

CITY OF HAMILTON

***PUBLIC WORKS DEPARTMENT
Water and Wastewater Division***

Report to: Chair and Members Public Works Committee	Submitted by: Gerry Davis, CMA General Manager Public Works Department
Date: August 31, 2009	Prepared by: Jim Harnum Extension 4483 Chris Shrive Extension 7209

**SUBJECT: Schedule C Class EA Biosolids Management Environmental Study Report - (PW07047b) - (City Wide)
*Public Works Committee Outstanding Business Item***

RECOMMENDATION:

- (a) That Council endorse the Schedule C Class EA Biosolids Management Environmental Study Report (Phases 3 and 4 document of the Class Environmental Assessment) and its preferred strategy of thermal reduction (fluidized bed incineration with energy recovery through steam generation);
- (b) That upon completion of the minimum 30 day review period, the General Manager, Public Works be authorized and directed to proceed with detailed design and implementation of the preferred solutions of the Class Environmental Assessment for the Biosolids Management Plan, provided that no bump-ups request are received from the public or Part 2 Orders received from the Ministry of the Environment (MOE);
- (c) That the item respecting "Biosolids Management Plan" be removed from the Outstanding Business List on the Public Works Committee Agenda.

Gerry Davis, CMA
General Manager
Public Works Department

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EXECUTIVE SUMMARY:

In order to meet existing commitments, accommodate future growth, and address regulatory requirements, a Biosolids Master Plan (BMP) for the City of Hamilton was developed to identify a preferred biosolids management strategy. The preferred long-term strategy of thermal reduction for the management of the City's biosolids was approved by Council in August 2007.

Additional detailed Triple Bottom Line assessments, including the potential for energy recovery of the report's recommended BMP alternative have since been undertaken through a Schedule C Class EA process, resulting in the identification of a preferred management strategy of fluidized bed incineration (with energy recovery through steam generation) for the City's biosolids over the next 30 years and beyond.

BACKGROUND:

The recommendations contained within this report have City wide implications.

The Biosolids Master Plan (BMP), as framed by the MEA's Municipal Class EA, entails a two-phase process with problem/opportunity identification undertaken in the first phase, and alternative solution/strategy identification, evaluation and the selection of a preferred solution/strategy undertaken in Phase 2. The latter stages of Phase 2 of the current Master Planning process culminated in the recommendation that the City undertake thermal reduction of the biosolids and disposal of the residual ash. A full description of BMP assessment activities and findings, including current practices, problem identification, technical review and analysis, alternative assessment and consultation leading to the identification of recommended alternatives, is described in the Biosolids Master Plan, August 2007, summarized in staff report PW07047(a) and approved by Council with an additional recommendation on August 8, 2007.

Additional detailed Triple Bottom Line assessments, including the energy recovery potential of that report's recommended BMP alternatives have since been undertaken through a Schedule C Class EA process, resulting in the identification of a preferred management strategy for the City's biosolids over the next 30 years.

In the Phases 3 and 4 Class EA study, sludge generation rates were projected for the planning period, from 2009 through to 2031. These were based on population projects for the Hamilton service area, as developed through the strategic policies generated in VISION 2020, "Building a Strong Foundation" (BASF), and its Growth Related Integrated Development Strategy (GRIDS).

Currently, approximately 60 dry tonnes per day of untreated sludge is projected to increase to about 100 dry tonnes per day in 2031. This corresponds to a current population of 380,000, with an expected increase to 600,000 by 2031.

ANALYSIS/RATIONALE:

In the 2007 Master Plan (Phases 1 and 2 of the Class EA process), thermal reduction and ash disposal were identified as the preferred long-term solution for managing Woodward Avenue Wastewater Treatment Plant (WWTP) biosolids. In Phases 3 and 4, the design concept for the entire sludge treatment train was developed, considering a Triple Bottom Line balance of:

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- Protecting the environment
- Minimizing social (community) impacts
- Minimizing costs

In addition, since wastewater sludge has an inherent energy value but also requires energy to process, transport and dispose, design concepts were evaluated in light of the City's Corporate Energy Policy. Specifically, evaluation criteria were developed with a goal to maximize the analysis of energy recovery and sustainability. A comprehensive range of technology options were therefore considered for each of the following steps of the sludge processing train:

- Digestion
- Energy recovery from digester gas
- Thermal reduction and energy recovery from waste heat.

For each of the technologies, quantitative impacts and benefits such as capital and operating costs, use of non-renewable energy services, energy and cost recovery, and greenhouse gas generation, were calculated. In addition, other potential impacts on reliability as related to the Triple Bottom Line goals were assessed. A comparative evaluation, with each process train consisting of compatible technologies, was completed to identify the preferred design concept for biosolids processing.

Many of the technologies that were identified to achieve the City's goals for energy efficiency are in limited use or not demonstrated in North America. Europe is advanced in the full-scale application of these technologies, however, due to high fuel prices and government environmental policies. During the Phase 3 and 4 Class EA study, the City and consultant project team visited a number of full scale facilities in the UK and Europe, to understand the facilities, operations and maintenance requirements, and applicability specifically to the Woodward Avenue WWTP.

To follow is an overview of each of the potential technologies considered in the development of a preferred design concept for the Woodward Avenue WWTP, the first two sections below (Digestion and Energy Recovery from Digester Gas) are outside of the scope of this Schedule C Class EA process, but are briefly summarized here for completeness

Digestion

The biological anaerobic digestion process generates a gas that is about 65% methane, about 33% carbon dioxide, with the remainder being hydrogen sulphide and other sulphurous and trace compounds. Due to the high methane content, the gas has energy value.

The digestion process is relatively efficient, converting (i.e., biodegrading) about half of the organic matter in the sludge into gas. However, technologies are available to condition the sludge upstream of the digesters (i.e., pre-condition), to enable a greater digestion the organic matter, and to therefore increase the generation of this gas. Various technologies are available using heat, chemical-mechanical processes and sound waves (sonification), all of which essentially break-up the biological material to a more readily biodegradable state. Full scale facilities have demonstrated that digester gas generation can be increased by approximately 50% with the use of pre-

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conditioning. Depending on the technology, other advantages such as improved dewaterability of the biosolids, can also be realized.

Energy Recovery from Digester Gas

At the Woodward Avenue WWTP, cogeneration using digester gas as fuel is currently practiced. This process recovers about 60% of the energy value of the gas, both as electricity and as heat. The latter is used to replace natural gas required to heat the digestion process.

Cleaning the digester gas to natural gas quality is an approach used prominently in Sweden, with expanding use in other European countries. Simple and low-cost proprietary technologies are used to remove carbon dioxide, strip impurities and dry the gas, which is then compressed for injection into the natural gas distribution system and/or used for vehicle fuel. In a growing number of cities, the gas is used to fuel maintenance vehicles, buses, and garbage trucks.

The gas purification process recovers more than 95% of the energy value of the biogas, and offers the advantage of being renewable, sustainable and replacing the equivalent (energy value) quantity of non-renewable gasoline.

Thermal Reduction and Energy Recovery

Many thermal technologies are available in various industrial applications to thermally reduce organic materials, leaving only ash, and allowing for energy recovery. Fluidized bed incineration has in recent years been further developed, refined and demonstrated for the efficient combustion of biosolids, and most wastewater treatment facilities with older multiple hearth incineration technologies are replacing these with fluidized bed technology as systems deteriorate with age. Fluidized bed incineration technology is at Peel Region's G.E. Booth WWTP and the Duffin Creek WWTP in Durham Region for more than 30 years. Waste heat is recycled back into the process to minimize energy input requirements, and excess heat can be used to generate steam.

Other technologies, adopted from those used in other industrial sectors, are being developed and pilot tested. These technologies show promise; however, they have not been demonstrated at a scale similar to what is required at the Woodward Avenue WWTP.

Preferred Design Concept

Based on a thorough evaluation of all technology options, a preferred design concept was developed. Although this is a comprehensive Preferred Design Concept, only the Thermal Reduction component is covered by this Schedule C Class EA process. The balance of the projects are for informational purposes only to put the entire process into context. These projects are covered under Schedule A of the MEA guidelines. The entire preferred design concept is summarized below:

Pre-conditioning of sludge prior to digestion, using a new sludge pre-thickening and pre-conditioning process

- Anaerobic digestion (using existing digesters)
- Use of digester gas for cogeneration, by expansion of the existing cogeneration facility, with a small portion of gas (15%) cleaned and used for City maintenance vehicles

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- Fluidized bed incineration with internal heat recovery, and use of waste heat for steam power generation.

Figure 1 presents a schematic of the preferred design concept.

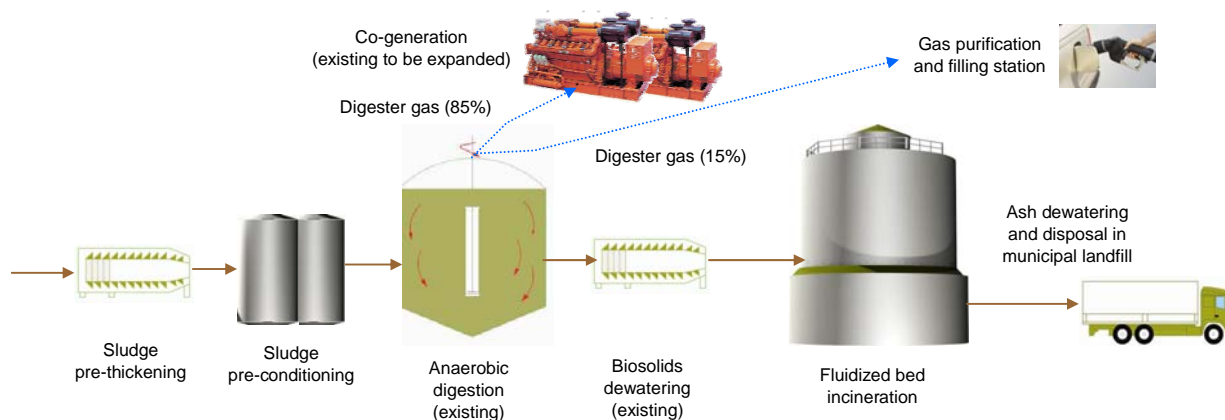


Figure 1 Recommended Biosolids Processing and Management Concept

Table 1 presents a summary of the options that were evaluated and the rationale for the preferred option. In general, the overall design concept has the following features relative to other options:

- Use of proven thermal reduction technologies, demonstrated at similar scale in Ontario and widely across North America and Europe
- Lowest greenhouse gas generation, about 50% of a similar process train without pre-conditioning
- Pre-conditioning with energy recovery from gas and steam is the only process train that has a net energy output – all other trains processing options have a net energy input, as required to heat the digesters and operate the incinerators
- Lowest use of non-renewable fuels, about 50% of a similar process train without pre-conditioning
- Similar capital and life-cycle costs – life-cycle costs for process trains without digestion, with digestion, and with digestion and pre-conditioning are all within ± 5 of each other
- Use of a small portion of digester gas as vehicle fuel allows for a slightly better recovery of energy and revenue from the digester gas, while continuing to operate cogeneration, and minimizing the risk of wholesale investment into a new (gas purification) technology for Hamilton
- Generates a digested sludge that meets 'Class A' quality¹, with fewer restrictions on land application. This allows for deferring the cost of a standby incinerator, since biosolids are of suitable quality for land application during scheduled maintenance shut-downs each year.

¹ Class A is a term used by U.S. EPA for biosolids that have virtually complete removal of pathogens. In Ontario, biosolids with this level of treatment can be exempt from Ontario Environmental Protection Act (EPA) requirements for application site permits.

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Table 1 Design Concepts Evaluated

Process	Design Concepts Evaluated	Preferred Concept	Rationale
Digestion	<ol style="list-style-type: none"> No digestion Digestion Pre-conditioning and digestion 	Pre-conditioning and digestion	<p>Approximately 50% more gas generation (and energy recovery potential) than with digestion only</p> <p>Less heat input required because sludge is thickened, and so there is less digester volume to heat</p> <p>Pre-conditioning generates a Class A¹ sludge, which has potential to be land applied with fewer restrictions, for example during periods of incinerator maintenance</p> <p>Pre-conditioning results in improved de-waterability of biosolids, so that less energy input is required in thermal reduction to volatilize water</p>
Digester gas use	<ol style="list-style-type: none"> Cogeneration of digester gas Cogeneration of digester gas, with a portion to be used as fuel for City maintenance vehicles 	Cogeneration of digester gas, with a portion to be used as fuel for City maintenance vehicles	<p>Cogeneration, which recovers about 60% of the methane energy value is already demonstrated at Woodward Avenue WWTP, and a demonstrated revenue source</p> <p>Only 15% would be used to replace approximately 1,000,000 L per year of gasoline, which is a non-renewable resource</p> <p>Use of digester gas as a fuel source is more efficient use of the gas (>95% recovery of methane energy) that cogeneration, and results in higher greenhouse gas (GHG) reduction</p> <p>Gas purification facilities are relatively low cost</p> <p>Use of only a small portion of the gas stream allows demonstration of the program at relatively low capital investment, and potential for future expansion</p>
Thermal reduction and energy recovery	<ol style="list-style-type: none"> Fluidized bed incineration: Common technology used for biosolids incineration (available from several vendors) Steam reformation: A process by Elementa Corporation, being pilot tested in Sault Ste. Marie Sludge Total Energy Recuperator Module (STERM™): A process by Enviro Energy Systems, being pilot tested in New Zealand Plasma Assisted Oxidation (PASO): A process by Fabgroup Technologies in Quebec, being pilot tested in Valleyfield, Quebec. 	Fluidized bed incineration with steam power generation	<p>Fluidized bed incineration is the only demonstrated technology at similar scale for biosolids</p> <p>It is modern technology, proven to have a high quality emission - better than required to meet regulatory standards</p> <p>Steam turbines allow for recovery of waste heat to generate 0.8 MW of electricity</p>

Human Health Risk Assessment and Air Dispersion Modeling

Human Health Risk Assessments (HHRA) and air dispersion modeling exercises are undertaken when air quality is identified as an issue with respect to the implementation of proposed processing facilities. These assessments and models are typically employed subsequent to the Class EA process and in support of Certificate of Approval or other regulatory and operational requirements.

Public consultation undertaken during the Master Plan process indicated that air quality was of concern to some stakeholders with respect to the preferred solution of thermal reduction. To address these concerns, the City committed to the undertaking of a Human Health Risk Assessment and air dispersion modeling of the proposed facility as a component of the Schedule C Class EA.

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HHRA and dispersion modeling reports have been filed with the ESR. Results indicate that the air quality and health risk associated with the implementation of the fluidized bed facility have been minimized through mitigative design and are acceptable accordant with regulatory levels, and in consideration of existing and cumulative air quality.

Implementation Plan

Accordant with a review of the Municipal Engineers Association Class EA document Schedules, the City identified the thermal reduction and digestion for energy recovery activities as follows:

Thermal Reduction (Incineration):

Schedule C: Activities Subject to the Full Planning Process of the Class EA

- 5. Establish a new biosolids landfill site or new biosolids incinerator site for the purposes of biosolids disposal

Digestion With Energy Recovery (Biogas):

Schedule A: Pre-Approved Activities

- 1. Normal or emergency operational activities:
 - modify, repair, reconstruct existing facilities to provide operational, maintenance or other improvements such as reducing odour, insulating buildings to reduce noise levels and conserve energy; and,
- 3. Expand/refurbish/upgrade sewage treatment plant including outfall up to rated capacity where no land acquisition is required.

The City proceeded with the identification and evaluation of alternative designs as described above. For the Schedule C thermal reduction component, fluidized bed incineration technology was recommended and is the subject of the Environmental Study Report to be filed for 30-day public review.

The Schedule A biogas project was submitted as a item proposal in the City's Infrastructure Fund request to the Federal and Provincial governments, and was selected with the City's additional support to be provided with \$30M in funding. The funding must be spent by 2011 and will support the transition to greater methane generation and biogas use at the WWTP. As a pre-approved activity under the MEA Class EA document, pre-design and design activities for the biogas component are now underway. In recognition of the profile and public interest of the Schedule A biogas component, the City has committed to advising the public prior to its implementation, in a manner similar to a Schedule A+ project.

The City's current biosolids management program involves beneficial use on agricultural land. The program has historically been successful; however, regulatory changes, climate changes and increased sludge generation due to growth in the City will reduce the reliability of this program. Furthermore, there is significant potential, particularly with implementation of pre-conditioning and gas use technologies, to reduce energy input and increase revenues through other approaches to biosolids management.

A preliminary expansion schedule has been developed to allow the phasing of facilities to realize energy recovery benefits as soon as possible, and ensure future compatibility

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with the expansion of the Woodward Avenue WWTP. The preliminary schedule is as follows:

- 2009 to 2011: Implementation of pre-conditioning (for a portion or all of the capacity), expansion of cogeneration and implementation of gas purification facilities
- 2012 to 2015: Implementation of pre-conditioning (for remaining capacity), fluidized bed incineration and ash handling facilities.

ALTERNATIVES FOR CONSIDERATION:

The broad range of biosolids management alternatives were assessed by the City in the Biosolids Master Plan (Phases 1 and 2 of the Class EA process). Refer to PW07047(a) for details of the assessment. Council endorsed the preferred management solution of thermal reduction with energy recovery. The current Schedule C Class EA (Phases 3 and 4 of the Class EA process) has assessed alternative design concepts for the preferred solution and has identified fluidized bed incineration and ash disposal, with energy recovery through steam generation.

Other technologies, adopted from those used in other industrial sectors, show promise, but they have not been demonstrated at a scale similar to what is required to support biosolids management at the Woodward Avenue WWTP.

Subject to completion of the Class EA process and the subsequent authority for proceeding to implementation, the City will have garnered a firm understanding of the implications and costs of the implementation of the preferred alternative. The City may then apply and utilize this understanding as a basis for peer reviewed analysis of other thermal reduction options, presently or possibly available in the City. The Council recommendation originally added to Report PW07047(a) has thus been carried through the Schedule C Class EA process, with the resulting preferred alternative serving as the foundation against which other vendor proposals representing thermal reduction management options may be considered.

Within the overall Master Planning and Schedule C Class EA design process there remains the option of maintaining the status quo (i.e. do nothing). In the present case, this would entail continuing with the existing land application program through the planning timeframe to 2031, with five year reviews accordant with MEA Class EA Master Planning practice. The Biosolids Master Plan Phases 1 and 2 document (as reported in PW07047(a)) fully evaluated the continuance of the City's current land application program and found that the overall sustainability of land applying municipal biosolids, especially over the medium- to long-term, carries a high risk and is tentative and uncertain. Land application remains as a management option available for the short term as the preferred solution is implemented, and as a contingency management procedure over the long term during short periods of process facility maintenance.

FINANCIAL/STAFFING/LEGAL IMPLICATIONS:

Financial Implications:

The preferred alternative has a capital cost for construction estimated at \$70M. This option will also have an operating cost impact that will be mitigated by the generation of electricity from steam and some savings on the disposal fees currently being paid for land application.

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Staffing Implications:

The addition of new processes and operations at the wastewater facility will not have significant implications on staffing levels. It would require the addition of some operational support in about five years' time once the facility is constructed.

Legal Implications:

Each of the recommended alternatives has specific regulatory/legal implications that stem from the overall responsibility the City carries with respect to the production and the regulated management of its biosolids. Many of these regulatory/legal responsibilities exist with current biosolids operations.

As with any WWTP upgrade, regulatory compliance is required. Regulations associated with emissions will require compliance and a new Certificate of Approval will be required; however, proper design, sampling and monitoring can ensure that compliance will be met. Emissions criteria have been well addressed by other municipalities in southern Ontario with the satisfactory compliance of regulatory requirements by their thermal facilities.

POLICIES AFFECTING PROPOSAL:

The Public Works Business Plan, Innovate Now -

The recommendations from this Report will assist in meeting Public Works' key goal, *to be recognized as the centre of environmental and innovative excellence in Canada*. In addition, implementing the recommendations will also assist Public Works in building on our Strategic Vision Drivers as follows:

o **Communities (Services our communities connect with and trust) –**

Implementing the biosolids management strategy as described in the Environmental Study Report will improve our local environment. Efficient and reliable operation of a fluidized bed incinerator will ensure excellent service to all respective communities well into the future. The transparent and consultative nature of the Class Environmental Assessment process builds trust within the community and Review Agencies demonstrating Hamilton's and Public Works' commitment to Service Excellence.

o **People (Skilled teams ready for any situation) -**

This strategy demonstrates the ability of our City staff to respond to an important and complex opportunity that affects our community. Implementing biosolids management improvements requires the knowledge and skill of many staff that work with the system on a daily basis. Through an extensive consultation process, stakeholders, including many employees were invited to provide their input and contribute throughout the process of decision making. The proposed solution represents forward thinking and contemporary practice. Projects such as this have the ability to contribute to the positive and progressive image that Hamilton seeks to maintain and will promote a sense of pride in staff.

o **Process (Smart processes to match our needs) -**

Throughout the Master Planning and Class EA processes, plans have been formulated to ensure that all aspects of the Triple Bottom Line approach to problem solving are considered. Social, Environmental, and Economic impacts were all assessed to provide

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a balanced approach to the preferred alternative. A detailed evaluation process was employed in order to effectively arrive at the optimal solution which meets Hamilton-specific goals and objectives. The result is a sustainable long-term approach that addresses pressures from City growth, legislated requirements, and environmental protection.

○ **Finances (Sound finance management for the long haul) –**

Government policy and legislation have been considered, abided, and adhered in the development of the preferred solution. The sound economic outcomes from this project for the City were a significant factor in the decision-making process.

A number of other policies, regulations and statutes pertain to this document, namely:

- Nutrient Management Act
- Regulation 34
- Water and Wastewater Master Plan Policy Paper endorsed by Council on May 11, 2005 (refer to PW05050)
- Places to Grow Legislation.
- Greenbelt Protection Act
- Safe Drinking Water Act
- Environmental Assessment Act
- Source Water Protection Act
- Ontario Regulation 419/05 - Air Pollution - Local Air Quality

RELEVANT CONSULTATION:

An extensive public consultation program was undertaken for the Biosolids Master Plan. Refer to PW 07047(a) for details.

Regulatory agencies were notified and consulted throughout the Schedule C Class EA process. Feedback has been supportive of the preferred solution. In particular, the MOE Regional office and Environmental Assessment and Approvals Branch were advised of activities and progress with respect to consultation with Part II Order requesters deferred from the Master Plan.

In addition, and in preparation for any opportunities relevant to participation in further peer review analysis, staff have initiated and maintained consultation with vendors and other business entities having a stake or interest in biosolids management in the City.

The following summarizes the public consultation process which took place during the development of Phases 3 and 4 of the Biosolids Management Schedule C Class EA:

- Notices of Commencement, March 2008
- Notices of Public Information Centre, June 2009
- Public Information Centre, Lakeland Community Centre, June 22, 2009
- Notices of Completion, September 2009 (Pending Council approval)

CITY STRATEGIC COMMITMENT:

By evaluating the “**Triple Bottom Line**”, (community, environment, economic implications) we can make choices that create value across all three bottom lines, moving us closer to our vision for a sustainable community, and Provincial interests.

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Community Well-Being is enhanced. Yes No

Reduced trucking from the Woodward Wastewater Treatment Plant to biosolids storage or to land application, the biosolids management program is controlled by of the City of Hamilton and does not depend upon willing "hosts", supportive weather conditions for land application, or for contractors to manage residuals.

Environmental Well-Being is enhanced. Yes No

Provides a long-term solution which is not susceptible to emerging regulatory changes such as source water protection planning. Does not require trucking of biosolids to rural locations outside the City, thereby reducing fossil fuel emissions and roadway congestion.

Economic Well-Being is enhanced. Yes No

By emerging from reliance on third-party service providers, the City maintains control over management of its biosolids and over the cost of disposal. The option is not as susceptible to price escalation as it is not as dependant on the intensive use of fossil fuels nor the influence of third-party negotiations for access to resources.

Does the option you are recommending create value across all three bottom lines?

Yes No

The Master Planning and Class EA process by its very nature considers natural, social, and economic impacts.

Do the options you are recommending make Hamilton a City of choice for high performance public servants?

Yes No