City of Hamilton

Biosolids Master Plan Addendum

Prepared for
City of Hamilton

February 2015

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Contents

1 Introduction

1.1 Background

This document is an Addendum to the City of Hamilton's (City) Biosolids Master Plan (August 2007)[1]. This Master Plan represented completion of Phases 1 and 2 of the Municipal Class Environmental Assessment (EA) process.

Biosolids are the material resulting from the treatment of the residual sludge from municipal wastewater treatment. Biosolids are similar in appearance to wet soil, containing a high percentage (75%) of water. The material is primarily organic and rich in nutrients. To generate biosolids, residual sludge is treated in anaerobic digesters, which reduce the mass of material to manage, and significantly reduce pathogenic (disease-causing) organisms and odour. The treated sludge, referred to as liquid biosolids, is then mechanically processed to remove a large portion of water (which is returned back to the wastewater treatment process). This dewatered material, containing approximately 25% solids and 75% water is referred to as biosolids.

Approximately 37,000 wet tonnes of biosolids are generated each year in Hamilton at the Woodward Avenue Wastewater Treatment Plant (WWTP), located at 700 Woodward Avenue. This plant also receives sludge from the Dundas WWTP. Currently, the City retains a contractor to manage its biosolids disposal through beneficial use on agricultural land for which services include but are not limited to: trucking, off-site storage, obtaining required land bank / approvals, as well as compliance to all associated provincial regulations. The 2007 Biosolids Master Plan was initiated due to concerns about the long-term reliability of the biosolids management program. Regulations regarding land application of biosolids were becoming increasingly stringent and the availability of suitable land was projected to become limited.

The goal of the 2007 Master Plan was to identify a preferred long-term strategy for the environmentally sustainable, reliable and cost-effective management of the City of Hamilton's biosolids, which would also support future growth in Hamilton. The City's Triple Bottom Line assessment approach that considers social, environmental, and economic impacts, was utilized to identify the recommended solution. A full range of biosolids management alternatives were reviewed in the Master Plan. The preferred solution was to implement thermal reduction (incineration) for biosolids management and to continue to use digestion for energy production through co-generation. The solution included construction of a new thermal reduction facility at the Woodward Avenue WWTP. It was anticipated that the preferred solution would be delivered using the City's traditional Design-Bid-Build (DBB) delivery model.

In 2010, subsequent to completing the Master Plan, the City completed Phases 3 and 4 of the Class EA process (Schedule C) for the new thermal reduction (TR) facility, which is documented in an Environmental Study Report (ESR)[2]. With completion of this Class EA, the City has met the Class EA requirements for the implementation of a TR facility and subsequently identified the required budget in 2015.

Since the completion of the Class EA, the land application program had become increasingly less reliable, specifically in 2014, the contractor's storage facility used for the City's biosolids was shut-down, resulting in the need to dispose a significant portion of the biosolids to landfill during months when biosolids could not be land applied (e.g., when ground was frozen or wet). In addition, Federal funding for a Public-Private Partnership (PPP) through a PPP Canada initiative was presented as an option and was further pursued as the preferred path forward for project delivery.

[1] http://www.hamilton.ca/biosolidmasterplan

[2] http://www.hamilton.ca/biosolidmasterplan

1.2 Purpose of this Addendum

Since 2007, new biosolids management opportunities have become available to the City of Hamilton. It is important to consider these now in finalizing the preferred biosolids management approach for the City, so that the selected solution best reflects the Triple Bottom Line.

Specifically, opportunities are as follows:

- The City plans to deliver the new biosolids management program over a 30-year term using a Design-Build-Finance-Operate-Maintain (DBFOM) delivery model, through a Public-Private Partnership (PPP) and has received approval for a funding commitment in support of the project from PPP Canada.
- The quality of the biosolids has improved such that, with adequate processing by enhanced treatment (ET) to remove pathogens, the processed biosolids can be registered as a fertilizer under the Federal *Fertilizers Act*.
- ET technologies reviewed in the Master Plan have matured, and new technologies are now available that have been demonstrated successfully.

This Master Plan Addendum presents more information on each of the above opportunities and rationale for recommending either of the two biosolids management approaches as preferred solutions for the City. The most cost-effective solution, meeting all of the City's criteria for reliability and performance, will be selected through the PPP procurement process. The two recommended biosolids management approaches are:

- Thermal reduction (TR), as recommended in the 2007 Master Plan and subsequent Class EA
- Enhanced treatment (ET), to produce a registered fertilizer product that will be marketed as a fertilizer (beneficial use)

In light of the recommendations from the Master Plan and Class EA and the advances to ET technologies, the City asked that the PPP process be open to both TR and ET processes. Considering a broader range of technologies allows the City to take full advantage of the Design-Build-Finance-Operate-Maintain project delivery model.

1.3 Master Plan Contact Information

This Addendum has been completed following the Class EA process, as outlined in the Municipal Class EA document (October 2000, as amended in 2007 and 2011).

This Addendum will be made available for a 30-day public and agency review period following publication of the Notice of Filing of Addendum. The City will make every effort to address any questions or concerns about the recommendations within the 30-day review period. Contact information for this addendum is as follows:

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For unresolved concerns, members of the public have the right to request a Part II Order within the 30-day review period. Requests for Part II Orders should be submitted, in writing, to the Ontario Minister of Environment and Climate Change:

Minister
Ministry of the Environment and Climate Change
Floor 11
77 Wellesley St West
Toronto ON M7A 2T5
Fax: 416-314-8452

A copy of the written request should also be sent to the proponent and to the Director, Environmental Approvals Branch:

Director, Environmental Approvals Branch
Ministry of the Environment and Climate Change
Floor 12A
2 St. Clair Ave W
Toronto ON M4V 1L5
EAASIBgen@ontario.ca

If no requests are received, the project may proceed as outlined in the Addendum.

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2 2007 Master Plan Overview

2.1 Overview

Biosolids management approaches falling into four general categories were evaluated as part of the Master Plan, as follows:

1. Land application of biosolids (referred to in the Master Plan as Class B Biosolids)
2. Land application of biosolids product resulting from the further processing of biosolids to remove and/or destroy all pathogens (referred to in the Master Plan as Class A Biosolids)
3. Thermal reduction
4. Landfilling

Each of these biosolids management methods are discussed in the following section. Within the Master Plan, land application of Class B biosolids (1.) and landfilling (4.) were screened out as a result of the evaluation. Rationale for these results, and for short-listing beneficial use of Class A (2.) and thermal reduction (3.), are presented at the end of this section.

2.2 Review of Biosolids Approaches

2.2.1 Land Application of Biosolids

This category refers to the beneficial use of biosolids on agricultural land. In the 2007 Master Plan, biosolids that had been digested and dewatered were referred to as Class B material, which is the United States Environmental Protection Agency (U.S. EPA) designation for biosolids. Anaerobic digestion, the current treatment at the Woodward Avenue WWTP, generates a product that meets the requirements of a Class B material, and is the minimum level of treatment acceptable for land application of biosolids.

Agricultural land application of biosolids is regulated by the Province of Ontario under the 2002 *Nutrient Management Act* (NMA). Regulations under the act (O. Reg. 267/03 and O. Reg. 338/09) specify how, where and when biosolids can be spread in Ontario to guard against the contamination of ground and surface water. Biosolids are applied at a rate that allows the crops to use most of the nutrients as they become available. Other controls include acceptable receiving site characteristics and biosolids application constraints such as crop suitability, soil permeability, soil quality standards, depth to ground water, biosolids application rate and timing (with respect to weather and other conditions), and separation distances from waterways, wells and residences.

Farms applying biosolids are required to complete a NASM (Non-Agricultural Sources Material) Plan, which reports the proposed application rates of material, under the NMA regulations. Soil tests are required to ensure an agricultural field is suitable to receive municipal wastewater biosolids. The concentrations of phosphorous and metals in the soil, and the acidity or alkalinity (pH) of the soil must meet provincial standards. The application rate or the amount of biosolids applied to an agricultural field is based on the soil test results for the field and crop nutrient requirements. In addition, regulations also limit the amount of heavy metals and solids that may be applied to the soil and these restrictions can influence the application.

Other site standards in the regulations include:

- Lands that receive biosolids must be a minimum distance away from residences, residential and commercial areas, municipal and private wells, and surface watercourses.
- Surface slopes must not exceed specified limits (to avoid runoff).

- Depth of soil to bedrock and groundwater must meet minimum requirements (to avoid potential effects on groundwater).
- Timing, method, and rate of application must be appropriate for the conditions at each site and the farmer's crop production system.
- Spreading during frozen conditions is not permitted.

Municipal wastewater treatment plants, land applicators, and farmers are required to keep detailed records for all sites where biosolids are applied to agricultural land.

Based on the land application constraints in Ontario's climate, where there is no other outlet for biosolids during non-spreading periods, as described above, seasonal storage is required. Generally, 240 days storage is recommended for seasonal storage, to provide capacity for periods when biosolids cannot be land applied, and to allow for weather variability.

An example of recently documented hardship in land application for Ontario Municipalities is the City of Toronto, who operates a biosolids management program with a Council-approved goal to provide 100% beneficial use (on land) for approximately 140,000 tonnes per year of biosolids from the Ashbridges Bay Treatment Plant (TP). In a report on the 2012 biosolids program[3], only 40,000 wet tonnes per year of biosolids (Class B) went directly or via seasonal storage to agricultural land. Due to lack of available land and seasonal storage capacity, the remainder was hauled to a range of processing facilities or to landfill.

2.2.2 Beneficial Use of a Class A Biosolids

In the 2007 Master Plan, a number of technologies were identified as meeting Class A (also a U.S. EPA term) requirements. These technologies process the biosolids to virtually remove or destroy all pathogens. Some of these technologies increase the volume of material to be hauled off-site while other technologies decrease the volume.

With processing to remove pathogens, the processed material could potentially be registered as a fertilizer product by the Canadian Food Inspection Agency (CFIA) of Agriculture and Agri-Food Canada, a department of the federal government, meeting regulatory requirements under the Federal *Fertilizers Act*.

With CFIA registration, the material can be distributed as a fertilizer product, subject to the requirements of the Federal *Fertilizers Act*, including provisions for content, benefit claims and labelling. With this registration in place, management of the product would be exempt from the requirements of the *Nutrient Management Act* and regulations, significantly reducing the restrictions on when and where the material can be used. Having noted that, fertilizer use in Canada remains a seasonal practice due to climate; and therefore, storage would still be required.

It is important to note that in the 2007 Master Plan, it was recognized that some of the metals concentrations in the Woodward Avenue WWTP biosolids exceeded the maximum levels allowed by the CFIA. Therefore, the Master Plan assessed that while there may be fewer restrictions in the management of a Class A (pathogen-free) biosolids, compared to a Class B biosolids, there was a risk that the material could not be registered as a fertilizer. As such, management under the *Nutrient Management Act* as described in Section 2.2.1 would be required.

2.2.3 Thermal Reduction

2.2.3.1 Description

Fluidized bed incineration is the most commonly used thermal reduction technology used for biosolids. Incineration is the combustion of the organic (carbon containing) solids in wastewater treatment residuals in the presence of oxygen to form carbon dioxide, water and very low levels of regulated exhaust emissions such as carbon monoxide (CO), total hydrocarbons (THCs) and oxides of nitrogen (NO_x). The temperature in

[3] http://www.toronto.ca/legdocs/mmis/2013/pw/bgrd/backgroundfile-58089.pdf

the combustion zone of furnaces is typically 760 to 870 °C. The inert solids that remain at the end of the process are in an inorganic form commonly known as ash.

Incineration takes advantage of the fuel value of biosolids, and the energy recovered can be used in heat exchangers and waste heat boilers to offset other energy uses within the plant. The process results in a large reduction of the biosolids in both volume and mass in comparison to other management options. The mass of solids in the ash is approximately 20 to 45% of that in the incinerator feed, thus reducing the mass that must be further managed off-site.

Incineration also achieves complete destruction of pathogens (disease-causing organisms), as well as organics. The remaining ash is inorganic and not susceptible to further biological activity or decomposition. It may be disposed as a conventional waste (i.e., non-hazardous).

All exhaust gases and solids (i.e., ash) are carried out the outlet at the top of the furnace unit. In the fluidized bed design, good fuel-air mixing is achieved and typically only 30 to 50% excess air (over that required for complete combustion) is required. The design also allows for good control of combustion air. These features result in near complete combustion and very low levels of regulated exhaust emissions such as carbon monoxide (CO), total hydrocarbons (THCs) and oxides of nitrogen (NO_x).

2.2.3.2 Ash Management

Typically, the ash resulting from the incineration process is mixed with effluent water from the scrubbers and pumped to ash lagoons where it is stored on-site for extended periods of time or indefinitely. When a lagoon is full, ash is removed and typically hauled to a sanitary landfill site for final disposal. At facilities where there is inadequate space for ash storage lagoons, ash is settled in settling basins, dewatered, temporarily stored and hauled off-site on a regular basis.

2.2.3.3 Experience

In Ontario, there are four biosolids incinerators, at the Highland Creek Treatment Plant in Toronto, G.E. Booth WWTP in Mississauga, Duffin Creek WWTP in Whitby and the Greenway WWTP in London.

2.2.3.4 Regulations

Thermal reduction (TR) facilities are governed by the terms and conditions of site-specific Environmental Compliance Approvals (ECA) for air emissions monitoring and maximum acceptable levels. These ECAs provide a general description of the emissions equipment discharging contaminants to the air, and specify monitoring and reporting requirements, including dispersion modelling reports based on O. Reg. 419 (MOE 2008). The O. Reg. 419 requirements are summarized in a single document entitled *Summary of Standards and Guidelines to Support Ontario Regulation 419: Air Pollution – Local Air Quality (Including Schedule 6 of O. Reg. 419 on Upper Risk Thresholds)*. Contaminants included in the regulation include particulate matter, ammonia, combustion gases, metals (including mercury), polychlorinated aromatic compounds (including dioxins and furans), volatile organic compounds, and total hydrocarbons.

As part of the Class EA completed for biosolids incineration at the Woodward Avenue WWTP, the City completed a Human Health Risk Assessment study of the emissions, in consultation with the Ontario Ministry of Environment and Climate Change (OMECC). OMECC approved the emission control strategy for the proposed facility.

The OMECC reviews current and anticipated regulatory trends at the Canadian federal level and in the United States in establishing terms and conditions for the ECA. In the United States, several regulatory considerations apply to facilities that incinerate sludge and/or biosolids. The United States 40 Code of Federal Regulations (CFR) Part 503 Biosolids Rule includes contaminant limits for metals, mercury, particulate matter, nitrogen oxides, sulphur oxides, total hydrocarbons and carbon monoxide.

In a review of the adequacy of the regulations, the U.S. EPA found that the risk to human health from dioxin and furan emissions from wastewater solids and biosolids incineration were negligible, and that the existing

regulations were adequate to protect the environment and human health. No additional regulations were recommended (Federal Register 2003) (Federal Register 2001).

Pollutants will not be in the incinerator emissions if they (or their precursors) are not in the sludge and/or biosolids. Sewer use by-laws enforced by the City of Hamilton also ensure that high concentrations of pollutants that could contaminate wastewater solids are controlled at the source and eliminated from the sewers.

Residual from thermal destruction (e.g., ash) is a non-hazardous waste and can be disposed at any waste management site with an ECA under the Ontario *Environmental Protection Act* (EPA) (R.R.O, 1990) and O. Reg. 347 that is approved for the management and disposal of waste, such as a municipal landfill, unless there are site-specific exceptions within the ECA.

2.2.4 Landfilling

Landfilling refers to the disposal of biosolids in a municipal landfill. In the Master Plan, it was identified that landfilling at the City of Hamilton's Glanbrook Landfill would not be consistent with the aggressive waste diversion target to extend the life of the landfill. Poor public acceptance was identified as the reason for not using biosolids as landfill cover material; however, the Master Plan did not identify how much of the biosolids could be used for this purpose. There were limited private landfills that could accepted biosolids in Ontario, and due to the long haul distance and uncertainty in securing a long-term contract, landfilling in the U.S. was not considered an attractive option.

2.3 Evaluation of Biosolids Management Approaches

The 2007 Biosolids Master Plan (BMP) evaluated a long list of biosolids management alternatives against a set of criteria that reflected a triple-bottom-line (TBL), to minimize environmental impacts, community (social) impacts, and cost. As part of the BMP, a Stakeholder Advisory Committee (SAC) was formed and met with the project team to review the project and recommendations at three points during the project.

The Master Plan team considered the input from the SAC to identify and short-list the following biosolids management approaches for detailed comparative evaluation:

- **Processing to achieve a Class A biosolids:** While it was recognized that even with a higher level of processing, the resulting processed biosolids would still need to be managed as a Class B biosolids under the *Nutrient Management Act* regulations (because of the metals content), it was thought that the lower pathogen content and less potential for odour generation would make a Class A biosolids more acceptable to the public, thereby, having less resistance to land application programs.
- **Thermal Reduction:** Thermal reduction was short-listed because it provides significant volume reduction, cost-effectiveness and there are a number of Ontario biosolids incineration facilities that operate and demonstrate that all air emission requirements can be readily met, in addition to meeting other requirements such as complete pathogen destruction and method of disposal.

Management of a Class B (anaerobic digestion without further processing) biosolids was not short-listed because of concerns related to the long-term reliability, in light of an increasingly smaller land base and public objections related to odour and pathogens.

Landfilling was not short-listed. As noted above, there were limited options for local landfill disposal, and uncertainty in the availability of landfill capacity in the U.S. within a reasonable haul distance. Also, landfilling does not take advantage of the energy or nutrient properties of the biosolids.

As discussed above, two biosolids management approaches were short-listed in the Master Plan, including enhanced treatment (ET) to produce a Class A biosolids and thermal reduction (TR). Several different ET processing methods were assessed; however, many were screened out for various reasons. Two ET

processing technologies, temperature-phased anaerobic digestion (TPAD) and alkaline stabilization, were evaluated, together with thermal reduction.

Based on a qualitative evaluation of the three options, thermal reduction (TR) was recommended in the 2007 Master Plan.

Section 3 presents new opportunities and an up-to-date review of the technologies assessed in the Master Plan, and others that have been successfully demonstrated since then, to present rationale that either of thermal reduction (TR) and enhanced treatment (ET) are preferred biosolids management approaches for the City of Hamilton.

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3 Opportunities – Rationale for Addendum

3.1 PPP Project Delivery

In 2011, the City of Hamilton identified the opportunity to deliver the biosolids management project using an alternative project delivery model, known as Public-Private Partnership (PPP or P3). Using this public sector/private sector approach allows the City to share project risks with a private sector partner. In comparison to the City's traditional Design-Bid-Build (DBB) delivery model, where the City retains risk associated with the individual phases of implementation, the Design-Bid-Finance-Operate-Maintain (DBFOM) delivery model that is utilized in PPPs transfers the responsibilities for all phases of implementation to a private partner. Using this model, the City's risk is reduced by having only one contract (with the DBFOM contractor) as opposed to having one contract for each phase of implementation.

Subsequent to the completion of the Class EA, the City received a funding commitment from PPP Canada in support of the biosolids management project.

Through the PPP process, the City will retain a project team to fully deliver the 30-year biosolids management program, providing the following services:

- Construction of all on-site facilities required for processing, truck-loading, storage and administering the biosolids management program
- Operation and maintenance of the biosolids management facilities for a 30-year period
- Project financing
- Management, including haulage, distribution, sale and/or disposal (e.g., ash) of the processed material.

Ultimately, at the end of the 30-year period, the City will own all facilities at the Woodward Avenue WWTP site.

Using a PPP process for biosolids management offers the City the following advantages:

- The City can specify all of the criteria for the biosolids management program, including performance criteria as related to odour, noise, and aesthetics, to minimize impacts to the community.
- The competitive process ensures that the City will select the lowest life-cycle cost solution that meets all of the specified performance criteria.
- The process allows for the proponents to be innovative in the program delivery, increasing cost competitiveness.
- The City minimizes its cost risk, because the cost of biosolids management over the next 30 years will be clearly defined through a Council-endorsed affordability cap.
- Through PPP Canada, the City has been approved for Federal funding for 25% of the on-site capital cost of the project, up to a total subsidy of $22.9 M.

The PPP is a competitive procurement process that will proceed in two phases:

1. **Prequalification:** Proponent teams will be required to submit a proposal to demonstrate that they are qualified to deliver the project and they can meet all of the City's mandatory requirements for project delivery. Qualifications will be based on:
    - Demonstrated experience with the proposed processing equipment (ET or TR) at facilities of similar size, and demonstrated experience in operations, maintenance and management of the product (fertilizer or ash)

- Ability to fit the proposed biosolids management solution in the allocated space at the Woodward Avenue WWTP
- Approach to provide reliable year round management of the product (fertilizer or ash), including contingencies, equipment redundancies and/or provisions of on- and off-site storage as to ensure uninterrupted processing of City Biosolids.
- Ability to provide project financing.

2. **Proposal:** Short-listed proponent teams will submit technical proposals to the City that demonstrate how their approach, including capital works, technology, operation, maintenance, and biosolids management plan, will achieve the City's specifications defined in a detailed Terms of Reference. Those proposals will include preliminary design of the facilities, operating and maintenance details, and product or residual (ash) management approach. A separate cost proposal will be submitted to provide pricing details for the 30-year life of the contract.

Through the evaluation process, a Preferred Proponent will be identified and recommended to City Council for approval.

3.2 Biosolids Quality

Since 2007, the metals concentrations of the biosolids have decreased such that biosolids processed using an ET technology can now be eligible for CFIA registration as a fertilizer product under the Federal *Fertilizers Act*. Table 1 compares Woodward Avenue WWTP biosolids metals content to maximum allowable levels as a fertilizer, as regulated by the CFIA of Agriculture and Agri-Food Canada under the Federal *Fertilizers Act*.

Table 1 Metals Concentrations in Woodward Avenue WWTP Biosolids Compared to Maximum Allowed in Fertilizers

	Concentration in mg/kg dry weight		
	Woodward Avenue WWTP Biosolids[1]		Fertilizer[2]
	2013	2014	
Arsenic	8.9	9.1	75
Cadmium	1.3	1.6	20
Cobalt	7.9	7.4	150
Mercury	0.23	0.26	5
Molybdenum	10.4	9.0	20
Nickel	35	33	180
Lead	59	100	500
Selenium	6.5	5.1	14
Zinc	818	869	1,850

Notes:
1. Woodward Avenue WWTP Annual Report
2. Canadian Federal *Fertilizers Act*

Enhanced treatment (ET) to process biosolids, referred to in the Master Plan as producing a Class A product, provides virtual elimination/destruction of pathogens. These Enhanced Treatment (ET) processes are now able to process biosolids to produce a material that can be registered and distributed as a fertilizer by CFIA.

With CFIA registration, the material can be distributed as a fertilizer product, subject to the requirements under the Federal *Fertilizers Act*, including provisions for content, benefit claims, and labelling. With this registration in place, management of the product is exempt from the requirements of the *Nutrient*

Management Act and regulations, significantly reducing the restrictions on when and where the material can be used. Having noted that, fertilizer use in Canada remains a seasonal practice due to climate; and therefore, storage is required. The CFIA registration form included in the regulation provides specific direction on the information required to register a fertilizer product.

3.3 Enhanced Treatment Technologies

3.3.1 Overview

In the Master Plan, a number of ET technologies were reviewed. Since completing the Master Plan, many of these technologies have matured and others have been successfully demonstrated. In addition, as discussed in Section 3.2, due to the improved quality of the biosolids, processing biosolids with any of these ET technologies result in a product that can be registered and marketed as a fertilizer.

For information, the following sections present a brief description of enhanced treatment technologies available that may be proposed through the PPP procurement process. This list is provided for information and not meant to be inclusive, and other technologies may be proposed and evaluated through the process.

3.3.2 Temperature-Phased Anaerobic Digestion

In the Master Plan, alternatives to the existing anaerobic digestion process were reviewed, that included high-temperature digestion phases to destroy pathogens. Temperature-phased anaerobic digestion (TPAD) was ranked highly as one approach to enhanced treatment.

High temperature (thermophilic) digestion occurs at temperatures between 50 and 75 °C, compared to 35 °C for the existing mesophilic digestion process. At the higher temperature, the biochemical reaction rates increase, thereby requiring a shorter hydraulic retention time (HRT) in the digester tanks (and a smaller volume of digester required).

Incorporating a thermophilic phase upstream of the existing digestion process, referred to as temperature-phased anaerobic digestion (TPAD), was considered to be one type of configuration for the Woodward Avenue WWTP. This process would generate a material physically similar to biosolids, with elimination of the pathogens and potentially less odour.

While the TPAD final product can be distributed as a fertilizer, seasonal storage would be required due to Ontario (and surrounding area) climate and growing seasons. For this type of material, an open or closed building (depending on the proximity to neighbours), including concrete pad and cover, would be required to provide storage appropriate to seasonal restrictions for use of the product.

3.3.3 Thermal Hydrolysis

Similar to the TPAD process, by pre-treating the sludge under high pressure and temperature before digestion, pathogens are eliminated. The resulting digested material, similar in physical qualities and appearance to biosolids or TPAD product, could be registered as a fertilizer product. Since this technology was relatively new to North America at the time of the 2007 Master Plan, it was not reviewed.

Thermal hydrolysis of sludge prior to anaerobic digestion has been implemented in over 25 locations in Europe since 1995, and there are now a few installations in Japan, Australia, United Arab Emirates and Chile. There is limited North American experience; however, the largest thermal hydrolysis facility in the world is currently being commissioned in Washington, DC, at the Blue Plains Advanced Wastewater Treatment Facility with a capacity of 1,500 tonnes of biosolids per day.

Thermal hydrolysis is a high-pressure steam treatment process. Prior to digestion, sludge is dewatered to 15% to 20% solids and fed through a hydrolysis vessel. The process involves the oxidation of sludge under elevated temperature (approximately 160 °C) and pressure (approximately 689 kPa). Under these conditions, pathogens are destroyed and cell structures in the sludge breakdown, releasing energy-rich compounds. Following hydrolysis, sludge is fed to the anaerobic digester where it readily breaks down into

easily biodegradable compounds, resulting in high volatile solids (organics) destruction and increased biogas production compared to conventional anaerobic digestion. In addition, the liquid digested biosolids are easier to dewater, reducing water content and mass of the biosolids that need to be further managed.

Similar to the product generated through TPAD, seasonal storage would be required due to Ontario (and surrounding area) climate and growing seasons. For this type of material, an open or closed building (depending on the proximity to neighbours), including concrete pad and cover, would be required to provide storage appropriate to seasonal restrictions for use of the product.

3.3.4 Alkaline Stabilization

Alkaline stabilization was ranked highly in the Master Plan as one approach to ET.

Alkaline stabilization involves mixing biosolids with an alkaline material, such as lime, cement kiln dust and fly ash. When the pH value of the mixture is maintained at or about 12 for at least 72 hours, and the temperature of 52 °C is maintained for at least 12 hours of this period, the resulting material will be adequately treated to meet the requirements of the Federal *Fertilizers Act*, for registration as a fertilizer product. The alkaline stabilized material can be used as a lime substitute, source of organic matter or specialty fertilizer. The material offers the benefits of improving soil properties such as pH, texture and water holding capacity.

The equipment used for alkaline stabilization includes feed conveyance equipment, an alkaline material storage and conveyance system, and mixer. Some proprietary technologies include heat drying to produce a drier finished material.

The volume of alkaline stabilized material to be transported would be more than the volume of biosolids due to the large volume of added chemicals. The volume of material to be managed and moved off-site is increased by approximately 10 to 50 percent.

While the final product can be distributed as a fertilizer, seasonal storage would be required due to Ontario (and surrounding area) climate and growing seasons. For this type of material, an open or closed building (depending on the proximity to neighbours), including concrete pad and cover, would be required to provide storage appropriate to seasonal restrictions for use of the product.

The process has been widely used in North America for more than 20 years. In Ontario, alkaline stabilization has been practiced for several years at smaller wastewater treatment facilities in Leamington and Sarnia. Both of these facilities process less than 20 dry tonnes per day. A larger facility operates in the Region of Niagara, Ontario, to process a portion of biosolids generated in the Region. Some material generated at the City of Toronto Ashbridges Bay Treatment Plant is also sent to this facility.

3.3.5 Heat Drying (Pelletization)

Biosolids drying, or pelletization, is the use of heat to evaporate water from biosolids, generating a finished material with a water content of 10% or less. The dried material is in pellet form, typically 2 to 4 mm in size, similar to some commercial fertilizers. The high temperature in the process destroys the pathogens within the biosolids. The volume of dried pellets generated from the process is about 30% of the volume of the biosolids feed.

Bulk storage of the dried product must be designed to keep the product dry. Engineered silos and other systems can be used to meet this need. However, the pellets can also be bulk-bagged and hauled off-site for seasonal storage at their ultimate destination.

In the 2007 Master Plan, the heat drying process was ranked poorly due to safety concerns with facility fires, including those that had been experienced in Windsor and Toronto facilities. Since that time, facility designs have improved to minimize fire risks. As of 2012, there were more than 60 drying systems operating in the U.S., and more than 100 in Europe. In Canada, thermal drying technology has been installed in several larger cities in Quebec, including Montreal, Quebec City and Laval. In Ontario, the facility at Toronto Ashbridges

Bay Treatment Plant has been operating without incident for more than 4 years, and processed 61,000 tonnes of biosolids in 2013.

The thermal drying process has been in use since the 1920s in the U.S., with Milwaukee, WI, being the first large scale program, producing a pellet product distributed as Milorganite®. Currently, cities such as New York, Boston, Baltimore, Tampa, and Houston are using drying for either all of their biosolids production, or a significant portion. Facilities range in size from less than 1 dry tonne per day up to 270 dry tonnes per day.

3.3.6 Composting

Composting of biosolids was reviewed in the 2007 Master Plan. It was ranked poorly because the metals content of the biosolids exceed Ontario guidelines for compost material for some of the metals. However, the compost produced from biosolids would meet the Federal *Fertilizers Act* requirements, and compost from biosolids could be marketed as a fertilizer product. As such, this technology is included as a potential ET technology in this Addendum.

Composting is the aerobic biological degradation of organic materials under controlled conditions. The process stabilizes biosolids by destroying pathogens (disease-causing organisms), minimizing odour, and reducing vector attraction potential (i.e., reducing attractiveness of biosolids to birds, rodents and insects). The stabilized compost product can be used as a soil amendment or mulch in landscaping, horticulture, and agriculture. There are three general methods of composting biosolids: windrow, aerated static pile, and in-vessel. Each method uses the same scientific principals but varies in procedures and equipment needs.

For the windrow system, the biosolids are mixed with other materials such as wood chips, which help to trap air in the pile, referred to as bulking agents. The biosolids and the bulking agents are piled in rows and mechanically turned periodically. The aerated static pile is a type of composting system where the material to be composted is mixed with the bulking agent and an air distribution system is used to force air through the materials. In-vessel composting occurs within an enclosed composting vessel in which operating conditions are controlled and monitored. Biosolids and bulking agents are first mixed before being introduced to the composting vessel. Air is introduced to the enclosed composting vessel, and mixing is provided.

The finished compost can be stored in covered bulk handling facilities to provide storage appropriate to seasonal restrictions for use of the product. Otherwise, compost could be bagged and marketed year round.

The volume of compost produced from biosolids would be more than the initial volume of unprocessed biosolids due to the large volume of added bulking agents required for composting biosolids.

The majority of composting facilities in Canada are located in British Columbia, Quebec and New Brunswick, although some facilities that compost other materials (e.g., green bin waste, leaf and yard waste) also accept compost.

3.3.7 Chemical Lysis

A process that uses chemical lysis to eliminate pathogens in the sludge is available and has been demonstrated in Ontario. The lysis process involves a combination of heat, alkali, and high-shear mixing to produce a liquid fertilizer product that can be registered for distribution under the Federal *Fertilizers Act*. The product can be stored for extended periods of time.

Like other ET products, the stabilized liquid material can only be applied to land on a seasonal basis, and therefore requires liquid storage facilities to provide storage appropriate to seasonal restrictions for use of the product.

3.4 Summary of Opportunities and Rationale for Addendum

Since the 2007 Master Plan, new opportunities have presented themselves for the City to secure the most sustainable program for biosolids management for a 30-year term. Section 3 presented those opportunities, as follows:

- The City has the opportunity to deliver the program through a Public-Private Partnership (PPP) approach, which reduces the City's risks, and ensures cost-competitiveness in establishing a 30-year strategy that fully meets all criteria for performance and reliability.
- The Woodward Avenue WWTP biosolids quality has improved, such that biosolids processed through an enhanced treatment (ET) technology meet the quality requirements and can be registered and marketed as a fertilizer.
- There are a number of ET technologies that have matured and/or been demonstrated successfully that are now available to the City. By opening the PPP procurement process up to both thermal reduction (TR) technology, as recommended in the Master Plan, and ET technology, the City is assured that the process will be competitive and will result in selection of the most sustainable biosolids management program for the City.

4 Biosolids Management Using Enhanced Treatment

4.1 Project Components

This section presents an overview of how biosolids would be managed using an enhanced treatment management approach, and how impacts considered in the Master Plan will be mitigated through the PPP procurement process. As noted, the option of biosolids management using a thermal reduction (TR) process continues to be one of the preferred biosolids management approaches. This approach is not discussed in detail within this document, because no changes to the recommendations in the 2010 Class EA that developed the preferred design concept and implementation approach for a TR process are being recommended in this Addendum.

Specifically, the recommended ET approach presented in this Addendum includes the following components:

- **Biosolids equalization:** Equalization of biosolids feed to the new processing facility would be provided by the proponent to account for variability in biosolids generation from the Woodward Avenue WWTP, with a goal to provide uninterrupted operation.
- **Biosolids processing at the Woodward Avenue WWTP:** For a biosolids management program based on ET, facilities would be constructed on-site to process the biosolids, using any one of the technologies (or others proposed) that can produce a product that can be registered as a fertilizer.
- **Truck loading:** All of the ET processes will generate fertilizer product that will need to be loaded onto trucks for off-site storage and/or distribution. Truck loading facilities will be designed specifically for the physical characteristics of the fertilizer product.
- **Product storage:** On-site and off-site project storage will be required as to demonstrate reliability and uninterrupted service compatible with the seasonal use of fertilizer products in this climate or any other final disposal option. Storage can be provided through engineered facilities (such as buildings or lagoons) or bulk-bags, as appropriate to the product.
- **Product registration and marketing:** All product produced using ET technology will be required by the City to be registered and marketed as a fertilizer under the Federal *Fertilizers Act*.

4.2 Location on the Woodward WWTP Site

Figure 1 presents the location available for the biosolids management facilities on the Woodward WWTP site. The technical specifications in the PPP procurement process will require that all ET processing, biosolids equalization, any on-site product storage, and truck loading facilities be located within this area. The City needs to reserve site capacity for future expansion and upgrades of the wastewater treatment plants, and therefore, proponents with facilities larger than this area will be disqualified in the prequalification stage.

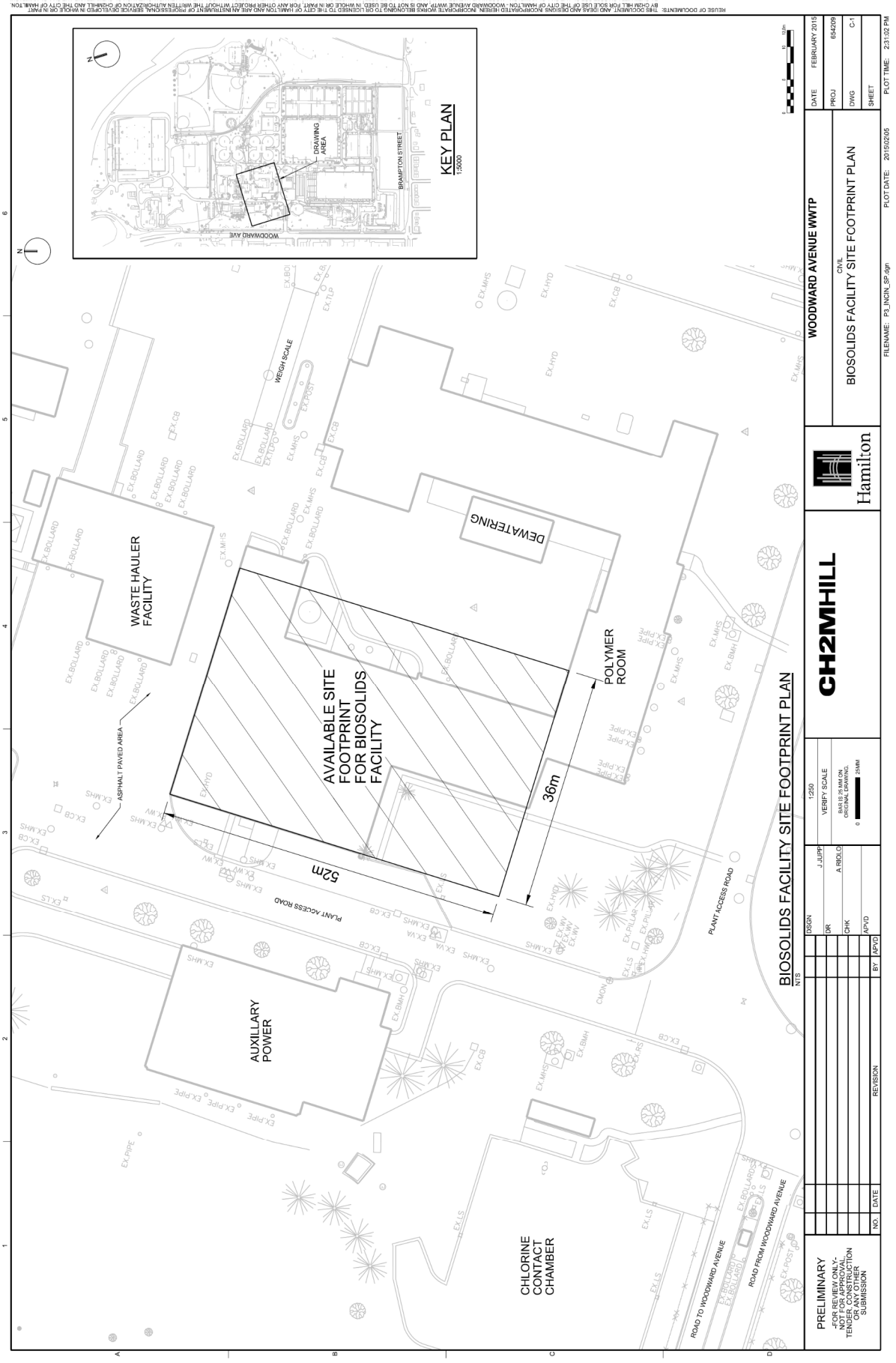

Figure 1 Site Available for a New Biosolids Facility at the Woodward Avenue WWTP

4.3 Impact Mitigation Measures

Through the technical specifications established for the technical proposals, the City will have the opportunity to establish criteria for the facility design and operation, to minimize environmental, health and safety and community impacts of the new biosolids management facilities. Specifically, criteria will be established for the following:

- **Technical performance:** Product of consistent quality to be registered as a fertilizer.
- **Facility operation:** On-site equalization storage of biosolids and product, equipment redundancy and contingency to minimize disruption to biosolids management program.
- **Year round management program reliability:** Demonstrated markets, and for products that are dependent on a seasonal market, storage (on- and off-site) appropriate to seasonal restrictions for use of the product.
- **Operator health and safety:** Facility design and operation plan to meet all building codes and legislative requirements, including ventilation and fire protection.
- **Odour and noise:** Facility design to require odour and noise control measures, so that there is no increase in odours or noise from existing levels at the property boundaries.
- **Traffic:** Facility operation to minimize traffic impact to the residences and businesses in the vicinity of the Woodward Avenue site.

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5 Summary and Recommendations

In 2007, the City completed a Biosolids Master Plan that led to the recommendation of a preferred biosolids management solution using thermal reduction (TR) technology. Since preparation of that Master Plan, biosolids management opportunities have become available to the City of Hamilton. It is important to consider these now in finalizing the preferred biosolids management approach for the City, so that the solution selected for the City best reflects the Triple Bottom Line.

In the 2007 Master Plan, four biosolids management approaches were evaluated, including:

1. Land application of biosolids (referred to in the Master Plan as Class B Biosolids)
2. Land application of biosolids product resulting from the further processing of biosolids to remove and/or destroy all pathogens (referred to in the Master Plan as Class A Biosolids)
3. Thermal reduction
4. Landfilling

Within the Master Plan, land application of Class B biosolids (1.) and landfilling (4.) were screened out as a result of the evaluation. In this Addendum, there is no change to this Master Plan recommendation. However, because new opportunities are available, the further processing of biosolids (enhanced treatment or 'ET', option 2.) is now identified, together with thermal reduction (or 'TR', option 3.), as a preferred solution for the Hamilton biosolids.

The rationale for short-listing either ET or TR approaches as preferred in this Addendum is that ET is equally capable of meeting the criteria that were established for TR. Specifically:

- The City has the opportunity to deliver the program through a Public-Private Partnership (PPP) approach, which reduces the City's risks, and ensures cost-competitiveness in establishing a 30-year Design-Build-Finance-Operate and Maintenance (DBFOM) strategy that fully meets all criteria for performance.
- The Woodward Avenue WWTP biosolids quality has improved, such that a biosolids processed through an enhanced treatment (ET) technology meets the quality requirements and can be registered and marketed as a fertilizer.
- There are a number of ET technologies that have matured and/or been demonstrated successfully that are now available to the City. By opening the PPP procurement process up to both thermal reduction (TR) technology, as recommended in the Master Plan, and ET technology, as recommended in this Addendum, the City can be assured that the process will be competitive and will result in selection of the most cost-effective biosolids management program for the City.

Through the technical specifications established for the technical proposals, the City will have the opportunity to establish criteria for the facility design and operation, to minimize environmental, health and safety and community impacts of the new biosolids management facilities. Specifically, criteria will be established for the following:

- Technical performance
- Facility operation
- Year round management program reliability
- Operator health and safety
- Odour and noise

With completion of a 30-day Public Review period for this Addendum to the 2007 Master Plan, and based on no requests for Part II orders, all Class Environmental Assessment requirements will be met, so that the City can proceed with the procurement of 30-year biosolids management program open to enhanced treatment (ET) and thermal reduction (ER) technologies.