefore the capacity of the incinerator and dryer need not be increased to accommodate codigested wastes. This assumption should be verified after the codigested wastes are better characterized during predesign.

Waste Loadout Facility

Alternative 3 includes costs for a liquid waste loading facility that could be used to unload and store wastes for codigestion. The costs include a single tank and a pumping/grinder train. With a truck volume of 5,500 gallons and the assumed 82,000 gallons of codigested wastes, 15 trucks per day would unload wastes. The single train is likely sufficient for this number of trucks, but the unloading system could be expanded if larger volumes of wastes are expected or faster unloading times are desired. The final number and size of the tanks and unloading stations required will depend upon waste volumes and concentrations, trucking schedules, and the potential need to segregate waste types. Air padding could also be considered to reduce unloading time.

Figures 1 and 2 are a plan and section of a typical codigestion receiving facility for processing large quantities of waste. A quick-connect hose fitting would be provided on the outside of the building to unload waste from the hauling trucks. A truck-size area around the fill station would be sloped to a catch basin underneath the hose connection, and a high-pressure hose would be available for haulers to wash out the truck and surrounding area. A swipe-card system would be installed to track and monitor haulers. Inside the building, an in-line grinder with an integral sediment trap and washout system coupled with a rotary lobe pump would draw waste from the trucks to fill the storage tanks.

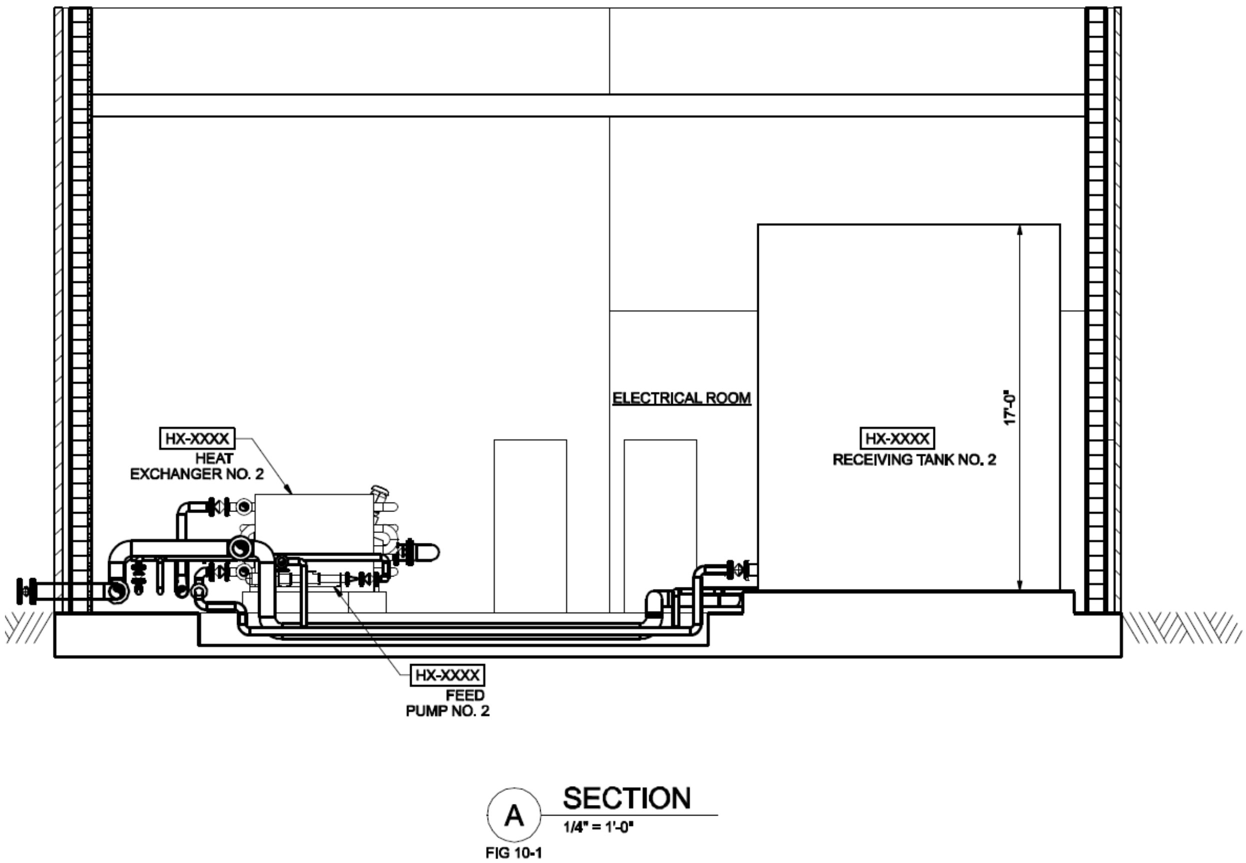
FIGURE 1
Typical, Large-Scale Codigestion Receiving Building Plan



Fees charged to waste haulers can also be a source of revenue for GBMSD. Based on codigestion operations at other facilities, fees charged for the types of wastes generated by Dean Foods and Agropure generally would range from $0.01 to $0.04 per gallon. Fees for higher strength wastes would be higher. Fees can vary widely depending on market conditions, competition for wastes, distance to the disposal site, trucking costs, and other factors. For this evaluation, it is assumed that GBMSD would receive a $0.01 per gallon tipping fee. Actual tipping fees will vary depending on waste characteristics, market competition, and other factors.

Table 6 shows that codigestion would add about $7 million to the capital cost to increase the biogas and digester system sizes but would add significant revenue from electricity and heat production and tipping fees. With codigestion, Alternative 3 becomes the most cost-effective option in terms of the 40-year present value; the 20-year present value is similar to that of the other alternatives.

FIGURE 2
Typical Codigestion Receiving Building Section



Examples of Codigestion Programs

Several municipal wastewater treatment plants in the U.S. and elsewhere have established or are establishing codigestion programs. Three such programs at wastewater treatment plants in Wisconsin and Iowa are described below. The ability to establish a codigestion program is depends largely upon the types and quantities of wastes available in the area around the treatment plant, but the following helps to demonstrate that codigestion has been successfully accomplished at plants in Wisconsin and the Midwest that likely have wastes available for codigestion similar to those GBMSD would have.

Des Moines

The Des Moines wastewater treatment plant operates a large codigestion receiving and processing facility. About 300,000 to 350,000 gallons per day (gpd) of high-strength waste is codigested. The waste is provided by dairies, restaurants (FOG), ethanol plants, and slaughterhouses. Des Moines receives about $3 million per year in fees and generates 2.6 megawatts of electricity and also waste heat from codigestion. The facility produces more gas than the cogeneration system can use, and excess gas is transported in a pipeline and sold to a nearby industrial facility for use in process heating. The plant has experienced foaming problems that require increased operator attention, but the increased cost to deal with foaming is outweighed by tipping fees and energy revenue.

TABLE 6
Net Present Value Comparison: Example Scenario for Codigesting

	Alternative 2	Alternative 3	Alternative 3 with Codigestion	Alternative 11	Alternative 14	Alternative 16
Capital Cost	$112,700,000	$148,900,000	$155,800,000	$80,600,000	$109,100,000	$90,700,000
Total Present Worth: 40-year	$190,400,000	$200,500,000	$164,700,000	$200,600,000	$185,800,000	$216,300,000
Total Present Worth: 20-year with salvage value	$125,900,000	$142,800,000	$128,800,000	$136,200,000	$121,400,000	$129,800,000
Annual O&M 2015	$2,300,000	$1,900,000	$1,000,000	$3,200,000	$2,100,000	$3,200,000
Annual O&M 2025	$3,200,000	$2,400,000	$900,000	$4,800,000	$3,100,000	$4,800,000
Annual O&M 2035	$4,700,000	$3,200,000	$700,000	$7,600,000	$4,700,000	$7,600,000
Annual O&M 2045	$6,900,000	$4,200,000	$200,000	$11,900,000	$7,000,000	$11,600,000
Annual O&M 2055	$10,100,000	$5,600,00	($1,100,000)	$19,200,000	$10,700,000	$18,000,000
40 Year Total O&M	$213,700,000	$139,200,000	$18,800,000	$359,600,000	$214,600,000	$350,400,000

See alternatives refinement memorandum for cost estimating assumptions.

Sheboygan

The Sheboygan wastewater treatment plant has increased the production of biogas by adding high-strength wastes to their anaerobic digesters. Before beginning codigestion, the treatment charges to some industries for wastes discharged to the collection system were relatively high because of the high strength of the waste. The high-strength wastes are now trucked to the Sheboygan plant for codigestion rather than discharged to the collection system, which resulted in increased biogas production and allowed Sheboygan to decrease treatment fees. The industries formerly were charged up to about $0.12 per gallon, but Sheboygan now charges them about $0.03 per gallon.

As of September 2010, Sheboygan codigested the following wastes:

- Adel Whey Wastes:
  - Mother Liquor: ~120,000 mg/L BOD
  - Permeate: ~100,000 BOD
  - Permeate rinse water: ~60,000 mg/L BOD
- Jeneil Biotech Wastes
  - Flavorings for dairy products: ~25,000 mg/L BOD
- Lake to Lake Cheese
  - Cheese processing brine:~ 35,000 mg/L BOD

Feeding the additional wastes to the digesters required minor operational modifications. The waste was dumped into an existing, unused digester tank and then pumped into the digesters for processing. But the solids in the holding tank tended to settle, causing pumping problems. To remedy the situation, a pump system previously used to empty the existing digester tank was configured to recirculate the waste, mixing it for about one hour per day to prevent settling. The biogas is treated to remove moisture, hydrogen sulfide, and siloxanes. The biogas is used in ten 30 kW microturbines to generate electricity.

Adding high-strength wastes to the digesters increased biogas production by more than 100 percent. The Sheboygan plant is also receiving revenue from selling the renewable energy certificates created by the project. Renewable energy certificates produce revenue of $3,000 to $6,000 per year.

Milwaukee Metropolitan Sewerage District

The Milwaukee Metropolitan Sewerage District has done extensive research with Marquette University on the feasibility of codigestion at its South Shore Water Reclamation Plant. More than 80 industries were contacted, and waste samples were analyzed to determine suitability for codigestion. The District projects that it will be able to double biogas production at South Shore and has begun limited full-scale codigestion. The District estimates tipping fees will average $0.04 per gallon and 30,000 to 40,000 gallons of codigested waste per day from the eight most promising of the 81 industries surveyed. This is estimated to result in net revenue of $640,000 per year from tipping fees and recovered energy.

Conclusions

Codigestion of wastes under Alternative 3 is feasible and will lower its 20-year life-cycle cost to a point similar to that of other alternatives and its 40-year life-cycle cost to less than that of the other alternatives. Implementing codigestion will increase the size of the digesters and biogas system and require GBMSD expenditures to develop the program. It could have some adverse impacts on digester operation, but increased revenues from increased energy production and tipping fees will outweigh the potential disadvantages.

Codigestion would increase biogas production by more than 50 percent. Implementing codigestion would increase the capital costs of Alternative 3 by about 5 percent because of the cost to increase the size of the digesters and biogas systems.

Several sources of wastes in northeast Wisconsin are suitable and desirable for codigestion. The proximity of some of those sources to the GBF likely would allow GBMSD to negotiate a competitive tipping fee. The most suitable of the wastes available in large quantities are dairy wastes. Dairy wastes with the highest strength would be most desirable, largely because they would minimize the need to increase the digester size while significantly increasing biogas production. Dairy wastes are also desirable because they generally do not contain large amounts of solids or debris, which could add to handling costs. Chloride concentrations in some high-strength dairy wastes could inhibit the digestion process, but that could be mitigated by controlling the rate of waste addition or by prohibiting the codigestion of high chloride wastes.

It is recommended that codigestion be assumed for Alternative 3, at the levels described in this memorandum, when comparing it to the other alternatives in the Solids Management Facility Plan, and that GBMSD evaluate codigestion further during the predesign of the solids facility. This evaluation should include laboratory testing of wastes, continuing discussion with potential waste sources to better define waste characteristics and quantities, continued assessment of potential tipping fees, and evaluation of methods to mitigate potential problems such as foaming and chloride toxicity. This evaluation can then be used to refine the size and features of the codigestion storage and handling facilities.

Appendix A
Contacts

TABLE A-1

Contact List for Potential Codigestion Waste Providers

Name	Company	Address	Fax #	Phone #	Type of Phone # (if known)	Email Address
Al	Schreiber Foods, Inc.	1695 Mills Street, Green Bay, WI 54302-2642		920-455-3235	Direct	al@sficorp.com
Bill	AK Pizza Crust	1326 Cornell Road, P.O. Box 12706, Green Bay, WI 54307-2706		920-662-0304	General	
Bill Trussler	Hinterland Brewing	313 Dousman Street, Green Bay, WI 54303		920-438-8050	General	info@hinterlandbeer.com
Brenda Wendt	Parallel 44 Vineyard and Winery	N2185 Sleepy Hollow Rd., Kewaunee, WI 54216		920-338-4400	General	brenda@parallel44.com
Brent	Titletown Brewing	200 Dousman St., Green Bay, WI		920-437-2337	General	info@titletownbrewing.com
Dan Brick	Brickstead Dairy	1734 Wayside Rd, Greenleaf, WI 54126		920-532-0386	Direct	dbrick@bricksteaddairy.com
Dan Jauquet	Seroogy's Chocolates	144 N. Wisconsin Street, DePere, WI 54115	920-336-5290	920-336-5043	Direct	dan@seroogys.com
Deb McMahon	Springside Cheese	7989 Arndt Road, Oconto Falls, WI 54154		920-829-6395		deb.mcmahon@springsidecheese.com
Harry	Melotte's Meats	4705 Brookside Road, Abrams, WI		920-435-1986		
James Bleick	Graf Creamery, Inc.	N4051 Creamery Street, Zachow, WI	715-758-8020	920-822-5877		jimb@grafcreamery.com
Jan	Red Oak	325 N. Third Avenue, Sturgeon Bay, Wis. 54235		920-743-7729		
Jerry Buresh	Eillien's Candies	1301 Waube Lane, Green Bay, WI 54304		920-336-7549		jb@eillienscandies.com
Jill Holewinski	Bay Valley Foods	1164 O Hare Boulevard, Hobart, WI		920-497-7132	General	jill_holewinski@bayvalleyfoods.com
Larry Collins	JBS—Green Bay	1330 Lime Kiln Road, Green Bay, WI	920-469-1183	920-406-2247	Direct	larry.collins@JBSSA.com
Lisa Schulze	Maplewood Meats	4663 Milltown Road, Green Bay, WI 54313-7465		920-865-7901	General	lisaschulze@maplewoodmeats.com
Luke Jacobs	Jacobs Meat Market	544 N Lawe St, Appleton, WI 54911-5300		920-733-1031	General	luke@jacobsmeatmarket.com
Mark	Beerntsen's Candies	200 N Broadway, Green Bay, WI 54303-2730		920-437-4400	General	mark@beerntsenscandies.com
Mark Schleitwiler	Belgioioso Cheese, Inc.	4200 Main Street, Green Bay, WI 54311	920-863-2810	920-863-2123	General	marks@belgioioso.com
Nick	Von Stiehl Winery	115 Navarino St., Algoma, WI 54201		920-487-5208	General	nick@vonstiehl.com
Otto	Otto's Meats	N5674 Adams Street, Luxemburg, WI		920-845-2612		
Paul Maney	American Foods Group	P.O. Box 8547, Green Bay, WI 54308		920-436-4205	Direct	pmaney@americanfoodsgroup.com
Phil Vangsnes	TNT Crust	508 Elizabeth Street, Green Bay, WI 54302	920-431-7253	920-431-7251	Direct	philip.vangsnes@tyson.com
Steve Williams	Birdseye Dairy, Inc.	520 North Broadway, Green Bay, WI		920-494-5388	General	steve.williams@birdseyedairy.com
Ted Winkelman	Agropur—Luxemburg	N2915 County Road AB, Luxemburg, WI 54217		920-845-2901 Ext 227	Direct	ted.winkelman@agropur.com
Tim Johnson	Agropur—Little Chute	2701 Freedom Rd, Appleton, WI 54913		920-788-2115 Ext 208	Direct	tim.johnson@agropur.com
Tom Pleshek	Alto Dairy	307 N Clark St, Black Creek, WI 54106		920-984-3331	General	tpleshek.@saputo.com
Troy	Kerrigan Brothers Winery	N2797 St HWY 55, Freedom, WI 54130		920-788-1423		troy@kerriganbrothers.com
Wally Heil	Dean Foods	P.O. Box 5187, Green Bay, WI 54311		920-338-3530		wally_heil@deanfoods.com
	Simon Creek	5896 Bochek Road, Sturgeon Bay, WI 54235		920-746-9307		
	Suamico Fish Co.	1184 Riverside Drive, Green Bay, WI 54313		920-434-2930		

Appendix B
Survey

Green Bay Metropolitan Sewerage District
Cleaning Water Today For Tomorrow's Generations

June 17, 2011

Name
Company
Address

Dear <Name>:

The Green Bay Metropolitan Sewerage District (GBMSD) is a public utility that reclaims wastewater at two treatment facilities in Green Bay and De Pere, WI. GBMSD is a wholesaler of wastewater treatment and conveyance services for 17 municipalities and serves more than 217,000 people in Brown and Kewanee Counties.

GBMSD is developing a Solids Management Facility Plan to address aging facilities, capacity issues, and regulatory changes, and is requesting your assistance with this important project. One of the plan's goals is to minimize impacts on the environment and operating costs by minimizing energy use through recovering waste energy and producing renewable fuels. One potential method of producing renewable energy is to transport organic wastes from industrial and commercial sources to the Green Bay Facility, treat them anaerobically, and utilize the biogas by-product as an energy source.

You are receiving this letter because you may be a potential producer of organic waste that could be utilized to produce energy from biogas. GBMSD may be able to utilize your wastes and help you reduce your disposal costs. We would ask that you complete the enclosed survey by June 20, 2011 to help us determine if we can utilize your waste and potentially reduce your disposal costs. The completed survey can be returned to Steve Graziano via e-mail or Fax, and we would appreciate you returning the survey even if all of the requested information is not immediately available.

A representative from CH2M HILL, an engineering firm working for GBMSD on this project, may contact you to help facilitate completion of the survey. Should you have any questions or require additional information, please do not hesitate to contact Steve Graziano (CH2M HILL) at (414) 847-0288, fax (414) 454-8890, or email: steven.graziano@ch2m.com, or Bill Angoli (GBMSD) at (920) 438-1034, fax (920) 438-3034, or email: wangoli@gbmsd.org.

Sincerely,

GREEN BAY METROPOLITAN SEWERAGE DISTRICT

William Angoli, P.E.
Project Manager

2231 North Quincy St. | Green Bay, WI 54302 | 920/432-4893 | Fax: 920/432-4302 | Email: gbmsd@gbmsd.org

Green Bay Metropolitan Sewerage District
Cleaning Water Today For Tomorrow's Generations

Organic Waste Survey for GBMSD

Name of the facility	
Address	
Contact person	
Job title	
Telephone number	
Fax number	
E-mail	
Source of waste	
Type of waste	
Daily waste production, wet tons/day or gallons/day	
Annual production, wet tons/year or	
Future plans for wasteload – increase, decrease, maintain status quo	
Current disposal method – landfill, discharge to municipal sewer, other	
Location of disposal site (landfill, etc.) if applicable	
Are any biocides, etc. added to the waste?	
Cost of current disposal, $/ton or gal disposed	
Frequency of waste generation - hrs/day and day/week	
Would you have a potential interest in participating with GBMSD on waste	
Total solids (TS), %	
Volatile solids (VS, % or % of TS)	
Organic content (TOC or COD), mg/L	
Nitrogen content (% of TS or mg/L)	
pH	
Oil, lipid content (% or mg/L)	
Ash content (% or % of TS)	

2231 North Quincy St. | Green Bay, WI 54302 | 920/432-4893 | Fax: 920/432-4302 | Email: gbmsd@gbmsd.org

Appendix C
Survey Responses

From: Graziano, Steven/MKE
Sent: Friday, July 01, 2011 3:20 PM
To: Desing, Bill/MKE
Cc: Ghylin, Trevor/MKE
Subject: FW: Reminder: Green Bay MSD Organic Waste Survey

I just got a response from Agropur. When asked about his BOD or COD and %VS and he explained a bit about each facility (see email correspondence below). Should I add this BOD into the memo? Also, sounds like they dispose of their whey...

Steve

From: Ted Winkelman [mailto:Ted.Winkelman@agropur.com]
Sent: Friday, July 01, 2011 3:09 PM
To: Graziano, Steven/MKE
Subject: RE: Reminder: Green Bay MSD Organic Waste Survey

No each plant is different but the only thing produced at Little Chute is a DAF sludge from there activated sludge plant. The B.O.D. from our high strength waste in Luxemburg varies depending upon how much of our whey stream is dumped for disposal on any given day but it generally is between 30,000 mg/l and 50,000 mg/l. I do not have any current data on volatiles but the TSS is up and down also with the whey solids that are generated for disposal. I hope this helps. Please let me know if I can offer any other assistance.

Thanks

Ted

From: Steven.Graziano@ch2m.com [mailto:Steven.Graziano@ch2m.com]
Sent: Friday, July 01, 2011 2:49 PM
To: Ted Winkelman
Subject: RE: Reminder: Green Bay MSD Organic Waste Survey

Thanks Ted. Would you by any chance know what the BOD or COD and %VS are for your Luxemburg facility? Also, I understand that both facilities produce different types of cheese and that the Little Chute location produces a fraction of the wastewater as Luxemburg. Do you find the cheese wastes from each facility to generally be similar in composition? Or is this not necessarily the case?

Thanks,

Steve Graziano
CH2M Hill
135 S 84th Street, Suite 400
Milwaukee, WI 53208
(414) 847-0288
steven.graziano@ch2m.com

From: Ted Winkelman [mailto:Ted.Winkelman@agropur.com]
Sent: Friday, July 01, 2011 1:58 PM
To: Graziano, Steven/MKE
Subject: RE: Reminder: Green Bay MSD Organic Waste Survey

Hi Steve, Sorry for some reason my first attempt at sending this didn't go through and I have been out of the office the past week at another facility.

Please see attachment, this is a total to the Luxemburg facility only. The Little Chute facility produces sludge also from there wwtp at approximantly 3 million gallons per year. If further details are needed please contact me and I will try to provide what is available.

Thanks

Ted Winkelman
Agropur inc
920-845-2901 ext227

From: Steven.Graziano@ch2m.com [mailto:Steven.Graziano@ch2m.com]
Sent: Monday, June 20, 2011 6:15 PM
To: Steven.Graziano@ch2m.com
Subject: Reminder: Green Bay MSD Organic Waste Survey

Hello,

This is an email reminder to please consider completing the Green Bay Metropolitan Sewerage District Organic Waste Survey. We would appreciate you returning the survey even if all of the requested information is not immediately available. Thank you for your assistance on this important project.

Sincerely,

Steve Graziano
CH2M Hill
Water/Wastewater Intern
135 S 84th Street, Suite 400
Milwaukee, WI 53208
(414) 847-0288
steven.graziano@ch2m.com

Organic Waste Survey for GBMSD

Name of the facility	Agropur Inc
Address	N 2915 Cty RD AB
Contact person	Ted Winkelman
Job title	Environmental Manager
Telephone number	920-845-2901 ext 227
Fax number	920-845-9908
E-mail	Ted.winkelman@agropur.com
Source of waste	WWTP Sludge and High Strength Dairy Waste
Type of waste	Dairy Processing Waste
Daily waste production, wet tons/day or gallons/day	30,000 gallons
Annual production, wet tons/year or gallons/year	15,000,000 gallons
Future plans for waste load – increase, decrease, maintain status quo	Maintain status quo or decrease
Current disposal method – landfill, discharge to municipal sewer, other	Land Application
Location of disposal site (landfill, etc.) if applicable	na
Are any biocides, etc. added to the waste?	no
Cost of current disposal, $/ton or gal disposed	
Frequency of waste generation - hrs/day and day/week	Daily 365 days a year
Would you have a potential interest in participating with GBMSD on waste disposal?	possibly
Total solids (TS), %	variable
Volatile solids (VS, % or % of TS)	Variable call for details
Organic content (TOC or COD), mg/L	Variable call for details
Nitrogen content (% of TS or mg/L)	Variable call for details
pH	unknown
Oil, lipid content (% or mg/L)	unknown
Ash content (% or % of TS)	unknown

Organic Waste Survey for GBMSD

Name of the facility	AK Pizza Crust
Address	3 locations in Green Bay
Contact person	Bill LaLuzerne
Job title	VP Operations
Telephone number	920.662.0304 x211
Fax number	920.662.0306
E-mail	blaluzerne@akcrust.com
Source of waste	Production of Pizza Crusts
Type of waste	Pizza Dough
Daily waste production, wet tons/day or gallons/day	
Annual production, wet tons/year or gallons/year	10,000 tons waste
Future plans for wasteload – increase, decrease, maintain status quo	Increase
Current disposal method – landfill, discharge to municipal sewer, other	Product is being sold
Location of disposal site (landfill, etc.) if applicable	NA
Are any biocides, etc. added to the waste?	No
Cost of current disposal, $/ton or gal disposed	0 – Sale generates income
Frequency of waste generation - hrs/day and day/week	24 hours/day, 5 days/week
Would you have a potential interest in participating with GBMSD on waste disposal?	Not for free
Total solids (TS), %	50%
Volatile solids (VS, % or % of TS)	??
Organic content (TOC or COD), mg/L	??
Nitrogen content (% of TS or mg/L)	??
pH	??
Oil, lipid content (% or mg/L)	3-5%
Ash content (% or % of TS)	??

Organic Waste Survey for GBMSD

Name of the facility	Belgioioso Cheese Inc
Address	4200 Main St G.B. WI 54311
Contact person	Mark Schleitwiler
Job title	VP Operations
Telephone number	(920) 863-2123
Fax number	(920) 863-2810
E-mail	Marks @ belgioioso.com
Source of waste	(5) Cheese Plants
Type of waste	Wash water from process equip
Daily waste production, wet tons/day or gallons/day	300,000 + gals/day
Annual production, wet tons/year or gallons/year	± 120,000,000 gal/yr
Future plans for wasteload – increase, decrease, maintain status quo	increase
Current disposal method – landfill, discharge to municipal sewer, other	Land Application 95+% Balance municipal
Location of disposal site (landfill, etc.) if applicable	Various sites in Brown, Oconto Manitowoc Outagamie + Shawano counties
Are any biocides, etc. added to the waste?	No
Cost of current disposal, $/ton or gal disposed	1.5¢/gal
Frequency of waste generation - hrs/day and day/week	24/7
Would you have a potential interest in participating with GBMSD on waste disposal?	Yes
Total solids (TS), %	—
Volatile solids (VS, % or % of TS)	—
Organic content (TOC or COD), mg/L	—
Nitrogen content (% of TS or mg/L)	150 mg/L
pH	± 6.5 - 7.5
Oil, lipid content (% or mg/L)	—
Ash content (% or % of TS)	—

Organic Waste Survey for GBMSD

Name of the facility	Dean Foods of WI, LLC d/b/a Morning Glory Dairy
Address	3399 S. Ridge Road; De Pere, WI 54115-5187
Contact person	Walter P. Heil, Jr.
Job title	Plant Manager
Telephone number	920-338-3530
Fax number	920-336-7317
E-mail	Wally_Heil@deanfoods.com
Source of waste	Processing of milk
Type of waste	Dairy Solids
Daily waste production, wet tons/day or gallons/day	14,000 gal. per day
Annual production, wet tons/year or gallons/year	5,000,000 gal. per year
Future plans for wasteload – increase, decrease, maintain status quo	Maintain status quo
Current disposal method – landfill, discharge to municipal sewer, other	Field spread
Location of disposal site (landfill, etc.) if applicable	N/A
Are any biocides, etc. added to the waste?	No
Cost of current disposal, $/ton or gal disposed	
Frequency of waste generation - hrs/day and day/week	7 days per week
Would you have a potential interest in participating with GBMSD on waste disposal?	perhaps
Total solids (TS), %	0.97%
Volatile solids (VS, % or % of TS)	unknown
Organic content (TOC or COD), mg/L	unknown
Nitrogen content (% of TS or mg/L)	1,000 mg/L
pH	91% > ph 6.0
Oil, lipid content (% or mg/L)	unknown
Ash content (% or % of TS)	unknown

Graf
Creamery Inc.

Corporate Office
N8790 Fairground Avenue, PO Box 130 • Greenwood, WI 54437-0130 • 1-800-428-8837 • Fax (715)267-6044
Facility Location
N4051 Creamery Street• Zachow, WI 54182-0049 • (715) 758-2137 • Fax (715)758-8020

Hello: 414-454-8890

TO: Steve Graziano

FROM: Jim Bleick

No. Of Pages: 2 (Including cover page)

Remarks:

Fax Number: (715) 758-8020

Telephone Number (715) 758-2137

If you did not receive all of the transmitted pages, please notify me. Thank you.

414-454-8890

Organic Waste Survey for GBMSD

Name of the facility	Graf Creamery Inc.
Address	N. 4051 Creamery St., Zachow, WI.
Contact person	James Bleick
Job title	Plant Manager
Telephone number	920-822-5877
Fax number	715-758-8020
E-mail	jimb@grafcreamery.com
Source of waste	Butter Plant
Type of waste	Rinse and Wash water
Daily waste production, wet tons/day or gallons/day	8500 gal./day avg.
Annual production, wet tons/year or gallons/year	3,102,500 gal. est.
Future plans for wasteload – increase, decrease, maintain status quo	Maintain status quo – increase slightly
Current disposal method – landfill, discharge to municipal sewer, other	Other- Ridge and Furrow, spray irrigation
Location of disposal site (landfill, etc.) if applicable	On our property
Are any biocides, etc. added to the waste?	no
Cost of current disposal, $/ton or gal disposed	Approx. .0150 - .0200/ gal.
Frequency of waste generation - hrs/day and day/week	24hrs/day, 7day/week
Would you have a potential interest in participating with GBMSD on waste disposal?	possibly
Total solids (TS), %	224 mg/L
Volatile solids (VS, % or % of TS)	?
Organic content (TOC or COD), mg/L	Lower than cheese plant, we are a Butter plant
Nitrogen content (% of TS or mg/L)	Spray irrigation – 62.1 mg/L
pH	8 PH
Oil, lipid content (% or mg/L)	Milk Fat content higher due to wash up of Butter equipment
Ash content (% or % of TS)	?

Organic Waste Survey for GBMSD

Name of the facility	JBS Green Bay
Address	1330 Lime Kiln Road - Green Bay
Contact person	Larry Collins
Job title	Environmental Manager
Telephone number	920. 406. 2247
Fax number	920. 469. 1183
E-mail	larry.collins@JBSSA.COM
Source of waste	Beef Product - Animal Slaughter
Type of waste	Paunch Manure
Daily waste production, wet tons/day or gallons/day	25 wet tons
Annual production, wet tons/year or gallons/year	6,864
Future plans for wasteload – increase, decrease, maintain status quo	Maintain
Current disposal method – landfill, discharge to municipal sewer, other	Digester or Land Application
Location of disposal site (landfill, etc.) if applicable	Various
Are any biocides, etc. added to the waste?	no
Cost of current disposal, $/ton or gal disposed	$3 per ton + transportation.
Frequency of waste generation - hrs/day and day/week	8 hours per day - 6 days per week
Would you have a potential interest in participating with GBMSD on waste disposal?	possibly - cost is #1 consideration
Total solids (TS), %	24%
Volatile solids (VS, % or % of TS)	not measured
Organic content (TOC or COD), mg/L	
Nitrogen content (% of TS or mg/L)	10,256 mg/Kg Organic N
pH	7 - 8
Oil, lipid content (% or mg/L)	not measured
Ash content (% or % of TS)	n/a

Organic Waste Survey for GBMSD

Name of the facility	Same
Address	
Contact person	
Job title	
Telephone number	
Fax number	
E-mail	
Source of waste	Animal Holding Pens
Type of waste	Barn Waste – Sawdust
Daily waste production, wet tons/day or gallons/day	34 wet Tons
Annual production, wet tons/year or gallons/year	9,479 Tons
Future plans for wasteload – increase, decrease, maintain status quo	Maintain
Current disposal method – landfill, discharge to municipal sewer, other	land application
Location of disposal site (landfill, etc.) if applicable	various
Are any biocides, etc. added to the waste?	n/a
Cost of current disposal, $/ton or gal disposed	$2-3 per ton
Frequency of waste generation - hrs/day and day/week	8 hours per day – 6 days per week
Would you have a potential interest in participating with GBMSD on waste disposal?	possibly – cost is #1 consideration
Total solids (TS), %	51%
Volatile solids (VS, % or % of TS)	not measured
Organic content (TOC or COD), mg/L	not measured
Nitrogen content (% of TS or mg/L)	9,329 mg/Kg Organic N
pH	8
Oil, lipid content (% or mg/L)	n/a
Ash content (% or % of TS)	n/a

Organic Waste Survey for GBMSD

Name of the facility	Same
Address	
Contact person	
Job title	
Telephone number	
Fax number	
E-mail	
Source of waste	Wastewater Anaerobic Contact tank
Type of waste	Waste activated Sludge
Daily waste production, wet tons/day or gallons/day	27 wet tons
Annual production, wet tons/year or gallons/year	6,853
Future plans for wasteload – increase, decrease, maintain status quo	decrease by 20%
Current disposal method – landfill, discharge to municipal sewer, other	digester – land application
Location of disposal site (landfill, etc.) if applicable	Various
Are any biocides, etc. added to the waste?	no
Cost of current disposal, $/ton or gal disposed	$4-5 per ton
Frequency of waste generation - hrs/day and day/week	16 hours per day – 6 days per week
Would you have a potential interest in participating with GBMSD on waste disposal?	possibly – cost is #1 consideration
Total solids (TS), %	17-20%
Volatile solids (VS, % or % of TS)	not measured regularily
Organic content (TOC or COD), mg/L	not measured
Nitrogen content (% of TS or mg/L)	54,969 mg/kg
pH	7.4
Oil, lipid content (% or mg/L)	n/a
Ash content (% or % of TS)	n/a

Organic Waste Survey for GBMSD

Name of the facility	Seroogy's Chocolates
Address	144 N. Wisconsin Street DePere WI 54115
Contact person	Dan Jauquet
Job title	Production Manager
Telephone number	920-336-5043
Fax number	920-336-5290
E-mail	dan@seroogys.com
Source of waste	Spillage or scrap
Type of waste	Chocolate
Daily waste production, wet tons/day or gallons/day	Less than 10 lbs.
Annual production, wet tons/year or gallons/year	unsure
Future plans for wasteload – increase, decrease, maintain status quo	Same or little change
Current disposal method – landfill, discharge to municipal sewer, other	landfill
Location of disposal site (landfill, etc.) if applicable	
Are any biocides, etc. added to the waste?	No
Cost of current disposal, $/ton or gal disposed	Uncertain
Frequency of waste generation - hrs/day and day/week	7 hrs per day /4 to 5 days per week
Would you have a potential interest in participating with GBMSD on waste disposal?	No
Total solids (TS), %	?
Volatile solids (VS, % or % of TS)	?
Organic content (TOC or COD), mg/L	?
Nitrogen content (% of TS or mg/L)	?
pH	?
Oil, lipid content (% or mg/L)	?
Ash content (% or % of TS)	?

Organic Waste Survey for GBMSD

Name of the facility	TNT Crust
Address	508 Elizabeth Street Green Bay, Wisconsin 54302
Contact person	Phil Vangsnes
Job title	Engineer
Telephone number	920-431-7251
Fax number	7253
E-mail	Philip.vangsnes@tyson.com
Source of waste	Food manufacturing equipment sanitation efforts
Type of waste	Wash water from Food manufacturing one event per week
Daily waste production, wet tons/day or gallons/day	394 cu ft sewage average/day mostly on Friday and Saturday
Annual production, wet tons/year or gallons/year	
Future plans for wasteload – increase, decrease, maintain status quo	Status quo
Current disposal method – landfill, discharge to municipal sewer, other	Municipal sewer
Location of disposal site (landfill, etc.) if applicable	
Are any biocides, etc. added to the waste?	no
Cost of current disposal, $/ton or gal disposed	City sewage charges
Frequency of waste generation - hrs/day and day/week	About 20 hours per week. Usually Friday or Saturday
Would you have a potential interest in participating with GBMSD on waste disposal?	We do all our bakery waste with an outside contractor who either feeds it or uses it in the production of Ethanol.
Total solids (TS), %	Don't know
Volatile solids (VS, % or % of TS)	Don't know
Organic content (TOC or COD), mg/L	Don't know
Nitrogen content (% of TS or mg/L)	Don't know
pH	Don't know
Oil, lipid content (% or mg/L)	Don't know
Ash content (% or % of TS)	Don't know

Additional notes sent by Phil Vangsnes in return email:

"We are a bakery that cleans up usually once a week. Our sewage flow are greatest then. Our bakery waste is currently being fed to livestock or taken off site by a contractor for use in Ethanol production."

Graziano, Steven/MKE

From: nick@vonstiehl.com
Sent: Tuesday, June 21, 2011 10:36 AM
To: Graziano, Steven/MKE
Subject: Re: Reminder: Green Bay MSD Organic Waste Survey

Hey Steve,
Sorry for the late reply. I just looked over the survey and I don't know the answers to most of questions you've asked. I asked some co-workers here some of the questions I couldn't answer like the % of total waste that was _____ and they also were stumped. Sorry I couldn't help out. We are a small business with limited resources in this area.
Nick

On Mon, 20 Jun 2011 17:14:42 -0600
<Steven.Graziano@ch2m.com> wrote:
> Hello,
>
> This is an email reminder to please consider completing
>the Green Bay Metropolitan Sewerage District Organic
>Waste Survey. We would appreciate you returning the
>survey even if all of the requested information is not
>immediately available. Thank you for your assistance on
>this important project.
>
> Sincerely,
>
> Steve Graziano
> CH2M Hill
> Water/Wastewater Intern
> 135 S 84th Street, Suite 400
> Milwaukee, WI 53208
> (414) 847-0288
> steven.graziano@ch2m.com
>

Nutrient Extraction / Struvite Control

PREPARED FOR: Bill Angoli/GBMSD

PREPARED BY: Trevor Ghylin/CH2M HILL
Jim Fisher/CH2M HILL

REVIEWED BY: Bruce Johnson/CH2M HILL
Bill Desing/CH2M HILL

DATE: June 28, 2011

Introduction

The process of anaerobic digestion that is used in Alternative 3 causes lysing of cells in waste activated sludge and degradation of organic solids in primary sludge. This results in ammonia production and release of soluble phosphorus. During dewatering, the soluble ammonia and phosphorus remain in the liquid and are recycled to the liquid treatment processes. The potential impacts of this were evaluated.

The secondary treatment process will acclimate to the higher levels of ammonia caused by digestion if the recycled ammonia is dosed continuously. Recycled ammonia should not be a concern if the ammonia is not returned as a slug load. Solids can be stored over weekends and dewatered during the week without upsetting the nitrification process. However, operation with significantly longer solids storage times is not recommended without first testing or modeling the impacts on the liquid treatment process. For Alternative 3 a centrate equalization tank should be provided to allow 24-hour continuous recycle. This tank is not necessary if the dewatering process is a 24/7 operation with continuous recycle. During predesign of the solids facilities, a detailed evaluation of the impacts of ammonia recycle should be done including an evaluation of potential impacts of future anticipated effluent nitrogen regulations.

One option for managing recycled phosphorus is to use a nutrient extraction process to produce struvite. The process will reduce recycled phosphorus by 90 percent or more while producing a fertilizer product that can be sold, and it prevents the formation of struvite in equipment and pipes. A second option for controlling phosphorus and preventing struvite formation in equipment and pipes is the use of ferric chloride.

This memorandum describes the potential problems caused by phosphorus released from anaerobic digestion and evaluates methods and costs for mitigating those problems.

Potential Impacts of Phosphorus Recycle

Impacts on Bio-P Process

Removal of biological phosphorus requires 7 to 12 grams of volatile fatty acids (VFAs) as COD per gram of soluble phosphorus. VFAs can form from readily biodegradable BOD in the unaerated zones of aeration tanks and conveyance. Because digestion releases phosphorus and returns it to the head of the plant by dewatering recycle, it will require a greater amount of soluble BOD for the removal of biological phosphorus. Soluble phosphorus in the recycled centrate could overload the Bio-P process and cause instability, requiring the need to supplement Bio-P with chemical precipitation of phosphorus. For example, Table 1 shows the costs incurred by GBMSD when 9,000 pounds per day of BOD from the Georgia-Pacific mill no longer entered the plant. The BOD reduction resulted in the need to use chemical precipitation to meet the phosphorus removal needs.

A rough phosphorus balance was performed by Ostara that can be used to make a preliminary determination of the impacts. Figure 1 demonstrates that the centrate recycle is almost half as much phosphorus load (868 lb P/day) as the raw wastewater influent (1,759 lb P/day). Table 2 shows a rough analysis of the potential impacts on the biological phosphorus removal (Bio-P) process. The soluble P load was calculated based on plant influent and estimated recycle load. The BOD to the aeration basins was determined from a spreadsheet model of the Green Bay Facility. This load assumes that Fox River Fiber wastewater is pumped to the Green Bay Facility. A rough rule of thumb is that the Bio-P process typically requires a minimum BOD:P ratio of 20:1 (lb/lb). From Table 2 it appears that there may be sufficient BOD to maintain Bio-P with the increased soluble phosphorus recycled from digestion. Further plant modeling is required to better evaluate this conclusion. If there is not enough readily biodegradable BOD for Bio-P, ferric chloride would have to be used to control effluent phosphorus.

TABLE 1
GBMSD Cost of Chemical Precipitation of Phosphorus during Low BOD Event

Date	Ferric Chloride (gal.)	Cost
December 2009	8,149	$12,142
January 2010	22,940	$34,181
February 2010	11,140	$16,599
March 2010	20,160	$30,038
April 2010	11,520	$17,165
5-month average		$22,025
Projected annual cost		$264,000

Note: ferric chloride cost = $1.49/gal @ 40% by weight.

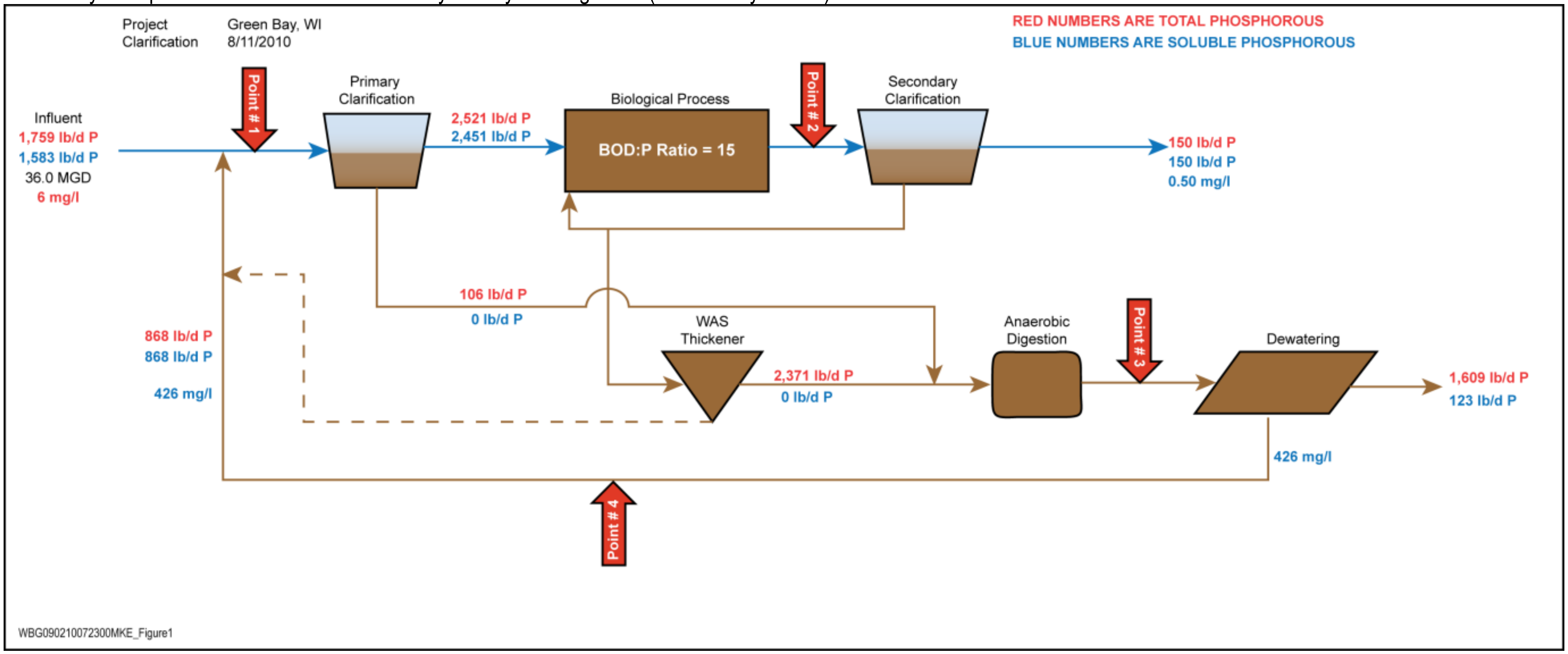
TABLE 2
Estimated BOD/P ratio in Bio-P Process with Digestion Online

Soluble P to aeration	2,451 lb/day
BOD to aeration	57,000 lb/day
BOD/P ratio	23

Struvite Formation

Anaerobic digestion releases particulate phosphorus in two ways. One is through the digestion of biomass and the release of phosphorus bound in the cell components. The second is the same as what occurs in the anaerobic zone of a Bio-P system, where under anaerobic conditions, phosphorus accumulating organisms will release stored phosphorus. Anaerobic digestion also causes ammonification, the conversion of organic nitrogen to ammonia. Struvite ($NH_4\ MgPO_4 \cdot 6H_2O$) commonly is formed as a result of these processes and is the primary means by which phosphorus is removed from WWTPs with anaerobic digestion and Bio-P. Most of the struvite comes is removed with the digested sludge and is not a maintenance issue. However, struvite can cause maintenance issues as it accumulates in digesters and precipitates out on surfaces in heat exchangers, pumps, and piping. Wastewater treatment plants that use Bio-P and anaerobic digestion commonly experience problems with struvite. The potential for struvite precipitation is determined by the conditional solubility product of magnesium, ammonia, and phosphorus and the pH.

FIGURE 1
Preliminary Phosphorus Balance for the Green Bay Facility with Digestion (Provided by Ostara)



As the concentrations of magnesium, ammonia, and phosphorus increase, the potential for precipitation increases. Conversely, a decrease in any of the three reactants decreases the potential for struvite precipitation. Ammonia concentrations are primarily a function of the amount of organic nitrogen in the digester feed sludges, volatile solids destruction, and digester pH. Therefore, plants with similar raw sludge characteristics using anaerobic digestion with similar volatile solids destruction will have similar ammonia concentrations. Plants practicing advanced digestion, which can result in greater volatile solids destruction and thus ammonia (and phosphorus) release, are therefore at greater risk of struvite problems. Plants using Bio-P will have a higher release of phosphorus from volatile solids destruction than plants using chemical phosphorus removal, because most of the chemically precipitated phosphorus will remain bound with the metal salt during digestion. Therefore, plants that use Bio-P are at greater risk of struvite problems. The concentration of magnesium is primarily a function of the influent wastewater magnesium concentration. Wastewater treatment plants in areas like Green Bay that are served by surface water generally have lower influent magnesium concentrations than plants in areas served by groundwater. However, industrial contributions could affect this. Plants served by groundwater or that receive industrial wastewaters containing magnesium are at greater risk of struvite problems. However, a brief literature review showed that the precise relationship between influent magnesium concentration and the amount of struvite precipitation is not well established.

The potential for precipitation is very pH dependent and increases as pH increases up to a pH of about 10.7. The pH effect is the reason struvite typically precipitates in pipe elbows and pump suctions. That is because a reduction in pressure at those points releases carbon dioxide, resulting in a pH increase.

Methods for Controlling Struvite Formation

Nutrient Extraction

Nutrient extraction is an innovative technology that can in some cases provide cost effective and sustainable struvite control. The amount of soluble phosphorus returned to liquid treatment can be reduced with nutrient extraction. Nutrient extraction also produces struvite pellets that can be sold as a fertilizer. The technology requires ammonia and therefore is applicable only to solids processing systems that include anaerobic digestion because digestion converts organic nitrogen into ammonia. Nutrient extraction cannot be applied to the non-digestion alternatives (Alternative 2–Incineration with Energy Recovery, Alternative 11—Composting, Alternative 14—Incineration with Drying, Alternative 16—Multiple Hearth Furnace Rehabilitation). The technology has the following advantages and disadvantages.

Advantages

- Reduces (by up to 90 percent) the soluble phosphorus in the recycle stream, enhancing the stability of the Bio-P process in liquid treatment
- Reduces (by 20 percent) ammonia in the recycle stream which decreases the costs of liquid treatment aeration
- Produces a sustainable pellet fertilizer valued at $100 to $300/ton
- Does not increase total sludge production

Disadvantages

- High capital cost
- If Ostara's WASSTRIP process is used, the gravity thickeners would have to be operated as fermentors which would increase odors and likely require odor control.

Three manufacturers that provide nutrient extraction technology:

- Ostara
- Multiform Harvest, Inc.
- Crystallactor

This evaluation uses information provided by Ostara, but any of the three manufacturers could provide similar technology. There are two methods to extract nutrients from digested sludge. Extraction must occur downstream of digestion (Ostara's Pearl Process) and can also occur upstream (Ostara's WASSTRIP process). The benefit of extracting nutrients upstream of digestion is that it reduces formation of struvite to lower levels than those that can be achieved in downstream nutrient extraction alone. However, extracting nutrients upstream of digestion requires an additional reactor, increasing capital cost.

Downstream Nutrient Extraction (Pearl)

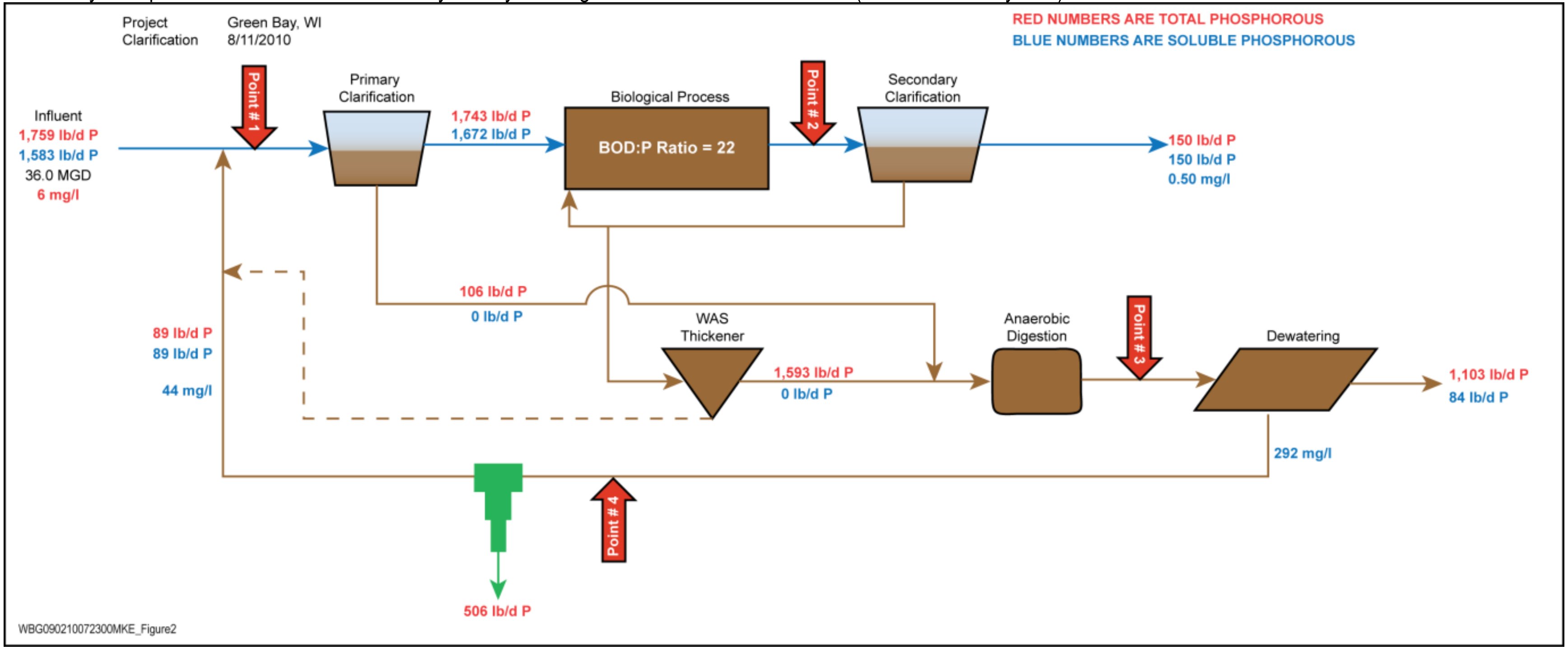
Figure 2 shows the phosphorus balance when nutrient extraction is used to remove phosphorus downstream of digestion (that is, from the dewatering centrate). In this example, the recycled phosphorus is reduced by about 90 percent, and the phosphorus content of the digested biosolids is reduced by about one-third. If the WASSTRIP process is added, the phosphorus content of the biosolids is reduced by over 50 percent as compared to a system without nutrient extraction.

The nutrient extraction process requires soluble phosphorus, ammonia and magnesium to produce struvite. The centrate from the digested sludge is rich in phosphorus and ammonia. Additional magnesium is added as necessary. Extracting nutrients downstream of digestion is a fairly simple process in that it involves just one unit process. The WASSTRIP process can be added and used to release additional phosphorus from the waste activated sludge before digestion and send the phosphorus to the Pearl process.

Upstream Nutrient Extraction (Pearl with WASSTRIP)

The WASSTRIP reactor provided by Ostara is placed upstream of digestion (Figure 3). Waste activated sludge flows to the reactor as do volatile fatty acids from fermented gravity thickener supernatant. The gravity thickeners would be required to be operated as fermentors for WASSTRIP to operate which would increase gravity thickener odors. The anaerobic conditions and presence of volatile fatty acids cause the waste activated sludge cells to release soluble phosphorus in the WASSTRIP reactor. The WASSTRIP sludge then flows to a thickening process, and the phosphorus-rich filtrate flows to the nutrient extraction reactor (Pearl in the case of Ostara). The nutrient extraction reactor also needs ammonia and magnesium to create struvite. The ammonia is obtained from the digested sludge centrate and magnesium is added as needed.

FIGURE 2
Preliminary Phosphorus Balance for the Green Bay Facility with Digestion and Nutrient Extraction (Ostara's Pearl System)



Ferric Chloride for Controlling Struvite Formation

Many plants that experience struvite problems dose ferric chloride upstream of anaerobic digestion to bind the soluble phosphorus and prevent struvite formation. This method is effective, but it can be costly and adds to the total amount of sludge produced. Ferric chloride addition to dewatering feed is somewhat less costly, since it both reduces pH (struvite is less likely to precipitate at lower pH) and binds up phosphorus. However the benefits of digester gas H_2S reduction are lost with this approach. Capital costs for storing and feeding ferric chloride are relatively small compared to nutrient extraction options. Depending on the quantity of ferric chloride required and the cost of ferric chloride, this can be a very cost-effective approach to controlling struvite.

The advantages and disadvantages of ferric chloride are listed below:

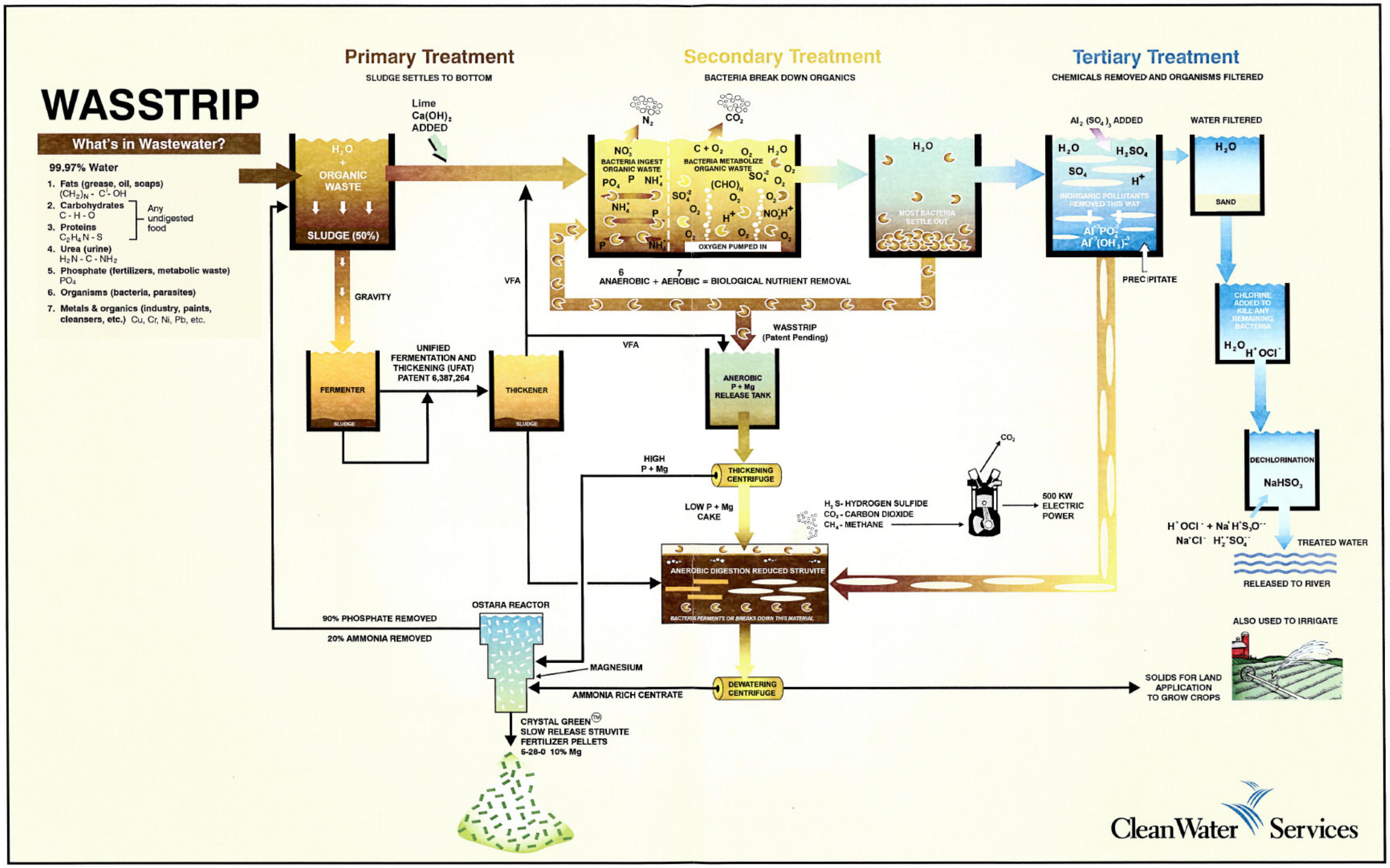
Advantages

- It requires minimal capital investment, because the ferric chloride dosing system already exists.
- It can be dosed to obtain almost any desired phosphorus level desired.
- It reduces digester gas H_2S if dosed upstream of anaerobic digestion.
- It improves sludge dewaterability.
- Unreacted iron in the dewatered cake could reduce sulfur dioxide emissions from the incinerator, although such emissions are not expected to be an air permit compliance issue.
- The costs of ferric chloride addition are somewhat offset by lower polymer use in dewatering (up to a 15 percent reduction).

Disadvantages

- Can be costly, depending on how much chemical is required to control struvite formation. However, some facilities use little to no ferric chloride to control struvite, whereas others require costly quantities to prevent struvite formation.
- Produces inert solids that could reduce the eutectic temperature in the incinerator and lead to slagging. However, some incinerator facilities use ferric to remove phosphorus and have operated consistently without slagging.

FIGURE 3
Process Flow Diagram of Ostara Nutrient Extraction with WASSTRIP



Cost Analysis

Three options for controlling struvite formation are: react as problems arise, add ferric chloride, extract nutrients. Tables 3 and 4 provide a cost analysis for nutrient extraction. Table 5 compares the costs and benefits of each of the three struvite control options.

TABLE 3
Assumptions for Nutrient Extraction Cost Estimate

	Assumption	Source/Comment
P to digesters (lb/day)	1,484	28 mgd to Green Bay Facility at 6 mg/L; 0.5 mg/L effluent; De Pere Facility plant model shows 500 lb/day in waste activated sludge; assume 40% released in digestion
$FeCl_3$:P (mol Fe:mol P)	0.3–1	
$FeCl_3$: P (lb/lb)	1.6–5.24	Three levels of ferric chloride for struvite control used (lowest estimate is based on engineering judgment and experience, typical estimate is based on WEFTEC paper cited above, and high estimate is based on Madison MSD data)
$FeCl_3$ dosage (lb/day)	2,374–7,781	
$FeCl_3$ dosage (tons/year)	433–1,420	
$FeCl_3$ cost ($/ton)	$693	Provided by GBMSD
Avoided cost of ferric chloride ($/year)	$300,000–$1,000,000	
Struvite production (tons/year)	731	Estimate provided by Ostara
Struvite value ($/ton)	$150	Estimate provided by Ostara
Struvite value ($/year)	$110,000	
N removed (lb/day)	230	Estimate provided by Ostara
Aeration cost ($/lb N)	$0.24	Estimate provided by Ostara
Avoided aeration power costs ($/year)	$20,000	
Nutrient extraction O&M cost: labor, energy, chemicals, etc. ($/year)	$200,000	Estimate provided by Ostara

TABLE 4
Cost of Nutrient Extraction

		Assumptions
Capital cost	$8,600,000	Includes engineering, contractor markups, contingency. Based on actual bid from Madison MSD.
Annual O&M	$200,000	From Ostara and Madison MSD pilot

TABLE 5
40 Year Present Worth Comparison of Ferric Chloride Addition and Nutrient Extraction

Discount rate (from Solids Management Facility Plan)	4.50%
Long term inflation rate (from Solids Management Facility Plan)	3.00%
Net discount rate (from Solids Management Facility Plan)	1.50%
Ferric chloride O&M cost per year—low dose	$300,000
Ferric chloride 40 year present worth—low dose	**$8,950,000**
Ferric chloride O&M cost per year—typical dose	$600,000
Ferric chloride 40 year present worth—typical dose	**$17,900,000**
Ferric chloride O&M cost per year—high dose	$1,000,000
Ferric chloride 40 year present worth—high dose	**$29,900,000**
Nutrient extraction O&M cost per year (O&M less fertilizer revenue and aeration savings)	$70,000
Nutrient extraction 40 Year Present Worth	**$10,700,000**

The Madison Metropolitan Sewerage District (MSD) completed a pilot study and a cost-effectiveness evaluation of nutrient extraction and determined that the process is feasible and cost-effective, and will result in significant benefits. As a result, Madison MSD is constructing a P-release reactor upstream of digestion and a nutrient extraction reactor (provided by Ostara). Some of the results and assumptions used in Madison MSD's cost analysis were used to verify assumptions made in Table 3. Based on Madison's ferric chloride consumption, GBMSD would use 7,781 lb/day of ferric chloride at a cost of $1,000,000 per year (Table 3). However, several plants achieve struvite control at a much lower dose of about 37 lb Fe/dry tons solids.[1] Based on this lower dose, GBMSD would consume 4,736 lb/day of ferric chloride at an annual cost of $600,000 per year (based on 2035 loads). Engineering experience has also shown that some plants can operate with ferric chloride doses as low as 18.5 lb Fe/dry tons solids for struvite control. The range of ferric chloride consumption presented in Table 3 reflects the wide range of dosages that different plants have experienced.

Madison MSD is implementing nutrient extraction because it is cost-effective at that facility, primarily because of to the anticipated savings in ferric chloride used to control struvite. Madison MSD spends $1 million per year for ferric chloride for struvite control. At this high cost, Madison MSD can justify the estimated $9.1 million capital cost for the nutrient extraction system.

Table 3 shows that the estimated range of annual cost benefits of nutrient extraction for GBMSD. These benefits are the avoided costs of ferric chloride, the revenue from sale of struvite pellets, and reduced aeration costs because of reduced nitrogen recycle. Table 5 compares ferric chloride addition and nutrient extraction on a 40-year present worth basis. The table shows that nutrient extraction will only be less costly than ferric chloride over a 40-year period if the ferric dose were found to be between low and typical. Table 6 provides an analysis of nutrient extraction in terms of simple payback period which does not account for

[1] WEFTEC. 2006. Simon Baker, Yoomin Lee, and Wang Li. "A Struvite Control and Phosphorus Removal Process for Centrate: Full-Scale Testing."

discount rate. The simple payback period ranges from 9 to 37 years, depending on the ferric chloride dose assumed for struvite control. Table 7 provides a summary of the comparison of ferric chloride and nutrient extraction for struvite control.

TABLE 6
Simple Payback Period for Nutrient Extraction

Capital cost of nutrient extraction	$8,600,000
Annual net O&M of nutrient extraction (labor, chemicals, energy minus value of struvite and ammonia removed)	$70,000
Ferric chloride O&M cost—low dose	$300,000
Ferric chloride O&M cost—low dose simple payback period (years)	37
Ferric chloride O&M cost—typical dose	$600,000
Ferric chloride O&M cost—typical dose simple payback period (years)	16
Ferric chloride O&M cost—high dose	$1,000,000
Ferric chloride O&M cost—high dose simple payback period (years)	9

Recommendation

The amount of struvite that will form in the digesters and the dose and cost of ferric chloride required to control the struvite is difficult to predict with confidence because of the multiple variables affecting struvite formation and deposition. While there is understanding of the fundamental reasons why some plants have more struvite problems than others, there is not sufficient understanding to accurately predict the level of struvite problems that GBMSD would experience. If the required ferric dose is near the lower range of what is reported at other plants, then ferric chloride will be the most cost-effective solution. However, if the required ferric dose is found to be higher than average, nutrient extraction would likely be more cost-effective than ferric chloride.

It is therefore recommended that nutrient extraction be deferred until after construction when some full scale operating experience is gained with digestion to determine the actual ferric usage and costs. If struvite becomes an issue or ferric chloride usage is high, then nutrient extraction can be installed later to address these issues. It is recommended that during design, comparison between ferric addition upstream and downstream of digestion be done to determine a preferred approach. It may also be beneficial to experiment with adding ferric chloride to primary treatment. Ferric chloride can be used initially to prevent struvite formation and the O&M budget should account for the potential cost of the ferric chloride. Space on the site (not building space) should be provided to include nutrient extraction in the future if it is found to be needed after operating the digestion system for a period of time. The estimated annual cost (debt services plus O & M costs) of nutrient extraction is $620,000 assuming a 20 year loan at 2.5% interest. If actual ferric chloride costs approach or exceed this value, GBMSD should consider implementing nutrient extraction.

TABLE 7
Summary of Comparison of Struvite Control Methods

Struvite Control Method	Costs	Benefits	Comments
React as problems arise (clean piping and heat exchangers as needed)	Maintenance costs could be determined by operating full scale digestion without ferric chloride or nutrient extraction. Potential ferric cost of $250,000/year if Bio-P is compromised. **Total Annual Cost:** Unknown; must be determined via full-scale operation.	Potential cost savings if maintenance costs are less than the cost of nutrient extraction or ferric chloride addition	Bio-P process may be compromised by increased soluble phosphorus in the recycle stream. This could be determined by plant modeling during predesign. Initial calculations suggest that Bio-P will continue to function with the increased soluble P in the centrate recycle (see analysis in Table 2). If Bio-P is compromised, chemical precipitation would be necessary for phosphorus removal. Table 1 shows that chemical precipitation may cost about $250,000/year, based on previous GBMSD experience.
Ferric Chloride addition upstream of digestion	Cost of increased sludge production (cost relatively low). **Total Annual Cost:** $300,000–$1,000,000/yr O&M; relatively negligible capital required.	Enhances stability of the Bio-P process by greatly reducing recycled soluble phosphorus. Reduces digester gas H_2S if dosed upstream of digestion. Reduces dewatering polymer usage.	The operation can be implemented by adding a low cost ferric dosing system.
Nutrient Extraction with P-release upstream of digestion	$200,000/year O&M; $8.6M capital	Enhances stability of the Bio-P process by greatly reducing recycled soluble phosphorus. Produces mineral fertilizer pellet production ($110,000/year revenue). Some ammonia removal/ aeration savings ($20,000/year).	Nutrient extraction is more sustainable than chemical precipitation because of the production of a fertilizer that displaces energy-intensive commercial fertilizer. Also, energy and carbon emissions associated with trucking and producing ferric chloride are reduced.

Refinement of Alternatives

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DATE: September 22, 2011

Introduction

The Green Bay Metropolitan Sewerage District (GBMSD) has updated its Solids Management Facility Plan, which was submitted to the Wisconsin Department of Natural Resources (WDNR) in November 2010, to reflect recent solids handling conditions and changes. The submitted facility plan had recommended Digestion with Thermal Processing (Alternative 3). The purpose of this technical memorandum is to update equipment and cost information for the final four alternatives presented in November 2010 to comply with the new Maximum Achievable Control Technology (MACT) standards and to incorporate recent revisions to 2035 flow and load projections. Subsequent to submitting the plan to the WDNR, GBMSD requested equipment and cost information for rehabilitating its existing multiple hearth furnaces (MHF) and for a modified version of Alternative 3. The modified version of Alternative 3 is referred to as Alternative 3B, Digestion with Thermal Processing and Electrical Generation. Alternative 3 is now referred to as Alternative 3A. This technical memorandum presents a comparison of the following six alternatives.

- Alternative 2—Incineration with Energy Recovery
- Alternative 3A—Digestion with Thermal Processing
- Alternative 3B—Digestion with Thermal Processing and Electrical Generation
- Alternative 11—Conventional Composting
- Alternative 14—Incineration with Drying
- Alternative 16—Rehabilitate Multiple Hearth Furnaces

Refinement to Alternatives and Cost Estimates

The following changes were made to all six alternatives:

- The size of the system was revised from 85 dry tons per day (dtpd) maximum month to 64 dtpd to reflect revisions to 2035 flows and load projections.
- Rehabilitation of the gravity thickeners was added, as described in Section 6.3.9 of the facility plan.
- An odor control system for the existing gravity thickeners was added, as described in Section 6.3.9 of the facility plan.

- Three existing single-stage pumps for (thickened waste activated sludge) were replaced with three, two-stage TWAS pumps, as described in Section 6.3.9 of the facility plan.
- A third redundant dewatering centrifuge was added for reliability and flexibility.
- All assumptions, such as discount rates, energy costs, contingencies, and material costs, were reviewed and refined when the changed conditions were found to justify revision.
- New vendor quotes were obtained for major equipment components to reflect the decrease in system size and potential market changes.
- A new electrical substation was added.
- New scum concentrators were added.

The following change was made to Alternatives 2, 3A, 3B, 14, and 16:

- The incinerator air pollution trains were revised to address the requirements of the final March 2011 sewage sludge incinerator (SSI) maximum achievable control technology (MACT) standards. See the MACT standard technical memorandum for details.

The following change was made to Alternative 11:

- The size and efficiency of the odor control system was increased to further minimize potential odor complaints.

The following change was made to Alternatives 3A and 3B:

- Industrial wastes—likely dairy industry wastes—would be codigested with other wastes. Based on a survey of potential sources, there are enough industrial waste streams readily available in northeastern Wisconsin that are suitable for codigestion. Codigestion requires larger digester, biogas cleaning and power generation systems to meet demand. Codigestion could generate revenue from tipping fees and would reduce electrical power costs significantly. See the Codigestion Technical Memorandum for details.

The following operation and maintenance (O&M) cost changes were made:

- Net pellet value was increased from $23/ton to $63/ton based on discussions with local fertilizer vendors who have expressed a desire to purchase pellets.
- Maintenance costs were refined to reflect actual GBMSD maintenance costs, rather than assuming maintenance costs are a percentage of equipment cost as is typically done for facility planning.
- The costs to treat centrate recycle under Alternatives 3A and 3B were reduced based on more refined estimates of actual GBMSD costs for treating recycled centrate.
- Ferric chloride costs were added in Alternatives 3A and 3B instead of capital and operating costs for the nutrient extraction system originally recommended to control struvite.
- Operating costs for the air pollution control system required to comply with MACT standards were refined by including system specific equipment operating costs.

- Electrical power costs were adjusted to reflect the projected 8.8 percent increase in electrical rates for 2012.

Other minor adjustments were made to the cost estimates for both capital and O&M costs.

Revised Process Flow Diagrams and Solids and Energy Balances

Appendix A contains revised process flow diagrams for the six alternatives. The solids and energy balances were revised to reflect the lower projected solids loadings. Appendix B contains the solids balances and Appendix C the energy balances. These have been revised to reflect reduction in loads and other refinements.

Revised Cost Estimates

The capital and O&M cost estimates were revised for the six alternatives. New quotes were obtained from vendors for major equipment to reflect the lower projected loadings and current market conditions. All assumptions were reviewed and assumptions were revised and refined where deemed appropriate.

Alternative 3B—Digestion with Thermal Processing and Electrical Generation

Exhibit 1 is an overall, simplified process flow diagram for Alternative 3B, Digestion with Thermal Processing and Electrical Generation. Under Alternative 3B, thickened sludge would be digested, and the digested, dewatered cake would be thermally oxidized. Energy would be recovered from the biogas produced in the digester and from the thermal oxidizer waste heat, as described below.

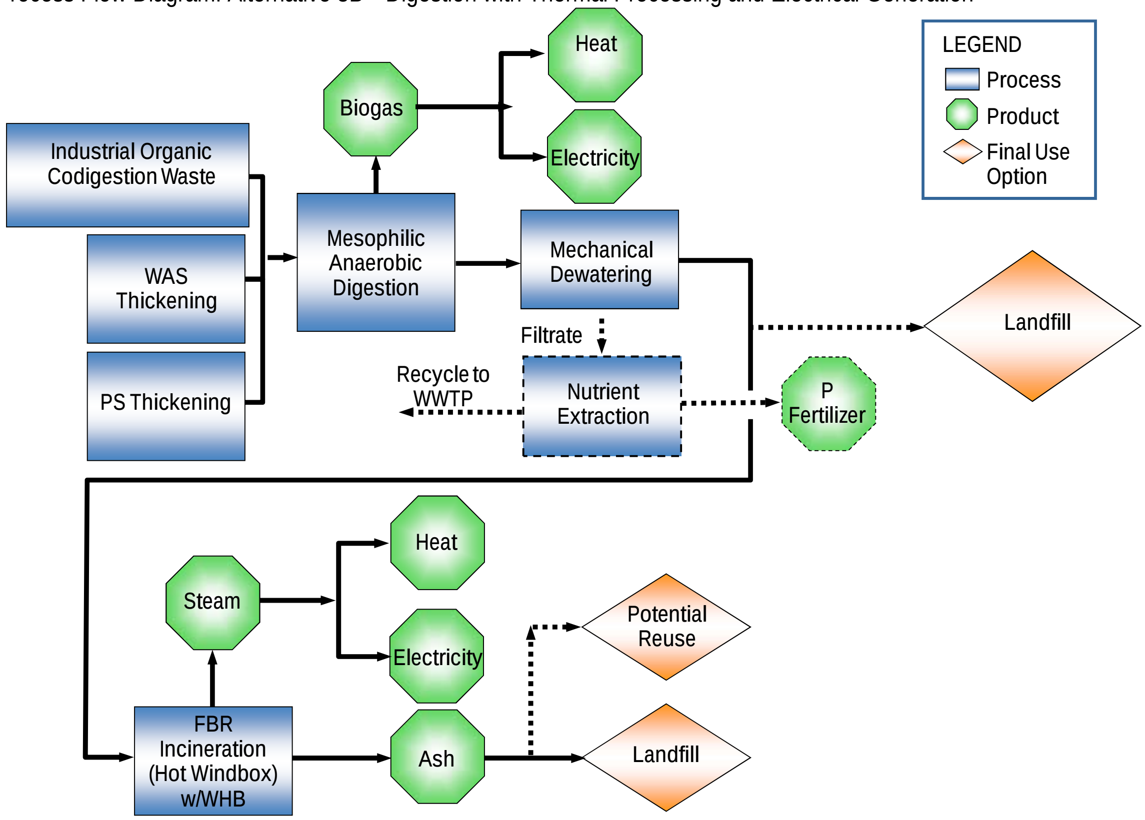
Thickening

Primary sludge would be thickened in the existing gravity thickeners, and waste activated sludge would be thickened using the existing gravity belt thickeners. As with all alternatives, the gravity thickeners and TWAS pumps would be rehabilitated. The combined thickened waste activated and primary sludge would be conveyed to storage tanks.

Digestion, Energy Recovery and Dewatering

The thickened sludge would be pumped to two mesophilic anaerobic digesters. The purpose of the digesters is to reduce sludge volumes and to produce biogas. The organic material in the sludges would be converted biologically to methane and carbon dioxide (biogas) in an airtight reactor. The digesters would be completely mixed and operated under anaerobic conditions at 35° to 38°C. The biogas produced would be combusted in one or more internal combustion engines that would drive a generator to produce electricity. Waste heat from the engines could be used to heat the digesters. Wastes from other sources, such as dairy wastes, would be digested along with municipal wastes to increase biogas production and electrical power generation. See the Codigestion Technical Memorandum for details. The digested sludge would be concentrated to about 25 percent solids using dewatering centrifuges. A nutrient extraction system could be added at some future time to produce a phosphorous fertilizer and prevent struvite formation should iron addition prove to be too costly. See the Nutrient Extraction Technical Memorandum for details.

EXHIBIT 1
Process Flow Diagram: Alternative 3B—Digestion with Thermal Processing and Electrical Generation

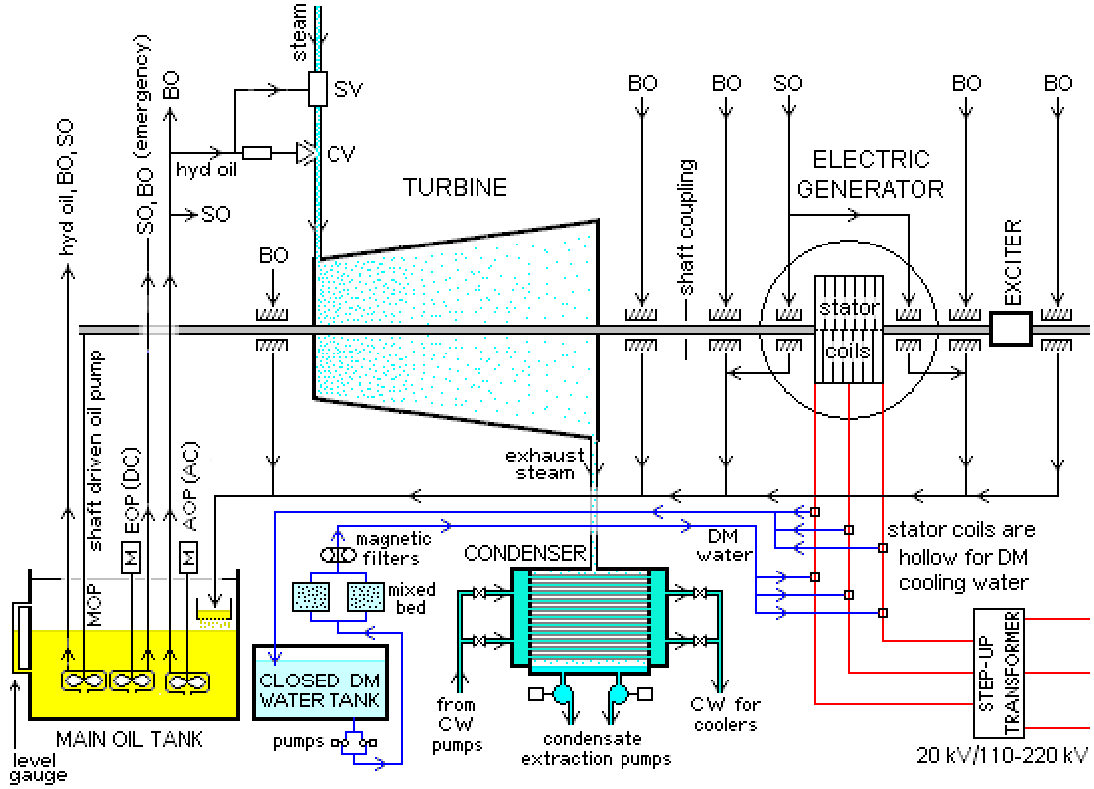


Incineration and Steam Turbine Power Generation

Under Alternative 3B, digested, dewatered biosolids would be conveyed to a single fluidized bed incinerator. Unlike a multiple hearth incinerator, in a fluidized bed incinerator, water flashes off and the sludge burns in one chamber. A fluidized bed incinerator is a cylindrical, vertically oriented, and refractory-lined steel shell that contains a sand bed and fluidized air diffusers called tuyeres. The bed expands to about 200 percent of its at-rest volume. The temperature of the bed is controlled between 1,400 and 1,500°F by injecting combustible materials into the sand bed. The residence time within the combustion zone is several seconds at 1,400 to 1,500°F. Ash is carried out the top of the furnace and removed by air pollution control devices. Feed is introduced to the furnace either above or directly into the bed. Airflow in the furnace is determined by several factors. Fluidizing and combustion airflow must be sufficient to expand the bed to a proper density yet low enough to prevent the biosolids from rising to and floating on the top of the bed. See the description of Alternative 2 in the facility plan for more information regarding how a fluidized bed incinerator operates.

In the Green Bay system, a waste heat steam boiler would use waste heat from incineration to produce steam that could be used in a steam turbine to generate electricity, or the steam could be used for building heat. With current natural gas and electrical prices, it likely would be most economical to use steam for building heat in the winter and power generation in warmer months. This could change if the relative price of electrical power increases at a rate faster than that of natural gas. Exhibit 2 is a schematic of a steam turbine power generation system. Power likely would be generated at 4160 volts.

EXHIBIT 2
Steam Turbine Generator System



SO-seal oil; BO-bearing oil; hyd oil-hydraulic oil; SV-stop valve; CV-control valve;
MOP-main oil pump; EOP-emergency oil pump; AOP-auxiliary oil pump; [M] - motor
CW-circulating water; DM-demineralised (water); DC - direct current; AC - alternating current

Some of the major advantages and disadvantages of Alternative 3B are described below. See the multi-attribute utility analysis scoring matrix guide for a detailed comparison of all the alternatives.

Advantages

- Significantly reduced air emissions, as compared to the those from the existing multiple hearth furnace incinerators
- Low greenhouse gas emissions due to the high degree of energy recovery and minimal use of auxiliary fuel (natural gas)
- Proven technologies
- Low operating cost due to high degree of energy recovery especially if energy prices continue to rise in the future
- Ability to add nutrient extraction technology in the future to remove phosphorus from biosolids and produce a mineralized phosphorus fertilizer product
- Volume reduction in digestion reduces the size and cost of the thermal oxidation system

Disadvantages

- High capital cost due to multiple unit processes
- Ash would likely be landfilled instead of beneficially reused
- Operation of steam boiler likely will require a licensed operator

Alternative 16—Rehabilitate Multiple Hearth Furnaces

The MHF solids processing facility was constructed about 35 years ago. Although the system has been well maintained and some components have been upgraded, many of the major systems are original and need to be replaced. Most of the solids building and the solids processing ancillary systems have reached the ends of their useful lives and are in need of replacement or major rehabilitation. Because the system does not have the capacity to process peak loads, excess dewatered cake must be landfilled. Also, according to a report by Black and Veatch (June 14, 2011), when modifications are made to the system in the future that have a value of more than $4.2 million, then air pollution control systems must be installed to comply with the more stringent USEPA 2011 SSI MACT standards for new multiple hearth furnaces. Installation of air pollution controls would require construction of a new building to house them because there is insufficient space in the Solids Building.

Exhibit 3 shows the costs of MHF equipment and the systems that require replacement. Costs that would count against the $4.2 million MACT threshold are also shown. The cost of the needed rehabilitation is more than $26 million, which would easily exceed the MACT $4.2 million threshold. Therefore, the air pollution control equipment needed to meet the “new source” SSI MACT standards for MHFs would need to be installed if the rehabilitation project were implemented. Appendix D shows the additional costs for implementing Alternative 16 for items such as building rehabilitation and ancillary systems.

The cost estimate includes a selective catalytic reduction (SCR) system for NO_x control to comply with MACT standards. Based on discussions with SCR technology vendors, the cost of an SCR system with installation and markups could range from $1.5 million to $6.0 million. The range is large because an SCR system has not been installed on an MHF, and there is uncertainty about how to design the system.

Updated Cost Estimates: Methodology and Assumptions

Exhibit 4 depicts the five levels of the American Academy of Cost Estimators cost opinions and their associated accuracies. The centerline of Exhibit 4 represents probable construction cost. It includes in general a 25 percent contingency based on items remaining to be defined and additional ancillary items identified as necessary during design. This contingency percentage is typical for this level of planning and design. That said, it is more likely that the eventual project cost will be nearer the opinion of probable cost (the centerline of the diagram, rather than the periphery). The red dot in Exhibit 4 represents the facilities plan capital cost opinions for the six alternatives. At this level of project definition, the 90th percentile accuracy of the cost estimated is -20 to +40 percent.

Exhibit 5 shows the major assumptions used for the revised cost estimates. Past work, including a Monte Carlo analysis, has shown that the cost estimates are more sensitive to changes in energy prices, discount rate, inflation rate, and landfilling costs. However, changes in some of these variables while they did change the absolute cost did not significantly change the relative costs between alternatives.

EXHIBIT 3
Alternative 16: Rehabilitate Multiple Hearth Furnaces—Equipment Replacement

Equipment	Estimated Cost	Class	Included for MACT SSI Threshold	Excluded for MACT SSI Threshold	Notes
Stacks	$1,810,000	ER1		$1,810,000	Relined in 1998.
Waste Heat Boiler	$13,080,000	ER2	$13,080,000		Duct and refractory replaced in 2004; the boiler is original from 1973.
Scrubbers	$1,060,000	ECE		$1,060,000	Precooler section replaced in 2004; significant retrofit (VenturiPak) in 2004; housing is original; some components are from 1973.
Center Shaft Cooling Fans	$70,000	ER2	$70,000		
MHF Burners	$35,000	ER2	$35,000		Burners in Hearths 3 and 5 were replaced; Replace 2 burners in each MHF.
Hearths	$780,000	ER1		$780,000	Replaced Hearth 2 in MHF 1 and Hearth 3 in both MHFs; Replace 9 of 14 hearths.
Scum Concentrators	$1,860,000	ER2	$1,860,000		
Polymer System	$650,000	OSSI		$650,000	VFDs replaced in 2009.
Conveyors	$680,000	OSSI	$680,000		Replaced 10-year-old inclined belt and crossover conveyors with screw conveyors in 2004. Keep 2004 screw conveyors; replace all other conveyors; replace SC-15, 16, 17, 18, 19, 20, SC-S1, SC-S2, SC-S7, SC-S8, SC-S10, SC-11, SC-12, SC-13, SC-14; Replace 16 conveyors, keep 4 screw conveyors from 2005.
Control System/Control Room	$5,160,000	ER2	$3,870,000	$1,290,000	Assume 75 percent of I&C System associated w/SSI. SCADA & HVAC replaced in 1990; 2004: Partial upgrade to control panel to include new PLC control system.
Center Shaft Drives	$210,000	ER2	$210,000		
Center Shafts	$460,000	ER1		$460,000	
Rabble Arms	$160,000	ER1		$160,000	Assume 6 arms per MHF; replaced some rabble arms.
Ash Handling System	$6,300,000	ER2	$6,300,000		

EXHIBIT 3
Alternative 16: Rehabilitate Multiple Hearth Furnaces—Equipment Replacement

Equipment	Estimated Cost	Class	Included for MACT SSI Threshold	Excluded for MACT SSI Threshold	Notes
Plant Boiler(s)	$3,650,000	OSSI		$3,650,000	
New ID Fans	$460,000	ER2	$460,000		
New WESP	$1,520,000	ECE		$1,520,000	
New Continuous Emission Monitor	$2,020,000	ECE		$2,020,000	
New GAC Scrubber	$11,560,000	ECE		$11,560,000	
RTO (CO control)	$4,620,000	ECE		$4,620,000	
APC Building	$2,080,000	ECE/OSSI		$2,080,000	
New SCR	$3,800,000	ECE		$3,800,000	
Total Equipment Cost	**$62,025,000**		**$26,565,000**	**$35,460,000**	

Notes: See Black and Veatch June 14, 2011 *MACT SSI Rule Evaluation Report* for definition of class of improvement and additional background.

No allowance has been made to modify building to bring it in compliance with current building such as access for the disabled, etc.

Costs include all contractor markups, engineering costs, administrative costs, etc. consistent with other assumptions used in the Solids Management Facility Plan.

EXHIBIT 4
American Academy of Cost Estimators Classification System

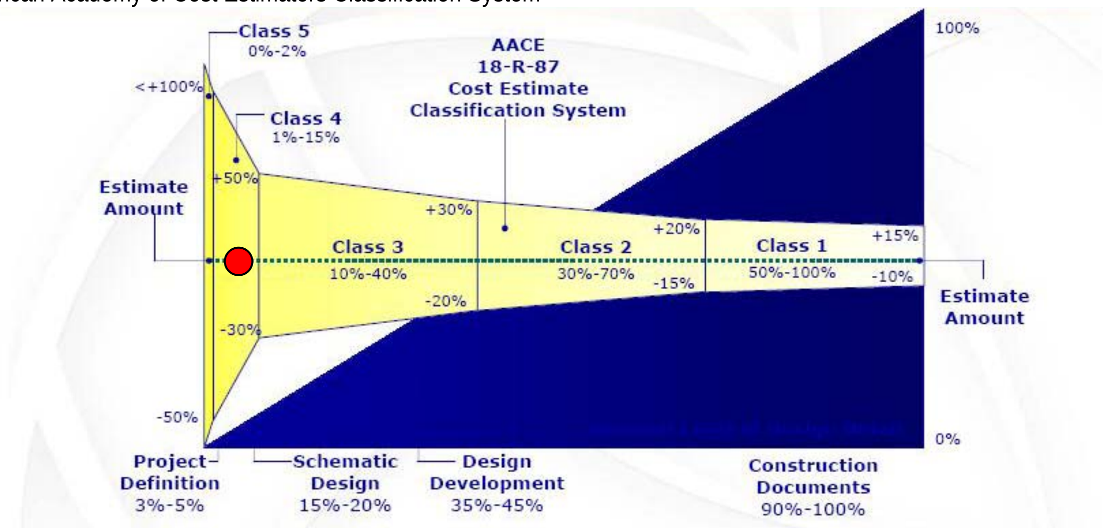


EXHIBIT 5
Major Assumptions

	Unit Cost		Time Period 2011–2015	Time Period 2016–2055	Notes
Discount rate			4.1%	4.1%	Fiscal year 2011 discount rate required by WDNR
General inflation rate			1.5	3	Judgment. Historical U.S. inflation has been 3.8 percent from 1910 to 2010.
Electricity and escalation rate above inflation	0.072	$/kWh	2	2	Based on 2012 GBMSD costs and U.S. Department of Energy projections
Natural gas and escalation rate above inflation	6	$/Mbtu	2	2	Based on 2011 natural gas costs and projection based on historical natural gas cost increases
Renewable electricity and escalation rate above inflation	0.072	$/kWh	2	2	It was assumed that there will be no premium for renewable energy
Renewable digester gas and escalation rate above inflation	6	$/Mbtu	2	2	It was assumed that there will be no premium for renewable energy
Compost value and escalation rate above inflation	10	$/yd^3	1	1	GBMSD composting study provided a value range of $7 to $15/yd^3 following 6 years of marketing. Assume greater than inflation due to increased cost of fertilizer which is tied to energy costs
Dried pellets and escalation rate above inflation	63	$/dry ton	2	2	Based on values received from local fertilizer vendors less $17/ton for hauling. Assume greater than inflation due to cost of fertilizer production being closely tied to energy costs

EXHIBIT 5
Major Assumptions

	Unit Cost		Time Period 2011–2015	2016–2055	Notes
Wood waste and escalation rate above inflation	9	$/yd^3	2	2	Value estimated assuming that wood value would be similar to that of coal (~$3/Mbtu). Assume greater than inflation because wood has energy value and should escalate with escalating energy cost.
Cost of landfillng ash and escalation rate above inflation	48	$/wet ton	1	1	Based on GBMSD's 2011 landfill hauling, tipping costs and other surcharges. Assume greater than inflation to account for potential landfill closings and increased hauling distance. Cost of cake disposal is about $92/wet ton depending on haul distance.
Polymer and escalation rate above inflation	2.09	$/lb	0	0	Based on GBMSD's 2012 contracted polymer costs.
Labor and escalation rate above inflation	40	$/hr	0	0	Based on GBMSD's 2011 average labor costs, including fringe benefits.
Ferric chloride and escalation rate above inflation	693	$/ton	0	0	Based on GBMSD's 2011 ferric chloride costs.

ENR Cost Index = 9104 (June 2011)	
Equipment installation factor	1.2 for centrifuges, 1.4 for all other equipment
Contingency	25% for all items except large cost equipment (10% contingency used for dryers and incinerators, because these equipment packages are fairly well defined.)
Construction Cost Factors	
Sitework	5%
Piping/Mechanical	6%
Electrical / I&C	6%
Contractor Markups	
Mobilization and insurance	1%
General conditions	10%
Profit	7%
Bond	2%
Professional Services and GBMSD Cost Factors	
Project development	0.3%
Preliminary design	1.5%
Final design	6%
Services during construction	6%

EXHIBIT 5
Major Assumptions

Commissioning	1%
Closeout	0.3%
GBMSD administration/legal	3%
Ferric chloride dose in Alternatives 3A and 3B	0.3 mol Fe/mol P
Total plant average natural gas usage for plantwide building heat = 69,120 MBtu/year (based on 2008 data).	
See codigestion memorandum for assumptions regarding codigestion.	
See MACT technical memorandum for additional assumptions regarding air pollution control equipment for meeting SSI MACT standards.	
Polymer dose is 8 lb polymer/ton solids for all alternatives with undigested solids and 12 lb polymer/ton solids for digested solids in Alternatives 3A and 3B.	
General System Maintenance Costs – Labor and Parts	
Alternative 2—Used Alternative 3A costs but adjusted costs proportional to capital costs Alternative 3A—Assumed to be the same as Alternative 16 Alternative 3B—Used Alternative 3A costs reduced by an amount proportional to difference equipment capital costs Alternative 11—Based on similar systems Alternative 14—Based on Alternative 3A cost but proportional to capital cost Alternative 16—Based on 2009 solids building maintenance costs provided by GBMSD; assumed 25% reduction due to rehabilitation, which will reduce costs.	
Other alternative specific maintenance costs estimated individually	
Operations Labor Alternative 2—16,000 hr/year (7.7 FTEs) Alternative 3A—20,732 hr/year (10 FTEs) Alternative 3B—18,732 hr/year (9 FTEs) Alternative 11—30,784 hr/year (15 FTEs) Alternative 14—18,732 hr/year (9 FTEs) Alternative 16—20,732 hr/year (10 FTEs, equal to current labor to operate existing solids facility per GBMSD)	
2011 average thickened solids loading: 46 dtpd (GBMSD data)	
2035 average thickened solids loading: 51 dtpd (flows and loads memorandum).	
2035 peak month thickened solids loading: 64 dtpd (flows and loads memorandum).	

Updated Cost Estimate: Results

Exhibit 6 compares the capital and O&M costs and present worth for each alternative. The 20-year present worth (including salvage value) of Alternatives 2, 3A, 3B, and 14 can be considered essentially equal according to the Wisconsin Department of Natural Resources guidance. The facility plan guidance states that it "considers alternative costs within 10% of each other to be essentially equal in monetary value due to normal cost estimating variability." [www.dnr.state.wi.us/org/water/wm/glwsp/facilities/munifp.htm#cost]. Alternatives 11 and 16 have a higher 20-year present worth. The 40-year present worth of Alternatives 3A and 3B is lower than that for the other alternatives. This is primarily because Alternatives 3A and 3B recover the most energy, which results in decreased costs as energy prices increase over the longer 40-year period.

EXHIBIT 6
Comparison of Estimated Costs

	Alternatives					
	2	3A	3B	11	14	16
Capital Cost	$112,700,000	$154,900,000	$146,900,000	$80,600,000	$109,100,000	$88,400,000
Total Present Worth (40 year)	$180,200,000	$149,000,000	$134,600,000	$218,100,000	$187,800,000	$215,800,000
Total Present Worth (20 year w/ Salvage Value)	$121,500,000	$121,600,000	$112,600,000	$143,400,000	$123,500,000	$130,300,000
Annual O&M 2015	$2,100,000	$700,000	$500,000	$3,500,000	$2,300,000	$3,300,000
Annual O&M 2025	$2,900,000	$400,000	$200,000	$5,400,000	$3,300,000	$5,000,000
Annual O&M 2035	$4,100,000	($100,000)	($520,000)	$8,700,000	$4,800,000	$7,700,000
Annual O&M 2045	$5,800,000	($1,300,000)	($1,900,000)	$13,900,000	$7,000,000	$11,500,000
Annual O&M 2055	$8,300,000	($3,600,000)	($4,600,000)	$22,800,000	$10,200,000	$17,300,000
20 Year Total O&M	$62,300,000	$7,500,000	$2,400,000	$119,000,000	$70,400,000	$108,800,000
40 Year Total O&M	$183,900,000	($23,800,000)	($42,800,000)	$417,000,000	$216,500,000	$350,200,000

Note: All costs are June 2011 dollars referenced to ENR CCI = 9104.

Appendix D contains a breakdown of capital costs and Appendix E a breakdown of O&M costs for each alternative. Exhibit 7 compares the annual payments (annual debt service plus annual O&M) for each alternative. Exhibit 8 compares their cumulative annual payments. These exhibits can provide insight into how selection of an alternative may affect user rates. User rate impacts are being evaluated by another consultant and, therefore, are not discussed in this memorandum.

EXHIBIT 7
Annual Cost of Alternatives
(Debt Service + O&M)

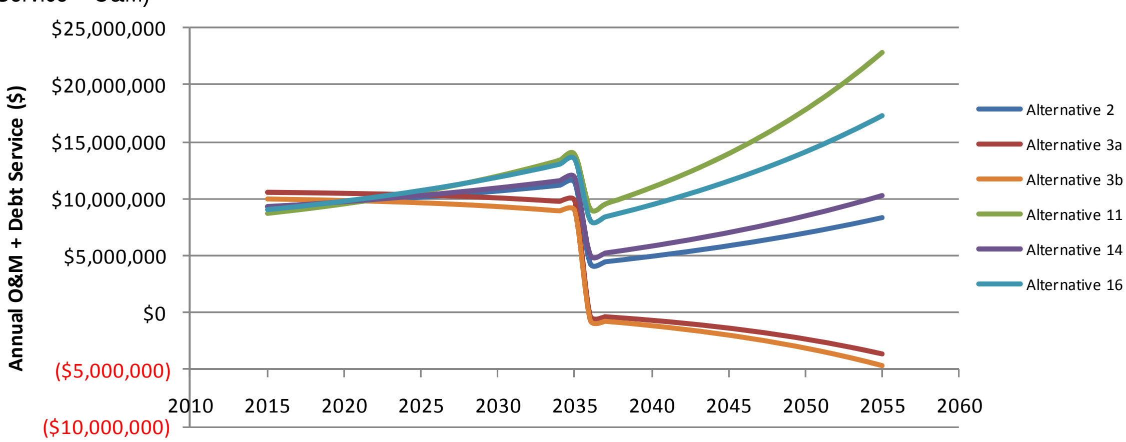
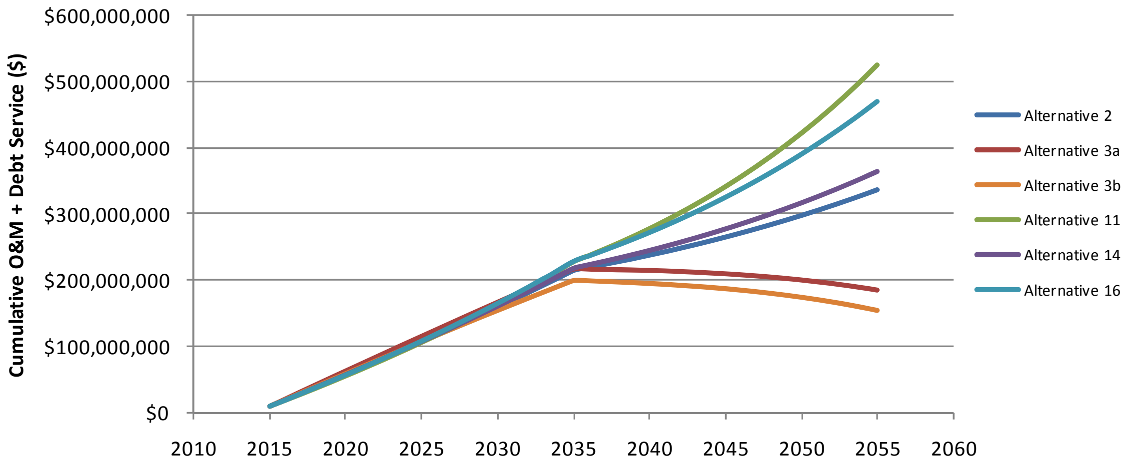


EXHIBIT 8
Cumulative Cost of Alternatives



Revised Multi-Attribute Utility Analysis

The results of the multi-attribute utility analysis were revised for the four original alternatives and two new alternatives using the newly revised costs. A team of seven GBMSD staff members scored each alternative using the attributes developed at the start of facilities planning. The attributes and associated weightings are as follows:

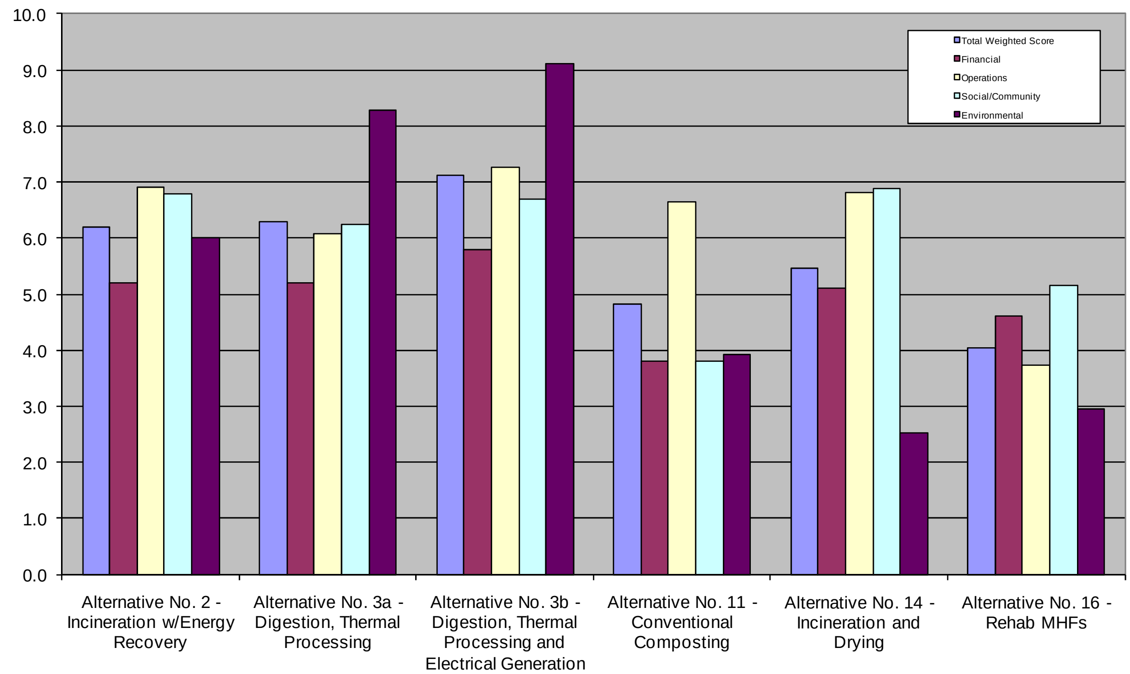
- Financial (present worth) (weight: 30%)
- Operations (weight: 35%)
  - Flexibility (weight: 20%)
  - Operability (weight: 30%)
  - Future regulatory requirements (weight: 30%)
  - Safety (weight: 20%)
- Social/community (weight: 15%)
  - Partnerships (weight: 15%)
  - Aesthetic impact (weight: 70%)
  - Key stakeholder acceptance (weight: 15%)
- Environmental (weight: 20%)
  - Beneficial reuse/recycling (weight: 30%)
  - Nonrenewable energy consumption (weight: 30%)
  - Nonbiogenic greenhouse gas emissions (weight: 40%)

A brief description of each attribute was written for each subcriterion to ensure that team members were able to make an informed scoring decision. Three categories were scored automatically without input from the project team members because they were calculated numeric criteria (life-cycle cost, nonrenewable energy consumption, and nonbiogenic greenhouse gas emissions). See the Solids Management Facility Plan for more details on the multi-attribute utility analysis methodology. Exhibit 9 presents the scores using the 20-year project net present value (NPV) costs.

Alternative 3B was scored highest by GBMSD staff, followed by Alternatives 2 and 3A.

EXHIBIT 9
MUA Scoring: 20-Year NPV

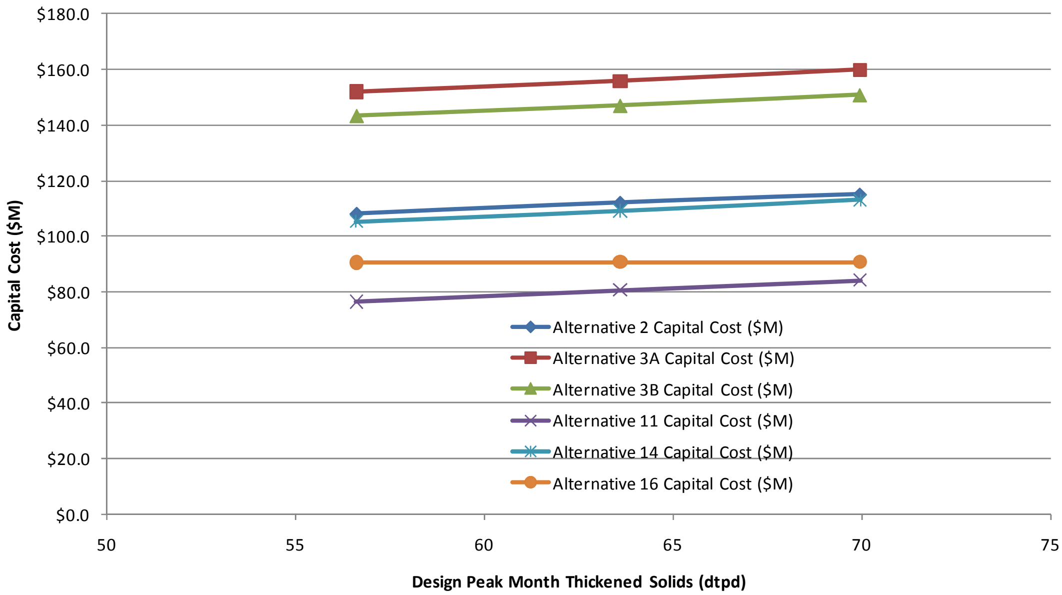
Alternative	Total Weighted Score	Financial	Operations	Social / Community	Environmental
2—Incineration with Energy Recovery	**6.2**	5.2	6.9	6.8	6.0
3A—Digestion with Thermal Processing	**6.3**	5.2	6.1	6.3	8.3
3B—Digestion with Thermal Processing and Electrical Generation	**7.1**	5.8	7.3	6.7	9.1
11—Conventional Composting	**4.8**	3.8	6.7	3.8	3.9
14—Incineration with Drying	**5.5**	5.1	6.8	6.9	2.5
16—Rehabilitate Multiple Hearth Furnaces	**4.1**	4.6	3.7	5.2	3.0



Impact of Load Changes on Costs

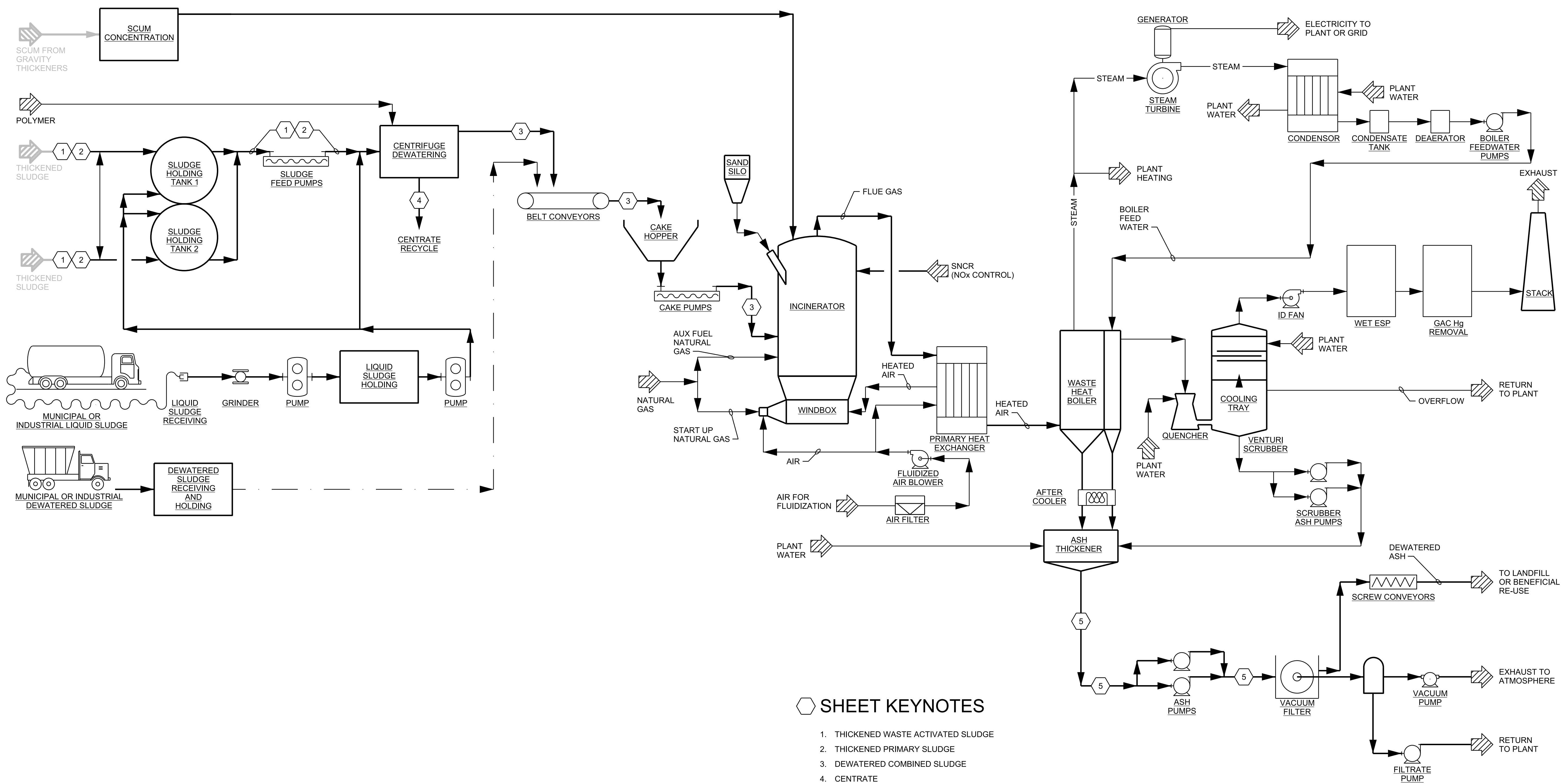
The updated Flows and Loads Technical Memorandum recommends that the revised 2035 peak month thickened sludge load used to size the solids system be 64 dtpd. Loads will decrease if industries pretreat their wastes. As discussed in the Flows and Loads Technical Memorandum, GBMSD may want to add some contingency capacity to the system. To help determine the impacts of potential changes on the proposed solids systems costs, cost curves were developed (Exhibit 10) that estimate how the capital costs will vary with changes in system size. It can be seen that the costs are relatively insensitive to changes in loads because of the economies of scale in large construction projects.

EXHIBIT 10
Impact of Loadings on Capital Cost (Base Case is 64 dtpd)



Appendix A

Process Flow Diagrams



SHEET KEYNOTES

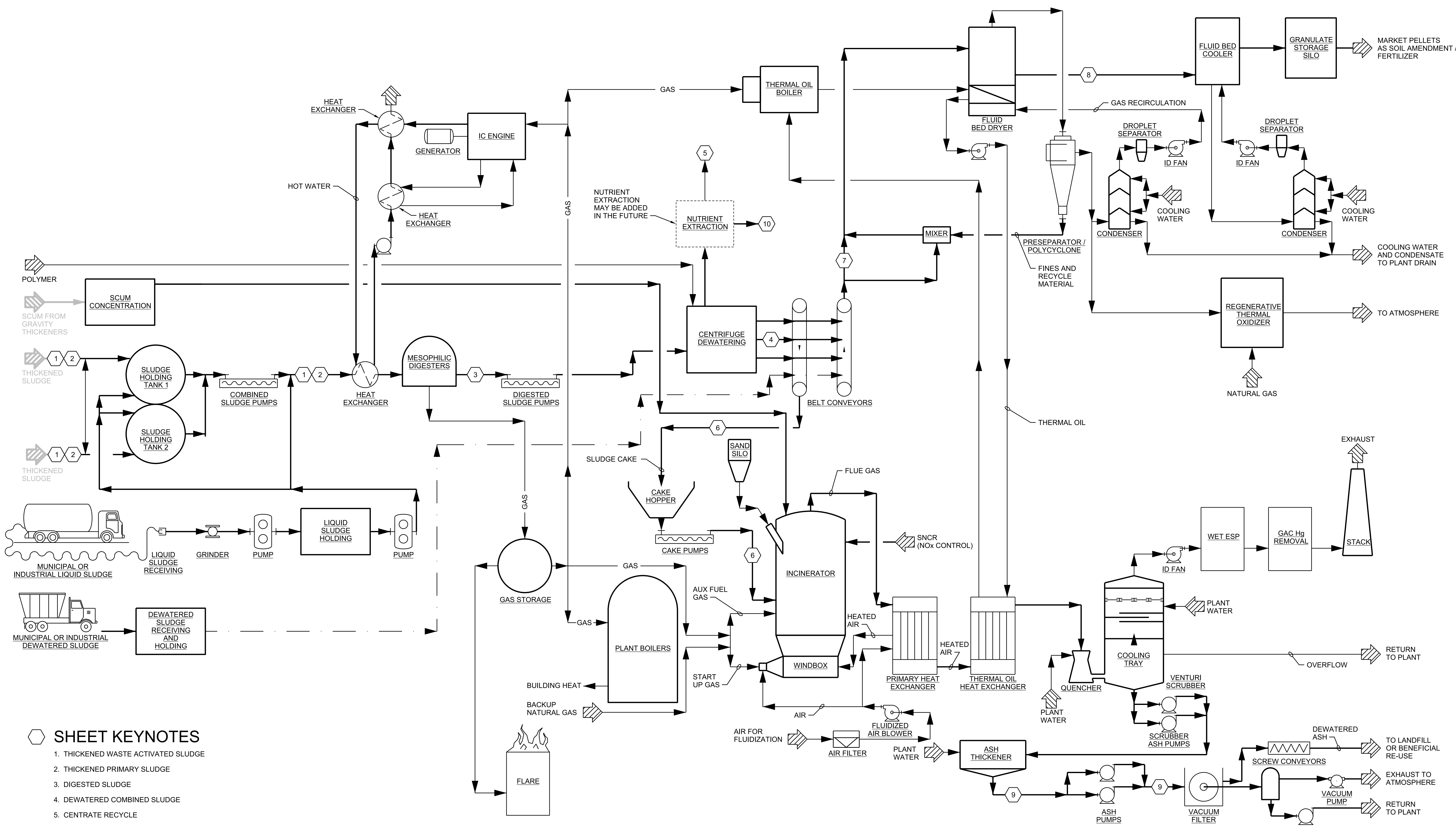
1. THICKENED WASTE ACTIVATED SLUDGE
2. THICKENED PRIMARY SLUDGE
3. DEWATERED COMBINED SLUDGE
4. CENTRATE
5. ASH

LEGEND

— · — · — TRANSPORTED WITH FRONT END LOADER

ALTERNATIVE 2 - INCINERATION WITH ENERGY RECOVERY
PROCESS FLOW DIAGRAM
SOLIDS FACILITY PLAN
GREEN BAY MSD
GREEN BAY, WI

CH2MHILL



SHEET KEYNOTES

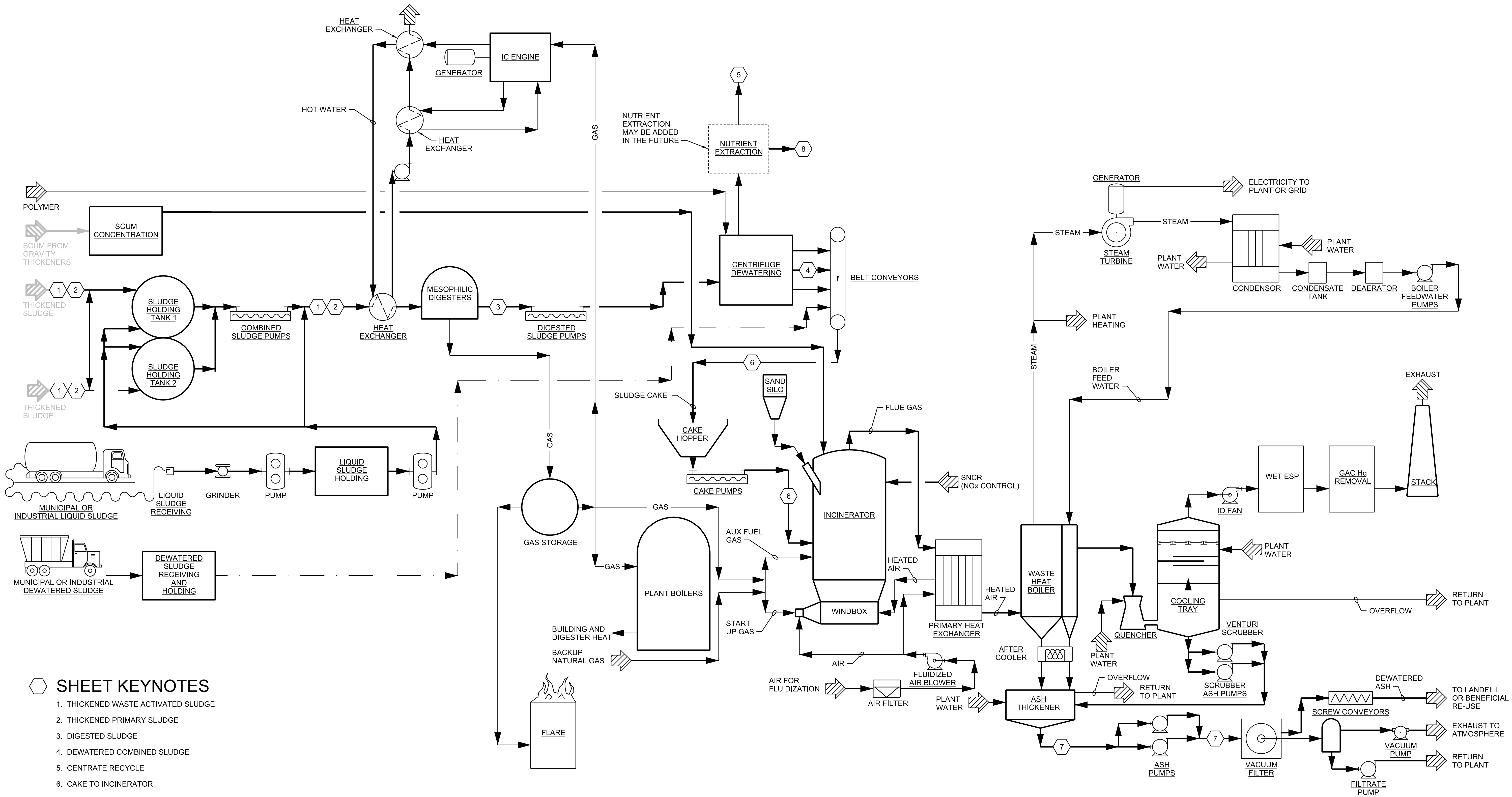
1. THICKENED WASTE ACTIVATED SLUDGE
2. THICKENED PRIMARY SLUDGE
3. DIGESTED SLUDGE
4. DEWATERED COMBINED SLUDGE
5. CENTRATE RECYCLE
6. CAKE TO INCINERATOR
7. CAKE TO DRYER
8. DRIED PELLETS
9. ASH
10. STRUVITE PELLETS

LEGEND

— · — · — TRANSPORTED WITH FRONT END LOADER

ALTERNATIVE 3A - DIGESTION WITH THERMAL PROCESSING
PROCESS FLOW DIAGRAM
SOLIDS FACILITY PLAN
GREEN BAY MSD
GREEN BAY, WI

CH2MHILL



SHEET KEYNOTES

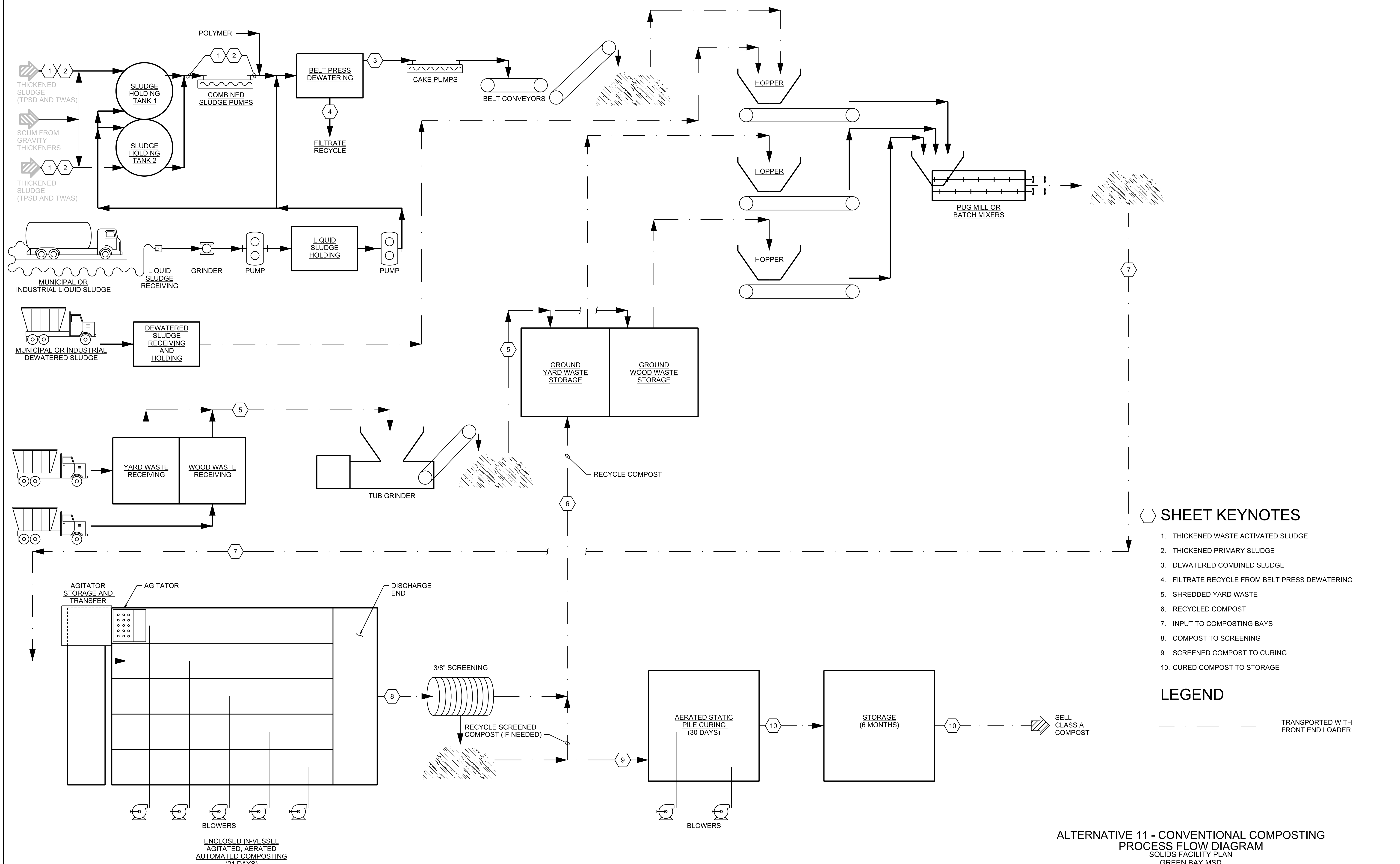
1. THICKENED WASTE ACTIVATED SLUDGE
2. THICKENED PRIMARY SLUDGE
3. DIGESTED SLUDGE
4. DEWATERED COMBINED SLUDGE
5. CENTRATE RECYCLE
6. CAKE TO INCINERATOR
7. ASH
8. STRUVITE PELLETS

LEGEND

— · — · — TRANSPORTED WITH FRONT END LOADER

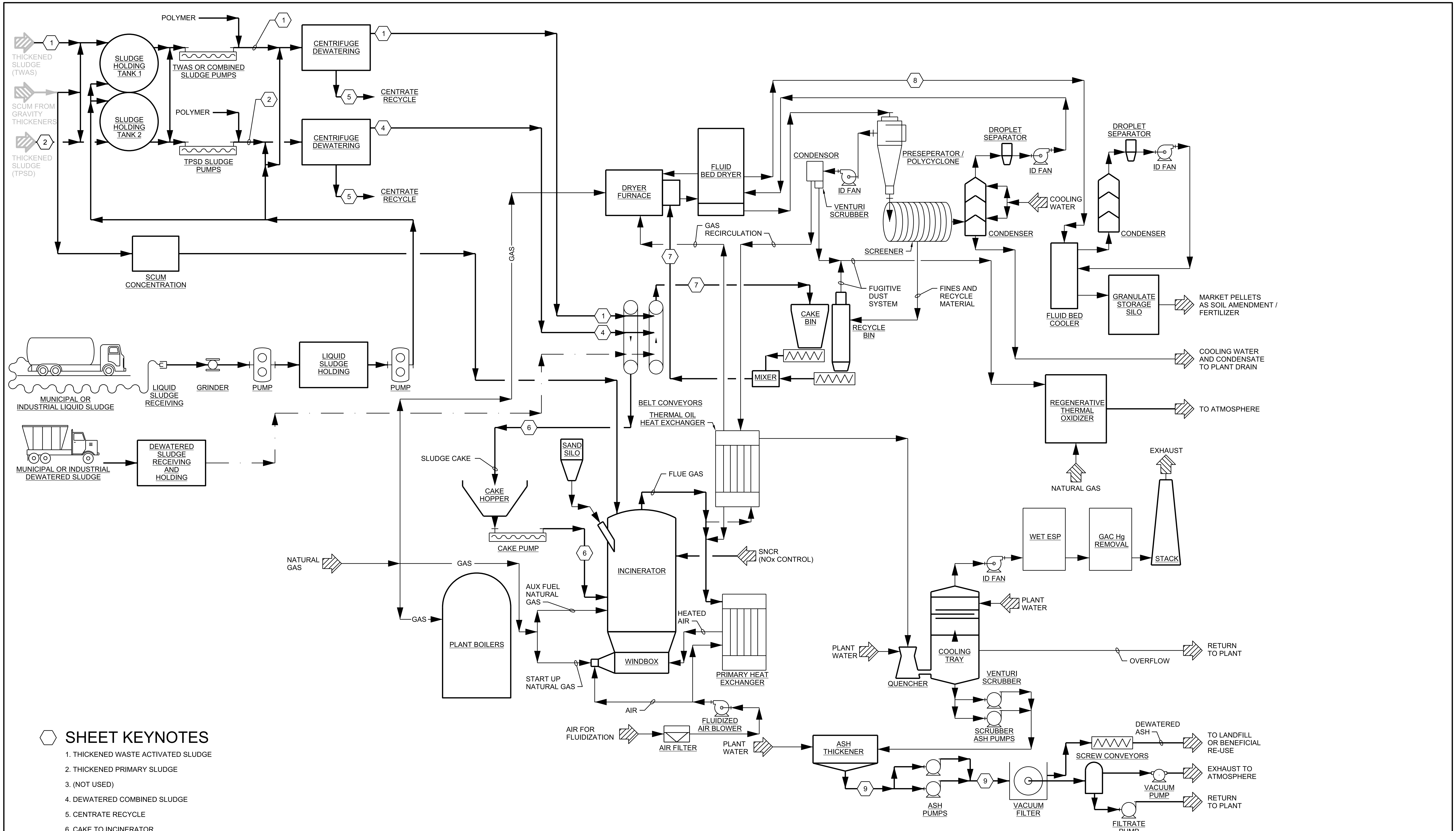
ALTERNATIVE 3B - DIGESTION WITH THERMAL PROCESSING AND ELECTRICAL GENERATION
PROCESS FLOW DIAGRAM
SOLIDS FACILITY PLAN
GREEN BAY MSD
GREEN BAY, WI

CH2MHILL



ALTERNATIVE 11 - CONVENTIONAL COMPOSTING
PROCESS FLOW DIAGRAM
SOLIDS FACILITY PLAN
GREEN BAY MSD
GREEN BAY, WI

CH2MHILL



SHEET KEYNOTES

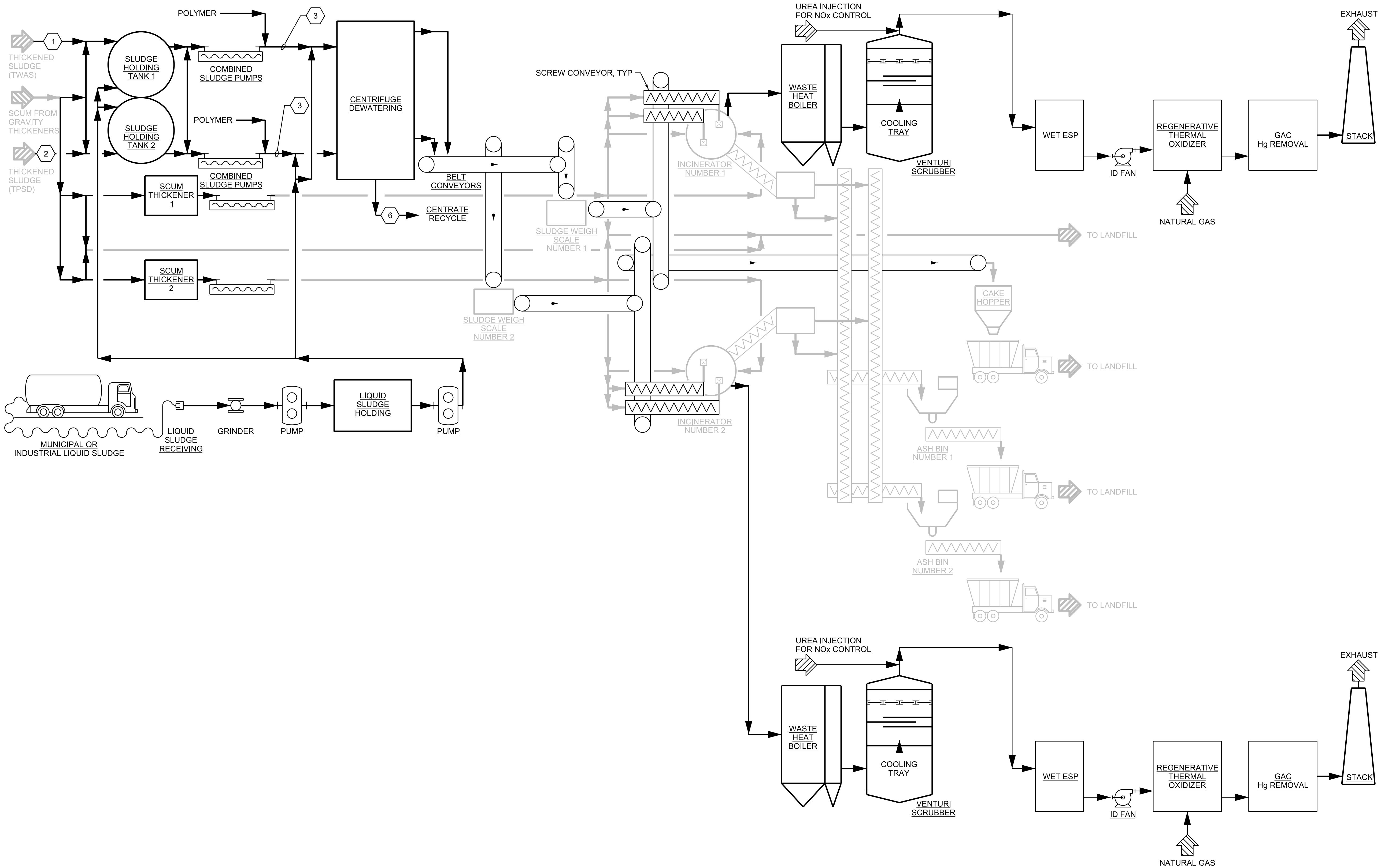
1. THICKENED WASTE ACTIVATED SLUDGE
2. THICKENED PRIMARY SLUDGE
3. (NOT USED)
4. DEWATERED COMBINED SLUDGE
5. CENTRATE RECYCLE
6. CAKE TO INCINERATOR
7. CAKE TO DRYER
8. DRIED PELLETS
9. ASH

LEGEND

— · — TRANSPORTED WITH FRONT END LOADER

ALTERNATIVE 14 - INCINERATION WITH DRYING
PROCESS FLOW DIAGRAM
SOLIDS FACILITY PLAN
GREEN BAY MSD
GREEN BAY, WI

CH2MHILL



SHEET KEYNOTES

1. THICKENED WASTE ACTIVATED SLUDGE
2. THICKENED PRIMARY SLUDGE
3. COMBINED SLUDGE
4. DEWATERED COMBINED SLUDGE
5. CENTRATE RECYCLE
6. CAKE TO INCINERATOR
7. CAKE TO DRYER
8. DRIED PELLETS
9. ASH

NOTE:

NOx CONTROLS REQUIRE FURTHER EVALUATION.

ALTERNATIVE 16 - REHABILITATE MULTIPLE HEARTH FURNACES
PROCESS FLOW DIAGRAM
SOLIDS FACILITY PLAN
GREEN BAY MSD
GREEN BAY, WI

CH2MHILL

Appendix B
Solids Balances

APPENDIX B

Solids Balances

TABLE B-1
Alternative 2: Incineration with Energy Recovery—Solids Balance

Description	Flow (gpm)	Flow (yd^3/day)	TSS (lb/day)	VSS (lb/day)	TSS (%)	VSS/TSS (%)
2035 Maximum Month Conditions						
Thickened primary sludge	71	N/A	51,660	38,745	6.1	75
Thickened waste activated sludge	134	N/A	75,600	68,040	4.7	90
Dewatered combined sludge	40	N/A	120,897	101,446	25.0	84
Centrate	164	N/A	6,363	5,339	0.34	84
Ash	N/A	16.0	19,451	0	67.0	0
2035 Average Conditions						
Thickened primary sludge	56	N/A	41,000	30,750	6.1	75
Thickened waste activated sludge	106	N/A	60,000	54,000	4.7	90
Dewatered combined sludge	32	N/A	95,950	80,513	25.0	84
Centrate	130	N/A	5,050	4,238	0.32	84
Ash	N/A	12.7	15,438	0	67.0	0

TABLE B-2
Alternative 3A: Digestion with Thermal Processing—Solids Balance

Description	Flow (gpm)	Flow (yd^3/day)	TSS (dry lb/day)	TSS (dtpd)	VSS (dry lb/day)	VSS (dtpd)	TSS (%)	VSS/TSS (%)
2035 Maximum Month Conditions								
Thickened primary sludge	71	N/A	51,660	26	38,745	19	6.1	75
Thickened waste activated sludge	134	N/A	75,600	38	68,040	34	4.7	90
Codigestate	57	N/A	—	—	—	—	—	—
Digested sludge (w/o codigestate)	204	N/A	78,262	39	57,787	29	3.2	74
Dewatered combined sludge	26	N/A	76,697	38	56,631	28	25.0	74
Centrate recycle	236	N/A	1,565	1	1,156	1	0.1	74
Cake to incinerator	17	N/A	48,319	24	35,678	18	25.0	74
Cake to dryer	9	N/A	28,378	14	20,953	10	25.0	74
Dried pellets	N/A	28.6	28,378	14	20,953	10	92.0	74
Ash	N/A	6.8	12,641	6	0	0	67.0	0
2035 Average Conditions								
Thickened primary sludge	56	N/A	41,000	21	30,750	15	6.1	75
Thickened waste activated sludge	106	N/A	60,000	30	54,000	27	4.7	90
Codigestate (w/o codigestate)	57	N/A	—	—	—	—	—	—
Digested sludge	162	N/A	62,113	31	45,863	23	3.2	74
Dewatered combined sludge	20	N/A	60,870	30	44,945	22	25.0	74
Centrate recycle	199	N/A	1,242	1	917	0	0.1	74
Cake to incinerator	13	N/A	38,348	19	28,990	14	25.0	74
Cake to dryer	8	N/A	22,522	11	15,956	8	25.0	74
Dried pellets	N/A	22.7	22,522	11	15,956	8	92.0	74
Ash	N/A	5.3	10,033	5	0	0	67.0	0

Note: It is assumed that suspended solids in codigested waste are negligible. This assumption may change depending upon the characteristics of codigested waste.

TABLE B-3
Alternative 3B: Digestion with Thermal Processing and Electrical Generation—Solids Balance

Description	Flow (gpm)	Flow (yd^3/day)	TSS (dry lb/day)	TSS (dtpd)	VSS (dry lb/day)	VSS (dtpd)	TSS (%)	VSS/TSS (%)
2035 Maximum Month Conditions								
Thickened primary sludge	71	N/A	51,660	26	38,745	19	6.1	75
Thickened waste activated sludge	134	N/A	75,600	38	68,040	34	4.7	90
Codigestate	57	N/A	—	—	—	—	—	—
Digested Sludge (w/o codigestate)	204	N/A	78,262	39	57,787	29	3.2	74
Dewatered combined sludge	26	N/A	76,697	38	56,631	28	25.0	74
Centrate recycle	236	N/A	1,565	1	1,156	1	0.1	74
Cake to Incinerator	26	N/A	76,697	38	56,631	28	25.0	74
Ash	N/A	10.6	20,066	10	0	0	67.0	0
2035 Average Conditions								
Thickened primary sludge	56	N/A	41,000	21	30,750	15	6.1	75
Thickened waste activated sludge	106	N/A	60,000	30	54,000	27	4.7	90
Codigestate	57	N/A	—	—	—	—	—	—
Digested Sludge (w/o codigestate)	162	N/A	62,113	31	45,863	23	3.2	74
Dewatered combined sludge	20	N/A	60,870	30	44,945	22	25.0	74
Centrate recycle	199	N/A	1,242	1	917	0	0.1	74
Cake to Incinerator	20	N/A	60,870	30	44,945	22	25.0	74
Ash	N/A	8.4	15,925	8	0	0	67.0	0

Note: It is assumed that suspended solids in codigested waste are negligible. This assumption may change depending upon the characteristics of codigested waste.

TABLE B-4
Alternative 11: Conventional Composting—Solids Balance

Description	Flow (gpm)	Flow (yd^3/day)	TSS (dry lb/day)	VSS (dry lb/day)	TSS (%)	VSS/TSS (%)	Wet Tons per Day	Bulk Density (tons/yd^3)
2035 Maximum Month Conditions								
Thickened primary sludge	71	N/A	51,660	38,745	6.1	75	N/A	N/A
Thickened waste activated sludge	134	N/A	75,600	68,040	4.7	90	N/A	N/A
Dewatered combined sludge	46	343	120,900	101,400	22.0	84	275	0.80
Filtrate recycle from belt press dewatering	159	N/A	6,360	5,326	0.34	84	3	N/A
Shredded yard waste	N/A	354	114,855	109,112	60	95	96	0.27
Recycled compost	N/A	351	165,532	137,392	62	83	133	0.38
Input to composting bays	N/A	1,049	401,287	346,804	40	86	504	0.48
Compost to screening	N/A	596	300,573	263,224	60	88	250	0.42
Screened compost to curing	N/A	245	135,041	125,832	60	83	117	0.45
Cured compost to storage	N/A	302	163,215	119,541	60	73	136	0.45
2035 Average Conditions								
Thickened primary sludge	56	N/A	41,000	30,750	6.1	75	N/A	N/A
Thickened waste activated sludge	106	N/A	60,000	54,000	4.7	90	N/A	N/A
Dewatered combined sludge	36	273	96,000	79,600	22	83	218	0.80
Filtrate recycle from belt press dewatering	126	N/A	5,000	4,230	0.33	85	N/A	N/A
Shredded yard waste	N/A	281	91,200	86,640	60	95	76	0.27
Recycled compost	N/A	279	131,440	109,095	62	83	106	0.38
Input to composting bays	N/A	833	318,640	275,335	40	86	400	0.48
Compost to screening	N/A	474	238,668	208,979	60	88	199	0.42
Screened compost to curing	N/A	195	107,228	99,884	60	83	93	0.45
Cured compost to storage	N/A	240	129,600	94,890	60	73	108	0.45

TABLE B-5
Alternative 14: Incineration with Drying—Solids Balance

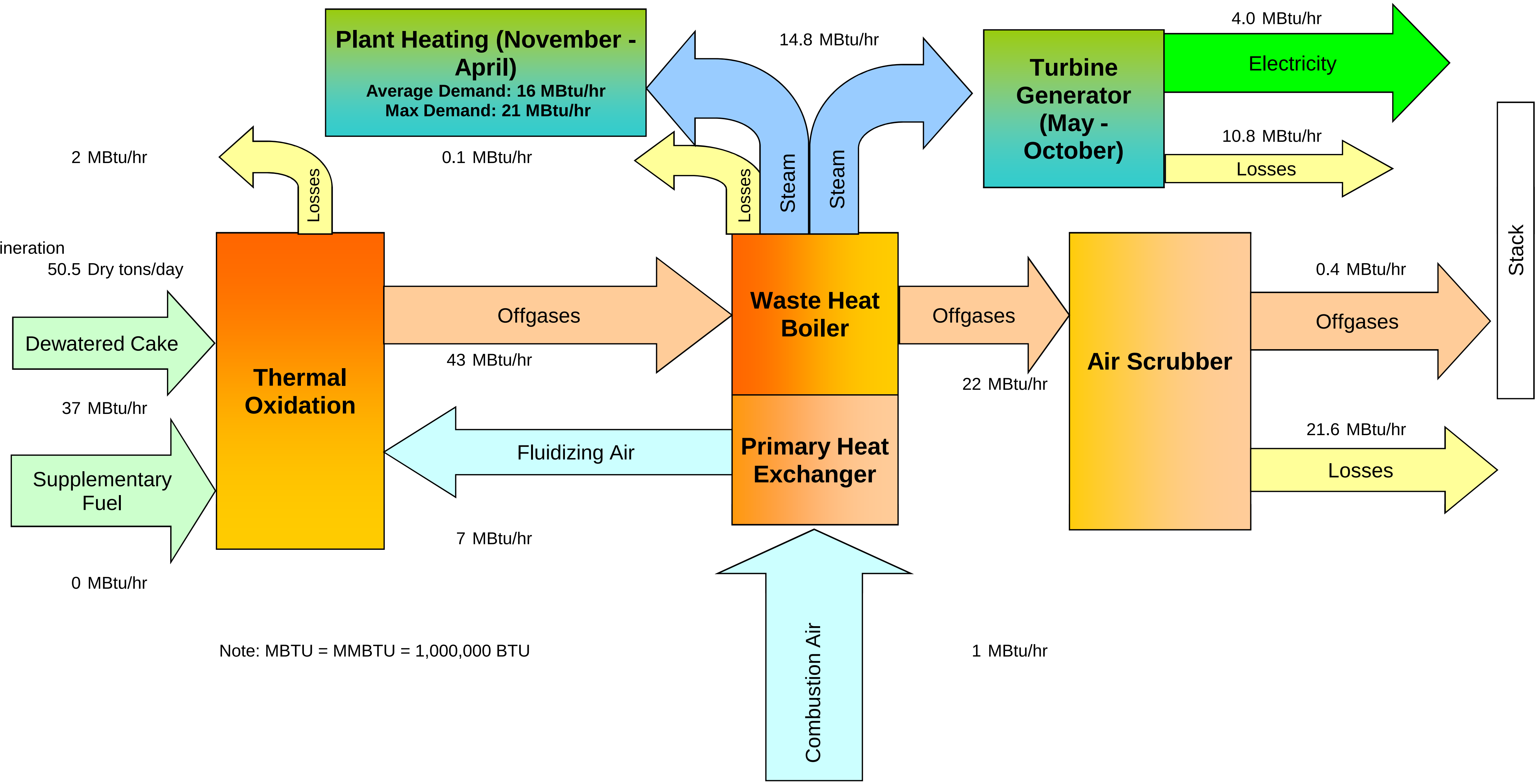
Description	Flow (gpm)	Flow (yd^3/day)	TSS (dry lb/day)	VSS (dry lb/day)	TSS (%)	VSS/TSS (%)
2035 Maximum Month Conditions						
Thickened primary sludge	71	N/A	51,660	38,745	6.1	75
Thickened waste activated sludge	134	N/A	75,600	68,040	4.7	90
Cake to dryer	17	N/A	51,986	43,148	25.0	83
Cake to incinerator	23	N/A	68,911	57,196	25.0	83
Filtrate recycle (dryer feed)	53	N/A	2,736	2,271	0.43	83
Filtrate recycle (incinerator feed)	111	N/A	3,627	3,010	0.27	83
Dried pellets	N/A	52.3	51,986	43,148	92.0	83
Ash	N/A	6.2	11,715	0	67.0	0
2035 Average Conditions						
Thickened primary sludge	56	N/A	41,000	30,750	6.1	75
Thickened waste activated sludge	106	N/A	60,000	54,000	4.7	90
Cake to dryer	14	N/A	41,259	34,245	25.0	83
Cake to incinerator	18	N/A	54,692	45,394	25.0	83
Filtrate recycle (dryer feed)	42	N/A	2,172	1,802	0.43	83
Filtrate recycle (incinerator feed)	88	N/A	2,879	2,389	0.27	83
Dried pellets	N/A	41.5	41,259	34,245	92.0	83
Ash	N/A	4.9	9,298	0	67.0	0

TABLE B-6
Alternative 16: Rehabilitate Multiple Hearth Furnaces—Solids Balance

Description	Flow (gpm)	Flow (yd^3/day)	TSS (dry lb/day)	VSS (dry lb/day)	TSS (%)	VSS/TSS (%)
2035 Maximum Month Conditions						
Thickened primary activated sludge	71	N/A	51,660	38,745	6.1	75
Thickened waste activated sludge	134	N/A	75,600	68,040	4.7	90
Dewatered combined sludge	40	N/A	120,897	101,446	25.0	84
Centrate	164	N/A	6,363	5,339	0.34	84
Ash	N/A	10.3	19,451	0	67.0	0
2035 Average Conditions						
Thickened primary activated sludge	56	N/A	41,000	30,750	6.1	75
Thickened waste activated sludge	106	N/A	60,000	54,000	4.7	90
Dewatered combined sludge	32	N/A	95,950	80,513	25.0	84
Centrate	130	N/A	5,050	4,238	0.32	84
Ash	N/A	8.2	15,438	0	67.0	0

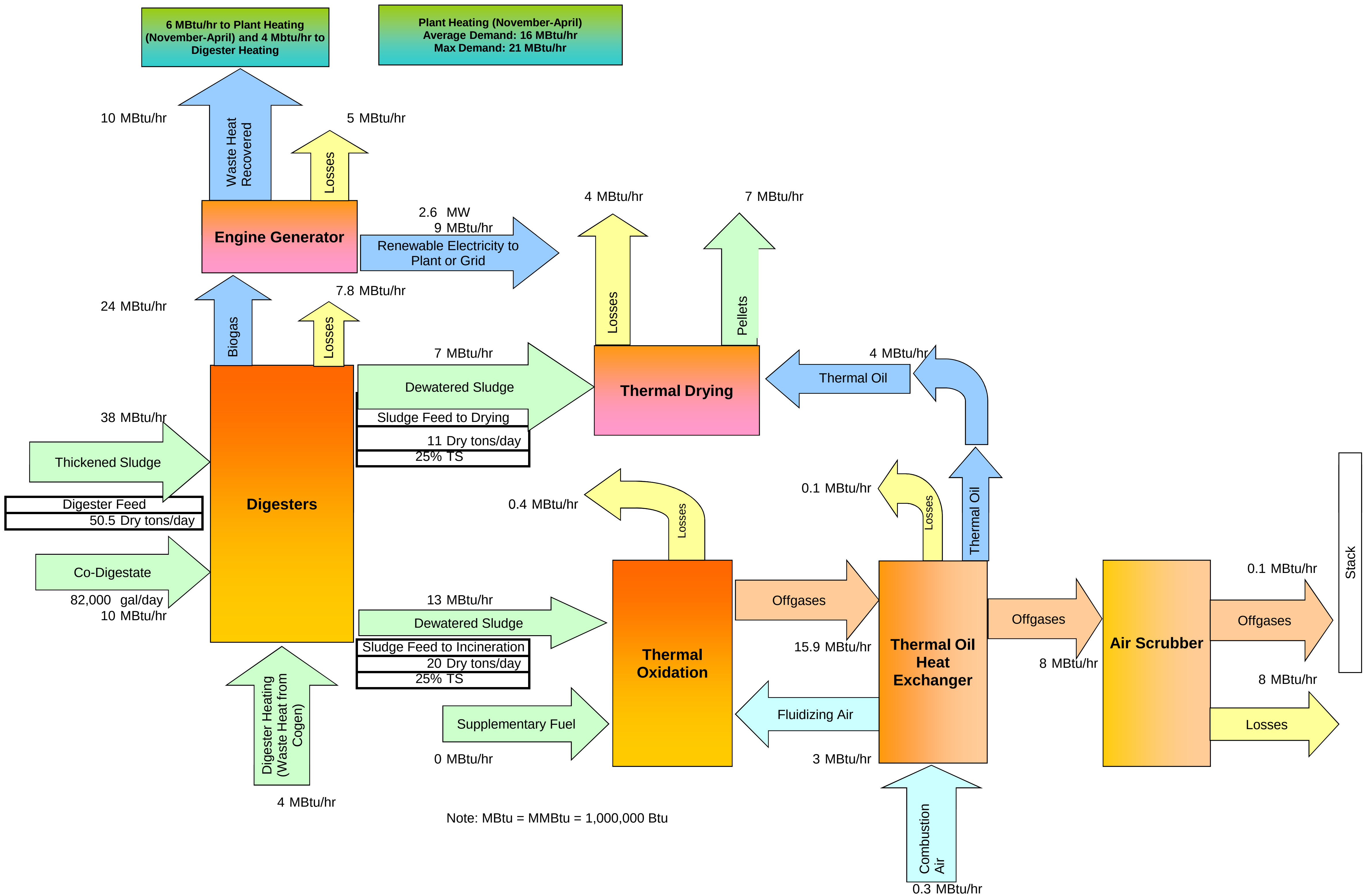
Appendix C
Energy Balances

FIGURE C-1
Alternative 2: Fluidized Bed Incineration with Energy Recovery—Energy Balance, 2035 Average
Green Bay Metropolitan Sewerage District



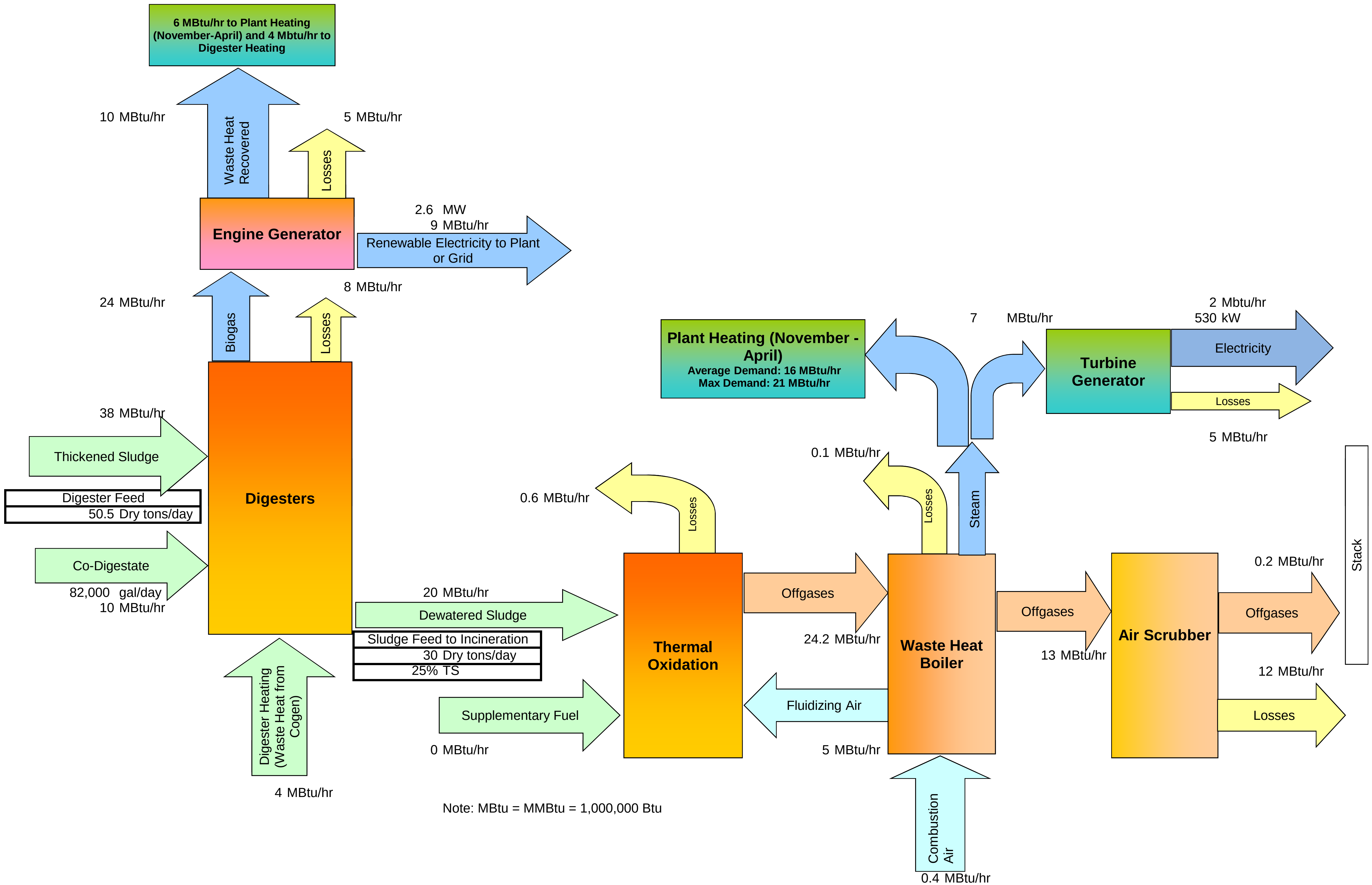
Note: MBTU = MMBTU = 1,000,000 BTU

FIGURE C-2
Alternative 3A: Digestion with Thermal Processing—Energy Balance, 2035 Average
Green Bay Metropolitan Sewerage District



Note: MBtu = MMBtu = 1,000,000 Btu

FIGURE C-3
Alternative 3B: Digestion Thermal Processing and Electrical Generation —Energy Balance, 2035 Average
Green Bay Metropolitan Sewerage District



Note: MBtu = MMBtu = 1,000,000 Btu

FIGURE C-4
Alternative 11: Composting—Energy Balance, 2035 Average
Green Bay Metropolitan Sewerage District

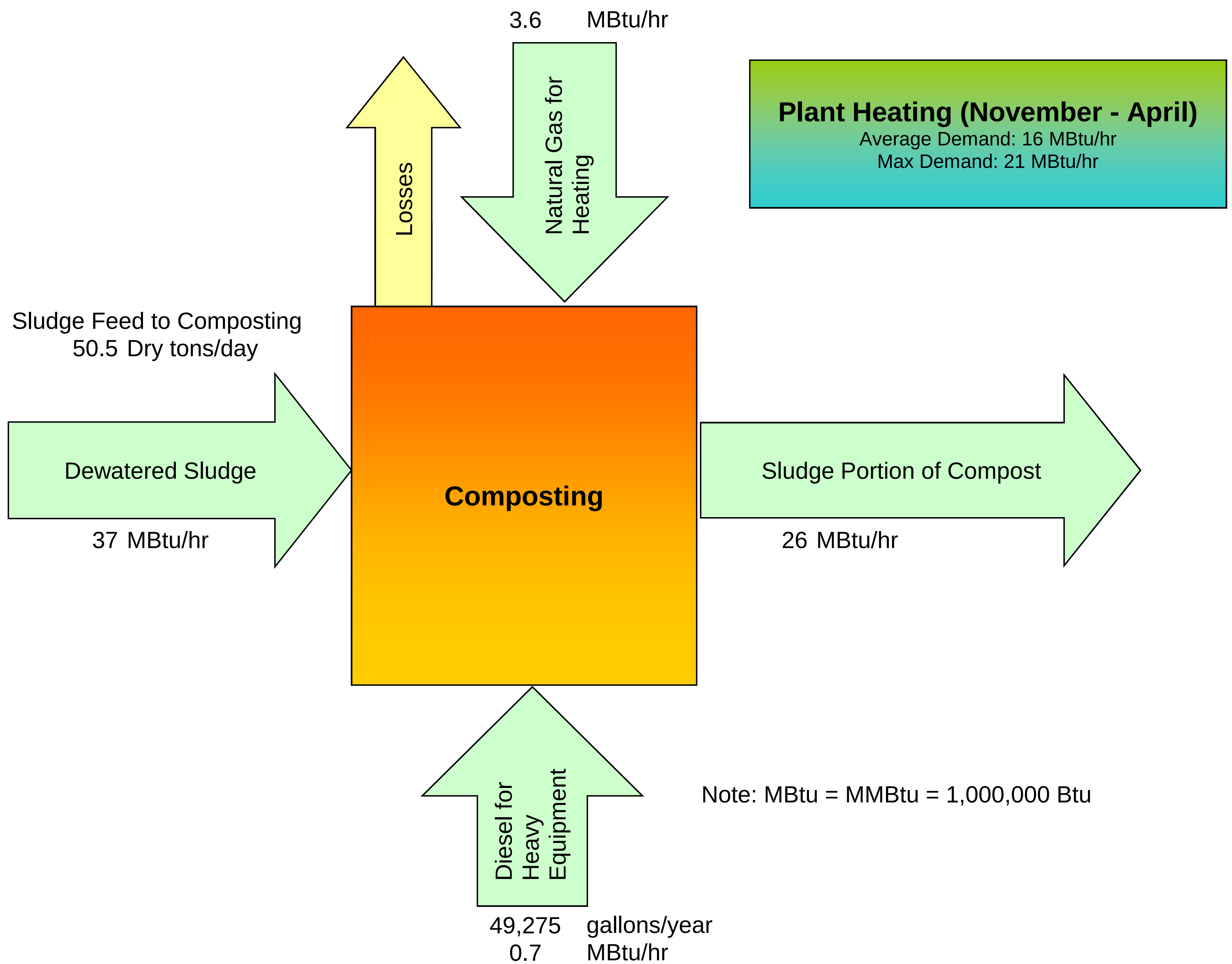


FIGURE C-5
Alternative 14: Incineration and Thermal Drying—Energy Balance, 2035 Average
Green Bay Metropolitan Sewerage District

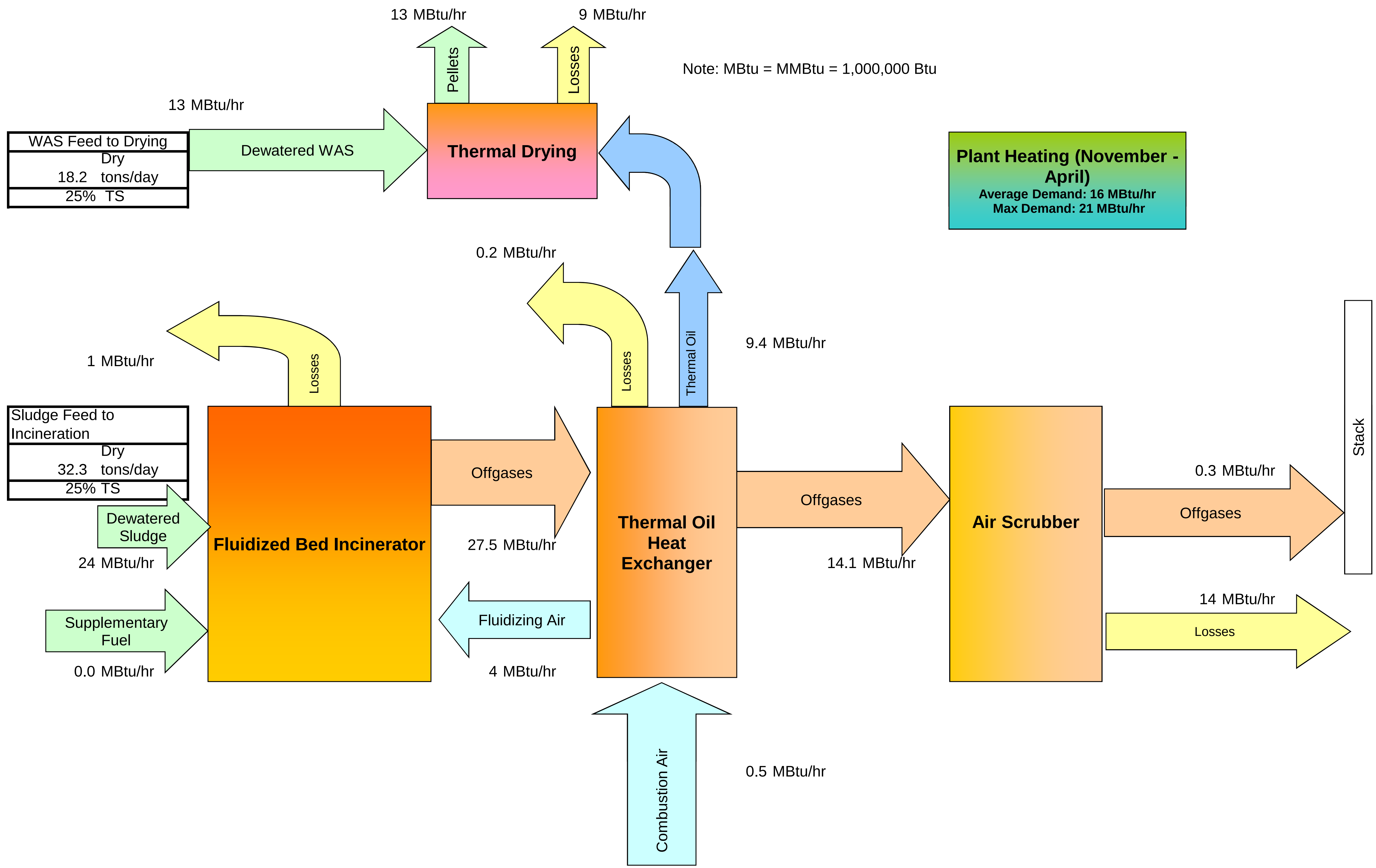
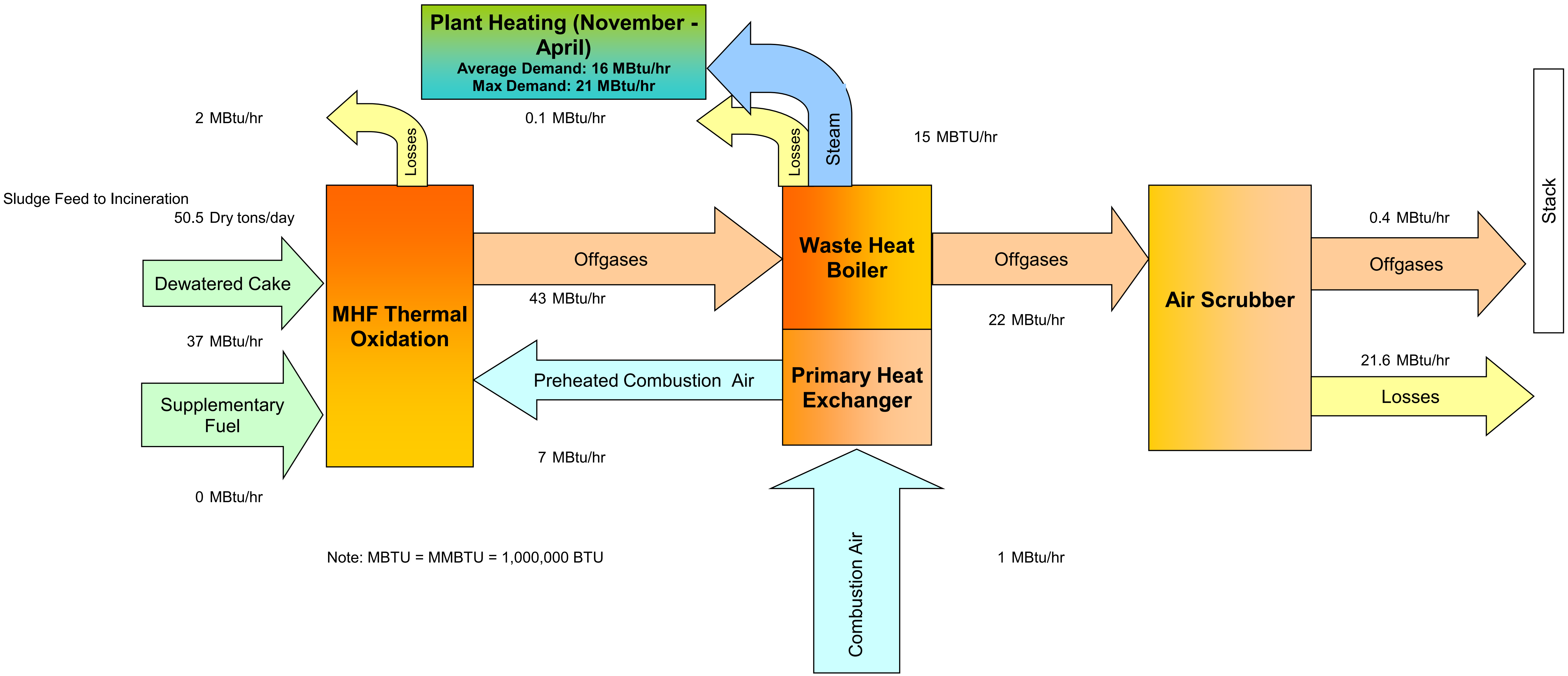


FIGURE C-6
Alternative 16: Rehabilitate Multiple Hearth Furnaces—Energy Balance, 2035 Average
Green Bay Metropolitan Sewerage District



Appendix D
Capital Cost Estimates

APPENDIX D

Capital Cost Estimates

TABLE D-1
Alternative 2: Incineration with Energy Recovery

Item	Capital Cost
Dewatering: Centrifuges and Polymer System	$12,200,000
Boilers	$3,200,000
Incinerator and Ancillary Systems	$72,900,000
Waste Heat Boiler and Steam Turbine System	$17,200,000
New Sludge Storage Tanks	$1,200,000
Demolition of Existing Solids Building	$1,600,000
Liquid and Dewatered Sludge Receiving and Storage	$1,100,000
Gravity Thickening and Gravity Belt Thickening Rehabilitation	$3,300,000
Initial Capital	**$112,700,000**

Note: All costs are June 2011 dollars referenced to ENR CCI: 9104

TABLE D-2
Alternative 3A: Digestion with Thermal Processing

Item	Capital Cost
Anaerobic Digestion System	$35,900,000
Dewatering: Centrifuges and Polymer System	$13,600,000
Boilers and Cogeneration System	$20,800,000
Thermal Drying System	$24,600,000
Incineration System	$52,800,000
New Sludge Storage Tanks	$1,200,000
Demolition of Existing Solids Building	$1,600,000
Liquid and Dewatered Sludge Receiving and Storage	$1,100,000
Gravity Thickening and Gravity Belt Thickening Rehabilitation	$3,300,000
Initial Capital	**$154,900,000**

Note: All costs are June 2011 dollars referenced to ENR CCI: 9104

TABLE D-3
Alternative 3B: Digestion with Thermal Processing and Electrical Generation

Item	Capital Cost
Anaerobic Digestion System	$35,900,000
Dewatering: Centrifuges and Polymer System	$13,600,000
Boilers and Cogeneration System	$20,800,000
Incinerator and Ancillary Systems	$57,368,000
Waste Heat Boiler and Steam Turbine System	$12,032,000
New Sludge Storage Tanks	$1,200,000
Demolition of Existing Solids Building	$1,600,000
Liquid and Dewatered Sludge Receiving and Storage	$1,100,000
Gravity Thickening and Gravity Belt Thickening Rehabilitation	$3,300,000
Initial Capital	**$146,900,000**

Note: All costs are June 2011 dollars referenced to ENR CCI: 9104

TABLE D-4
Alternative 11: Conventional Composting

Unit Process	Capital Cost
Dewatering: belt filter presses and polymer	$13,900,000
Boilers	$2,700,000
Composting	$56,800,000
New sludge storage tanks	$1,200,000
Demolition of existing solids processing building	$1,600,000
Liquid and dewatered sludge receiving and storage	$1,100,000
Gravity thickening and gravity belt thickening rehabilitation	$3,300,000
Initial capital	**$80,600,000**

Note: All costs are June 2011 dollars referenced to ENR CCI: 9104

TABLE D-5
Alternative 14: Incineration with Drying

Unit Process	Capital Cost
Dewatering: centrifuges and polymer system	$12,800,000
Boilers	$3,200,000
Thermal drying	$28,800,000
Incineration	$57,100,000
New sludge storage tanks	$1,200,000
Demolition of existing solids building	$1,600,000
Liquid and dewatered sludge receiving and storage	$1,100,000
Gravity thickening and gravity belt thickening rehabilitation	$3,300,000
Initial Capital	**$109,100,000**

Note: All costs are June 2011 dollars referenced to ENR CCI: 9104

TABLE D-6
Alternative 16: Rehabilitate Multiple Hearth Furnaces

Unit Process	Capital Cost
Dewatering: centrifuges and polymer system	$12,60,000
Boilers	$3,200,000
Rehabilitation of solids building	$3,400,000
Incineration system	$64,300,000
New sludge storage tanks	$1,200,000
Equipment demolition	$400,000
Gravity thickening and gravity belt thickening rehabilitation	$3,300,000
Initial Capital	**$88,400,000**

Note: All costs are June 2011 dollars referenced to ENR CCI: 9104.

Appendix E
O&M Cost Estimates

GREEN BAY METROPOLITAN SEWERAGE DISTRICT
Solids Management Alternatives Evaluation - Net Present Value
GENERAL ASSUMPTIONS / NPV ANALYSIS RESULTS

Financial Assumptions				2011-2015	2016-2055
Default Cost Estimation Year	2011		*Short-Term Threshold*	2015	
Discount Rate	4.13%				
General Inflation Rate				1.50%	3.00%
Capital Cost Incremental Escalation Rate				-0.50%	0.00%
Energy Cost Assumptions				**2011-2015**	**2016-2055**
Electricity Cost & Incremental Escalation Rate	$	0.072	$/kwhr	2.00%	2.00%
Natural Gas Cost & Incremental Escalation Rate	$	6.00	$/Mbtu	2.00%	2.00%
Renewable Energy Pricing & Incremental Escalation Rate	$	0.072	$/kwhr	2.00%	2.00%
Renewable Digester Gas Value	$	6.00	$/Mbtu		
Byproduct Assumptions				**2011-2015**	**2016-2055**
Compost Value	$	10.00	$/cy	1.00%	1.00%
Dried Pellet Price & Incremental Escalation Rate	$	63.00	$/wet ton	2.00%	2.00%
Wood Waste for Amendment Cost & Incremental Escalation	$	9.00	$/cy	2.00%	2.00%
Landfill / Tipping Fee Assumptions				**2011-2015**	**2016-2055**
Cost of Ash Landfilllng & Incremental Escalation	$	48.00	$/wet ton	1.00%	1.00%

Solids Loadings			Input Costs			
2011 Average Loading	46	Dry Tons/dy	Polymer	$	2.09	$/lb
2035 Average Loading	51	Dry Tons/dy	Labor	$	40.00	$/hr
			Ferric Chloride	$	693.00	$/ton

Alternative 3 Specific Values			2011-2015	2016-2055
Tipping Fees to GBMSD from Co-Digestion Waste Haulers ($/gal)	$	0.010	1.00%	1.00%
Volume of Co-Digestion Waste Hauled (gal/day)		82,000		
Biogas Production/Energy Content of Sludge (Btu/lb VSR)		9,000		

Alternative 2—Incineration with Energy Recovery (Annual O&M Quantities)

Year	Total Thickened Solids Load (dry tons/day)	Total Plant-wide Building Heat Required NG (MBtu/year)	Energy Recovered from Incinerator WHB for Plant-wide Building Heat (MBTU/year)	Electricity Consumed in Solids Process (Kw-hr/year)	Polymer (lbs/year)	Operations Labor (hours/year)	Electricity Produced by Steam Turbine (Kwhr/year)	Ash Disposal (wet tons/year)
2015	46.8	69,120	58,712	9,154,486	136,753	16,000	5,553,882	3,419
2016	47.0	69,120	58,974	9,195,209	137,362	16,000	5,578,588	3,434
2017	47.3	69,120	59,235	9,235,932	137,970	16,000	5,603,294	3,449
2018	47.5	69,120	59,496	9,276,654	138,578	16,000	5,628,000	3,464
2019	47.7	69,120	59,757	9,317,377	139,187	16,000	5,652,706	3,480
2020	47.9	69,120	60,018	9,358,100	139,795	16,000	5,677,412	3,495
2021	48.1	69,120	60,280	9,398,823	140,403	16,000	5,702,118	3,510
2022	48.3	69,120	60,541	9,439,546	141,012	16,000	5,726,824	3,525
2023	48.5	69,120	60,802	9,480,268	141,620	16,000	5,751,529	3,541
2024	48.7	69,120	61,063	9,520,991	142,228	16,000	5,776,235	3,556
2025	48.9	69,120	61,324	9,561,714	142,837	16,000	5,800,941	3,571
2026	49.1	69,120	61,585	9,602,437	143,445	16,000	5,825,647	3,586
2027	49.3	69,120	61,847	9,643,160	144,053	16,000	5,850,353	3,601
2028	49.5	69,120	62,108	9,683,882	144,662	16,000	5,875,059	3,617
2029	49.8	69,120	62,369	9,724,605	145,270	16,000	5,899,765	3,632
2030	50.0	69,120	62,630	9,765,328	145,878	16,000	5,924,471	3,647
2031	50.2	69,120	62,891	9,806,051	146,487	16,000	5,949,176	3,662
2032	50.4	69,120	63,152	9,846,774	147,095	16,000	5,973,882	3,677
2033	50.6	69,120	63,414	9,887,496	147,703	16,000	5,998,588	3,693
2034	50.8	69,120	63,675	9,928,219	148,312	16,000	6,023,294	3,708
2035	51.0	69,120	63,936	9,968,942	148,920	16,000	6,048,000	3,723
2036	51.0	69,120	63,936	9,968,942	148,920	16,000	6,048,000	3,723
2037	51.0	69,120	63,936	9,968,942	148,920	16,000	6,048,000	3,723
2038	51.0	69,120	63,936	9,968,942	148,920	16,000	6,048,000	3,723
2039	51.0	69,120	63,936	9,968,942	148,920	16,000	6,048,000	3,723
2040	51.0	69,120	63,936	9,968,942	148,920	16,000	6,048,000	3,723
2041	51.0	69,120	63,936	9,968,942	148,920	16,000	6,048,000	3,723
2042	51.0	69,120	63,936	9,968,942	148,920	16,000	6,048,000	3,723
2043	51.0	69,120	63,936	9,968,942	148,920	16,000	6,048,000	3,723
2044	51.0	69,120	63,936	9,968,942	148,920	16,000	6,048,000	3,723
2045	51.0	69,120	63,936	9,968,942	148,920	16,000	6,048,000	3,723
2046	51.0	69,120	63,936	9,968,942	148,920	16,000	6,048,000	3,723
2047	51.0	69,120	63,936	9,968,942	148,920	16,000	6,048,000	3,723
2048	51.0	69,120	63,936	9,968,942	148,920	16,000	6,048,000	3,723
2049	51.0	69,120	63,936	9,968,942	148,920	16,000	6,048,000	3,723
2050	51.0	69,120	63,936	9,968,942	148,920	16,000	6,048,000	3,723
2051	51.0	69,120	63,936	9,968,942	148,920	16,000	6,048,000	3,723
2052	51.0	69,120	63,936	9,968,942	148,920	16,000	6,048,000	3,723
2053	51.0	69,120	63,936	9,968,942	148,920	16,000	6,048,000	3,723
2054	51.0	69,120	63,936	9,968,942	148,920	16,000	6,048,000	3,723
2055	51.0	69,120	63,936	9,968,942	148,920	16,000	6,048,000	3,723

Alternative 2—Incineration with Energy Recovery (Annual O&M Costs)

Year	Plant-wide Heating Required Natural Gas ($/year)	Energy Recovered from incinerator WHB for Plant-wide Building Heat ($/year)	Electricity Consumed in Solids Process ($/year)	Polymer ($/year)	Operations Labor ($/year)	Maintenance ($/year)	Electricity Produced ($/year)	Ash Disposal ($/year)	Sand & Chemicals for FBI ($/year)	Air Pollution Control ($/year)	Total O&M ($/year)
2015	$459,807	-$390,573	$730,781	$298,870	$669,234	$191,151	-$443,354	$176,722	$250,510	$130,000	$2,073,148
2016	$482,798	-$411,926	$770,734	$309,205	$689,311	$196,885	-$467,592	$184,609	$258,025	$130,578	$2,142,628
2017	$506,938	-$434,438	$812,855	$319,892	$709,991	$202,792	-$493,146	$192,843	$265,766	$131,157	$2,214,650
2018	$532,285	-$458,171	$857,261	$330,942	$731,290	$208,876	-$520,086	$201,441	$273,739	$131,735	$2,289,312
2019	$558,899	-$483,192	$904,075	$342,366	$753,229	$215,142	-$548,488	$210,418	$281,951	$132,313	$2,366,713
2020	$586,844	-$509,569	$953,428	$354,178	$775,826	$221,596	-$578,430	$219,792	$290,410	$132,891	$2,446,967
2021	$616,186	-$537,376	$1,005,455	$366,391	$799,101	$228,244	-$609,994	$229,578	$299,122	$133,470	$2,530,177
2022	$646,995	-$566,689	$1,060,302	$379,018	$823,074	$235,092	-$643,269	$239,796	$308,096	$134,048	$2,616,463
2023	$679,345	-$597,591	$1,118,120	$392,073	$847,766	$242,144	-$678,346	$250,463	$317,339	$134,626	$2,705,940
2024	$713,312	-$630,165	$1,179,069	$405,570	$873,199	$249,409	-$715,323	$261,601	$326,859	$135,205	$2,798,735
2025	$748,978	-$664,504	$1,243,318	$419,524	$899,395	$256,891	-$754,302	$273,228	$336,665	$135,783	$2,894,976
2026	$786,427	-$700,701	$1,311,044	$433,950	$926,377	$264,598	-$795,390	$285,368	$346,764	$136,361	$2,994,798
2027	$825,748	-$738,856	$1,382,434	$448,864	$954,168	$272,536	-$838,701	$298,041	$357,167	$136,940	$3,098,340
2028	$867,036	-$779,075	$1,457,686	$464,282	$982,793	$280,712	-$884,355	$311,272	$367,882	$137,518	$3,205,751
2029	$910,387	-$821,468	$1,537,007	$480,221	$1,012,277	$289,133	-$932,478	$325,084	$378,919	$138,096	$3,317,178
2030	$955,907	-$866,154	$1,620,615	$496,699	$1,042,645	$297,807	-$983,202	$339,503	$390,286	$138,674	$3,432,781
2031	$1,003,702	-$913,254	$1,708,742	$513,734	$1,073,924	$306,741	-$1,036,667	$354,556	$401,995	$139,253	$3,552,726
2032	$1,053,887	-$962,899	$1,801,630	$531,343	$1,106,142	$315,943	-$1,093,020	$370,269	$414,055	$139,831	$3,677,181
2033	$1,106,582	-$1,015,225	$1,899,535	$549,547	$1,139,326	$325,422	-$1,152,418	$386,672	$426,477	$140,409	$3,806,327
2034	$1,161,911	-$1,070,377	$2,002,726	$568,365	$1,173,506	$335,184	-$1,215,022	$403,796	$439,271	$140,988	$3,940,348
2035	$1,220,006	-$1,128,506	$2,111,488	$587,817	$1,208,711	$414,288	-$1,281,006	$421,670	$452,449	$141,566	$4,148,483
2036	$1,281,006	-$1,184,931	$2,217,062	$605,451	$1,244,973	$426,716	-$1,345,057	$438,537	$466,022	$141,566	$4,291,345
2037	$1,345,057	-$1,244,177	$2,327,915	$623,615	$1,282,322	$439,518	-$1,412,310	$456,078	$480,003	$141,566	$4,439,587
2038	$1,412,310	-$1,306,386	$2,444,311	$642,323	$1,320,792	$452,704	-$1,482,925	$474,321	$494,403	$141,566	$4,593,419
2039	$1,482,925	-$1,371,706	$2,566,527	$661,593	$1,360,415	$466,285	-$1,557,071	$493,294	$509,235	$141,566	$4,753,062
2040	$1,557,071	-$1,440,291	$2,694,853	$681,441	$1,401,228	$480,273	-$1,634,925	$513,026	$524,512	$141,566	$4,918,754
2041	$1,634,925	-$1,512,306	$2,829,596	$701,884	$1,443,265	$494,682	-$1,716,671	$533,547	$540,248	$141,566	$5,090,736
2042	$1,716,671	-$1,587,921	$2,971,076	$722,940	$1,486,562	$509,522	-$1,802,505	$554,889	$556,455	$141,566	$5,269,255
2043	$1,802,505	-$1,667,317	$3,119,629	$744,629	$1,531,159	$524,808	-$1,892,630	$577,084	$573,149	$141,566	$5,454,581
2044	$1,892,630	-$1,750,683	$3,275,611	$766,967	$1,577,094	$540,552	-$1,987,261	$600,168	$590,343	$141,566	$5,646,987
2045	$1,987,261	-$1,838,217	$3,439,391	$789,977	$1,624,407	$556,769	-$2,086,624	$624,175	$608,054	$141,566	$5,846,759
2046	$2,086,624	-$1,930,128	$3,611,361	$813,676	$1,673,139	$573,472	-$2,190,956	$649,142	$626,295	$141,566	$6,054,191
2047	$2,190,956	-$2,026,634	$3,791,929	$838,086	$1,723,333	$590,676	-$2,300,504	$675,107	$645,084	$141,566	$6,269,598
2048	$2,300,504	-$2,127,966	$3,981,525	$863,229	$1,775,033	$608,396	-$2,415,529	$702,111	$664,437	$141,566	$6,493,306
2049	$2,415,529	-$2,234,364	$4,180,602	$889,126	$1,828,284	$626,648	-$2,536,305	$730,196	$684,370	$141,566	$6,725,652
2050	$2,536,305	-$2,346,082	$4,389,632	$915,799	$1,883,133	$645,447	-$2,663,120	$759,404	$704,901	$141,566	$6,966,985
2051	$2,663,120	-$2,463,386	$4,609,113	$943,273	$1,939,627	$664,810	-$2,796,276	$789,780	$726,048	$141,566	$7,217,675
2052	$2,796,276	-$2,586,556	$4,839,569	$971,571	$1,997,816	$684,755	-$2,936,090	$821,371	$747,829	$141,566	$7,478,107
2053	$2,936,090	-$2,715,883	$5,081,547	$1,000,719	$2,057,750	$705,298	-$3,082,895	$854,226	$770,264	$141,566	$7,748,682
2054	$3,082,895	-$2,851,678	$5,335,625	$1,030,740	$2,119,483	$726,457	-$3,237,039	$888,395	$793,372	$141,566	$8,029,816
2055	$3,237,039	-$2,994,261	$5,602,406	$1,061,662	$2,183,067	$748,250	-$3,398,891	$923,931	$817,173	$141,566	$8,321,942

Alternative 3A—Digestion with Thermal Processing (Annual O&M Quantities)

Year	Total Thickened Solids Load (dry tons/day)	Total Plant-wide Building Heat Required (MBtu/year)	Building Heat Recovered from Engine Generator Waste Heat (Mbtu/yr)	RTO Natural Gas Demand (Mbtu/year)	Electricity Consumed in Solids Process (Kw-hr/year)	Ferric Chloride (tons/year)	Polymer (lbs/year)	Operations Labor (hours/year)	Electricity Production from Biogas (Kwhr/year)	Biogas Production (MBtu/year)	Ash Disposal (wet tons/year)	Pellet Sales (wet tons/year)	TKN Centrate Recycle (lbs/day)
2015	46.8	69,120	23,802	3,313	4,728,566	439	118,975	20,732	20,915,216	193,389	2,095	3,447	1,341
2016	47.0	69,120	23,908	3,328	4,749,601	441	119,505	20,732	21,008,255	194,249	2,104	3,463	1,347
2017	47.3	69,120	24,014	3,343	4,770,635	443	120,034	20,732	21,101,294	195,110	2,114	3,478	1,353
2018	47.5	69,120	24,120	3,358	4,791,670	445	120,563	20,732	21,194,333	195,970	2,123	3,493	1,359
2019	47.7	69,120	24,226	3,372	4,812,704	447	121,092	20,732	21,287,373	196,830	2,132	3,509	1,365
2020	47.9	69,120	24,332	3,387	4,833,739	449	121,622	20,732	21,380,412	197,691	2,141	3,524	1,371
2021	48.1	69,120	24,438	3,402	4,854,773	451	122,151	20,732	21,473,451	198,551	2,151	3,539	1,377
2022	48.3	69,120	24,544	3,417	4,875,808	453	122,680	20,732	21,566,490	199,411	2,160	3,555	1,383
2023	48.5	69,120	24,649	3,431	4,896,842	454	123,209	20,732	21,659,529	200,271	2,169	3,570	1,389
2024	48.7	69,120	24,755	3,446	4,917,877	456	123,739	20,732	21,752,569	201,132	2,179	3,585	1,395
2025	48.9	69,120	24,861	3,461	4,938,912	458	124,268	20,732	21,845,608	201,992	2,188	3,601	1,401
2026	49.1	69,120	24,967	3,476	4,959,946	460	124,797	20,732	21,938,647	202,852	2,197	3,616	1,407
2027	49.3	69,120	25,073	3,490	4,980,981	462	125,326	20,732	22,031,686	203,712	2,207	3,631	1,413
2028	49.5	69,120	25,179	3,505	5,002,015	464	125,856	20,732	22,124,725	204,573	2,216	3,647	1,419
2029	49.8	69,120	25,285	3,520	5,023,050	466	126,385	20,732	22,217,765	205,433	2,225	3,662	1,425
2030	50.0	69,120	25,391	3,534	5,044,084	468	126,914	20,732	22,310,804	206,293	2,235	3,677	1,431
2031	50.2	69,120	25,496	3,549	5,065,119	470	127,443	20,732	22,403,843	207,154	2,244	3,693	1,436
2032	50.4	69,120	25,602	3,564	5,086,153	472	127,973	20,732	22,496,882	208,014	2,253	3,708	1,442
2033	50.6	69,120	25,708	3,579	5,107,188	474	128,502	20,732	22,589,922	208,874	2,263	3,723	1,448
2034	50.8	69,120	25,814	3,593	5,128,222	476	129,031	20,732	22,682,961	209,734	2,272	3,739	1,454
2035	51.0	69,120	25,920	3,608	5,149,257	478	129,560	20,732	22,776,000	210,595	2,281	3,754	1,460
2036	51.0	69,120	25,920	3,608	5,149,257	478	129,560	20,732	22,776,000	210,595	2,281	3,754	1,460
2037	51.0	69,120	25,920	3,608	5,149,257	478	129,560	20,732	22,776,000	210,595	2,281	3,754	1,460
2038	51.0	69,120	25,920	3,608	5,149,257	478	129,560	20,732	22,776,000	210,595	2,281	3,754	1,460
2039	51.0	69,120	25,920	3,608	5,149,257	478	129,560	20,732	22,776,000	210,595	2,281	3,754	1,460
2040	51.0	69,120	25,920	3,608	5,149,257	478	129,560	20,732	22,776,000	210,595	2,281	3,754	1,460
2041	51.0	69,120	25,920	3,608	5,149,257	478	129,560	20,732	22,776,000	210,595	2,281	3,754	1,460
2042	51.0	69,120	25,920	3,608	5,149,257	478	129,560	20,732	22,776,000	210,595	2,281	3,754	1,460
2043	51.0	69,120	25,920	3,608	5,149,257	478	129,560	20,732	22,776,000	210,595	2,281	3,754	1,460
2044	51.0	69,120	25,920	3,608	5,149,257	478	129,560	20,732	22,776,000	210,595	2,281	3,754	1,460
2045	51.0	69,120	25,920	3,608	5,149,257	478	129,560	20,732	22,776,000	210,595	2,281	3,754	1,460
2046	51.0	69,120	25,920	3,608	5,149,257	478	129,560	20,732	22,776,000	210,595	2,281	3,754	1,460
2047	51.0	69,120	25,920	3,608	5,149,257	478	129,560	20,732	22,776,000	210,595	2,281	3,754	1,460
2048	51.0	69,120	25,920	3,608	5,149,257	478	129,560	20,732	22,776,000	210,595	2,281	3,754	1,460
2049	51.0	69,120	25,920	3,608	5,149,257	478	129,560	20,732	22,776,000	210,595	2,281	3,754	1,460
2050	51.0	69,120	25,920	3,608	5,149,257	478	129,560	20,732	22,776,000	210,595	2,281	3,754	1,460
2051	51.0	69,120	25,920	3,608	5,149,257	478	129,560	20,732	22,776,000	210,595	2,281	3,754	1,460
2052	51.0	69,120	25,920	3,608	5,149,257	478	129,560	20,732	22,776,000	210,595	2,281	3,754	1,460
2053	51.0	69,120	25,920	3,608	5,149,257	478	129,560	20,732	22,776,000	210,595	2,281	3,754	1,460
2054	51.0	69,120	25,920	3,608	5,149,257	478	129,560	20,732	22,776,000	210,595	2,281	3,754	1,460
2055	51.0	69,120	25,920	3,608	5,149,257	478	129,560	20,732	22,776,000	210,595	2,281	3,754	1,460

Alternative 3A—Digestion with Thermal Processing (Annual O&M Costs)

Year	Plant Heating Required Natural Gas ($/year)	Building Heat Recovered from Engine Generator Waste Heat ($/yr)	Dryer RTO Natural Gas Demand ($/year)	Electricity Consumed in Solids Process ($/year)	Ferric Chloride ($/year)	Biogas Cleaning ($/year)	Polymer ($/year)	Operations Labor ($/year)	Maintenance ($/year)	Electricity Produced from Biogas ($/year)	Ash Disposal ($/year)	Pellet Sales ($/year)	TKN Centrate Recycle Treatment ($/year)	Sand & Chemicals for FBI ($/year)	Air Pollution Control ($/year)	Tipping Fee Revenue from Co-digestion Waste Providers	Total O&M ($/year)
2015	$459,807	-$158,341	$22,042	$377,470	$318,020	$100,156	$260,017	$867,160	$262,727	-$1,669,613	$108,286	-$240,793	$108,610	$125,545	$47,905	-$322,313	$666,685
2016	$482,798	-$166,997	$23,247	$398,107	$329,017	$103,620	$269,009	$893,175	$270,608	-$1,760,892	$113,118	-$253,957	$111,275	$129,312	$48,118	-$335,206	$654,353
2017	$506,938	-$176,124	$24,517	$419,864	$340,389	$107,201	$278,306	$919,970	$278,727	-$1,857,125	$118,164	-$267,836	$114,004	$133,191	$48,331	-$348,614	$639,903
2018	$532,285	-$185,745	$25,857	$442,801	$352,146	$110,904	$287,919	$947,569	$287,089	-$1,958,579	$123,432	-$282,468	$116,796	$137,187	$48,544	-$362,559	$623,178
2019	$558,899	-$195,889	$27,269	$466,982	$364,303	$114,733	$297,859	$975,996	$295,701	-$2,065,536	$128,933	-$297,893	$119,655	$141,302	$48,757	-$377,061	$604,010
2020	$586,844	-$206,582	$28,757	$492,474	$376,872	$118,691	$308,135	$1,005,276	$304,572	-$2,178,292	$134,676	-$314,155	$122,582	$145,541	$48,971	-$392,143	$582,219
2021	$616,186	-$217,855	$30,327	$519,348	$389,867	$122,784	$318,760	$1,035,435	$313,709	-$2,297,160	$140,673	-$331,298	$125,577	$149,908	$49,184	-$407,829	$557,616
2022	$646,995	-$229,739	$31,981	$547,678	$403,303	$127,015	$329,746	$1,066,498	$323,121	-$2,422,468	$146,934	-$349,370	$128,644	$154,405	$49,397	-$424,142	$529,998
2023	$679,345	-$242,266	$33,725	$577,543	$417,194	$131,390	$341,103	$1,098,493	$332,814	-$2,554,565	$153,470	-$368,421	$131,783	$159,037	$49,610	-$441,108	$499,147
2024	$713,312	-$255,472	$35,563	$609,025	$431,556	$135,913	$352,846	$1,131,447	$342,799	-$2,693,815	$160,295	-$388,504	$134,996	$163,808	$49,823	-$458,752	$464,839
2025	$748,978	-$269,393	$37,501	$642,211	$446,404	$140,589	$364,986	$1,165,391	$353,083	-$2,840,604	$167,419	-$409,674	$138,285	$168,722	$50,036	-$477,103	$426,830
2026	$786,427	-$284,068	$39,544	$677,194	$461,754	$145,424	$377,536	$1,200,352	$363,675	-$2,995,337	$174,858	-$431,990	$141,651	$173,784	$50,249	-$496,187	$384,866
2027	$825,748	-$299,536	$41,697	$714,069	$477,624	$150,422	$390,511	$1,236,363	$374,585	-$3,158,442	$182,623	-$455,513	$145,097	$178,997	$50,462	-$516,034	$338,673
2028	$867,036	-$315,841	$43,967	$752,938	$494,030	$155,588	$403,925	$1,273,454	$385,823	-$3,330,369	$190,730	-$480,308	$148,624	$184,367	$50,675	-$536,675	$287,965
2029	$910,387	-$333,028	$46,359	$793,910	$510,991	$160,930	$417,793	$1,311,658	$397,398	-$3,511,592	$199,194	-$506,444	$152,234	$189,898	$50,888	-$558,142	$232,434
2030	$955,907	-$351,143	$48,881	$837,096	$528,525	$166,452	$432,128	$1,351,007	$409,320	-$3,702,612	$208,029	-$533,994	$155,929	$195,595	$51,102	-$580,468	$171,754
2031	$1,003,702	-$370,238	$51,539	$882,616	$546,651	$172,161	$446,948	$1,391,537	$421,599	-$3,903,955	$217,252	-$563,031	$159,711	$201,463	$51,315	-$603,687	$105,582
2032	$1,053,887	-$390,364	$54,341	$930,596	$565,388	$178,062	$462,269	$1,433,284	$434,247	-$4,116,176	$226,881	-$593,638	$163,581	$207,507	$51,528	-$627,834	$33,558
2033	$1,106,582	-$411,578	$57,294	$981,167	$584,758	$184,162	$478,106	$1,476,282	$447,275	-$4,339,859	$236,932	-$625,898	$167,543	$213,732	$51,741	-$652,948	-$44,709
2034	$1,161,911	-$433,937	$60,406	$1,034,468	$604,782	$190,468	$494,477	$1,520,571	$460,693	-$4,575,620	$247,424	-$659,899	$171,598	$220,144	$51,954	-$679,066	-$129,626
2035	$1,220,006	-$457,502	$63,687	$1,090,647	$625,480	$196,987	$511,401	$1,566,188	$569,417	-$4,824,108	$258,376	-$695,736	$175,748	$226,749	$52,167	-$706,228	-$126,722
2036	$1,281,006	-$480,377	$66,871	$1,145,179	$644,245	$202,897	$526,743	$1,613,173	$586,499	-$5,065,313	$268,711	-$730,523	$179,263	$233,551	$52,167	-$734,477	-$210,386
2037	$1,345,057	-$504,396	$70,214	$1,202,438	$663,572	$208,984	$542,545	$1,661,569	$604,094	-$5,318,579	$279,460	-$767,049	$182,848	$240,558	$52,167	-$763,856	-$300,375
2038	$1,412,310	-$529,616	$73,725	$1,262,560	$683,479	$215,253	$558,821	$1,711,416	$622,217	-$5,584,508	$290,638	-$805,402	$186,505	$247,774	$52,167	-$794,411	-$397,072
2039	$1,482,925	-$556,097	$77,411	$1,325,688	$703,984	$221,711	$575,586	$1,762,758	$640,883	-$5,863,733	$302,264	-$845,672	$190,235	$255,208	$52,167	-$826,187	-$500,869
2040	$1,557,071	-$583,902	$81,282	$1,391,972	$725,103	$228,362	$592,853	$1,815,641	$660,110	-$6,156,920	$314,354	-$887,956	$194,040	$262,864	$52,167	-$859,235	-$612,195
2041	$1,634,925	-$613,097	$85,346	$1,461,571	$746,856	$235,213	$610,639	$1,870,110	$679,913	-$6,464,765	$326,928	-$932,353	$197,920	$270,750	$52,167	-$893,604	-$731,481
2042	$1,716,671	-$643,752	$89,613	$1,534,649	$769,262	$242,269	$628,958	$1,926,213	$700,311	-$6,788,004	$340,005	-$978,971	$201,879	$278,872	$52,167	-$929,348	-$859,207
2043	$1,802,505	-$675,939	$94,094	$1,611,382	$792,340	$249,537	$647,827	$1,984,000	$721,319	-$7,127,404	$353,606	-$1,027,920	$205,916	$287,238	$52,167	-$966,522	-$995,853
2044	$1,892,630	-$709,736	$98,799	$1,691,951	$816,110	$257,024	$667,262	$2,043,520	$742,959	-$7,483,774	$367,750	-$1,079,316	$210,035	$295,855	$52,167	-$1,005,183	-$1,141,947
2045	$1,987,261	-$745,223	$103,739	$1,776,549	$840,593	$264,734	$687,280	$2,104,825	$765,248	-$7,857,963	$382,460	-$1,133,281	$214,235	$304,731	$52,167	-$1,045,390	-$1,298,035
2046	$2,086,624	-$782,484	$108,926	$1,865,376	$865,811	$272,676	$707,898	$2,167,970	$788,206	-$8,250,861	$397,758	-$1,189,945	$218,520	$313,873	$52,167	-$1,087,206	-$1,464,691
2047	$2,190,956	-$821,608	$114,372	$1,958,645	$891,785	$280,856	$729,135	$2,233,009	$811,851	-$8,663,404	$413,669	-$1,249,443	$222,891	$323,289	$52,167	-$1,130,694	-$1,642,524
2048	$2,300,504	-$862,689	$120,091	$2,056,577	$918,539	$289,282	$751,009	$2,299,999	$836,207	-$9,096,574	$430,215	-$1,311,915	$227,348	$332,988	$52,167	-$1,175,922	-$1,832,174
2049	$2,415,529	-$905,823	$126,095	$2,159,406	$946,095	$297,960	$773,539	$2,368,999	$861,294	-$9,551,403	$447,424	-$1,377,511	$231,895	$342,978	$52,167	-$1,222,959	-$2,034,315
2050	$2,536,305	-$951,114	$132,400	$2,267,376	$974,478	$306,899	$796,745	$2,440,069	$887,132	-$10,028,973	$465,321	-$1,446,386	$236,533	$353,267	$52,167	-$1,271,877	-$2,249,658
2051	$2,663,120	-$998,670	$139,020	$2,380,745	$1,003,712	$316,106	$820,648	$2,513,272	$913,746	-$10,530,422	$483,934	-$1,518,705	$241,264	$363,865	$52,167	-$1,322,752	-$2,478,950
2052	$2,796,276	-$1,048,604	$145,971	$2,499,782	$1,033,824	$325,589	$845,267	$2,588,670	$941,159	-$11,056,943	$503,291	-$1,594,641	$246,089	$374,781	$52,167	-$1,375,662	-$2,722,984
2053	$2,936,090	-$1,101,034	$153,269	$2,624,771	$1,064,838	$335,357	$870,625	$2,666,330	$969,394	-$11,609,790	$523,423	-$1,674,373	$251,011	$386,024	$52,167	-$1,430,689	-$2,982,587
2054	$3,082,895	-$1,156,086	$160,933	$2,756,010	$1,096,783	$345,418	$896,744	$2,746,320	$998,475	-$12,190,280	$544,360	-$1,758,091	$256,031	$397,605	$52,167	-$1,487,916	-$3,258,632
2055	$3,237,039	-$1,213,890	$168,980	$2,893,810	$1,129,687	$355,780	$923,646	$2,828,709	$1,028,429	-$12,799,793	$566,134	-$1,845,996	$261,152	$409,533	$52,167	-$1,547,433	-$3,552,045

Alternative 3B—Digestion with Thermal Processing and Electrical Generation (Annual O&M Quantities)

Year	Total Thickened Solids Load (dry tons/day)	Total Plantwide Building Heat Required (MBtu/year)	Energy Recovered from Engine Generator Waste Heat for Plantwide Building Heat (Mbtu/yr)	Energy Recovered from Incinerator WHB for Plantwide Building Heat (MBTU/year)	Electricity Consumed in Solids Process (kWh/year)	Electricity Produced by Steam Turbine (kWh/year)	Ferric Chloride (tons/year)	Polymer (lb/year)	Operations Labor (hours/year)	Electricity Production from Biogas (kWh/year)	Biogas Production (MBtu/year)	Ash Disposal (wet tons/year)	TKN Centrate Recycle (lb/day)
2015	46.8	69,120	23,802	27,769	4,487,648	2,131,743	439	118,975	18,732	20,915,216	193,389	3,352	1,341
2016	47.0	69,120	23,908	27,893	4,507,611	2,141,226	441	119,505	18,732	21,008,255	194,249	3,367	1,347
2017	47.3	69,120	24,014	28,016	4,527,574	2,150,709	443	120,034	18,732	21,101,294	195,110	3,382	1,353
2018	47.5	69,120	24,120	28,140	4,547,537	2,160,192	445	120,563	18,732	21,194,333	195,970	3,397	1,359
2019	47.7	69,120	24,226	28,264	4,567,499	2,169,675	447	121,092	18,732	21,287,373	196,830	3,411	1,365
2020	47.9	69,120	24,332	28,387	4,587,462	2,179,157	449	121,622	18,732	21,380,412	197,691	3,426	1,371
2021	48.1	69,120	24,438	28,511	4,607,425	2,188,640	451	122,151	18,732	21,473,451	198,551	3,441	1,377
2022	48.3	69,120	24,544	28,634	4,627,388	2,198,123	453	122,680	18,732	21,566,490	199,411	3,456	1,383
2023	48.5	69,120	24,649	28,758	4,647,351	2,207,606	454	123,209	18,732	21,659,529	200,271	3,471	1,389
2024	48.7	69,120	24,755	28,881	4,667,314	2,217,089	456	123,739	18,732	21,752,569	201,132	3,486	1,395
2025	48.9	69,120	24,861	29,005	4,687,277	2,226,572	458	124,268	18,732	21,845,608	201,992	3,501	1,401
2026	49.1	69,120	24,967	29,128	4,707,239	2,236,054	460	124,797	18,732	21,938,647	202,852	3,516	1,407
2027	49.3	69,120	25,073	29,252	4,727,202	2,245,537	462	125,326	18,732	22,031,686	203,712	3,531	1,413
2028	49.5	69,120	25,179	29,375	4,747,165	2,255,020	464	125,856	18,732	22,124,725	204,573	3,546	1,419
2029	49.8	69,120	25,285	29,499	4,767,128	2,264,503	466	126,385	18,732	22,217,765	205,433	3,561	1,425
2030	50.0	69,120	25,391	29,622	4,787,091	2,273,986	468	126,914	18,732	22,310,804	206,293	3,575	1,431
2031	50.2	69,120	25,496	29,746	4,807,054	2,283,469	470	127,443	18,732	22,403,843	207,154	3,590	1,436
2032	50.4	69,120	25,602	29,869	4,827,016	2,292,951	472	127,973	18,732	22,496,882	208,014	3,605	1,442
2033	50.6	69,120	25,708	29,993	4,846,979	2,302,434	474	128,502	18,732	22,589,922	208,874	3,620	1,448
2034	50.8	69,120	25,814	30,116	4,866,942	2,311,917	476	129,031	18,732	22,682,961	209,734	3,635	1,454
2035	51.0	69,120	25,920	30,240	4,886,905	2,321,400	478	129,560	18,732	22,776,000	210,595	3,650	1,460
2036	51.0	69,120	25,920	30,240	4,886,905	2,321,400	478	129,560	18,732	22,776,000	210,595	3,650	1,460
2037	51.0	69,120	25,920	30,240	4,886,905	2,321,400	478	129,560	18,732	22,776,000	210,595	3,650	1,460
2038	51.0	69,120	25,920	30,240	4,886,905	2,321,400	478	129,560	18,732	22,776,000	210,595	3,650	1,460
2039	51.0	69,120	25,920	30,240	4,886,905	2,321,400	478	129,560	18,732	22,776,000	210,595	3,650	1,460
2040	51.0	69,120	25,920	30,240	4,886,905	2,321,400	478	129,560	18,732	22,776,000	210,595	3,650	1,460
2041	51.0	69,120	25,920	30,240	4,886,905	2,321,400	478	129,560	18,732	22,776,000	210,595	3,650	1,460
2042	51.0	69,120	25,920	30,240	4,886,905	2,321,400	478	129,560	18,732	22,776,000	210,595	3,650	1,460
2043	51.0	69,120	25,920	30,240	4,886,905	2,321,400	478	129,560	18,732	22,776,000	210,595	3,650	1,460
2044	51.0	69,120	25,920	30,240	4,886,905	2,321,400	478	129,560	18,732	22,776,000	210,595	3,650	1,460
2045	51.0	69,120	25,920	30,240	4,886,905	2,321,400	478	129,560	18,732	22,776,000	210,595	3,650	1,460
2046	51.0	69,120	25,920	30,240	4,886,905	2,321,400	478	129,560	18,732	22,776,000	210,595	3,650	1,460
2047	51.0	69,120	25,920	30,240	4,886,905	2,321,400	478	129,560	18,732	22,776,000	210,595	3,650	1,460
2048	51.0	69,120	25,920	30,240	4,886,905	2,321,400	478	129,560	18,732	22,776,000	210,595	3,650	1,460
2049	51.0	69,120	25,920	30,240	4,886,905	2,321,400	478	129,560	18,732	22,776,000	210,595	3,650	1,460
2050	51.0	69,120	25,920	30,240	4,886,905	2,321,400	478	129,560	18,732	22,776,000	210,595	3,650	1,460
2051	51.0	69,120	25,920	30,240	4,886,905	2,321,400	478	129,560	18,732	22,776,000	210,595	3,650	1,460
2052	51.0	69,120	25,920	30,240	4,886,905	2,321,400	478	129,560	18,732	22,776,000	210,595	3,650	1,460
2053	51.0	69,120	25,920	30,240	4,886,905	2,321,400	478	129,560	18,732	22,776,000	210,595	3,650	1,460
2054	51.0	69,120	25,920	30,240	4,886,905	2,321,400	478	129,560	18,732	22,776,000	210,595	3,650	1,460
2055	51.0	69,120	25,920	30,240	4,886,905	2,321,400	478	129,560	18,732	22,776,000	210,595	3,650	1,460

Alternative 3B—Digestion with Thermal Processing and Electrical Generation (Annual O&M Costs and Present Worth)

Year	Total Plantwide Building Heat Required NG ($/year)	Energy Recovered from Engine Generator Waste Heat for Plantwide Building Heat ($/yr)	Energy Recovered from Incinerator WHB for Plantwide Building Heat ($/year)	Electricity Consumed in Solids Process ($/year)	Electricity Produced by Steam Turbine ($/year)	Ferric Chloride ($/year)	Biogas Cleaning ($/year)	Polymer ($/year)	Operations Labor ($/year)	Maintenance ($/year)	Electricity Produced from Biogas ($/year)	Ash Disposal ($/year)	TKN Centrate Recycle Treatment ($/year)	Sand & Chemicals for FBI ($/year)	Air Pollution Control ($/year)	Tipping Fee Revenue from Co-digestion Waste Providers	Total O&M ($/year)
2015	$459,807	-$158,341	-$184,731	$358,239	-$170,172	$318,020	$100,156	$260,017	$783,506	$249,590	-$1,669,613	$173,257	$108,610	$152,928	$71,858	-$322,313	$530,818
2016	$482,798	-$166,997	-$194,830	$377,824	-$179,476	$329,017	$103,620	$269,009	$807,011	$257,078	-$1,760,892	$180,989	$111,275	$157,516	$72,177	-$335,206	$510,913
2017	$506,938	-$176,124	-$205,478	$398,472	-$189,284	$340,389	$107,201	$278,306	$831,221	$264,791	-$1,857,125	$189,062	$114,004	$162,242	$72,497	-$348,614	$488,497
2018	$532,285	-$185,745	-$216,703	$420,240	-$199,624	$352,146	$110,904	$287,919	$856,158	$272,734	-$1,958,579	$197,491	$116,796	$167,109	$72,816	-$362,559	$463,388
2019	$558,899	-$195,889	-$228,537	$443,189	-$210,526	$364,303	$114,733	$297,859	$881,843	$280,916	-$2,065,536	$206,293	$119,655	$172,122	$73,136	-$377,061	$435,399
2020	$586,844	-$206,582	-$241,012	$467,383	-$222,018	$376,872	$118,691	$308,135	$908,298	$289,343	-$2,178,292	$215,482	$122,582	$177,286	$73,456	-$392,143	$404,325
2021	$616,186	-$217,855	-$254,164	$492,887	-$234,134	$389,867	$122,784	$318,760	$935,547	$298,024	-$2,297,160	$225,076	$125,577	$182,604	$73,775	-$407,829	$369,945
2022	$646,995	-$229,739	-$268,029	$519,774	-$246,905	$403,303	$127,015	$329,746	$963,613	$306,965	-$2,422,468	$235,094	$128,644	$188,083	$74,095	-$424,142	$332,044
2023	$679,345	-$242,266	-$282,644	$548,117	-$260,369	$417,194	$131,390	$341,103	$992,522	$316,173	-$2,554,565	$245,552	$131,783	$193,725	$74,415	-$441,108	$290,367
2024	$713,312	-$255,472	-$298,051	$577,995	-$274,562	$431,556	$135,913	$352,846	$1,022,297	$325,659	-$2,693,815	$256,471	$134,996	$199,537	$74,734	-$458,752	$244,664
2025	$748,978	-$269,393	-$314,292	$609,491	-$289,523	$446,404	$140,589	$364,986	$1,052,966	$335,429	-$2,840,604	$267,871	$138,285	$205,523	$75,054	-$477,103	$194,660
2026	$786,427	-$284,068	-$331,412	$642,691	-$305,294	$461,754	$145,424	$377,536	$1,084,555	$345,491	-$2,995,337	$279,772	$141,651	$211,689	$75,374	-$496,187	$140,065
2027	$825,748	-$299,536	-$349,459	$677,687	-$321,918	$477,624	$150,422	$390,511	$1,117,092	$355,856	-$3,158,442	$292,197	$145,097	$218,039	$75,693	-$516,034	$80,577
2028	$867,036	-$315,841	-$368,481	$714,577	-$339,441	$494,030	$155,588	$403,925	$1,150,605	$366,532	-$3,330,369	$305,168	$148,624	$224,580	$76,013	-$536,675	$15,871
2029	$910,387	-$333,028	-$388,532	$753,461	-$357,912	$510,991	$160,930	$417,793	$1,185,123	$377,528	-$3,511,592	$318,710	$152,234	$231,318	$76,333	-$558,142	-$54,398
2030	$955,907	-$351,143	-$409,667	$794,447	-$377,382	$528,525	$166,452	$432,128	$1,220,677	$388,854	-$3,702,612	$332,846	$155,929	$238,257	$76,652	-$580,468	-$130,597
2031	$1,003,702	-$370,238	-$431,944	$837,647	-$397,903	$546,651	$172,161	$446,948	$1,257,297	$400,519	-$3,903,955	$347,604	$159,711	$245,405	$76,972	-$603,687	-$213,110
2032	$1,053,887	-$390,364	-$455,425	$883,182	-$419,533	$565,388	$178,062	$462,269	$1,295,016	$412,535	-$4,116,176	$363,009	$163,581	$252,767	$77,292	-$627,834	-$302,345
2033	$1,106,582	-$411,578	-$480,174	$931,177	-$442,332	$584,758	$184,162	$478,106	$1,333,866	$424,911	-$4,339,859	$379,091	$167,543	$260,350	$77,611	-$652,948	-$398,734
2034	$1,161,911	-$433,937	-$506,259	$981,762	-$466,361	$604,782	$190,468	$494,477	$1,373,882	$437,658	-$4,575,620	$395,878	$171,598	$268,161	$77,931	-$679,066	-$502,735
2035	$1,220,006	-$457,502	-$533,753	$1,035,079	-$491,688	$625,480	$196,987	$511,401	$1,415,099	$540,946	-$4,824,108	$413,402	$175,748	$276,206	$78,251	-$706,228	-$524,675
2036	$1,281,006	-$480,377	-$560,440	$1,086,833	-$516,272	$644,245	$202,897	$526,743	$1,457,552	$557,174	-$5,065,313	$429,938	$179,263	$284,492	$78,251	-$734,477	-$628,486
2037	$1,345,057	-$504,396	-$588,462	$1,141,174	-$542,086	$663,572	$208,984	$542,545	$1,501,278	$573,889	-$5,318,579	$447,136	$182,848	$293,027	$78,251	-$763,856	-$739,619
2038	$1,412,310	-$529,616	-$617,885	$1,198,233	-$569,190	$683,479	$215,253	$558,821	$1,546,317	$591,106	-$5,584,508	$465,021	$186,505	$301,817	$78,251	-$794,411	-$858,497
2039	$1,482,925	-$556,097	-$648,780	$1,258,145	-$597,650	$703,984	$221,711	$575,586	$1,592,706	$608,839	-$5,863,733	$483,622	$190,235	$310,872	$78,251	-$826,187	-$985,572
2040	$1,557,071	-$583,902	-$681,219	$1,321,052	-$627,532	$725,103	$228,362	$592,853	$1,640,487	$627,104	-$6,156,920	$502,967	$194,040	$320,198	$78,251	-$859,235	-$1,121,321
2041	$1,634,925	-$613,097	-$715,280	$1,387,105	-$658,909	$746,856	$235,213	$610,639	$1,689,702	$645,917	-$6,464,765	$523,085	$197,920	$329,804	$78,251	-$893,604	-$1,266,238
2042	$1,716,671	-$643,752	-$751,044	$1,456,460	-$691,854	$769,262	$242,269	$628,958	$1,740,393	$665,295	-$6,788,004	$544,009	$201,879	$339,698	$78,251	-$929,348	-$1,420,858
2043	$1,802,505	-$675,939	-$788,596	$1,529,283	-$726,447	$792,340	$249,537	$647,827	$1,792,605	$685,253	-$7,127,404	$565,769	$205,916	$349,889	$78,251	-$966,522	-$1,585,733
2044	$1,892,630	-$709,736	-$828,026	$1,605,747	-$762,769	$816,110	$257,024	$667,262	$1,846,383	$705,811	-$7,483,774	$588,400	$210,035	$360,386	$78,251	-$1,005,183	-$1,761,450
2045	$1,987,261	-$745,223	-$869,427	$1,686,034	-$800,908	$840,593	$264,734	$687,280	$1,901,774	$726,986	-$7,857,963	$611,936	$214,235	$371,197	$78,251	-$1,045,390	-$1,948,630
2046	$2,086,624	-$782,484	-$912,898	$1,770,336	-$840,953	$865,811	$272,676	$707,898	$1,958,828	$748,795	-$8,250,861	$636,413	$218,520	$382,333	$78,251	-$1,087,206	-$2,147,917
2047	$2,190,956	-$821,608	-$958,543	$1,858,853	-$883,001	$891,785	$280,856	$729,135	$2,017,593	$771,259	-$8,663,404	$661,870	$222,891	$393,803	$78,251	-$1,130,694	-$2,359,999
2048	$2,300,504	-$862,689	-$1,006,470	$1,951,795	-$927,151	$918,539	$289,282	$751,009	$2,078,120	$794,397	-$9,096,574	$688,345	$227,348	$405,617	$78,251	-$1,175,922	-$2,585,600
2049	$2,415,529	-$905,823	-$1,056,794	$2,049,385	-$973,508	$946,095	$297,960	$773,539	$2,140,464	$818,229	-$9,551,403	$715,878	$231,895	$417,786	$78,251	-$1,222,959	-$2,825,476
2050	$2,536,305	-$951,114	-$1,109,633	$2,151,855	-$1,022,184	$974,478	$306,899	$796,745	$2,204,678	$842,775	-$10,028,973	$744,513	$236,533	$430,319	$78,251	-$1,271,877	-$3,080,431
2051	$2,663,120	-$998,670	-$1,165,115	$2,259,447	-$1,073,293	$1,003,712	$316,106	$820,648	$2,270,818	$868,058	-$10,530,422	$774,294	$241,264	$443,229	$78,251	-$1,322,752	-$3,351,305
2052	$2,796,276	-$1,048,604	-$1,223,371	$2,372,420	-$1,126,958	$1,033,824	$325,589	$845,267	$2,338,943	$894,101	-$11,056,943	$805,266	$246,089	$456,526	$78,251	-$1,375,662	-$3,638,986
2053	$2,936,090	-$1,101,034	-$1,284,539	$2,491,041	-$1,183,306	$1,064,838	$335,357	$870,625	$2,409,111	$920,924	-$11,609,790	$837,476	$251,011	$470,222	$78,251	-$1,430,689	-$3,944,412
2054	$3,082,895	-$1,156,086	-$1,348,766	$2,615,593	-$1,242,471	$1,096,783	$345,418	$896,744	$2,481,384	$948,552	-$12,190,280	$870,975	$256,031	$484,328	$78,251	-$1,487,916	-$4,268,566
2055	$3,237,039	-$1,213,890	-$1,416,205	$2,746,372	-$1,304,594	$1,129,687	$355,780	$923,646	$2,555,826	$977,008	-$12,799,793	$905,815	$261,152	$498,858	$78,251	-$1,547,433	-$4,612,481

Alternative 11—Composting (Annual O&M Quantities)

Year	Total Thickened Solids Load (dry tons/day)	Total Plant-wide Building Heat NG (MBtu/year)	Electricity Consumed in Solids Process (Kw-hr/year)	Wood Amendment (cy/year)	Polymer (lbs/year)	Operations Labor (hours/year)	Compost Sales (cy/year)
2015	46.8	109,748	8,116,859	21,906	136,753	30,784	74,875
2016	47.0	109,748	8,152,967	22,003	137,362	30,784	75,208
2017	47.3	109,748	8,189,074	22,101	137,970	30,784	75,541
2018	47.5	109,748	8,225,181	22,198	138,578	30,784	75,874
2019	47.7	109,748	8,261,288	22,296	139,187	30,784	76,207
2020	47.9	109,748	8,297,395	22,393	139,795	30,784	76,540
2021	48.1	109,748	8,333,502	22,491	140,403	30,784	76,873
2022	48.3	109,748	8,369,609	22,588	141,012	30,784	77,206
2023	48.5	109,748	8,405,716	22,685	141,620	30,784	77,539
2024	48.7	109,748	8,441,823	22,783	142,228	30,784	77,872
2025	48.9	109,748	8,477,930	22,880	142,837	30,784	78,205
2026	49.1	109,748	8,514,037	22,978	143,445	30,784	78,538
2027	49.3	109,748	8,550,144	23,075	144,053	30,784	78,871
2028	49.5	109,748	8,586,251	23,173	144,662	30,784	79,205
2029	49.8	109,748	8,622,358	23,270	145,270	30,784	79,538
2030	50.0	109,748	8,658,465	23,368	145,878	30,784	79,871
2031	50.2	109,748	8,694,572	23,465	146,487	30,784	80,204
2032	50.4	109,748	8,730,679	23,563	147,095	30,784	80,537
2033	50.6	109,748	8,766,786	23,660	147,703	30,784	80,870
2034	50.8	109,748	8,802,893	23,757	148,312	30,784	81,203
2035	51.0	109,748	8,839,000	23,855	148,920	30,784	81,536
2036	51.0	109,748	8,839,000	23,855	148,920	30,784	81,536
2037	51.0	109,748	8,839,000	23,855	148,920	30,784	81,536
2038	51.0	109,748	8,839,000	23,855	148,920	30,784	81,536
2039	51.0	109,748	8,839,000	23,855	148,920	30,784	81,536
2040	51.0	109,748	8,839,000	23,855	148,920	30,784	81,536
2041	51.0	109,748	8,839,000	23,855	148,920	30,784	81,536
2042	51.0	109,748	8,839,000	23,855	148,920	30,784	81,536
2043	51.0	109,748	8,839,000	23,855	148,920	30,784	81,536
2044	51.0	109,748	8,839,000	23,855	148,920	30,784	81,536
2045	51.0	109,748	8,839,000	23,855	148,920	30,784	81,536
2046	51.0	109,748	8,839,000	23,855	148,920	30,784	81,536
2047	51.0	109,748	8,839,000	23,855	148,920	30,784	81,536
2048	51.0	109,748	8,839,000	23,855	148,920	30,784	81,536
2049	51.0	109,748	8,839,000	23,855	148,920	30,784	81,536
2050	51.0	109,749	8,839,000	23,855	148,920	30,785	81,536
2051	51.0	109,750	8,839,000	23,855	148,920	30,786	81,536
2052	51.0	109,751	8,839,000	23,855	148,920	30,787	81,536
2053	51.0	109,752	8,839,000	23,855	148,920	30,788	81,536
2054	51.0	109,753	8,839,000	23,855	148,920	30,789	81,536
2055	51.0	109,754	8,839,000	23,855	148,920	30,790	81,536

Alternative 11—Conventional Composting (Annual O&M Costs)

Year	Plantwide Heating Natural Gas ($/year)	Electricity Consumed in Solids Process ($/year)	Polymer ($/year)	Cost of Wood Amendment ($/year)	Operations Labor ($/year)	Maintenance ($/year)	Compost Sales ($/year)	Odor Control ($/year)	Total O&M ($/year)
2015	$832,375	$738,740	$312,454	$237,550	$1,346,128	$262,727	-$859,534	$658,755	$3,529,195
2016	$882,317	$786,548	$323,259	$250,537	$1,386,512	$270,608	-$897,892	$678,518	$3,680,407
2017	$935,256	$837,433	$334,431	$264,229	$1,428,107	$278,727	-$937,943	$698,873	$3,839,113
2018	$991,372	$891,593	$345,983	$278,663	$1,470,951	$287,089	-$979,762	$719,840	$4,005,729
2019	$1,050,854	$949,237	$357,927	$293,881	$1,515,079	$295,701	-$1,023,426	$741,435	$4,180,688
2020	$1,113,905	$1,010,589	$370,276	$309,924	$1,560,532	$304,572	-$1,069,015	$763,678	$4,364,461
2021	$1,180,739	$1,075,886	$383,044	$326,836	$1,607,348	$313,709	-$1,116,613	$786,588	$4,557,537
2022	$1,251,584	$1,145,380	$396,245	$344,665	$1,655,568	$323,121	-$1,166,309	$810,186	$4,760,440
2023	$1,326,679	$1,219,341	$409,893	$363,459	$1,705,235	$332,814	-$1,218,194	$834,491	$4,973,718
2024	$1,406,280	$1,298,053	$424,003	$383,271	$1,756,392	$342,799	-$1,272,364	$859,526	$5,197,960
2025	$1,490,656	$1,381,822	$438,591	$404,156	$1,809,084	$353,083	-$1,328,919	$885,312	$5,433,785
2026	$1,580,096	$1,470,969	$453,673	$426,171	$1,863,356	$363,675	-$1,387,961	$911,871	$5,681,850
2027	$1,674,902	$1,565,840	$469,264	$449,378	$1,919,257	$374,585	-$1,449,602	$939,227	$5,942,851
2028	$1,775,396	$1,666,799	$485,384	$473,839	$1,976,835	$385,823	-$1,513,952	$967,404	$6,217,528
2029	$1,881,919	$1,774,237	$502,047	$499,623	$2,036,140	$397,398	-$1,581,131	$996,426	$6,506,659
2030	$1,994,835	$1,888,567	$519,274	$526,801	$2,097,224	$409,320	-$1,651,263	$1,026,319	$6,811,077
2031	$2,114,525	$2,010,229	$537,083	$555,448	$2,160,141	$421,599	-$1,724,475	$1,057,109	$7,131,659
2032	$2,241,396	$2,139,692	$555,493	$585,643	$2,224,945	$434,247	-$1,800,901	$1,088,822	$7,469,337
2033	$2,375,880	$2,277,453	$574,524	$617,468	$2,291,693	$447,275	-$1,880,683	$1,121,487	$7,825,097
2034	$2,518,433	$2,424,043	$594,197	$651,012	$2,360,444	$460,693	-$1,963,966	$1,155,131	$8,199,987
2035	$2,669,539	$2,580,025	$614,533	$686,366	$2,431,257	$569,417	-$2,050,903	$1,189,785	$8,690,019
2036	$2,829,711	$2,734,827	$632,969	$720,684	$2,504,195	$586,499	-$2,132,939	$1,225,479	$9,101,425
2037	$2,999,494	$2,898,916	$651,958	$756,718	$2,579,321	$604,094	-$2,218,257	$1,262,243	$9,534,487
2038	$3,179,463	$3,072,851	$671,517	$794,554	$2,656,701	$622,217	-$2,306,987	$1,300,110	$9,990,426
2039	$3,370,231	$3,257,222	$691,662	$834,282	$2,736,402	$640,883	-$2,399,266	$1,339,114	$10,470,530
2040	$3,572,445	$3,452,656	$712,412	$875,996	$2,818,494	$660,110	-$2,495,237	$1,379,287	$10,976,163
2041	$3,786,791	$3,659,815	$733,785	$919,796	$2,903,048	$679,913	-$2,595,046	$1,420,666	$11,508,768
2042	$4,013,999	$3,879,404	$755,798	$965,786	$2,990,140	$700,311	-$2,698,848	$1,463,286	$12,069,876
2043	$4,254,839	$4,112,168	$778,472	$1,014,075	$3,079,844	$721,319	-$2,806,802	$1,507,184	$12,661,099
2044	$4,510,129	$4,358,898	$801,826	$1,064,779	$3,172,239	$742,959	-$2,919,074	$1,552,400	$13,284,156
2045	$4,780,737	$4,620,432	$825,881	$1,118,018	$3,267,407	$765,248	-$3,035,837	$1,598,972	$13,940,858
2046	$5,067,581	$4,897,658	$850,657	$1,173,919	$3,365,429	$788,206	-$3,157,271	$1,646,941	$14,633,120
2047	$5,371,636	$5,191,518	$876,177	$1,232,614	$3,466,392	$811,851	-$3,283,562	$1,696,349	$15,362,975
2048	$5,693,934	$5,503,009	$902,462	$1,294,245	$3,570,383	$836,207	-$3,414,904	$1,747,240	$16,132,576
2049	$6,035,570	$5,833,189	$929,536	$1,358,957	$3,677,495	$861,294	-$3,551,500	$1,799,657	$16,944,198
2050	$6,397,763	$6,183,181	$957,422	$1,426,905	$3,787,943	$887,132	-$3,693,560	$1,853,646	$17,800,432
2051	$6,781,690	$6,554,172	$986,145	$1,498,251	$3,901,708	$913,746	-$3,841,303	$1,909,256	$18,703,665
2052	$7,188,657	$6,947,422	$1,015,729	$1,573,163	$4,018,890	$941,159	-$3,994,955	$1,966,533	$19,656,598
2053	$7,620,046	$7,364,267	$1,046,201	$1,651,821	$4,139,591	$969,394	-$4,154,753	$2,025,530	$20,662,097
2054	$8,077,322	$7,806,123	$1,077,587	$1,734,412	$4,263,917	$998,475	-$4,320,943	$2,086,295	$21,723,188
2055	$8,562,040	$8,274,491	$1,109,915	$1,821,133	$4,391,977	$1,028,429	-$4,493,781	$2,148,884	$22,843,088

Alternative 14—Incineration with Drying (Annual O&M Quantities)

Year	Total Thickened Solids Load (dry tons/day)	Total Plantwide Building Heat Required NG (MBtu/year)	RTO Natural Gas Demand (Mbtu/year)	Electricity Consumed in Solids Process (kWh/year)	Polymer (lb/year)	Operations Labor (hr/year)	Ash Disposal (wet tons/year)	Pellet Sales (wet tons/year)
2015	46.8	69,120	3,313	8,911,190	136,753	18,732	1,966	7,597
2016	47.0	69,120	3,328	8,950,830	137,362	18,732	1,975	7,631
2017	47.3	69,120	3,343	8,990,471	137,970	18,732	1,983	7,665
2018	47.5	69,120	3,358	9,030,111	138,578	18,732	1,992	7,699
2019	47.7	69,120	3,372	9,069,752	139,187	18,732	2,001	7,733
2020	47.9	69,120	3,387	9,109,392	139,795	18,732	2,010	7,766
2021	48.1	69,120	3,402	9,149,033	140,403	18,732	2,018	7,800
2022	48.3	69,120	3,417	9,188,673	141,012	18,732	2,027	7,834
2023	48.5	69,120	3,431	9,228,314	141,620	18,732	2,036	7,868
2024	48.7	69,120	3,446	9,267,954	142,228	18,732	2,045	7,902
2025	48.9	69,120	3,461	9,307,595	142,837	18,732	2,053	7,935
2026	49.1	69,120	3,476	9,347,235	143,445	18,732	2,062	7,969
2027	49.3	69,120	3,490	9,386,876	144,053	18,732	2,071	8,003
2028	49.5	69,120	3,505	9,426,516	144,662	18,732	2,080	8,037
2029	49.8	69,120	3,520	9,466,157	145,270	18,732	2,088	8,071
2030	50.0	69,120	3,534	9,505,797	145,878	18,732	2,097	8,104
2031	50.2	69,120	3,549	9,545,438	146,487	18,732	2,106	8,138
2032	50.4	69,120	3,564	9,585,078	147,095	18,732	2,114	8,172
2033	50.6	69,120	3,579	9,624,719	147,703	18,732	2,123	8,206
2034	50.8	69,120	3,593	9,664,359	148,312	18,732	2,132	8,240
2035	51.0	69,120	3,608	9,704,000	148,920	18,732	2,141	8,273
2036	51.0	69,120	3,608	9,704,000	148,920	18,732	2,141	8,273
2037	51.0	69,120	3,608	9,704,000	148,920	18,732	2,141	8,273
2038	51.0	69,120	3,608	9,704,000	148,920	18,732	2,141	8,273
2039	51.0	69,120	3,608	9,704,000	148,920	18,732	2,141	8,273
2040	51.0	69,120	3,608	9,704,000	148,920	18,732	2,141	8,273
2041	51.0	69,120	3,608	9,704,000	148,920	18,732	2,141	8,273
2042	51.0	69,120	3,608	9,704,000	148,920	18,732	2,141	8,273
2043	51.0	69,120	3,608	9,704,000	148,920	18,732	2,141	8,273
2044	51.0	69,120	3,608	9,704,000	148,920	18,732	2,141	8,273
2045	51.0	69,120	3,608	9,704,000	148,920	18,732	2,141	8,273
2046	51.0	69,120	3,608	9,704,000	148,920	18,732	2,141	8,273
2047	51.0	69,120	3,608	9,704,000	148,920	18,732	2,141	8,273
2048	51.0	69,120	3,608	9,704,000	148,920	18,732	2,141	8,273
2049	51.0	69,120	3,608	9,704,000	148,920	18,732	2,141	8,273
2050	51.0	69,120	3,608	9,704,000	148,920	18,732	2,141	8,273
2051	51.0	69,120	3,608	9,704,000	148,920	18,732	2,141	8,273
2052	51.0	69,120	3,608	9,704,000	148,920	18,732	2,141	8,273
2053	51.0	69,120	3,608	9,704,000	148,920	18,732	2,141	8,273
2054	51.0	69,120	3,608	9,704,000	148,920	18,732	2,141	8,273
2055	51.0	69,120	3,608	9,704,000	148,920	18,732	2,141	8,273

Alternative 14—Incineration with Drying (Annual O&M Costs)

Year	Plantwide Heating Required Natural Gas ($/year)	Dryer RTO Natural Gas Demand ($/year)	Electricity Consumed in Solids Process ($/year)	Polymer ($/year)	Operations Labor ($/year)	Maintenance ($/year)	Ash Disposal ($/year)	Pellet Sales ($/year)	Sand & Chemicals for FBI ($/year)	Air Pollution Control ($/year)	Total O&M ($/year)
2015	$459,807	$22,042	$711,360	$298,870	$783,506	$185,045	$101,615	-$530,673	$152,928	$78,000	$2,262,500
2016	$482,798	$23,247	$750,250	$309,205	$807,011	$190,596	$106,150	-$559,685	$157,516	$78,347	$2,345,435
2017	$506,938	$24,517	$791,252	$319,892	$831,221	$196,314	$110,885	-$590,272	$162,242	$78,694	$2,431,683
2018	$532,285	$25,857	$834,477	$330,942	$856,158	$202,204	$115,829	-$622,519	$167,109	$79,041	$2,521,383
2019	$558,899	$27,269	$880,048	$342,366	$881,843	$208,270	$120,991	-$656,514	$172,122	$79,388	$2,614,682
2020	$586,844	$28,757	$928,089	$354,178	$908,298	$214,518	$126,380	-$692,352	$177,286	$79,735	$2,711,733
2021	$616,186	$30,327	$978,734	$366,391	$935,547	$220,953	$132,007	-$730,134	$182,604	$80,082	$2,812,697
2022	$646,995	$31,981	$1,032,123	$379,018	$963,613	$227,582	$137,882	-$769,962	$188,083	$80,429	$2,917,744
2023	$679,345	$33,725	$1,088,404	$392,073	$992,522	$234,409	$144,016	-$811,948	$193,725	$80,776	$3,027,047
2024	$713,312	$35,563	$1,147,734	$405,570	$1,022,297	$241,442	$150,420	-$856,207	$199,537	$81,123	$3,140,791
2025	$748,978	$37,501	$1,210,275	$419,524	$1,052,966	$248,685	$157,106	-$902,863	$205,523	$81,470	$3,259,165
2026	$786,427	$39,544	$1,276,201	$433,950	$1,084,555	$256,146	$164,086	-$952,044	$211,689	$81,817	$3,382,370
2027	$825,748	$41,697	$1,345,694	$448,864	$1,117,092	$263,830	$171,374	-$1,003,885	$218,039	$82,164	$3,510,617
2028	$867,036	$43,967	$1,418,945	$464,282	$1,150,605	$271,745	$178,981	-$1,058,531	$224,580	$82,511	$3,644,121
2029	$910,387	$46,359	$1,496,158	$480,221	$1,185,123	$279,897	$186,923	-$1,116,131	$231,318	$82,858	$3,783,113
2030	$955,907	$48,881	$1,577,544	$496,699	$1,220,677	$288,294	$195,214	-$1,176,845	$238,257	$83,205	$3,927,833
2031	$1,003,702	$51,539	$1,663,329	$513,734	$1,257,297	$296,943	$203,869	-$1,240,841	$245,405	$83,552	$4,078,528
2032	$1,053,887	$54,341	$1,753,748	$531,343	$1,295,016	$305,851	$212,905	-$1,308,293	$252,767	$83,899	$4,235,464
2033	$1,106,582	$57,294	$1,849,051	$549,547	$1,333,866	$315,027	$222,337	-$1,379,389	$260,350	$84,246	$4,398,910
2034	$1,161,911	$60,406	$1,949,500	$568,365	$1,373,882	$324,478	$232,182	-$1,454,324	$268,161	$84,593	$4,569,153
2035	$1,220,006	$63,687	$2,055,371	$587,817	$1,415,099	$401,054	$242,460	-$1,533,303	$276,206	$84,940	$4,813,337
2036	$1,281,006	$66,871	$2,158,140	$605,451	$1,457,552	$413,086	$252,159	-$1,609,969	$284,492	$84,940	$4,993,727
2037	$1,345,057	$70,214	$2,266,047	$623,615	$1,501,278	$425,478	$262,245	-$1,690,467	$293,027	$84,940	$5,181,434
2038	$1,412,310	$73,725	$2,379,349	$642,323	$1,546,317	$438,243	$272,735	-$1,774,990	$301,817	$84,940	$5,376,769
2039	$1,482,925	$77,411	$2,498,317	$661,593	$1,592,706	$451,390	$283,644	-$1,863,740	$310,872	$84,940	$5,580,058
2040	$1,557,071	$81,282	$2,623,233	$681,441	$1,640,487	$464,932	$294,990	-$1,956,927	$320,198	$84,940	$5,791,646
2041	$1,634,925	$85,346	$2,754,394	$701,884	$1,689,702	$478,880	$306,790	-$2,054,773	$329,804	$84,940	$6,011,892
2042	$1,716,671	$89,613	$2,892,114	$722,940	$1,740,393	$493,247	$319,061	-$2,157,512	$339,698	$84,940	$6,241,164
2043	$1,802,505	$94,094	$3,036,720	$744,629	$1,792,605	$508,044	$331,824	-$2,265,387	$349,889	$84,940	$6,479,862
2044	$1,892,630	$98,799	$3,188,556	$766,967	$1,846,383	$523,285	$345,096	-$2,378,657	$360,386	$84,940	$6,728,384
2045	$1,987,261	$103,739	$3,347,983	$789,977	$1,901,774	$538,984	$358,900	-$2,497,590	$371,197	$84,940	$6,987,164
2046	$2,086,624	$108,926	$3,515,383	$813,676	$1,958,828	$555,153	$373,256	-$2,622,469	$382,333	$84,940	$7,256,650
2047	$2,190,956	$114,372	$3,691,152	$838,086	$2,017,593	$571,807	$388,187	-$2,753,593	$393,803	$84,940	$7,537,303
2048	$2,300,504	$120,091	$3,875,709	$863,229	$2,078,120	$588,962	$403,714	-$2,891,272	$405,617	$84,940	$7,829,613
2049	$2,415,529	$126,095	$4,069,495	$889,126	$2,140,464	$606,631	$419,863	-$3,035,836	$417,786	$84,940	$8,134,093
2050	$2,536,305	$132,400	$4,272,970	$915,799	$2,204,678	$624,829	$436,657	-$3,187,628	$430,319	$84,940	$8,451,269
2051	$2,663,120	$139,020	$4,486,618	$943,273	$2,270,818	$643,574	$454,123	-$3,347,009	$443,229	$84,940	$8,781,706
2052	$2,796,276	$145,971	$4,710,949	$971,571	$2,338,943	$662,882	$472,288	-$3,514,360	$456,526	$84,940	$9,125,986
2053	$2,936,090	$153,269	$4,946,496	$1,000,719	$2,409,111	$682,769	$491,180	-$3,690,077	$470,222	$84,940	$9,484,718
2054	$3,082,895	$160,933	$5,193,821	$1,030,740	$2,481,384	$703,251	$510,827	-$3,874,581	$484,328	$84,940	$9,858,538
2055	$3,237,039	$168,980	$5,453,512	$1,061,662	$2,555,826	$724,349	$531,260	-$4,068,310	$498,858	$84,940	$10,248,115

Alternative 16—Rehabilitate Multiple Hearth Furnaces (Annual O&M Quantities)

Year	Total Thickened Solids Load (dry tons/day)	Total Plantwide Building Heating Required (MBtu/year)	Energy Recovered from Incinerator WHB Energy for Plantwide Building Heat (MBTU/year)	RTO Natural Gas Demand (Mbtu/year)	Electricity Consumed in Solids Process (kWh/year)	Polymer (lb/year)	Operations Labor (hours/year)	Ash and CakeDisposal (wet tons/year)
2015	46.8	69,120	58,712	60,244	9,154,486	136,753	20,732	7,205
2016	47.0	69,120	58,974	60,512	9,195,209	137,362	20,732	7,287
2017	47.3	69,120	59,235	60,780	9,235,932	137,970	20,732	7,369
2018	47.5	69,120	59,496	61,048	9,276,654	138,578	20,732	7,451
2019	47.7	69,120	59,757	61,316	9,317,377	139,187	20,732	7,533
2020	47.9	69,120	60,018	61,584	9,358,100	139,795	20,732	7,615
2021	48.1	69,120	60,280	61,852	9,398,823	140,403	20,732	7,697
2022	48.3	69,120	60,541	62,120	9,439,546	141,012	20,732	7,779
2023	48.5	69,120	60,802	62,388	9,480,268	141,620	20,732	7,860
2024	48.7	69,120	61,063	62,656	9,520,991	142,228	20,732	7,942
2025	48.9	69,120	61,324	62,924	9,561,714	142,837	20,732	8,024
2026	49.1	69,120	61,585	63,192	9,602,437	143,445	20,732	8,106
2027	49.3	69,120	61,847	63,460	9,643,160	144,053	20,732	8,188
2028	49.5	69,120	62,108	63,728	9,683,882	144,662	20,732	8,270
2029	49.8	69,120	62,369	63,996	9,724,605	145,270	20,732	8,352
2030	50.0	69,120	62,630	64,264	9,765,328	145,878	20,732	8,434
2031	50.2	69,120	62,891	64,532	9,806,051	146,487	20,732	8,516
2032	50.4	69,120	63,152	64,800	9,846,774	147,095	20,732	8,597
2033	50.6	69,120	63,414	65,068	9,887,496	147,703	20,732	8,679
2034	50.8	69,120	63,675	65,336	9,928,219	148,312	20,732	8,761
2035	51.0	69,120	63,936	65,604	9,968,942	148,920	20,732	8,843
2036	51.0	69,120	63,936	65,604	9,968,942	148,920	20,732	8,843
2037	51.0	69,120	63,936	65,604	9,968,942	148,920	20,732	8,843
2038	51.0	69,120	63,936	65,604	9,968,942	148,920	20,732	8,843
2039	51.0	69,120	63,936	65,604	9,968,942	148,920	20,732	8,843
2040	51.0	69,120	63,936	65,604	9,968,942	148,920	20,732	8,843
2041	51.0	69,120	63,936	65,604	9,968,942	148,920	20,732	8,843
2042	51.0	69,120	63,936	65,604	9,968,942	148,920	20,732	8,843
2043	51.0	69,120	63,936	65,604	9,968,942	148,920	20,732	8,843
2044	51.0	69,120	63,936	65,604	9,968,942	148,920	20,732	8,843
2045	51.0	69,120	63,936	65,604	9,968,942	148,920	20,732	8,843
2046	51.0	69,120	63,936	65,604	9,968,942	148,920	20,732	8,843
2047	51.0	69,120	63,936	65,604	9,968,942	148,920	20,732	8,843
2048	51.0	69,120	63,936	65,604	9,968,942	148,920	20,732	8,843
2049	51.0	69,120	63,936	65,604	9,968,942	148,920	20,732	8,843
2050	51.0	69,120	63,936	65,604	9,968,942	148,920	20,732	8,843
2051	51.0	69,120	63,936	65,604	9,968,942	148,920	20,732	8,843
2052	51.0	69,120	63,936	65,604	9,968,942	148,920	20,732	8,843
2053	51.0	69,120	63,936	65,604	9,968,942	148,920	20,732	8,843
2054	51.0	69,120	63,936	65,604	9,968,942	148,920	20,732	8,843
2055	51.0	69,120	63,936	65,604	9,968,942	148,920	20,732	8,843

Alternative 16—Rehabilitate Multiple Hearth Furnaces (Annual O&M Costs)

Year	Plantwide Heating Required Natural Gas ($/year)	Energy Recovered from Incinerator WHB for Plantwide Building Heat ($/year)	RTO Natural Gas Demand ($/year)	Electricity Consumed in Solids Process ($/year)	Polymer ($/year)	Operations Labor ($/year)	Maintenance ($/year)	Ash and Cake Disposal ($/year)	Air Pollution Control ($/year)	Total O&M ($/year)
2015	$459,807	-$390,573	$400,760	$730,781	$298,870	$867,160	$262,727	$558,687	$130,000	$3,318,219
2016	$482,798	-$411,926	$422,670	$770,734	$309,205	$893,175	$270,608	$587,636	$130,578	$3,455,478
2017	$506,938	-$434,438	$445,769	$812,855	$319,892	$919,970	$278,727	$618,008	$131,157	$3,598,877
2018	$532,285	-$458,171	$470,121	$857,261	$330,942	$947,569	$287,089	$649,869	$131,735	$3,748,700
2019	$558,899	-$483,192	$495,794	$904,075	$342,366	$975,996	$295,701	$683,291	$132,313	$3,905,243
2020	$586,844	-$509,569	$522,859	$953,428	$354,178	$1,005,276	$304,572	$718,346	$132,891	$4,068,825
2021	$616,186	-$537,376	$551,391	$1,005,455	$366,391	$1,035,435	$313,709	$755,112	$133,470	$4,239,773
2022	$646,995	-$566,689	$581,469	$1,060,302	$379,018	$1,066,498	$323,121	$793,671	$134,048	$4,418,433
2023	$679,345	-$597,591	$613,176	$1,118,120	$392,073	$1,098,493	$332,814	$834,105	$134,626	$4,605,161
2024	$713,312	-$630,165	$646,601	$1,179,069	$405,570	$1,131,447	$342,799	$876,506	$135,205	$4,800,343
2025	$748,978	-$664,504	$681,835	$1,243,318	$419,524	$1,165,391	$353,083	$920,963	$135,783	$5,004,370
2026	$786,427	-$700,701	$718,976	$1,311,044	$433,950	$1,200,352	$363,675	$967,574	$136,361	$5,217,658
2027	$825,748	-$738,856	$758,126	$1,382,434	$448,864	$1,236,363	$374,585	$1,016,441	$136,940	$5,440,644
2028	$867,036	-$779,075	$799,394	$1,457,686	$464,282	$1,273,454	$385,823	$1,067,669	$137,518	$5,673,787
2029	$910,387	-$821,468	$842,893	$1,537,007	$480,221	$1,311,658	$397,398	$1,121,369	$138,096	$5,917,561
2030	$955,907	-$866,154	$888,744	$1,620,615	$496,699	$1,351,007	$409,320	$1,177,656	$138,674	$6,172,468
2031	$1,003,702	-$913,254	$937,073	$1,708,742	$513,734	$1,391,537	$421,599	$1,236,653	$139,253	$6,439,038
2032	$1,053,887	-$962,899	$988,012	$1,801,630	$531,343	$1,433,284	$434,247	$1,298,484	$139,831	$6,717,819
2033	$1,106,582	-$1,015,225	$1,041,703	$1,899,535	$549,547	$1,476,282	$447,275	$1,363,284	$140,409	$7,009,392
2034	$1,161,911	-$1,070,377	$1,098,294	$2,002,726	$568,365	$1,520,571	$460,693	$1,431,191	$140,988	$7,314,361
2035	$1,220,006	-$1,128,506	$1,157,938	$2,111,488	$587,817	$1,566,188	$569,417	$1,502,348	$141,566	$7,728,261
2036	$1,281,006	-$1,184,931	$1,215,835	$2,217,062	$605,451	$1,613,173	$586,499	$1,562,442	$141,566	$8,038,102
2037	$1,345,057	-$1,244,177	$1,276,627	$2,327,915	$623,615	$1,661,569	$604,094	$1,624,940	$141,566	$8,361,205
2038	$1,412,310	-$1,306,386	$1,340,458	$2,444,311	$642,323	$1,711,416	$622,217	$1,689,938	$141,566	$8,698,152
2039	$1,482,925	-$1,371,706	$1,407,481	$2,566,527	$661,593	$1,762,758	$640,883	$1,757,535	$141,566	$9,049,562
2040	$1,557,071	-$1,440,291	$1,477,855	$2,694,853	$681,441	$1,815,641	$660,110	$1,827,836	$141,566	$9,416,081
2041	$1,634,925	-$1,512,306	$1,551,748	$2,829,596	$701,884	$1,870,110	$679,913	$1,900,950	$141,566	$9,798,386
2042	$1,716,671	-$1,587,921	$1,629,336	$2,971,076	$722,940	$1,926,213	$700,311	$1,976,988	$141,566	$10,197,180
2043	$1,802,505	-$1,667,317	$1,710,802	$3,119,629	$744,629	$1,984,000	$721,319	$2,056,067	$141,566	$10,613,200
2044	$1,892,630	-$1,750,683	$1,796,342	$3,275,611	$766,967	$2,043,520	$742,959	$2,138,310	$141,566	$11,047,222
2045	$1,987,261	-$1,838,217	$1,886,160	$3,439,391	$789,977	$2,104,825	$765,248	$2,223,842	$141,566	$11,500,053
2046	$2,086,624	-$1,930,128	$1,980,468	$3,611,361	$813,676	$2,167,970	$788,206	$2,312,796	$141,566	$11,972,538
2047	$2,190,956	-$2,026,634	$2,079,491	$3,791,929	$838,086	$2,233,009	$811,851	$2,405,307	$141,566	$12,465,561
2048	$2,300,504	-$2,127,966	$2,183,466	$3,981,525	$863,229	$2,299,999	$836,207	$2,501,520	$141,566	$12,980,050
2049	$2,415,529	-$2,234,364	$2,292,639	$4,180,602	$889,126	$2,368,999	$861,294	$2,601,581	$141,566	$13,516,971
2050	$2,536,305	-$2,346,082	$2,407,271	$4,389,632	$915,799	$2,440,069	$887,132	$2,705,643	$141,566	$14,077,335
2051	$2,663,120	-$2,463,386	$2,527,634	$4,609,113	$943,273	$2,513,272	$913,746	$2,813,870	$141,566	$14,662,207
2052	$2,796,276	-$2,586,556	$2,654,016	$4,839,569	$971,571	$2,588,670	$941,159	$2,926,424	$141,566	$15,272,694
2053	$2,936,090	-$2,715,883	$2,786,717	$5,081,547	$1,000,719	$2,666,330	$969,394	$3,043,481	$141,566	$15,909,960
2054	$3,082,895	-$2,851,678	$2,926,053	$5,335,625	$1,030,740	$2,746,320	$998,475	$3,165,221	$141,566	$16,575,217
2055	$3,237,039	-$2,994,261	$3,072,355	$5,602,406	$1,061,662	$2,828,709	$1,028,429	$3,291,830	$141,566	$17,269,734

Alternative 2—Incineration with Energy Recovery

Overview of Alternative

Primary and waste activated sludge are potential sources of renewable biomass energy as they contain approximately 10,000 BTUs per dry pound of volatile solids. Alternative 2 uses a fluidized bed incinerator to capture the renewable energy and to convert the waste activated and primary sludge into an inert ash product.

Energy is released from the solids during the thermal oxidation process. Part of the energy is then captured from the fluidized bed exhaust by a heat exchanger and waste heat boiler.

The waste heat boiler captures heat from the incineration process to produce steam to help heat the plant during the winter (November to April) and to run a steam turbine to generate renewable electricity during the summer (May to October), resulting in reduced greenhouse gas emissions.

Alternative 2 uses thermal oxidation to convert solids to ash using new state-of-the-art technology fluidized bed incinerators. The fluidized bed incineration technology would result in decreased air emissions, improved reliability, and less maintenance and operator attention as compared with the existing multiple hearth incinerators.

Under Alternative 2 the solids processing building and sludge storage tanks would be demolished. Two new sludge storage tanks and a new solids processing building

Advantages

- Generates renewable energy that can be used by the plant.
- Easy implementation—the technology is similar to the existing solids processing system.
- Air emissions are reduced in comparison to existing multiple hearth furnace incinerators.
- Reduced amounts of greenhouse gas (GHG) emissions are released due to energy capture in the waste heat boiler and reduced fuel consumption.
- Proven technology.
- Low operations and maintenance costs.
- Solids volume is reduced.
- Small footprint.
- Minimal complexity.

Disadvantages

- Limited flexibility. Only one option for processing of solids.
- Limited modularity.
- Incinerator not able to process solids from wide range of sources (e.g. industrial, food waste).
- Limited redundancy. Single incinerator relies on land filling during downtimes.
- Some GHG and other emissions are released from incinerators.
- Greater energy use and GHG emissions than Alternatives 3A and 3B.
- Ash would likely be placed in a landfill instead of beneficially reused.
- No recycling of nutrients or production of a valuable end product. Phosphorus recovery cannot be used.
- Potential for negative perception from public and regulatory agencies.

with one new exhaust stack would be installed south of the existing solids processing building. The new building would house a new fluidized bed incinerator and a new dewatering facility to dewater thickened primary solids and thickened waste activated solids to about 25 percent solids. The dewatered cake would then be fed to the incinerators. The resulting ash would be placed in a landfill unless a beneficial use is identified.

Technology Description

The operation of a multiple hearth furnace involves a two-step process that consists of drying and then combustion. In a fluidized bed incinerator, water flashes off and the biosolids burn in one process.

A fluidized bed incinerator is a cylindrical, vertically oriented, refractory-lined steel shell that contains a sand bed and fluidized air diffusers called tuyeres. Experience and hardware developed by fluidized bed incinerator manufacturers in the metallurgical and chemical industries have been applied in the combustion of biosolids. The sand bed in a fluidized bed incinerator is about 3.5 feet deep and sits on a refractory-lined grid. This grid contains tuyeres through which air is injected into the furnace at a pressure of 3 to 5 pounds per square inch gauge (psig) to fluidize the bed. The bed expands to roughly 200 percent of its at-rest volume. The temperature of the bed is controlled between 1,400° and 1,500°F. If the sludge does not have sufficient calorific content, additional energy is provided by injecting fuel into the sand bed. At 25 percent solids, the incinerator will be able to operate autogenously (without additional natural gas).

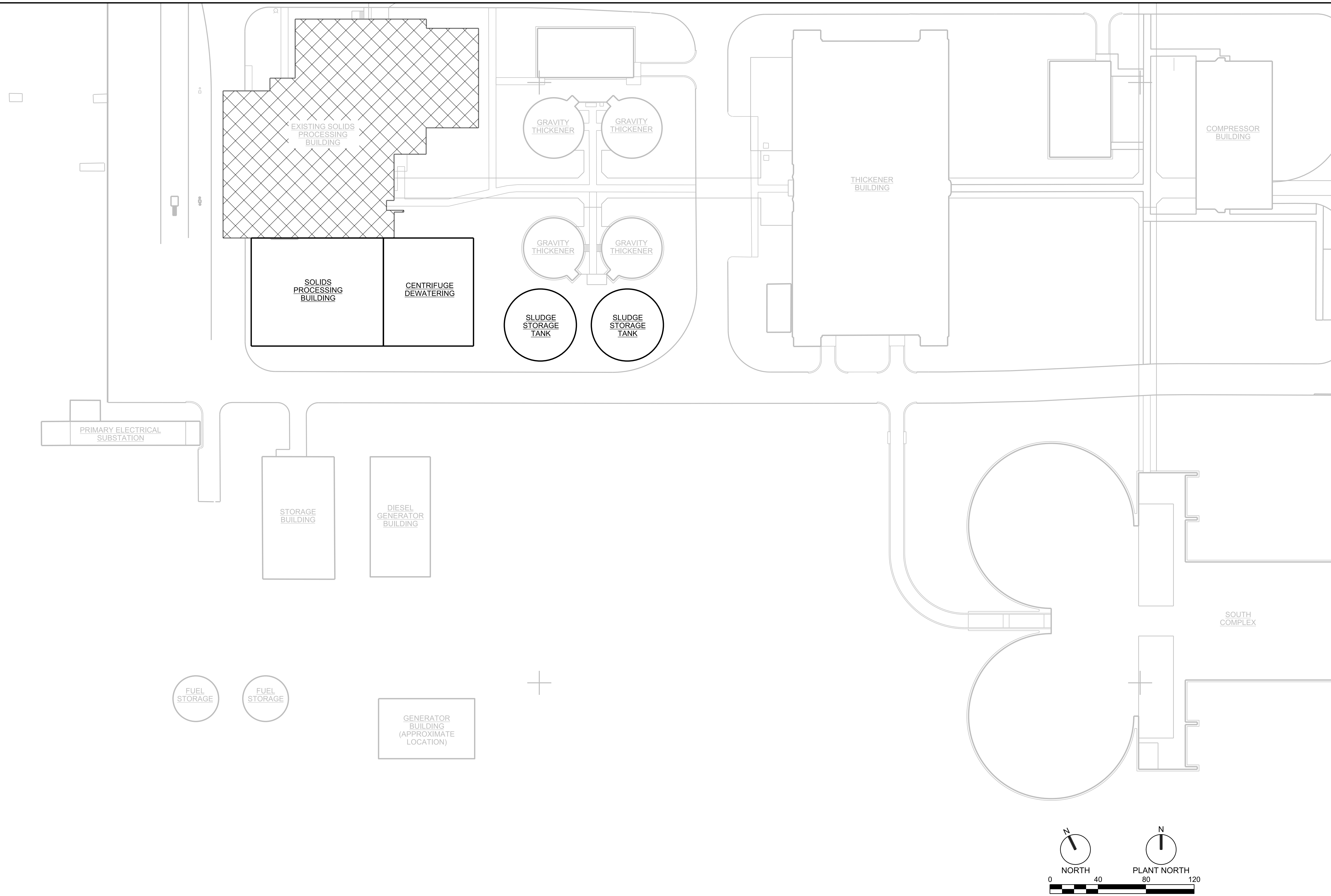
The reaction section of the incinerator is a single chamber unit in which both drying and combustion occur in a fluidized sand bed and freeboard. The residence time within the freeboard zone typically is about 7 seconds at 1,500° to 1,600°F. Ash is carried out the top of the furnace and is removed by an air pollution control device (venturi/impingement tray scrubbers). Sand carried out with the ash must be replaced. Sand losses typically are 5 percent of the bed volume for every 300 hours of operation. Feed to the furnace is introduced either above or directly into the bed.

Airflow in the furnace is determined by several factors. Fluidizing and combustion air must be sufficient to expand the bed to a proper density yet low enough to prevent the biosolids from rising to and floating on top of the bed. Too much air blows sand and products of incomplete combustion into the offgases. This depletes the stored heat energy and increases fuel consumption unnecessarily. Minimum oxygen requirements must be met to ensure complete oxidation of all combustible biosolids. Temperatures must be sufficiently high to ensure complete combustion, but low enough to protect the refractory, and heat exchanger, and flue gas ducting, and to prevent slag formation.

The quantity of excess air is maintained in the range of 20 to 45 percent of the quantity required for combustion to minimize fuel cost. Fluidized bed incinerators operate at much lower excess air rates than typical multiple hearth furnace operations. This results in a greater heat efficiency of the fluidized bed system at similar exit temperatures. Alternative 2 also uses a hot windbox design in which the fluidizing air passes through a heat exchanger before injection into the combustion chamber. This arrangement increases the thermal efficiency of the process by using the exhaust gases to preheat the incoming combustion air.

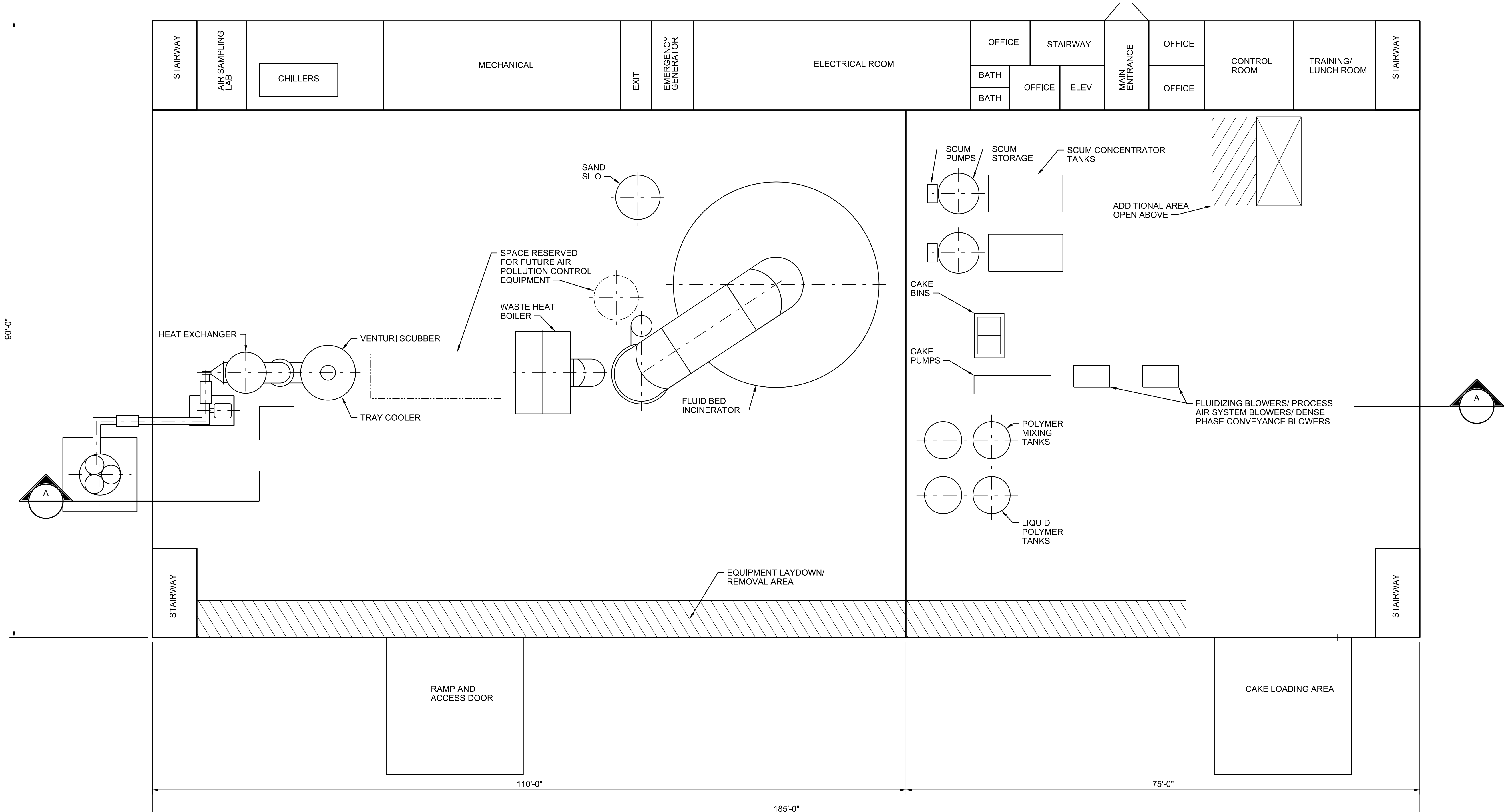
Mixing in the fluidized bed ensures rapid and uniform distribution of fuel and air and consequently good heat transfer and combustion. The bed provides substantial heat capacity, which helps to reduce short-term temperature fluctuations that may result from varying feed heating values. This heat storage capacity also enables quicker startup, if the shutdown period has been short. Organic particles remain in the sand bed until they are reduced to mineral ash. The mixing of the bed comminutes the ash material, eliminating the buildup of clinkers. The resulting fine ash is constantly stripped from the bed by the upflowing gases.

The fluidized bed incinerator is relatively simple to operate, has a minimum of mechanical components, and typically has a slightly lower capital cost than the multiple hearth furnace, although the cost of the ash system, which requires thickening and dewatering, results in comparable capital costs. Normal operation of the fluidized bed incinerator results in exhaust temperatures of 1,500°F to 1,550°F for several seconds. As a result, odors and carbonyl and unburned hydrocarbon emissions are minimal. This results in the ability to meet hydrocarbon emission regulations without the use of an afterburner.



ALTERNATIVE 2 - INCINERATION WITH ENERGY RECOVERY
SITE PLAN
SOLIDS FACILITY PLAN
GREEN BAY MSD
GREEN BAY, WI

CH2MHILL



GROUND LEVEL PALN

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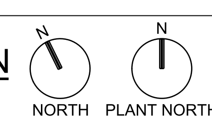
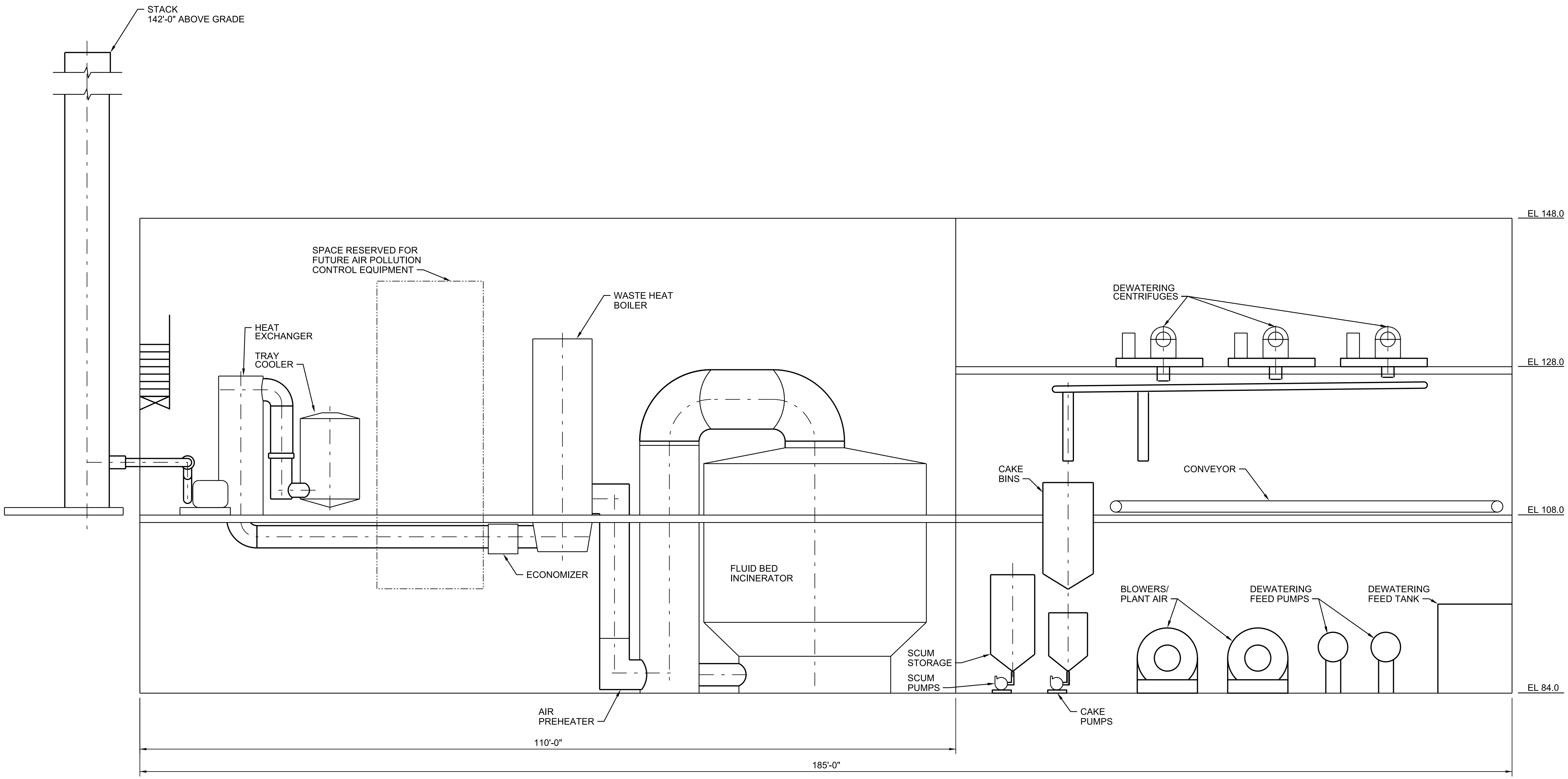


ALTERNATIVE 2 - INCINERATION WITH ENERGY RECOVERY
SOLIDS PROCESSING BUILDING PLAN

SOLIDS FACILITY PLAN
GREEN BAY MSD
GREEN BAY, WI

CH2MHILL



A SECTION
1/8"=1'-0"

ALTERNATIVE 2 - INCINERATION WITH ENERGY RECOVERY
SOLIDS PROCESSING BUILDING SECTION
SOLIDS FACILITY PLAN
GREEN BAY MSD
GREEN BAY, WI

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Alternative 3A—Digestion with Thermal Processing

Description of Alternative

Alternative 3A consists of digesting thickened sludge, and then incinerating a portion of the sludge to produce waste heat that will be used to dry the remainder of the sludge to produce a pellet fertilizer product. The biogas from the digesters will be burned in engine generators to produce electricity. Waste heat from these generators will be captured for digester heating and plant heating.

The existing solids processing building and sludge storage tanks will be demolished. A new solids processing building and storage tanks will be installed south of the existing building. One new exhaust stack will be constructed.

Gravity thickened primary solids and thickened waste activated solids are fed to two digesters to reduce the solids mass by about 35 percent and produce biogas. Solids are then dewatered in two centrifuges to about 25 percent solids.

This alternative could in the future utilize nutrient recovery technology to extract phosphorus from the digested sludge filtrate if use of ferric chloride for struvite control is too costly. The nutrient extraction process produces a valuable mineral pelletized fertilizer.

Following dewatering, a portion of the digested sludge is fed to a fluidized bed incinerator, while the remainder is fed to a fluidized bed dryer to produce a pellet fertilizer product. The incinerator is sized to process 66 percent of the 2035 peak month load and the dryer is sized to the remaining 33 percent.

Heat is recovered from the incinerator exhaust using thermal oil as the heat

Advantages

- Sustainable solution because it has the low net energy use and greenhouse gas emissions and the dried pellets provides beneficial re-use of solids
- Significant opportunities for partnering with regional interests because the digestion process makes it the most effective alternative at using the widest range of other types of solids (e.g. industrial wastes) with resultant increase in biogas production and renewable electricity.
- Provides multiple methods for solids disposal which mitigates the risk of cost increases associated with the disposal method or changes in regulations.
- Manages annual costs by mitigating the risks of energy price increases, provides multiple methods for solids disposal, and creates revenue from processing of non-GBMSD solids.
- Ability to use nutrient recovery processes to reduce phosphorus content of pellets and produce a valuable mineral fertilizer.
- Volume is reduced in digestion and again in incineration and drying.

Disadvantages

- Highest capital cost.
- Increased complexity because of the operation of an incinerator and dryer and the management of two separate solids streams/products.
- Larger footprint than Alternatives 2 and 14.
- Ash would likely be placed in a landfill instead of beneficially reused.
- Potential safety concerns with the dryer and biogas.
- Limited full-scale similar operations in use.

transfer medium. Heat recovered from the incinerator is used as a heat source for the dryer. The resulting granules are stored before transported offsite for use. With 66 percent of solids sent to the incinerator and 33 percent sent to the dryer, no supplemental natural gas is required. Depending on the amount of dried pellets desired, the drying process may require supplemental fuel, such as digester gas or natural gas. Ash from the incineration process would be placed in a landfill unless a beneficial use is identified.

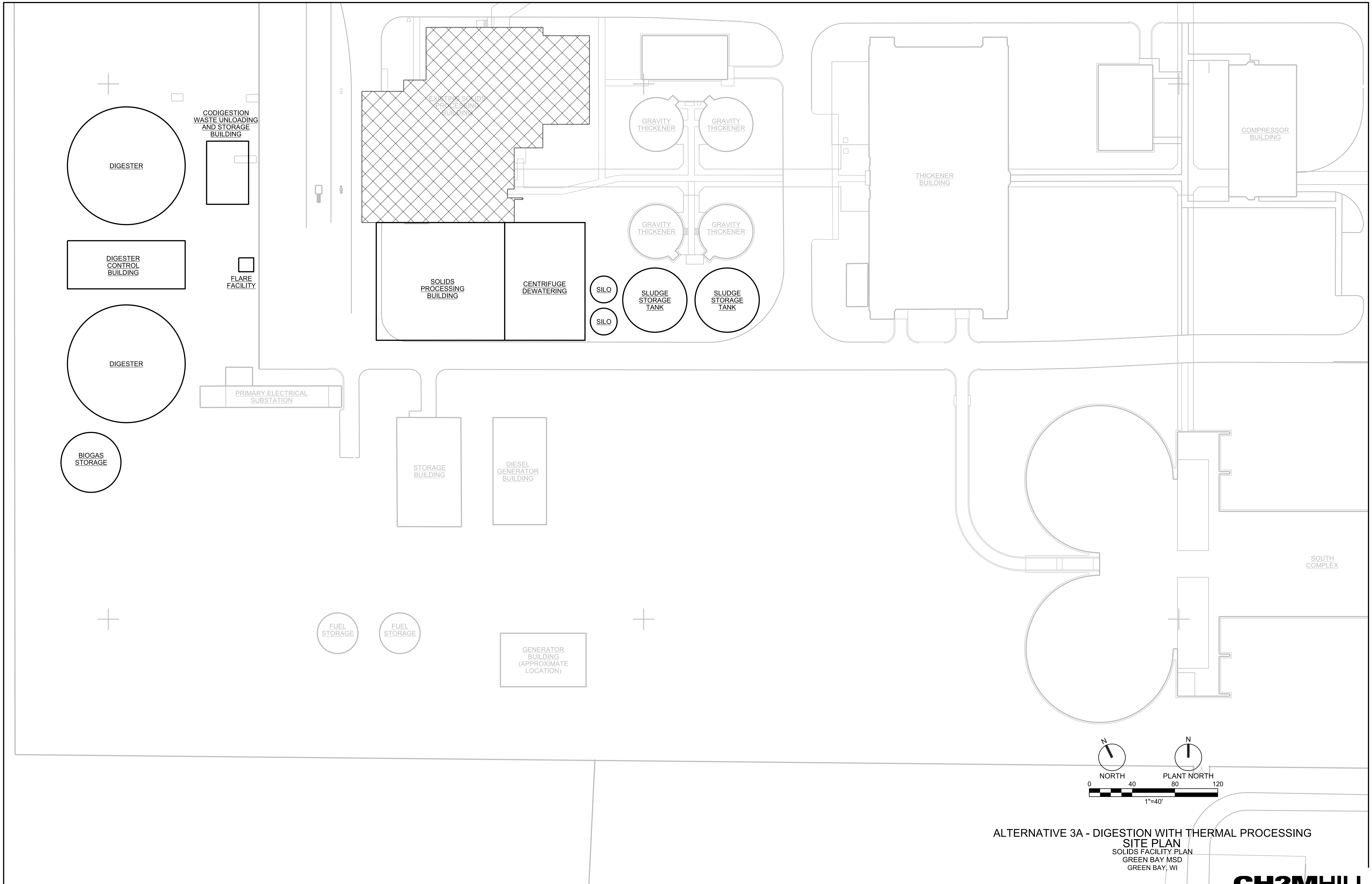
The biogas produced in the digesters would be cleaned and burned in an internal combustion engine with a generator. Heat will be recovered from the internal combustion engines which will reduce gas usage. If more pellet product is desired, the digester gas could be used to run the dryer at a higher capacity.

The fluidized bed incinerator is expected to be offline for about 2 to 3 weeks per year for maintenance. Two silos are included to provide 2 months of pellet storage during winter months.

Refer to the description of Alternative 2 for a discussion of fluidized bed incineration.

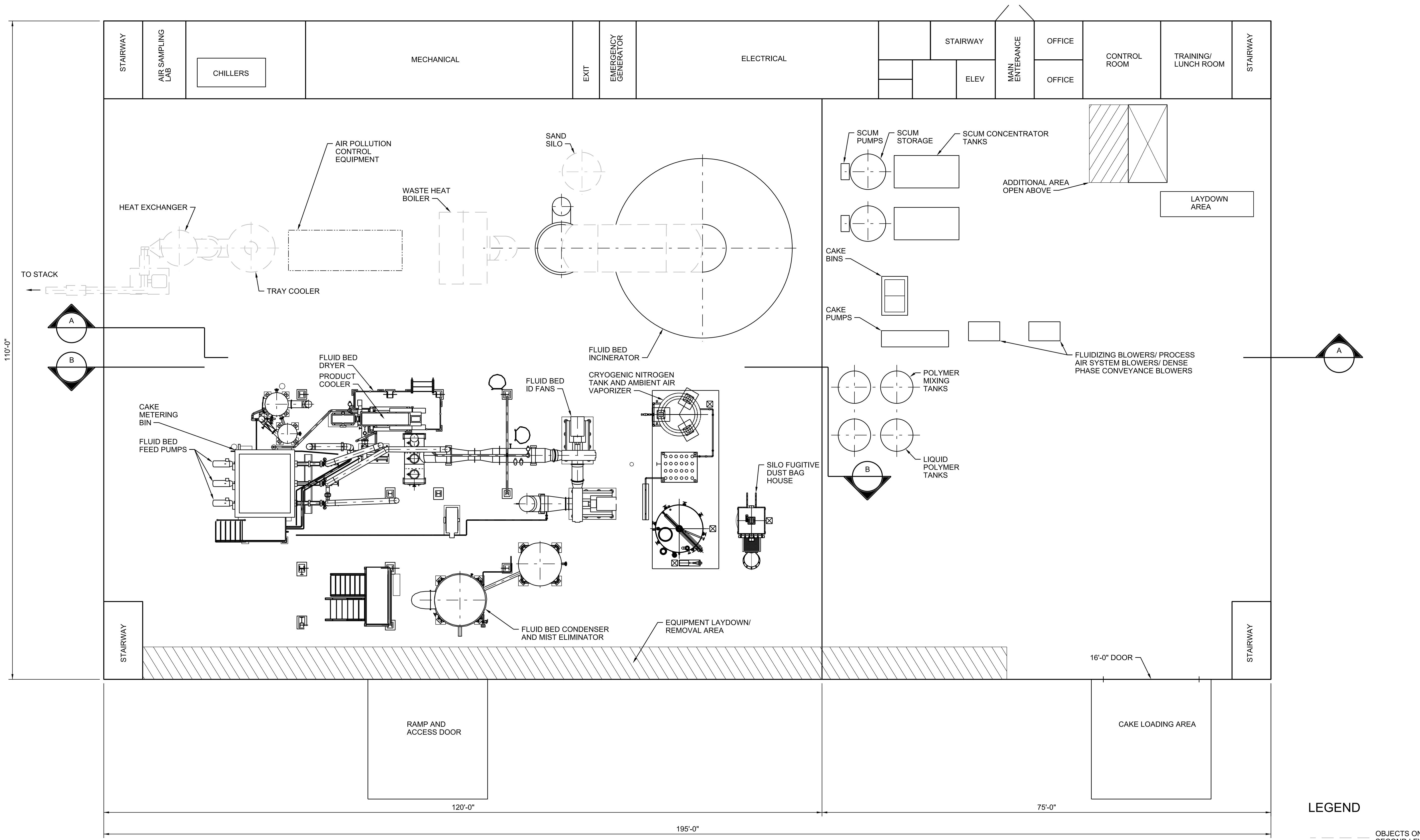
This alternative can accept organic industrial wastes in the digesters which will help homogenize and degrade solids to make them more amenable to drying and incineration. However, fibrous or nondigestable material may pass through digestion and cause issues in drying or incineration.

High strength wastes from non-GBMSD sources will be beneficial because they will result in increased production of digester gas and renewable electricity. Additionally, a fee can be charged for accepting these wastes. However, because digestion is a biological process, bench scale studies must be performed prior to full scale co-digestion.



ALTERNATIVE 3A - DIGESTION WITH THERMAL PROCESSING
SITE PLAN
SOLIDS FACILITY PLAN
GREEN BAY MSD
GREEN BAY, WI

CH2MHILL



GROUND LEVEL PLAN

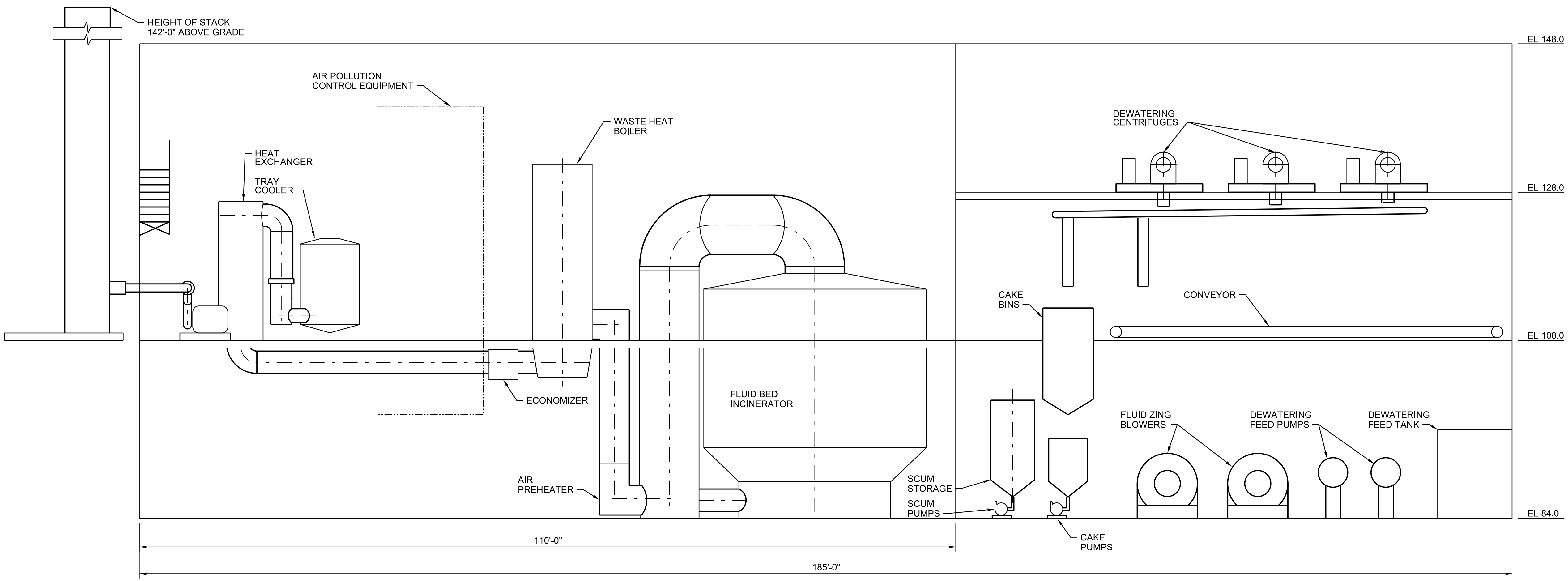
1/8"=1'-0"

N NORTH

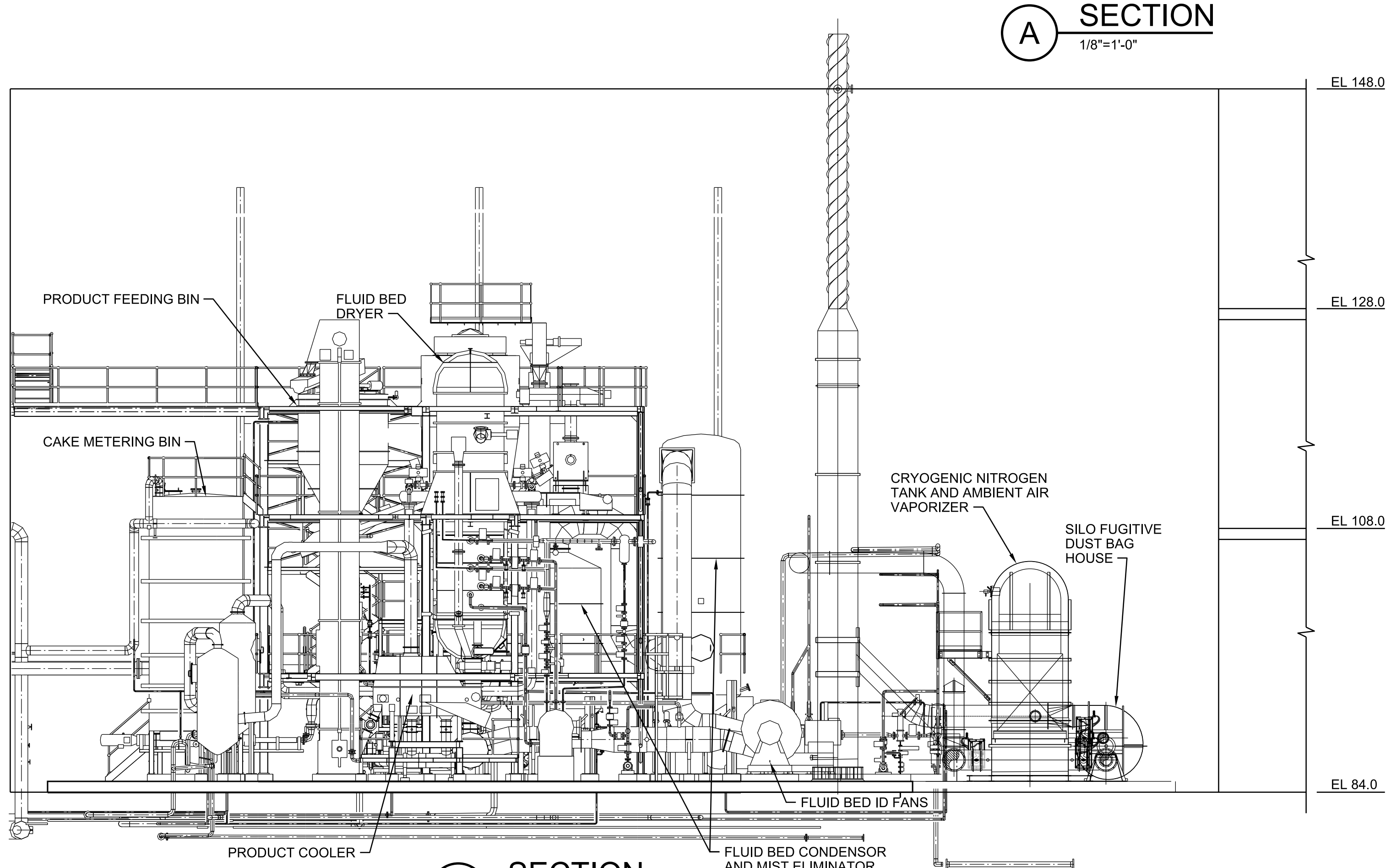
N PLANT NORTH

ALTERNATIVE 3A - DIGESTION WITH THERMAL PROCESSING
SOLIDS PROCESSING BUILDING PLAN
SOLIDS FACILITY PLAN
GREEN BAY MSD
GREEN BAY, WI

CH2MHILL



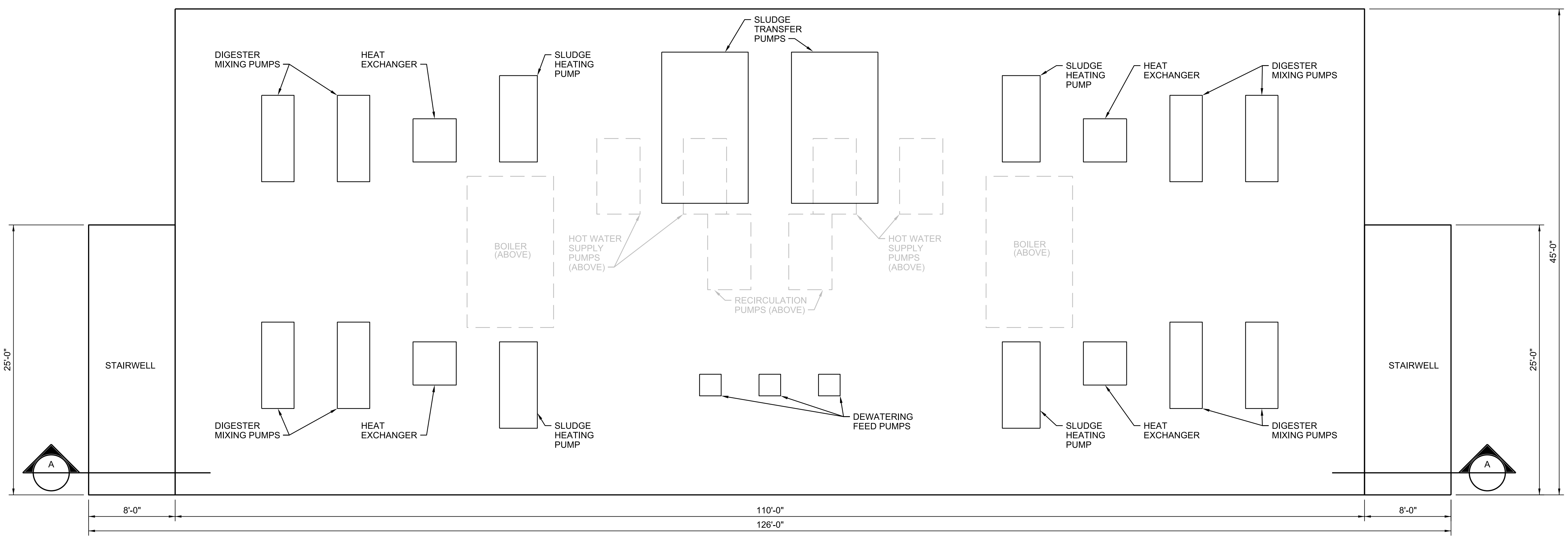
A SECTION
1/8"=1'-0"



B SECTION
1/8"=1'-0"

ALTERNATIVE 3A - DIGESTION WITH THERMAL PROCESSING
SOLIDS PROCESSING BUILDING SECTIONS
SOLIDS FACILITY PLAN
GREEN BAY MSD
GREEN BAY, WI

CH2MHILL



FIRST FLOOR PLAN
3/16"=1'-0"

LEGEND

— — — — OBJECTS ON SECOND FLOOR

ALTERNATIVE 3A - DIGESTION WITH THERMAL PROCESSING
DIGESTER CONTROL BUILDING PLAN
SOLIDS FACILITY PLAN
GREEN BAY MSD
GREEN BAY, WI

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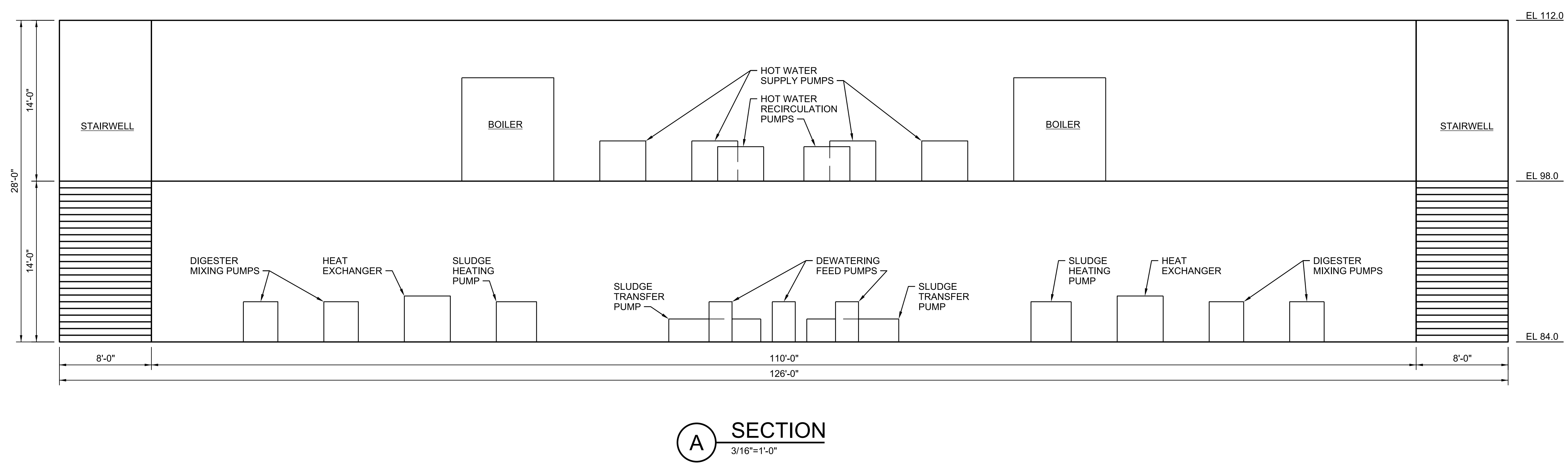

ALTERNATIVE 3A - DIGESTION WITH THERMAL PROCESSING
DIGESTER CONTROL BUILDING SECTION
SOLIDS FACILITY PLAN
GREEN BAY MSD
GREEN BAY, WI

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Alternative 3B—Digestion with Thermal Processing and Electrical Generation

Description of Alternative

For Alternative 3B, thickened sludge would be digested, and the digested, dewatered cake would be thermally oxidized. Energy would be recovered from the biogas produced in the digester and from the thermal oxidizer waste heat, as described below. See Chapter 6 for additional details regarding Alternative 3B.

Thickening

Primary sludge would be thickened in the existing gravity thickeners, and waste activated sludge would be thickened using the existing gravity belt thickeners. As with all alternatives, the gravity thickeners and TWAS pumps would be rehabilitated. The combined thickened waste activated and primary sludge would be conveyed to storage tanks.

Digestion, Energy Recovery and Dewatering

The thickened sludge would be pumped to two mesophilic anaerobic digesters. The purpose of the digesters is to reduce sludge volumes and to produce biogas. The organic material in the sludges would be converted biologically to methane and carbon dioxide (biogas) in the airtight reactors. The digesters would be completely mixed and operated under anaerobic conditions at 35° to 38°C. The biogas produced would be combusted in one or more internal combustion engines that would drive a generator to produce electricity. Waste heat from the engines would be used to heat the digesters. Wastes from other sources, such as dairy wastes, would be digested along with municipal wastes to increase biogas production and electrical power generation. See the Codigestion Technical Memorandum for details (Appendix 5-2). The digested sludge would be concentrated to about 25 percent solids using dewatering centrifuges or other technologies. A nutrient extraction system could be added at some future time to produce a phosphorous fertilizer and prevent struvite formation should iron addition prove to be too costly. See the

Advantages

- Air emissions would be significantly reduced, as compared to the those from the multiple hearth furnace incinerators.
- Greenhouse gas emissions would be low because of to the high degree of energy recovery and minimal use of auxiliary fuel (natural gas).
- The technologies are proven.
- Operating cost would be low because of high degree of energy recovery, especially as energy prices continue to rise in the future.
- Nutrient extraction technology can be added in the future to remove phosphorus from biosolids and to produce a valuable phosphorus fertilizer product.
- Volume reduction in digestion reduces the size and cost of the thermal oxidation system.

Disadvantages

- Capital cost would be high because of multiple unit processes.
- Ash likely would be landfilled instead of beneficially reused.
- Operation of steam boiler likely would require a licensed operator.

Nutrient Extraction Technical Memorandum for details (Appendix 5-3).

Incineration and Steam Turbine Power Generation

Digested, dewatered biosolids would be conveyed to a single fluidized bed incinerator. Unlike a multiple hearth incinerator, in a fluidized bed incinerator, water flashes off and the sludge burns in one chamber. See Alternative 2 for a description of fluidized bed incineration.

A waste heat steam boiler would use waste heat from incineration to produce steam that could be used in a steam turbine to generate electricity, or the steam could be used for building heat. With current natural gas and electrical prices, it likely would be most economical to use steam for building heat in the winter and power generation in warmer months. This could change if the relative price of electrical power increases at a rate faster than that of natural gas.

Alternative 11 – Composting

Description of Alternative

Under Alternative 11, gravity thickened primary solids and thickened waste-activated solids would be co-dewatered on belt presses to about 22 percent solids content, mixed with ground yard waste, and fed to an in-vessel aerated composting process. Composting is an aerobic thermophilic process. Elevated temperatures in the composting process provide a high level of pathogen destruction and a high rate of volatile solids oxidation. Composting results in a volume and weight reduction due to volatile solids oxidation and water evaporation and produces a Class A solid that can be sold. As with the other alternatives, sizing of facilities is based on a year 2035 design peak month.

Dewatering

A new belt press dewatering building will be installed adjacent to the composting facility to eliminate the need for hauling dewatered solids to the facility. Gravity thickened primary sludge and gravity belt thickened TWAS will be pumped to the new dewatering building. New thickened storage tanks were assumed thickened sludge storage may not be necessary for composting operations.

Compost Amendment

Yard waste, wood waste, and other organic material received would be ground in a tub grinder at the compost facility. It was assumed that the cost of hauling yard waste to the composting facility would be paid for by the

Advantages

- Solids and nutrients (phosphorus and nitrogen) can be recycled into a valuable end product.
- The Class A biosolids that would be produced could be sold.
- There would be flexibility to process many types of organic solids.
- A valuable soil amendment product would be produced.
- Public perception would be positive. Composting is a well-known process with a generally positive connotation.
- The processes are commonly used and well understood.
- Capital cost would be low.

Disadvantages

- The change in operation would be significant, constituting a completely new business for GBMSD.
- Odor problems may arise.
- There is uncertainty regarding the ability to market compost product.
- There is uncertainty regarding the availability of wood waste amendments.
- There would be no production of renewable electricity or energy recovery from biosolids.
- The large system footprint would occupy most of the remaining land onsite.
- The system has high operating costs and is labor-intensive.
- The operation of heavy equipment raises some safety concerns.
- There would be reliance on others for collection of yard waste.
- There would be a greater volume of material to dispose of due to yard waste addition.

generators of the material. The City of Green Bay was assumed to be the primary generator of yard waste.

Mixing

Dewatered solids would be transferred to a cake hopper using a front end loader or conveyors. From the cake hopper, the dewatered solids along with yard waste, ground wood waste, and recycled compost would be fed to a mixer. Mixed solids would be transferred to the loading end of each composting bay using a front-end loader. Mixing can occur in the loading end of the composting building.

Composting

The in-vessel system consists of a series of parallel open top concrete bays, mobile mechanical agitators that agitate one bay at a time, blowers and air piping for aeration, a building, and a biofilter to control odors and evaporated moisture.

The mechanical agitation provides mixing, shredding, uniform composting conditions, and aeration, and moves the compost from the loading end to the unloading end. Blowers aerate the piles to maintain aerobic conditions and control the temperature of the compost. Aeration also reduces odor potential. A biofiltration system controls the remaining odors from the composting and curing process. However, there will be some fugitive odors that are not captured and treated and some odors from the biofilter outlet because the biofilter will not remove about 10 percent of the odors.

The building was assumed to be a metal building with a spray-applied polyurethane foam insulation and corrosion protection interior coating. Only the mixing and loading area will be heated to prevent fog during cold weather, when mixing and loading occur. Sufficient heat is generated in the composting bays to maintain sufficient temperature in the compost without heating the air space.

Screening

Screening would occur before curing to minimize the required curing area. A high recycle rate of the oversized compost captured during screening was assumed to minimize the quantity of yard waste and wood waste required. This assumption was based on estimates of available yard waste from the City of Green Bay. The amount of compost estimated for recycling can be reduced if more yard waste than assumed available is received. Screening is assumed to occur in the Curing Building.

Curing

After active composting, the compost is transferred by front-end loader to an enclosed aerated curing building to further stabilize and dry the compost. The process is referred to as an aerated static pile. The resulting product has low odor potential and can be stored without odor control.

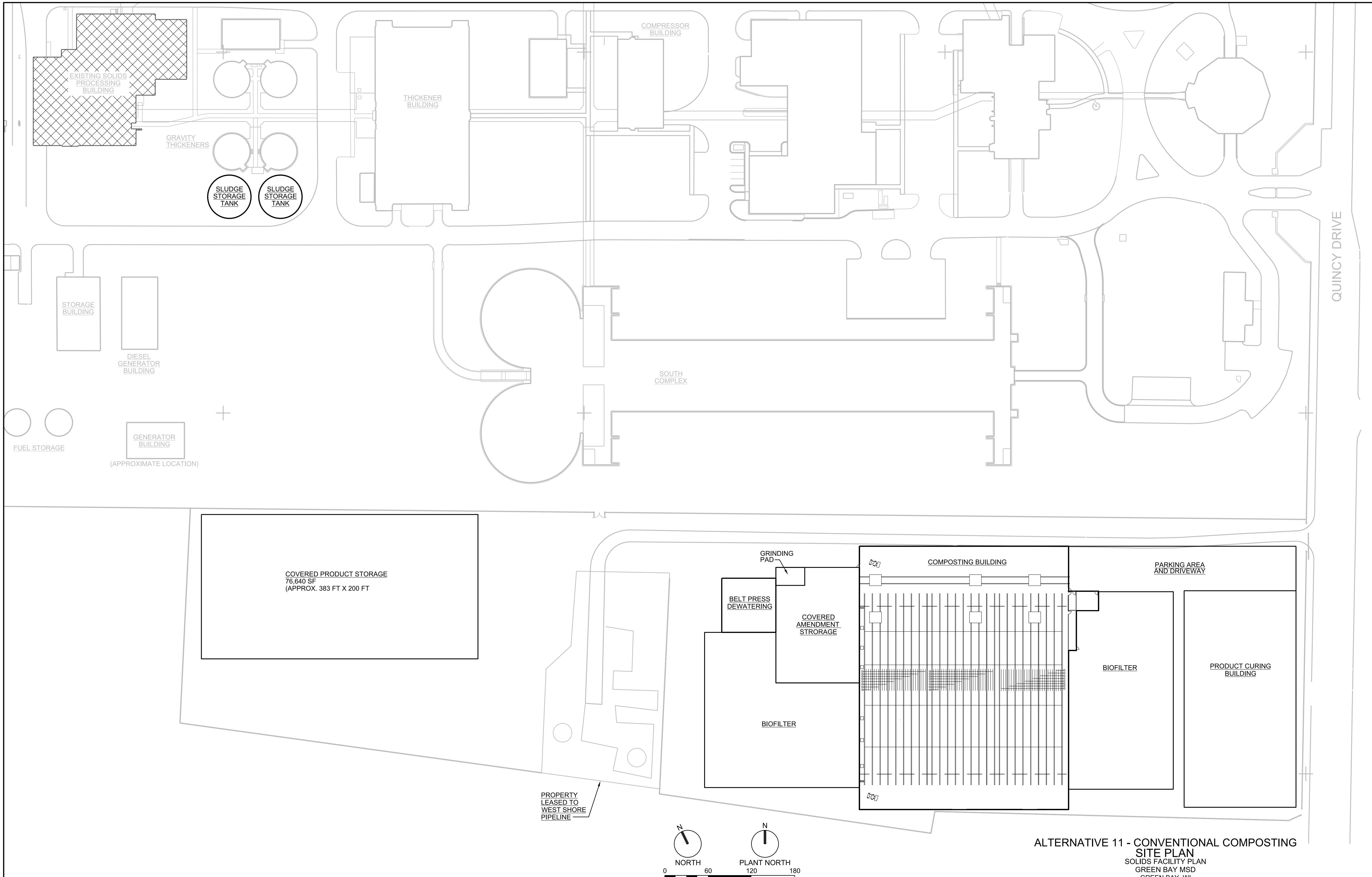
The cost estimate for the building was prepared assuming construction of a metal building with a spray-applied polyurethane foam insulation and corrosion protection interior coating. However, other building types may be considered during design. The curing building is an unheated building.

Storage

Common storage areas would be used for yard waste, wood waste, recycled compost, and other amendments (if any), and finished compost product storage. Typically, the quantity of compost stored in the fall would be minimized to maximize space for storing yard waste and wood waste. As the yard waste and wood waste is consumed over the winter, this space would be used to store compost that is generated. This shared storage area minimizes the area required.

Product

Composted material can be sold as a valuable soil amendment. Receiving soils will benefit from the organic, nitrogen, and phosphorus content in the composted solids. Typical markets for compost include landscapers, villages, gardeners, golf courses, and farmers. Ideally, purchasers would pay for the cost of hauling compost from the composting facility. However, the cost estimate included a transportation allowance that would cover short distance transportation of product to end users.



ALTERNATIVE 11 - CONVENTIONAL COMPOSTING
SITE PLAN
SOLIDS FACILITY PLAN
GREEN BAY MSD
GREEN BAY, WI

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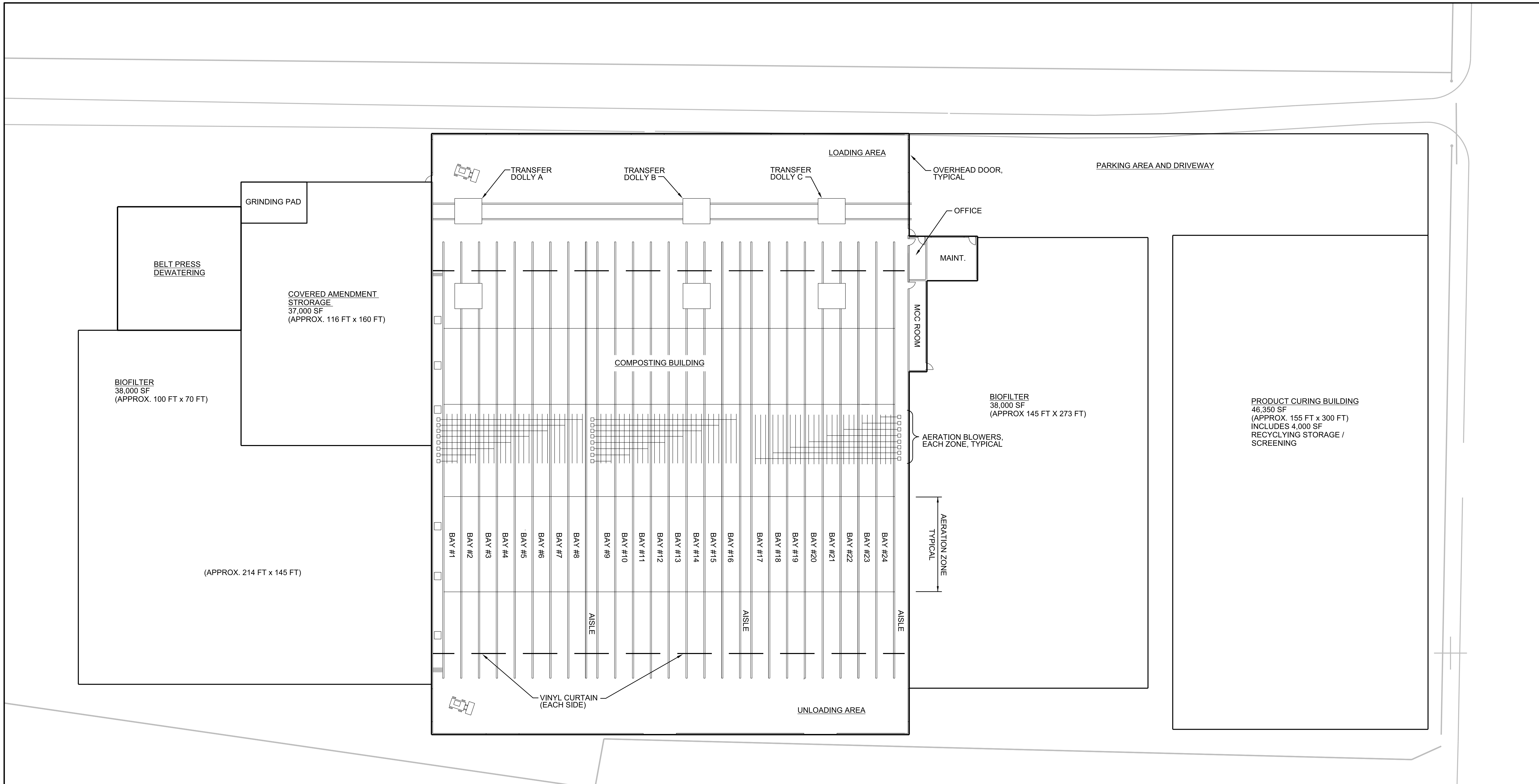
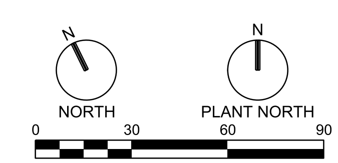


NOTE:
FOR COVERED PRODUCT STORAGE AREA, SEE FIGURE 1, ALTERNATIVE 11 - SITE PLAN.



ALTERNATIVE 11 - CONVENTIONAL COMPOSTING
BUILDING PLAN
SOLIDS FACILITY PLAN
GREEN BAY MSD
GREEN BAY, WI

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Alternative 14—Incineration and Thermal Drying

Description of Alternative

Alternative 14 consists of drying most of the waste activated sludge (WAS) and incinerating all primary sludge. Some of the WAS would be mixed as needed with primary sludge prior to incineration. The amount of WAS sent to drying would be such that the dryer heating demand is matched with the waste heat available from the incinerator. Approximately 60 percent of all solids would be incinerated and 40 percent would be dried. Natural gas would not be required for drying.

A new solids processing building and storage tanks will be installed south of the existing building. The new building would house the dewatering and drying system. One new exhaust stack would be constructed.

Two new sludge storage tanks would provide provides storage capacity for a dryer or incineration to be taken out of service for maintenance.

WAS Drying

The WAS would be dewatered to 25 percent using centrifuges or other technologies. Following dewatering, WAS would be conveyed to the fluid bed drying system. The fluid bed dryer would be thermally coupled with the fluidized bed incinerator. Thermal oil would transfer heat from the incinerator to the dryer, to provide all of the dryer's heating needs. The amount of WAS sent to the dryer would be based on the amount of heat available for drying.

Advantages

- Recycling of solids and nutrients into a valuable end product.
- Flexibility to incinerate or dry solids.
- Significant volume reduction.

Disadvantages

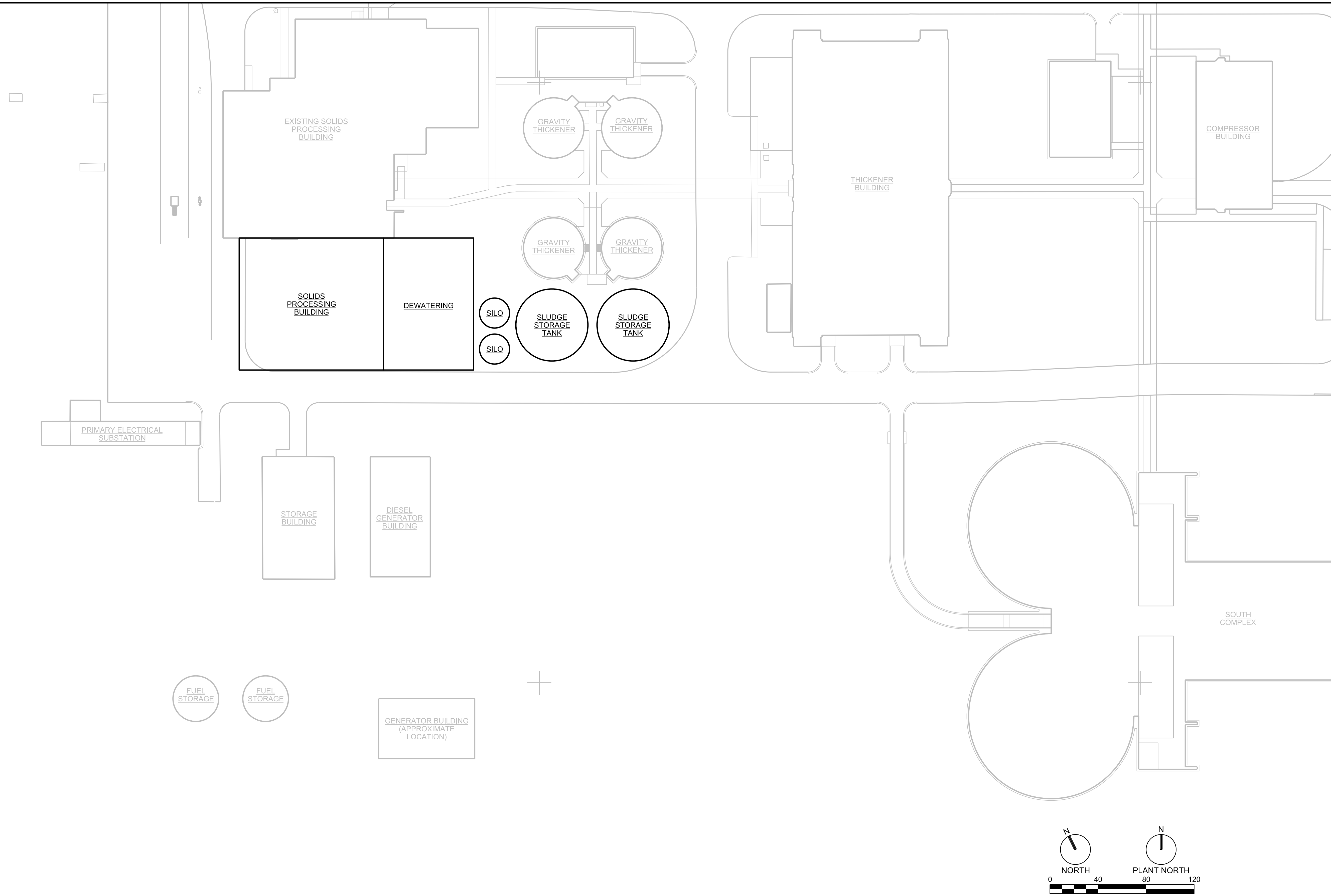
- Minimal protection from risk of increasing energy prices.
- High O&M costs due to lack of heat recovery for space heating or electricity production.
- High greenhouse gas emissions because of lack of energy recovery for space heating or electricity production.
- May not be able to process significant amounts of non-municipal solids
- Increased complexity because of the operation of an incinerator and dryer and the management of two separate solids streams/products.
- Dryers are known to have potential safety issues.
- Ash would likely be placed in a landfill instead of beneficially reused.

The dryer system would create dried pellets that would be sold as a slow release fertilizer. Two silos would provide 2 months of pellet storage during winter.

Primary Sludge Incineration

Gravity thickened primary sludge would be dewatered to 25 percent solids content and incinerated in a new fluidized bed incinerator. A new fluidized bed incinerator will result in improved reliability, less operation and maintenance attention, reduced air emissions, and higher heat efficiency compared to the existing multiple hearth incinerators. The higher heat efficiency is a result of fluidized bed incinerators typically operating at much lower excess air rates than typical multiple hearth furnace operations.

Refer to the Alternative 2 description for information on fluidized bed incineration.



ALTERNATIVE 14 - INCINERATION WITH DRYING

SITE PLAN

SOLIDS FACILITY PLAN

GREEN BAY MSD

GREEN BAY, WI

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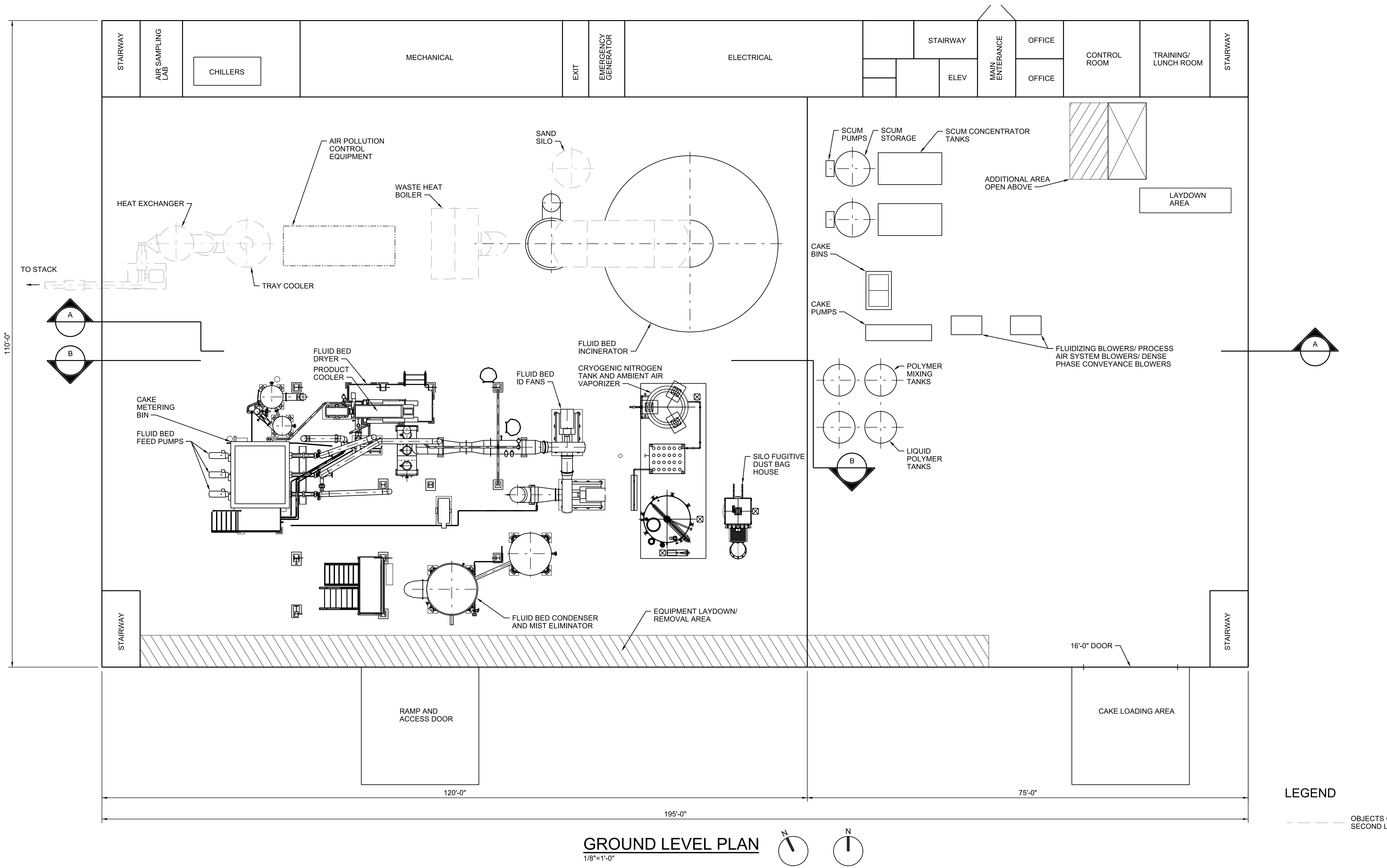

GROUND LEVEL PLAN

1/8"=1'-0"

ALTERNATIVE 14 - INCINERATION WITH DRYING
SOLIDS PROCESSING BUILDING PLAN
SOLIDS FACILITY PLAN
GREEN BAY MSD
GREEN BAY, WI

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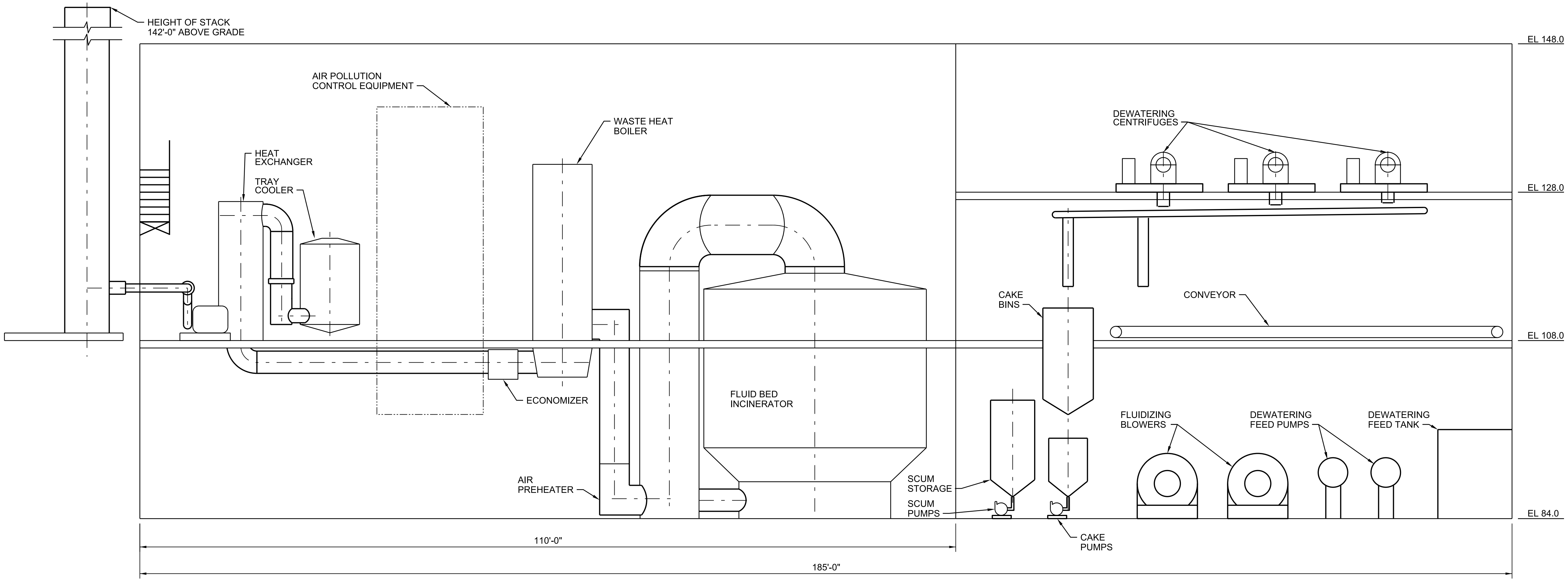
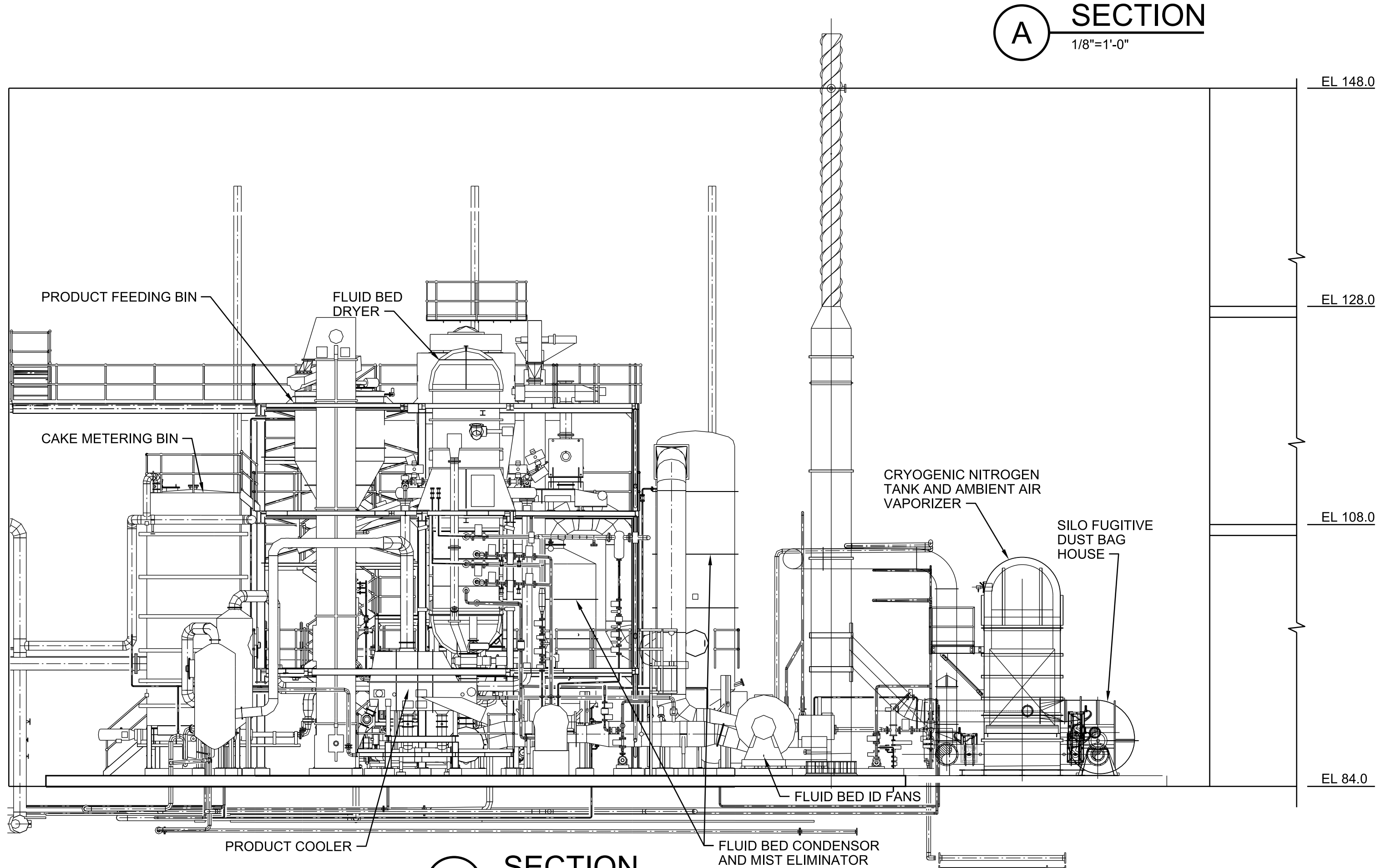


A SECTION
1/8"=1'-0"



B SECTION
1/8"=1'-0"

ALTERNATIVE 14 - INCINERATION WITH DRYING
SOLIDS PROCESSING BUILDING SECTIONS
SOLIDS FACILITY PLAN
GREEN BAY MSD
GREEN BAY, WI

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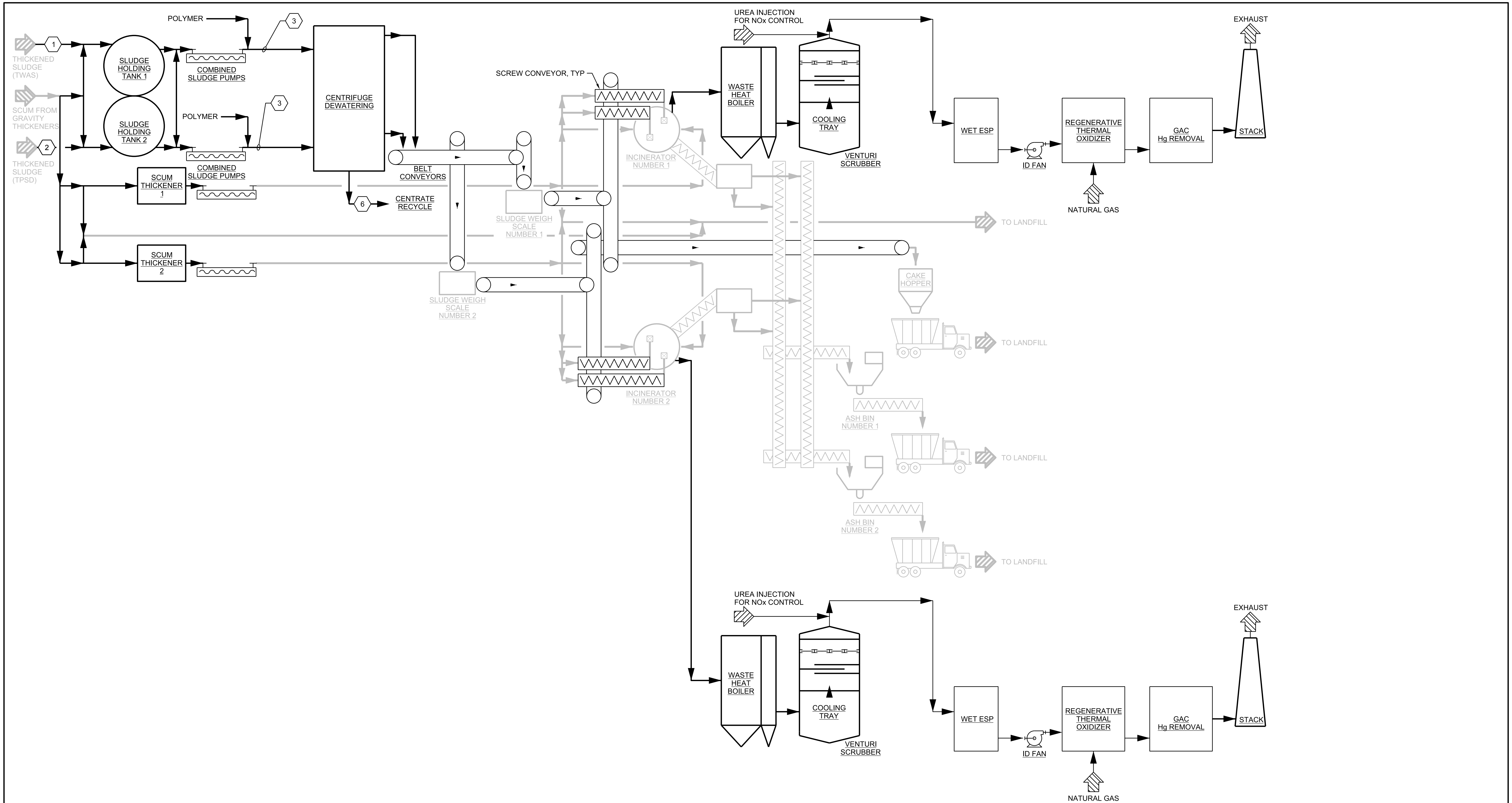
Alternative 16—Rehabilitate Multiple Hearth Furnaces

See Appendix 5-4, Refinement of Alternatives Technical Memorandum, for a description of and process flow diagram for Alternative 16.



SHEET KEYNOTES

1. THICKENED WASTE ACTIVATED SLUDGE
2. THICKENED PRIMARY SLUDGE
3. COMBINED SLUDGE
4. DEWATERED COMBINED SLUDGE
5. CENTRATE RECYCLE
6. CAKE TO INCINERATOR
7. CAKE TO DRYER
8. DRIED PELLETS
9. ASH

NOTE:

NOx CONTROLS REQUIRE FURTHER EVALUATION.

ALTERNATIVE 16 - REHABILITATE MULTIPLE HEARTH FURNACES
PROCESS FLOW DIAGRAM
SOLIDS FACILITY PLAN
GREEN BAY MSD
GREEN BAY, WI

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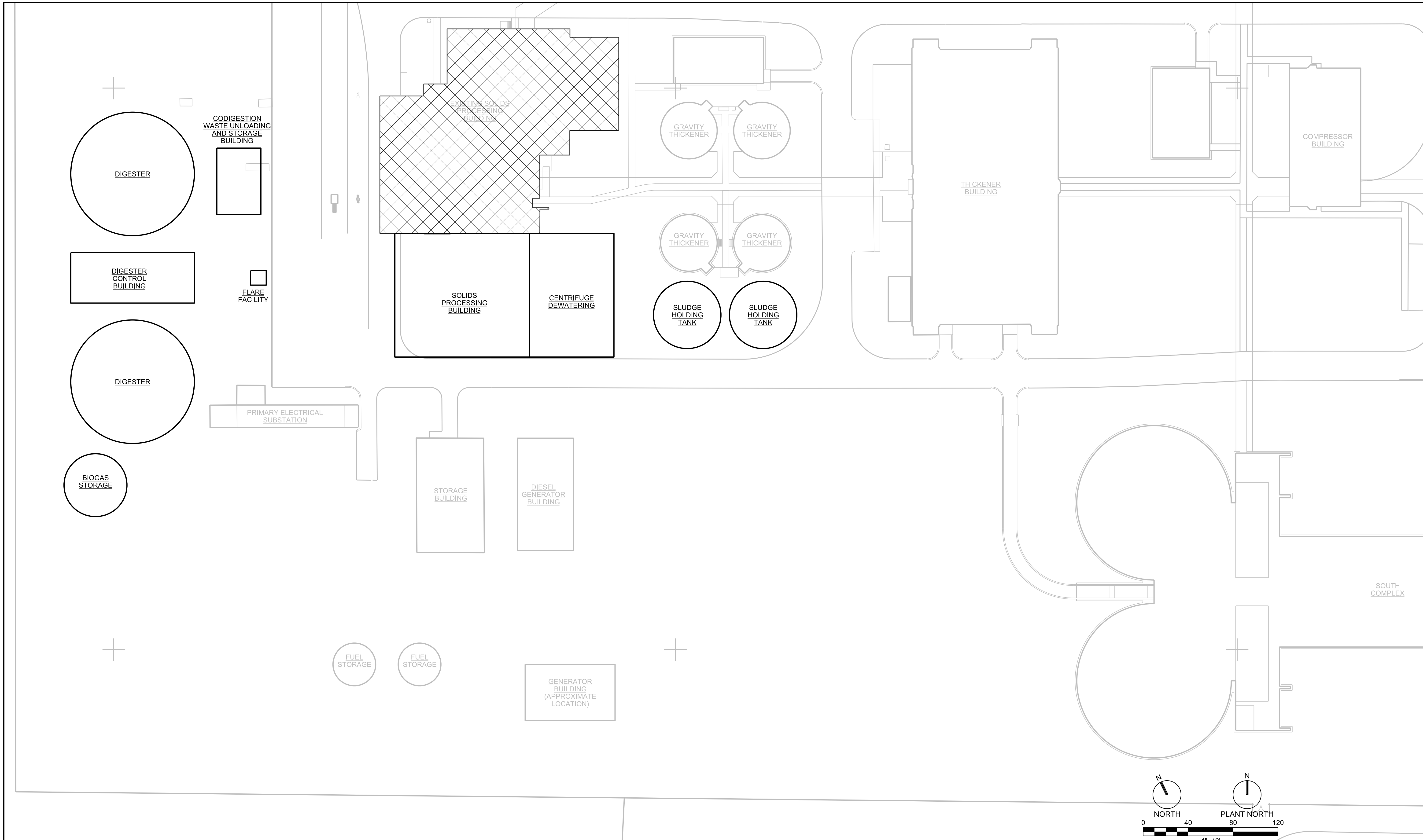
Appendix 6-1. Drawings for Selected Alternative



ALTERNATIVE 3B - DIGESTION WITH THERMAL PROCESSING AND ELECTRICAL GENERATION
SITE PLAN

SOLIDS FACILITY PLAN
GREEN BAY MSD
GREEN BAY, WI

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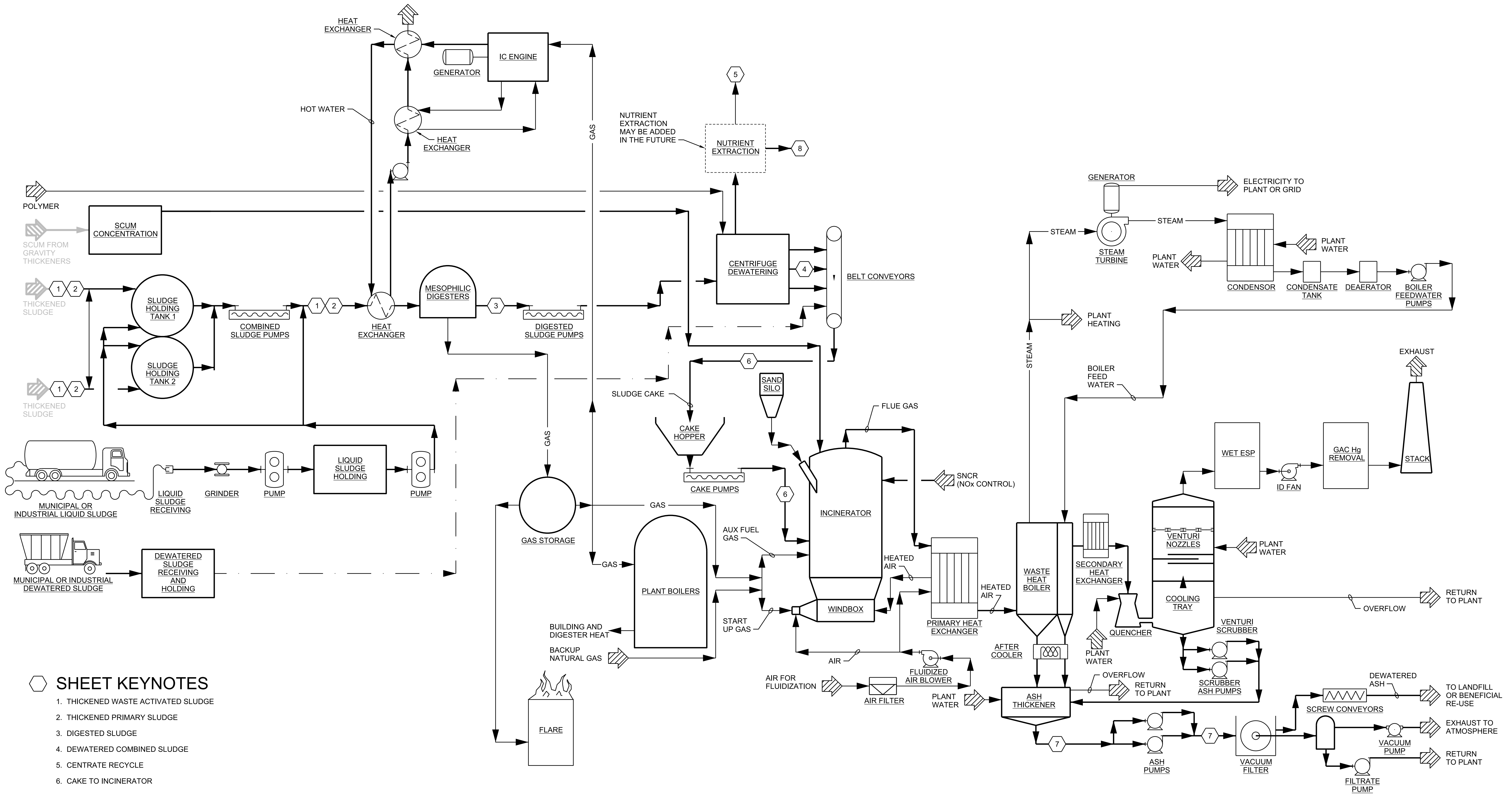

SHEET KEYNOTES

1. THICKENED WASTE ACTIVATED SLUDGE
2. THICKENED PRIMARY SLUDGE
3. DIGESTED SLUDGE
4. DEWATERED COMBINED SLUDGE
5. CENTRATE RECYCLE
6. CAKE TO INCINERATOR
7. ASH
8. STRUVITE PELLETS

LEGEND

— · — · — TRANSPORTED WITH FRONT END LOADER

ALTERNATIVE 3B - DIGESTION WITH THERMAL PROCESSING AND ELECTRICAL GENERATION
PROCESS FLOW DIAGRAM
SOLIDS FACILITY PLAN
GREEN BAY MSD
GREEN BAY, WI

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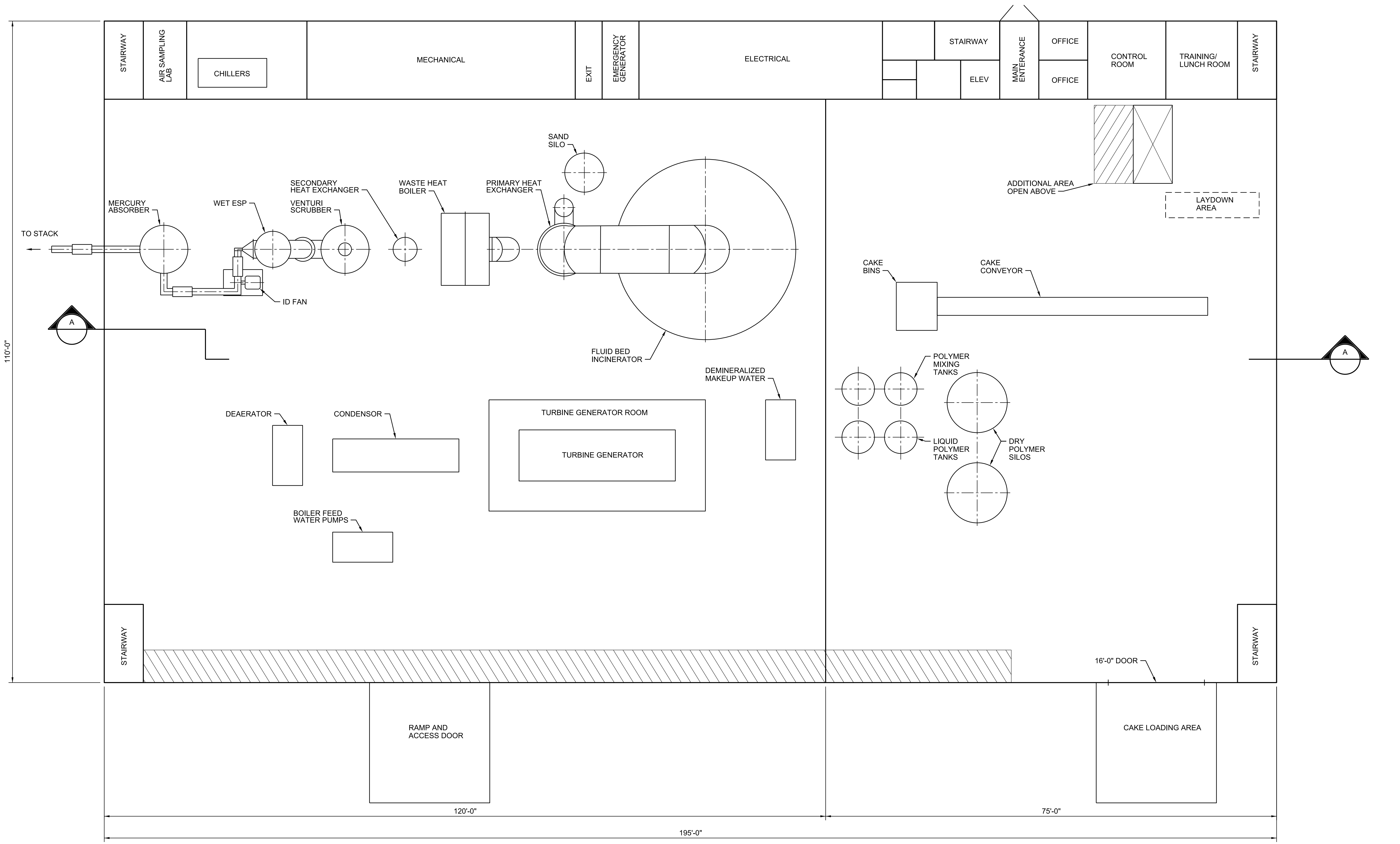
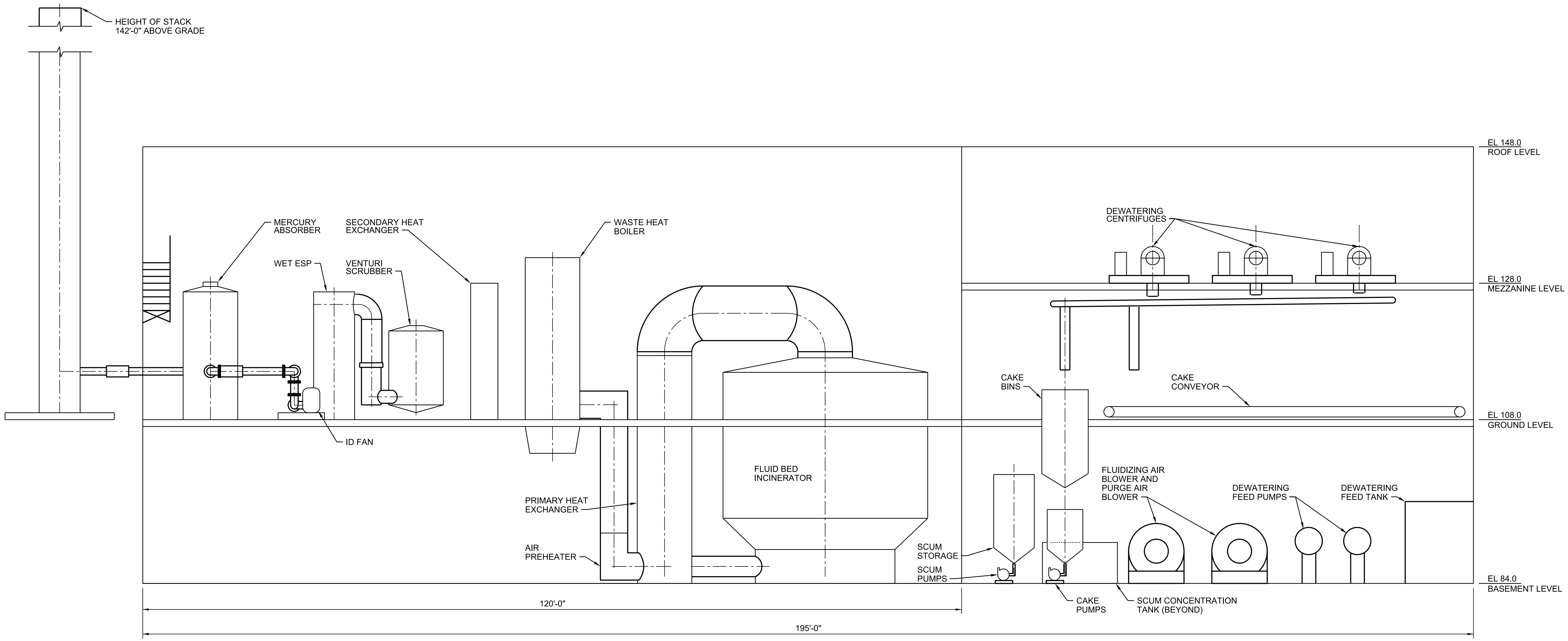


GROUND LEVEL PLAN

1/8"=1'-0"

ALTERNATIVE 3B - DIGESTION WITH THERMAL PROCESSING AND ELECTRICAL GENERATION
SOLIDS PROCESSING BUILDING PLAN
SOLIDS FACILITY PLAN
GREEN BAY MSD
GREEN BAY, WI

CH2MHILL



A SECTION
1/8"=1'-0"

ALTERNATIVE 3B - DIGESTION WITH THERMAL PROCESSING AND ELECTRICAL GENERATION
SOLIDS PROCESSING BUILDING SECTION
SOLIDS FACILITY PLAN
GREEN BAY MSD
GREEN BAY, WI

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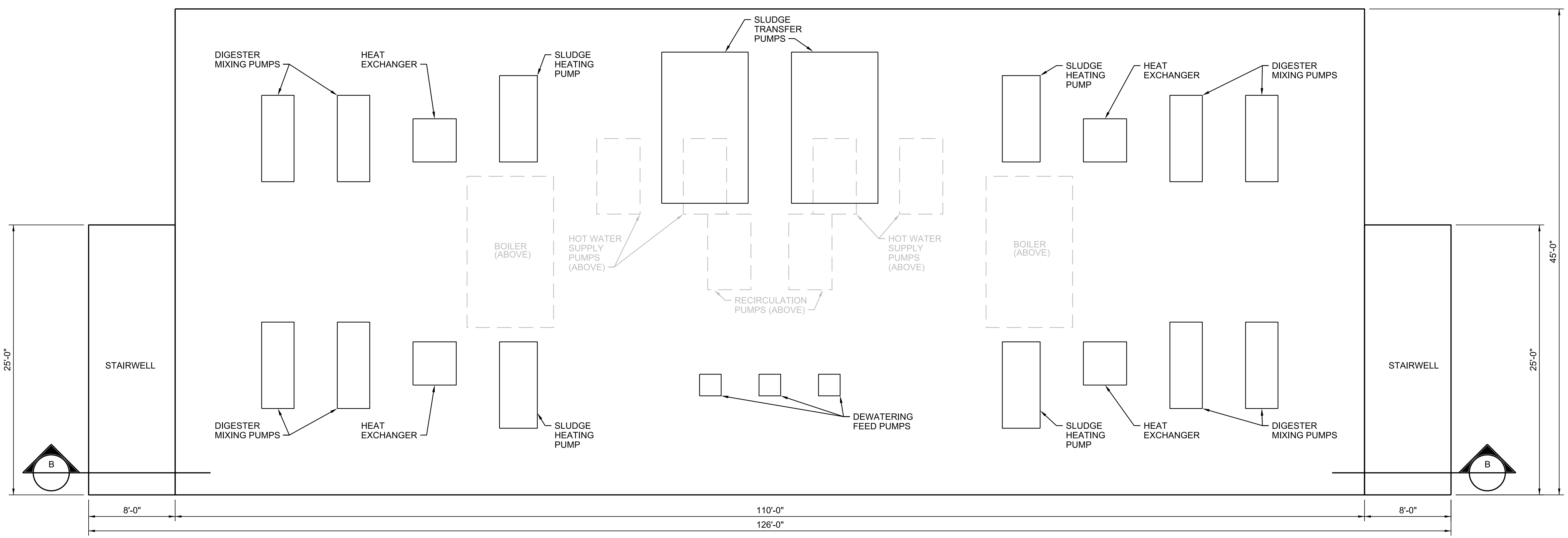


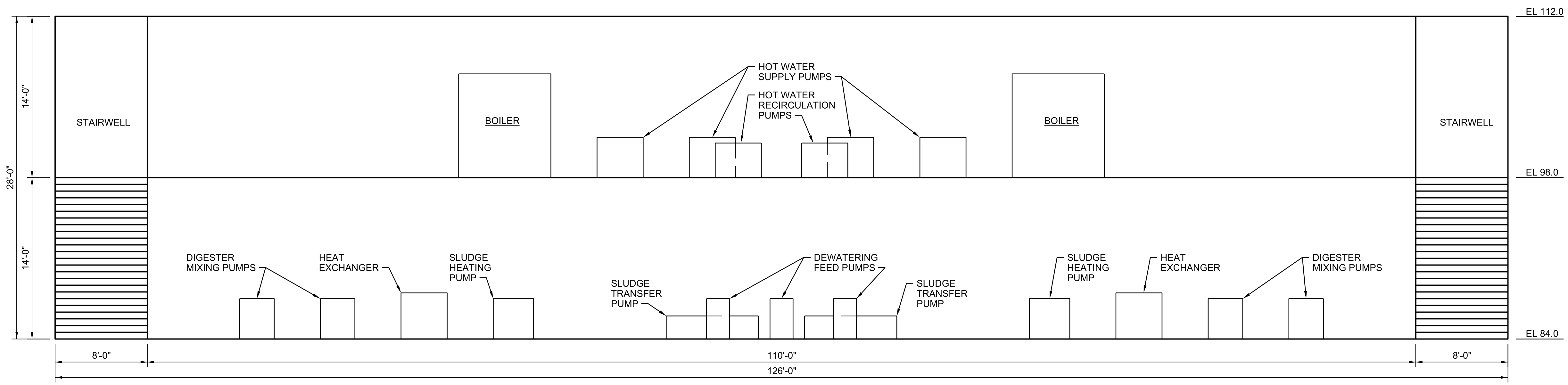
FIRST FLOOR PLAN
3/16"=1'-0"

NORTH
PLANT NORTH

LEGEND
OBJECTS ON SECOND FLOOR

ALTERNATIVE 3B - DIGESTION WITH THERMAL PROCESSING AND ELECTRICAL GENERATION
DIGESTER CONTROL BUILDING PLAN
SOLIDS FACILITY PLAN
GREEN BAY MSD
GREEN BAY, WI

CH2MHILL



B SECTION
3/16"=1'-0"

ALTERNATIVE 3B - DIGESTION WITH THERMAL PROCESSING
AND ELECTRICAL GENERATION
DIGESTER CONTROL BUILDING SECTION
SOLIDS FACILITY PLAN
GREEN BAY MSD
GREEN BAY, WI

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