BIOSOLIDS MANAGEMENT MASTER PLAN

ENVIRONMENTAL ASSESSMENT

DOCUMENT SUMMARY REPORT

FINAL

Prepared for:

The City of Greater Sudbury

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DC 071472.17

March 2009

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GLOSSARY OF TERMS

For clarity and consistency in this report we have adopted the following glossary of terms from the Biosolids Best Management Practice published by the InfraGuide, National Guide to Sustainable Municipal Infrastructure.

Aerobic: A process in which oxygen is utilized. Aerobic biosolids decomposition is achieved when microorganisms utilize oxygen in the process of consuming waste.

Anaerobic: A process occurring without oxygen. Anaerobic biosolids decomposition is achieved after oxygen is consumed and aerobic organisms die.

Beneficial Use: Taking advantage of the nutrient content and soil conditioning properties of a biosolids product to supply some or all of the fertilizer needs of an agronomic crop or for stabilizing vegetative cover (in land reclamation, silviculture, landfill cover or similar applications).

Biofilter: A filter media that utilizes microorganisms to treat pollutants. The microorganisms reduce undesirable characteristics of a pollutant by capturing and / or consuming unwanted compounds.

Biosolids: A primarily organic product produced by wastewater treatment processes that can be beneficially used. They are the treated solid or semi-solid residues generated during the treatment of domestic sewage in a wastewater treatment facility (such facilities may also receive an industrial component). Biosolids must meet regulations of the jurisdiction from which they are produced or applied. Requirement may include pollutant concentration, pathogen reduction, and vector attraction reduction criteria.

Biosolids Application Rate: The maximum amount of biosolids on a dry weight basis that can be applied to a land application site, usually defined in dry tonnes/hectare. There are usually restrictions on the frequency of application depending on jurisdictional regulations.

Biosolids Cake: Biosolids dewatered to a solids concentration greater than 22%. Most biosolids cake is in the range of 22 to 35% solids concentration. (See also sludge cake).

Bioxide®: A calcium nitrate solution manufactured by US Filter Davis Products (SIEMENS) to control odours in wastewater collection and treatment systems.

Composting: A stabilization process where organic solid waste material is maintained at operating conditions of 55^{o}C or greater for a period of time.

Dewatered Biosolids: The biosolids remaining after removal of water by draining, centrifugation, filtering or pressing.

Dry Tonnes: The measurement of the weight in metric tonnes of the dry solids in sludge or biosolids (i.e., the mass of solids without water, 1 tonne = 1000 kg).

Heat Drying: Dewatered cake is dried by direct or indirect contact with a heat source, and moisture content is reduced to 10 percent or lower. Sludge particles reach temperatures well in excess of 100^{o}C.

Land Application**:** The placement of biosolids at a predetermined rate (see biosolids application rate) to support vegetative growth either on the surface or in the subsurface.

Land Application Site: An area of land covered by a single permit or certificate of approval on which biosolids are applied to condition the soil, fertilize crops or promote vegetation growth.

Mesophilic: A method of digesting or treating sludge at temperatures in the Mesophilic range; 30 to 35 º C.

Moisture Content: The quantity of water present in soil, biosolids, or residual solids, usually expressed in percentage of wet weight.

Nutrient: Any substance that is required for plant growth. The term generally refers to nitrogen, phosphorus, and potassium in agriculture, but can also apply to other essential and trace elements.

Pathogens: Organisms such as bacteria, protozoa, viruses, and parasites causing disease in humans and animals. Examples of pathogens that can be present in biosolids are Salmonella, coliform, shigella, eschericia coli, hepatitis A virus, rotavirus, polioviruses, cryptosporidium and giardia lamblia. Indicator pathogens are typically used to test for pathogens. Fecal coliform is mainly used as an indicator however Salmonella species (sp) is also used.

Putrescibility: The ability of a material to decompose or rot and become malodorous.

Sludge: Unstabilized organic solids sometimes referred to as residual solids.

Sludge Cake: Sludge, dewatered to a solids concentration greater than 22%.

Soil Amendment: Anything that is added to the soil (i.e., lime, gypsum, inorganic fertilizers and organic material, including biosolids) to improve its physical or chemical condition for plant growth.

Solids Concentration: Usually quoted in percentage (%), it is the % by weight of solid material in sludge or biosolids (1% solids = 10,000 mg solids / litre volume).

Soil Conditioner: Any material applied to improve aggregation and stability of structural soil aggregates.

Thermophilic: A method of digesting or treating sludge at temperatures in the Thermophilic range; 50 to 60º C.

Vector Attraction: The characteristic of residual solids or biosolids that attracts rodents, flies, mosquitoes, or other organisms capable of transporting infectious agents such as pathogens.

Volatile Solids: Materials, generally organic, which can be driven off from a sample by heating, usually to 550^{o}C. The non-volatile inorganic solids remain as ash.

EXECUTIVE SUMMARY

The focus of the Biosolids Management Master Plan is to provide the City of Greater Sudbury with a sustainable plan to deal with the handling and disposal of sludge generated by the wastewater plants.

In preparing this report, the concerns (private, public, and regulatory) relating to biosolids have been investigated including biosolids quantity projections, how they are generated, biosolids quality, storage, and disposal issues. To meet the future needs and regulatory requirements, this report will also address future treatment capacity required by the City and the surrounding areas.

The planning of this project was completed as a Master Plan activity under the Municipal Class Environmental Assessment which incorporated "project specific" Schedule 'B' activities related to the construction of a Biosolids Treatment Facility at an existing landfill or sewage treatment plant.

The desired features and key strategies for a Biosolids Management Master Plan were developed through consultation with representatives from the City of Greater Sudbury. The following key elements were developed and found to be relevant to the selection process:

- Public acceptance
- Cease the disposal of sludge or biosolids products into the tailings ponds
- Reduce or eliminate haulage of unstabilized (and odourous) material
- Reduced haulage costs and truck traffic
- Reduced haulage of unstabilized (odourous) material
- Odour management / control (enclosed process)
- Produce Class A odour free end-product with minimal residual odour
- End use /disposal diversity (landfill cover, mine reclamation, agricultural, land reclamation, marketable soil product)
- Proven technology installation in Ontario
- Reliability and ease of operation
- Treatment of recycle streams
- Capital costs / operating costs

Development of alternative solutions for the City was conducted on two (2) fronts. Planning alternatives were developed to facilitate the siting of a new biosolids treatment facility.

Technology alternatives were developed to “best fit” with the City’s existing wastewater processes technologies while providing a useable biosolid end-product.

A detailed evaluation of the eight (8) combined planning / technical alternatives were conducted utilizing the criteria established. The results of the evaluation matrix indicate the following highest scoring technology/planning options:

- Schwing Bioset™ at the Sudbury Wastewater Treatment Plant (SWWTP)
- ATTAD™ at the SWWTP
- N-Viro™ at the SWWTP
- N-Viro™ at the Sudbury Landfill Site

Each alternative produces a Class A, near pathogen free soil type end-product, with little health risk to the public or workers managing the process. All The first three can be sited at the Sudbury Wastewater Treatment Plant (SWWTP) and incorporate ‘closed’ vessel process to reduce odour and as a result, odour emissions. Processing at the SWWTP has a number of advantages including reduced haulage of sludge and reduced sludge truck traffic, reduced / manageable odour emissions as well as the ability to treat the recycle from the Biosolids Process. From the City’s perspective the siting of the new facility at the SWWTP will greatly reduce the trucking through the City and in recognition of this siting, of the N-Viro™ process at the Landfill site is not a preferred option.

End-use diversity was a key consideration of the evaluation process. Products more suitable to the local geography were deemed to have greater end use diversity. Each of the technologies produces a soil amendment type product that may be used on agricultural lands, mine or land reclamation projects and / or sold as a topsoil product.

Preliminary capital cost estimates to construct the biosolids facility, common ancillary components and the associated operation costs fore the facility utilizing the recommended technologies, over a fifty (50) year period, are summarized in the following table.

Summary of Preferred Alternatives Costs

	Capital Cost	Annual, Operating Costs (50 year period)	Net Present Value	Cost Per Dry Tonne
ATTAD™	$38.3 M	$1.3 M	$71.0 M	$418
N-Viro™	$32.2 M	$1.25 M	$64.0 M	$375
Schwing Bioset™	$29.0 M	$1.4 M	$65.0 M	$379

Conclusions and recommendations from this study follows:

The City of Greater Sudbury should consider;

- Increasing sludge sample frequency for metals.
- Constructing a centralized biosolids treatment facility at the SWWTP.
- Short-term storage be provided at the plant site until such time as the Primary Clarifiers / Storm Tank are required.
- Long-term Storage Options at the Sudbury Landfill Site.
- End-Use / Disposal options be explored in detail to determine the safest and most economically beneficial options (i.e. landfill cover vs. land reclamation or soil amendment product or a combination there of).
- Develop a nutrient management strategy for end-use / disposal as required.
- Incorporate technologies such as ATTAD™, N-Viro ™, and Schwing Bioset™, as part of the treatment solution.
- As a result of the tight timeframe for ceasing the discharge of unstabilized sludge into the tailings ponds, the City may consider alternative delivery methods in lieu of the traditional design-tender-construction.
- Consider implementing a source control plan that would include a program to reduce metals at the source.

1.0 INTRODUCTION

1.1. Project Background

The City of Greater Sudbury (City) is fairly unique in its management of solids generated at its wastewater facilities. Waste Activated Sludge (WAS) from nine of the City's secondary wastewater treatment plants, Espanola WWTP, Vale Inco's Copper Cliff WWTP, and the McFarlane Lake Provincial Facility is collected by truck and hauled to the City's Sludge Transfer Station at the Vale Inco's Tailings site where it is pumped to the R1 and R3 Tailings Ponds. Refer to **Figure 2.0.**

This practice has been in place for more than thirty (30) years, and while the operation has been generally trouble free, on occasion throughout the history of the relationship between Vale Inco and the City, operational issues have arisen. This has resulted in odour problems, complaints from local workers, area residents and issues relating to plastics and needles being washed up on the tailings pond beaches.

Localized odour issues were historically minor in nature, and were successfully dealt with by the City altering the sludge discharge locations and INCO burying the deposited sludge within the tailings area.

The odour problems of 2005 and 2007 were sparked by a combination of changes that altered the pond dynamics and developed sustained and significant odour issues. Numerous complaints were received from local residents in Lively, Walden, and Copper Cliff.

In response to recent concerns regarding odour and disposal in the tailings ponds as well as anticipating impending restrictions from the Ministry of the Environment, the City has undertaken a comprehensive Biosolids Management Master Plan following the Class Environmental Assessment process, to ensure a broad range of options and possible solutions are evaluated.

In 2008, the City retained Dennis Consultants, a division of R.V. Anderson Associates Limited (RVA) to undertake a Biosolids Management Master Plan in accordance with the Municipal Class Environmental Assessment (EA) process.

The focus of the Biosolids Management Master Plan is to provide the City of Greater Sudbury with a sustainable plan to deal with the handling and disposal of sludge generated by the wastewater plants over the next 25 years. The three (3) primary technical requirements of the Biosolids Management Master Plan are as follows:

- Environmental Responsibility
- Improve Odour Management
- Cost Effectiveness

In preparing this report, the concerns (private, public, and regulatory) relating to biosolids have been investigated including biosolids quantity projections, how they are generated, biosolids quality, storage, and disposal issues. To meet the future needs and regulatory requirements, this report addresses future treatment capacity required by the City and the surrounding areas.

1.2. Class Environmental Process

The Municipal Engineers Association Municipal Class Environmental Assessment (Class EA) (September, 2007) process sets out a planning and decision-making process to be followed for municipal water, storm water management and wastewater undertakings in order to meet the requirements of Ontario's Environmental Assessment Act. Adherence to the prescribed process ensures that potentially affected natural, social, economic, cultural, and technical components of the environment are considered, the advantages and disadvantages of identified alternatives are evaluated, and adequate opportunities for public involvement provided. The Class EA process is illustrated in **Figure 1.0.**

The Class EA approach includes mandatory requirements for public and regulatory agency input and expedites the environmental assessment. The Municipal Class EA identifies three (3) different categories or 'schedules' of projects as follows:

- **Schedule A** projects are limited in scale and minimal adverse effects. These projects are approved and may proceed to implementation without following further Class EA steps.
- **Schedule B** projects have the potential for some adverse environmental effects and must be subjected to a screening process, involving consultation with the directly affected public and relevant government agencies to ensure that any concerns are addressed. If there are no outstanding concerns, then the proponent may proceed to implementation.
- **Schedule C** projects have the potential for significant environmental effects and must proceed under the full planning and documentation procedures in the Class EA document.

The Master Planning Process is actively promoted by the Ministry of the Environment (MOE) to develop overview plans and strategies for implementing municipal infrastructure. It adheres to the following principles:

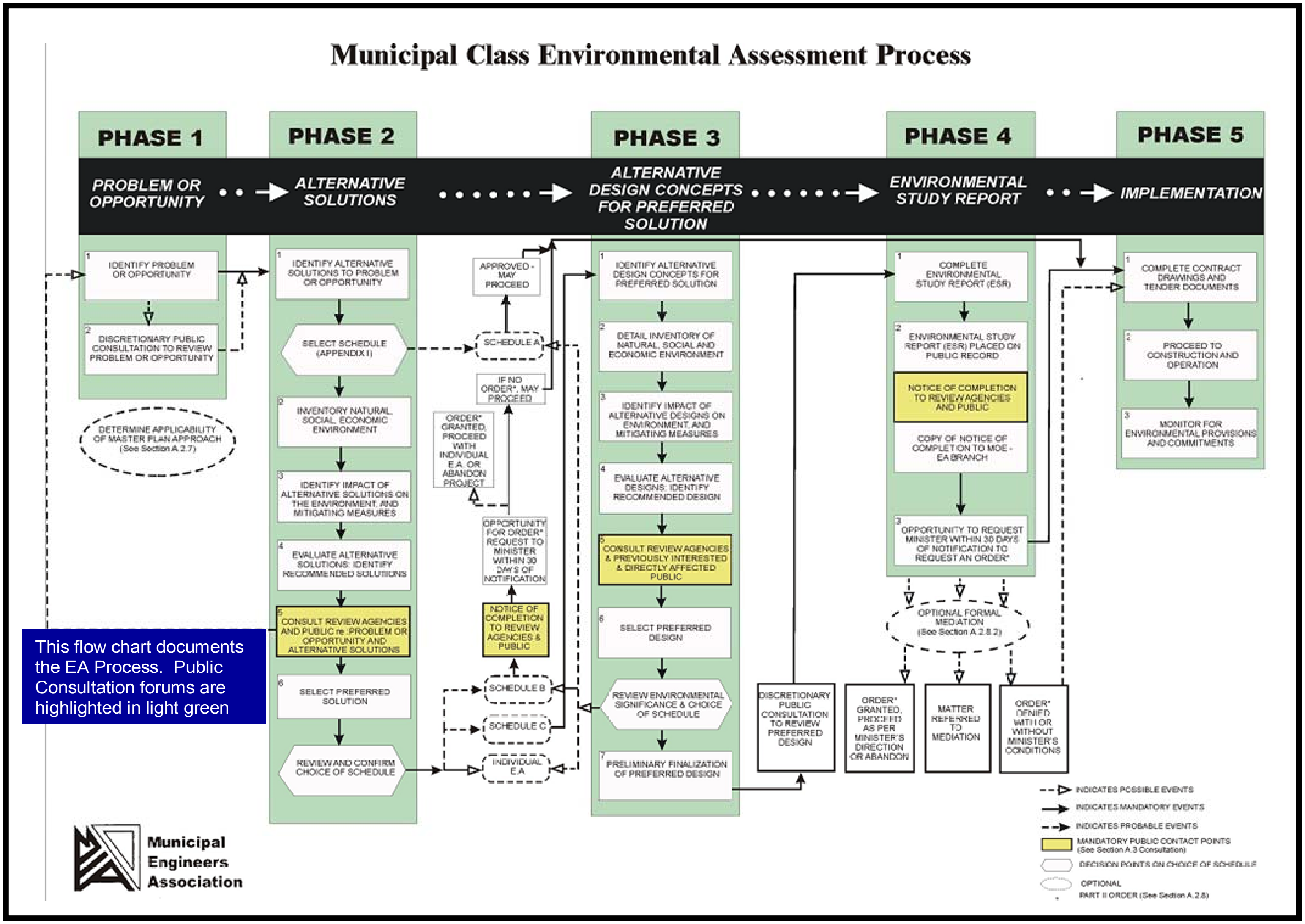
- Consult with affected parties and involve the public early and throughout the process when options are still available to decision makers
- Consider a reasonable range of alternatives
- Identify and consider the affects of each alternative on all aspects of the environment
- Evaluate the alternatives in terms of their advantages and disadvantages considering potential mitigation
- Provide clear, complete documentation of the planning process to allow for traceability of the decision-making process

The Master Plan approach can lead to better long range (20+ years) infrastructure planning, which enables municipalities to identify and provide for existing and future needs. The broader scope of a Master Plan study provides the framework for implementing future works and developments in an integrated and comprehensive manner. The interrelated projects identified should be more efficient than isolated project decision-making and should function together as a complete system in a manner more sensitive to all aspects of the environment.

The objective of using the Master Plan approach is to develop and document a multi-year infrastructure plan which identifies what, when, and where new or improved water and wastewater facilities are required to address future municipal needs. It permits the combined impact of the alternatives to be understood, allows the opportunity to integrate with land use planning, and permits the selection of a preferred set of alternatives. It documents the public input and local political acceptance of the plan. It sets out a process by which the Master Plan will be regularly updated, and identifies the trigger mechanisms for potential modifications in the future (i.e. changes in population projections).

This project has been carried out in accordance with the Class EA Master Plan guidelines while incorporating the specific requirements for Schedule B projects as they relate to establishing a Biosolids Management Facility.

Figure 1.0 – Municipal Class Environmental Assessment Process



1.3. Guidelines and Legislation

Municipal wastewater treatment plants generate liquid and solid discharges that must be managed in a manner that is protective of the environment. In the past, attention focused on the liquid effluent discharge. Ample legislation and effective facilities and operating procedures have evolved in this regard. In the case of solids management, the same level of attention has only recently started to appear. Driven in part by a heightened public awareness, a clearer understanding of environmental impacts associated with past disposal methods and stricter land use legislation. Evaluating changes to the current and anticipated applicable laws, regulations, and guidelines in the municipal, provincial, or federal jurisdiction is an important consideration in the development and implementation of a biosolids management program.

Regulation of biosolids in Ontario has historically been handled under the Environmental Protection Act and the Ontario Water Resources Act. Although these remain key legislations for compliance and regulation of waste management and sewage treatment approvals, there is new legislation, i.e., the Nutrient Management Act (NMA), which was passed on June 27, 2002. The NMA is intended to regulate all land-applied nutrients in Ontario, including biosolids.

Land application of biosolids is also regulated under Part V of Ontario's Environmental Protection Act, and Ontario Regulation 347. The Ministry of the Environment currently approves the spreading of biosolids or non-agricultural wastes through the Ministry of the Environment Land Application Program. The Ministry has recently been reviewing this program.

A generator of nutrient wastes, such as biosolids, (known as Non Agricultural Source Material (NASM)) who chooses to land apply these biosolids is required to prepare a Nutrient Management Strategy (NMS), which "sets out an environmentally acceptable method for managing all prescribed materials generated at an agricultural or non-agricultural operation."

The use of biosolids particularly in applications on agricultural land, has taken place for decades without documented adverse effects to human health or the environment. Recent public concern, questioning the safety and sustainability of biosolids management programs, has prompted the need to include public consultation into the development of biosolids management initiatives. Determining public concerns early on, allowing them to be addressed as part of the planning process, results in a better overall project.

Legislation is also in place to govern other biosolids products. For example, if biosolids are transformed into a fertilizer product that is intended for sale to the public, they are governed by The Federal Fertilizer Act (FFA). The Fertilizer Act is administered by the Canadian Food Inspection Agency.

Another example of applicable legislation addresses the incineration of biosolids. During incineration, air emissions are governed by the Air Management Act, which is administered by the Ministry of the Environment. The ash produced, if intended for landfill, will then have to meet MOE and municipal landfill regulations before being allowed to be land-filled.

Biosolids management best practices guideline have been developed by the Canadian Federal Government, through the Infrastructure Canada Program and the National Research Council and included in the National Guide to Sustainable Municipal Infrastructure (InfraGuide). The InfraGuide is the culmination of the efforts of many experts in the field. The report sets out the “best practices” to support sustainable municipal decision making. The “best practices” for biosolids management have been applied to this Master Planning process. The primary goals of the established best practices in the InfraGuide are:

- Compliance with regulatory requirements
- Improved biosolids quality
- Improved odour management
- Improvements in safety
- Wider public acceptance
- Improved cost effectiveness
- Sustainability

1.4. Quality Classes of Biosolids

In general, the regulations in Ontario were drawn from the US Environmental Protection Agency (EPA) Regulation 503, which defines a number of category and levels to which biosolids can be processed. The most commonly referenced categories are Class A, Class B and Exceptional Quality (EQ).

In Canada, the Fertilizer Act is the only national regulation that makes reference to biosolids, since biosolids, as with all environmental legislation, is under provincial jurisdiction. Regulations in some provinces refer to the EPA definitions, while others have developed their own terminology and definitions. The EPA guidelines[1] define Class A, Class B, and EQ biosolids as follows:

Class A biosolids - material that has received treatment using a “process to further reduce pathogens” (PFRP). Class A treatment processes include: composting with a higher degree of temperature control, heat drying, heat treatment, high temperature-high pH processing (pH greater than 12 for 72 hours with a temperature above 52°C), and thermophilic (high temperature) digestion.

Class A biosolids must undergo an advanced treatment process to reduce pathogen levels to below detectable limits.

Class A biosolids are considered pathogen free when process requirements are met and product testing proves that fecal coliform densities are below 1000 organisms per gram of dry solids. Use of Class A biosolids is then unrestricted by regulation and for example, can be bagged and marketed to the public.

Class B biosolids – material that has received treatment using a “process to significantly reduce pathogens”(PSRP). Class B treatment processes include aerobic and anaerobic digestion, composting (with limited temperature control), and lime stabilization. Class B biosolids are not considered pathogen free, but have undergone sufficient processing to achieve a 2 million fecal coliform per gram of dry solids maximum (2-log reduction) in fecal coliform density. End use restrictions to protect public health include: limiting access, crop selection, minimum buffer zones to residences and water sources, and prescribing waiting periods before harvest. Class B biosolids processing reduces pathogens to levels that are protective of public health and the environment, under specific use conditions, but not to undetectable levels. Accordingly, crop harvesting and site restrictions apply to the use of Class B biosolids to minimize run off and the potential for human or animal contact with the biosolids.

Class B biosolids cannot be sold or given away in a bag form or other container for land application and public contact sites, lawns, or home gardens. Class B biosolids can however be used in bulk for appropriate land application such as for agriculture, forest lands, reclamation sites, and other controlled sites, as long as vector attraction, pollutant, management practice requirements and the Nutrient Management Act provisions are also met.

[1] A Plain English Guide to the EPA Part 403 Biosolids Rule. U.S. Environmental Protection Agency, Washington, DC: Office of Wastewater Management, 1994

Class B biosolids can be used as Municipal landfill cover provided that they also meet other regulatory requirements governing landfills.

The concentration limits for metal or other contaminants for Class A and Class B biosolids are the same.

Exceptional Quality (EQ) – biosolids although not explicitly defined have pathogen limits similar to those of Class A, a reduced level of degradable compound, and lower metal limits. EQ biosolids are considered virtually unregulated and can be bagged and marketed to the public.

2.0 PROBLEM / OPPORTUNITY

The objective of this study is;

- To review sewage sludge management alternatives in order to develop and implement a long-term Biosolids Management Program for sustainable treatment and disposal / end-use of the City's waste activated sewage sludge".
- To prepare a Master Plan for the City of Greater Sudbury's Biosolids Management in accordance with the Class EA Process.

2.1 Description of Study Area

The City of Greater Sudbury is a dynamic and diverse regional capital functioning as the service hub for Northeastern Ontario, a market estimated at 550,000 people, as well as a world renowned mining centre.

In 2001 the City of Greater Sudbury was formed as a result of the amalgamation of the towns and cities that formed the former Regional Municipality of Sudbury, as well as several unorganized townships. Approximately 85% of City's 155,225 residents are serviced by the City's wastewater facilities.

Ten (10) wastewater treatment plants widely dispersed throughout the City's 3627 square kilometer geographical area service the residents (refer to **Figure 2.0**). Nine of these facilities operate as Secondary Treatment Facilities. Waste Activated Sludge (WAS) from the treatment process is thickened using gravity thickeners to 2 to 3% solids concentration. Thickened WAS is collected from nine of the ten facilities, Espanola WWTP, Vale Inco's Copper Cliff WWTP, and the McFarlane Lake Provincial Facility and hauled to the City's sludge transfer station at Vale Inco tailings site where it is pumped to the R1 and R3 Tailings Ponds.

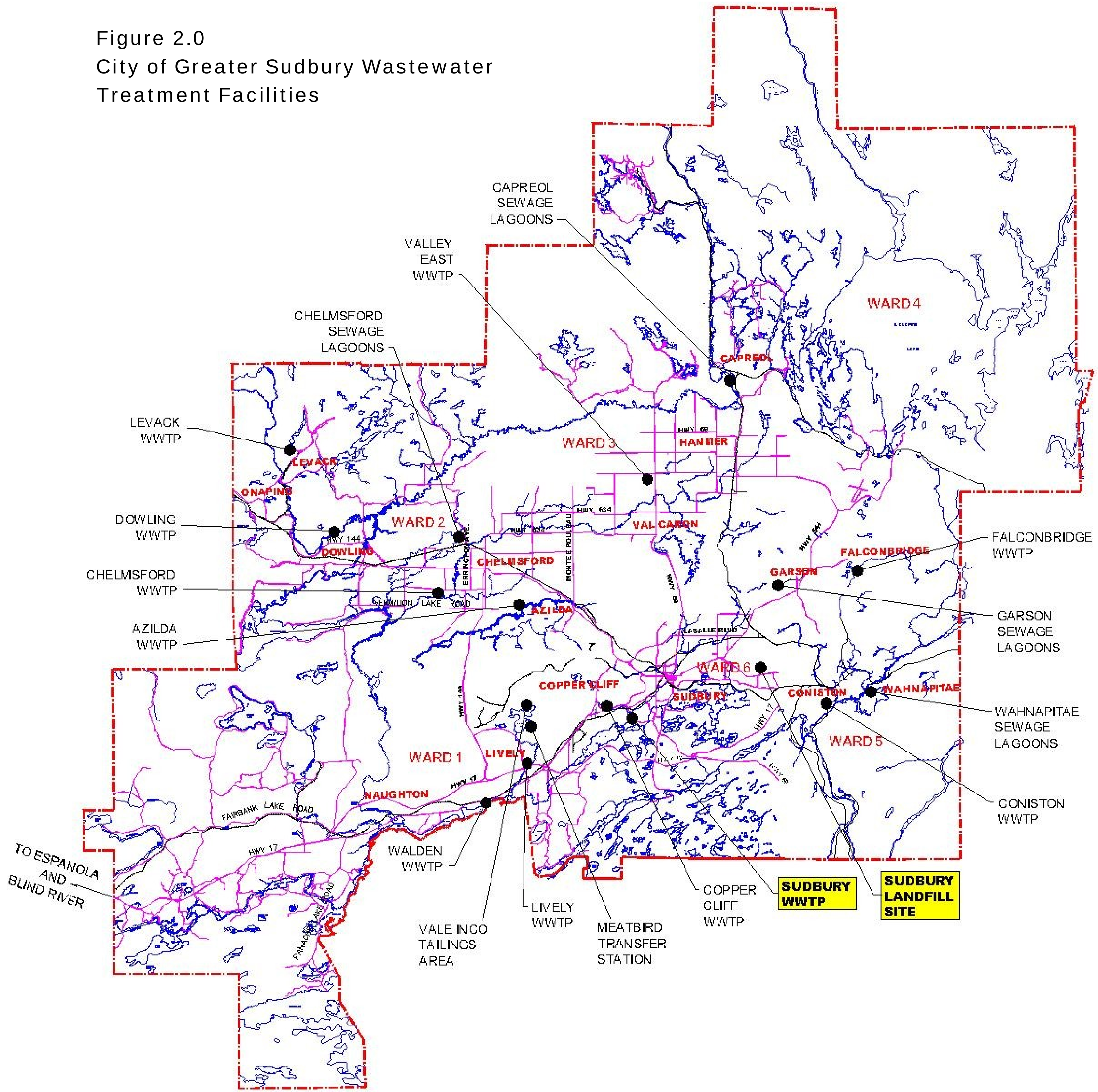
Table 2.1.1 lists the wastewater treatment plants, rated capacity, and population served.

Table 2.1.1: Population Serviced / Plant Capacity

Plant Name	Rated Capacity (m3/day)	Population Served
Azilda	2840	4112
Chelmsford	7100	7332
Coniston	3000	2129
*Copper Cliff WWTP	6800	2302
Dowling	3200	1657
Falconbridge	909	754
Levack	2270	2320
Lively	1600	2763
Sudbury	102375	84876
Valley East	11400	17415
Walden	4500	3376
*Espanola WWTP	4500	5314

* Facilities not operated by the City of Greater Sudbury

Figure 2.0
City of Greater Sudbury Wastewater Treatment Facilities



2.2 History of Waste Disposal / Odour Issues

The City of Greater Sudbury has, over the past thirty (30) years, disposed of thickened waste activated sludge by pumping it into Vale Inco's R1 and R3 tailings ponds. Localized odour issues were historically minor in nature and were successfully dealt with by the City altering the sludge discharge locations and INCO burying the deposited sludge with the tailings.

During the summer of 2005, odour issues developed as a result of a number of changes to the tailings operations and sustained spells of very hot dry weather conditions. Lime stabilization of the tailings ponds was attempted; however, shortly after initiation it was abandoned due to the vast quantity of lime required to stabilize the biologically active pond. Odour control using the use of Bioxide or (calcium nitrate) was piloted by the City in July, 2005. Initial test results were encouraging and full scale Bioxide application to the tailings ponds was employed by the City in August 2005. The overall result from the first four months of the Bioxide Testing Program proved positive.

In 2006, the City implemented a Bioxide Injection Pilot Program at the Sudbury WWTP Sludge Thickening Facility in addition to dosing at the tailings area. This program was extended into 2007 with reduced injection rates during winter months. The results of sampling at the plant and tailings area indicated that the dosing program was starting to have a positive impact on odours. However, several extreme odour events occurred in 2007.

The odour problems in 2007 were sparked by a combination of factors:

- Sustained periods of very hot dry weather which occurred earlier than expected (beginning of May)
- Changes in INCO operations of tailings disposal
- Inability to alter sludge discharge locations, (R1 was too shallow to discharge sludge)
- Shallow pond depth in the areas of discharge of the WAS
- Accelerated tailings deposition in the R3 Pond
- Localized Bioxide injection was unable to control odours in a large scale rapidly changing tailings pond environment

The combination of these factors is believed to have altered the pond dynamics, lowering the pH and reducing the nitrate residual. As a result, unfavourable anaerobic conditions rapidly developed, ultimately generating unacceptable levels of Hydrogen Sulphide (H_2S).

As a temporary solution, Vale Inco modified the tailings discharge locations in the R3 Pond and Vale Inco freed up resources to assist the City with Bioxide / Lime hydro spraying operations.

A Coherent Water Resonator was installed in the tailings pond on July 31st, 2007 in attempt to increase microbial activity and dissolved oxygen levels in the tailings pond. Success of this unit was variable and intermittent odour problems arose in early 2008.

In October 2008, Vale Inco indicated that in their opinion the sludge disposal and tailings discharge will continue to be incompatible and has therefore requested the City pursue alternatives to dispose of the waste sludge that will no longer include disposal in the tailings ponds. (Refer to Vale Inco's letter, **Appendix C**)

The repeated odour events over the past few years have convinced the City that alternative sludge handling methods must be developed. In addition, Vale Inco has notified the City that they intend to amend their current MOE Certificate of Approval and remove the provisions to allow the discharge of municipal wastewater sludge into the tailings area.

2.3 Concerns Regarding Biosolids

The concerns pertaining to wastewater treatment plant residues in the past prompted the development of numerous regulations that have guided this and similar projects. These concerns include, but are not limited to:

- Concentration of contaminants – metals, toxic substances, nutrients
- Concentration of pathogens (disease causing agents including bacteria, viruses)
- Generation of odours

Addressing these concerns will need to proceed on a number of levels including;

- Public education programs
- Municipal sewer use by law restrictions and limitations
- Treatment Technology / upgrades to;
  - Reduce putrescibility
  - Reduce pathogens
- Employment of safe disposal practices that protect human health by following regulations regarding soil, crop, animal, ground water, surface water, and human contact.

2.4 Project Approach

The method used as the basis for this study is the Municipal Engineers Association Class Environmental Assessment (September 2007) process, integrated with recommendations from the InfraGuide to develop the following project approach:

- Create a summary of the existing situation
- Outline the criteria and standards by which the plan will proceed
- Present biosolids production projections for the area
- Review mandatory, immediate storage requirements
- Describe the concerns around biosolids
- Review disposal alternatives including a review of available, suitable land for application
- Evaluate process options that produce a biosolids product that meet the criteria established relevant to the City of Greater Sudbury
- Summarize storage options to meet the Ministry of the Environment regulations
- Review process and storage locations to evaluate haulage costs
- Consolidate input from the public, government agencies and special interest groups
- Present the conclusions and recommendations

2.5 Establishing Criteria

In keeping with the outline of the Class EA planning process, the desired features and key strategies for a Biosolids Management Plan were developed through consultation with representatives from the City of Greater Sudbury. In reference to the typical issues identified by the InfraGuide "Best Practices", the following issues were noted as key elements and relevant for the City:

- Protection of Environment, Workers and Public Health
- Economic Sustainability
- Public Acceptance
- Operational Ease and Reliability
- Odour Control

These elements formed and established the basis of the planning study and the evaluation criteria for which the various planning and technology alternative would be reviewed and evaluated.

2.6 Pre-Screening

A pass / fail ranking system was used to quickly eliminate unsuitable or undesirable options. Options receiving a “pass” mark proceeded to a more detailed evaluation, whereby relative weighting of each criterion, according to importance was assigned and evaluated.

Charts at both stages of the process were developed to summarize the selection and evaluation process. Refer to **Table 5.2.1.**

At the conclusion of the pre-screening evaluation process, a short list of alternatives that met the established criteria were developed.

3.0 PUBLIC CONSULTATION

Public Consultation and development of meaningful dialogue between project planners, interest groups, agencies and the general public is key to successful environmental assessment planning.

A public consultation plan was developed in parallel with city initiatives to update the public on odour abatement progress and to satisfy the mandatory points of contact established in the Class EA process.

Methods of public consultation are described below:

3.1 Project Initiation

On February 14, 2008, a Notice of Project Commencement was issued and advertised in the local newspapers (Sudbury Star, Le Voyager, and Northern Life) as well as the City's Web Site.

The Notice identified the initiation of the project and presented the Problem Statement, clearly defining the issues to be addressed by the project objectives.

Problem Statement:

> ***"The City of Greater Sudbury must review sewage sludge management alternatives in order to develop and implement a long-term Biosolids Management Program for sustainable treatment and disposal / end-use of its sewage sludge."***

A copy of the Notice of Commencement is included in **Appendix A**.

3.2 Stakeholder Consultation

Agency and interest group input is an important part of the public consultation process. A mailing list of interest groups, and government review agencies, was developed using the City's experience with previous projects identifying potentially interested environmental and community groups and a standard list contained in the Class EA. Individual letters requesting comments were sent to each group and agency describing the project, with an invitation to the first Public Information Centre (PIC).

Similarly with the Second PIC, letters providing an update on the project and requesting comments were sent to each group and agency describing the project, with an invitation to the second Public Information Centre.

A copy of the mailing list and stakeholder letter is presented in **Appendix B1 & B2**.

Generating interest was found to be a challenge with the project, agency input was generally low, and few comments were received. Comments are included in **Appendix C**.

3.3 Public Information Centres Phase 1 and 2

Public Information Centres (PIC) were held in April and July 2008. The purpose of the first PIC was to inform residents, agencies and interest groups about the project initiation and to seek input to assist in creating a biosolids management plan for the City.

The first PIC was held at the Walden Community Center on April 15th, 2008. This meeting was held to update the residents of Lively and Walden on the status of the City's Odour Abatement program, the history of biosolids management, the results of the 2007 immediate odour abatement action plan, the proposed Odour Abatement Plan for 2008 – 2010, and introduce technologies and biosolids end-products being considered. PIC #1 materials, attendance and comments are attached in **Appendix D1 – D5**.

Items noted from discussions at the first PIC included:

- Emphasis should be placed on "Green" Environmentally Conscious Solutions.
- Odour Control / Management
- Cost of Options Presented
- Lack of interest from public as shown by lack of attendance (**Appendix D4**)

The second PIC was held on July 22, 2008 at the McClelland Arena in Copper Cliff. This meeting was held to update the residents of Lively and Walden, and inform residents in the vicinity of the Sudbury Wastewater Treatment Plant of the proposed technologies and odour abatement strategies for the Kelly Lake Road facility. The display material presented included the information from the first meeting and expanded on the tasks that had been carried out since then (**Refer to Appendix E3**). These tasks included prescreening of the various options, evaluation of both the planning and technical alternatives, as well as the capital and operating cost over a 50-year life cycle, and presentation of a preferred location and technical alternatives for a Biosolids Management Facility.

A presentation summarizing the evaluation process completed to date was also presented. Three (3) technology alternatives were presented and identified for further investigation including ATTAD^{TM}, N-Viro ^{TM} and Schwing Bioset^{TM}. Each alternative was found to satisfy the City's desired features and could be constructed at a preferred single site for treatment and storage. The Sudbury Wastewater Treatment Plant was identified as the preferred planning alternative. Materials presented at the second PIC, attendance and comments are included in **Appendix E1 – E5**.

Key items noted from the second PIC include:

- End use / disposal options need to be resolved
- Impacts of metal content on end use options
- Odour control beyond 2010.

In general, attendance at public meetings was low and generating interest was a challenge. Press releases that resulted in articles in the local newspaper kept the general public informed. Few comments were received and these are included in **Appendices D5 and E5.**

3.4 City of Greater Sudbury Council Presentations

On February 14, 2008, a presentation of the Odour Abatement Program and need to progress with the Environmental Assessment / Master Planning Process was made to City Council (Refer to **Appendix F**).

3.5 Notice of Completion

A Notice of Completion was prepared and issued on February 11th, 2009, initiating the 30-day Public Review Record. The Notice was placed in the local newspapers (Sudbury Star, Le Voyager and Northern Life) as well as the City's Web Site.

A copy of the Notice of Completion and advertisements can be found in **Appendix S**.

On February 18, 2009, a follow-up summary presentation of the work to date, evaluation process completed, concerns pertaining to Biosolids and a short list of alternatives for Biosolids Management and disposal was presented to City Council. The presentation concluded with an outline of the Master Plan Recommendations.

Council was in support of the activities to date. Many of the concerns of council members parallel those of the general public, and primarily revolved around scheduling and the cost of the project.

4.0 DESCRIPTION OF THE ENVIRONMENT

4.1 Natural Features and Functions

Impacts to the natural environment are those that would occur to the natural plant and animal life either on or off the project site, as a direct result of the project. To assist in determining the possible impacts, a cursory natural environment investigation was undertaken.

On a broad level, the City of Greater Sudbury lies within the Sudbury basin, forming part of the Canadian Shield. The topography is variable and is comprised of a mix of bedrock, wetlands, lakes, agriculture, and wooded areas. The surrounding landscape is recovering from years of mining activity. Regreening and Land Reclamation projects have transformed the landscape over the past 30 years with great success. Trees and grass now cover what years ago was barren terrain. Efforts at regreening have earned the community world wide recognition.

Mining remains the predominant industry in the area, and the City is deemed a regional centre functioning as the service hub for North Eastern Ontario. Many of the mines share in the City's Regreening projects and have embarked on their own Acid Mine Reclamation projects to improve the landscape.

Sudbury has an active Agricultural Sector, concentrated along an extensive swath of land that forms the centre of the Sudbury Basin. The City's Official Plan Review adopted in June 2006 identifies the need to maintain prime Agricultural Lands. The supporting Background Study also recommends the preservation of topsoil, and prohibiting the removal of topsoil in Agricultural Lands.

On a global scale, positive impacts and opportunities exist for a soil conditioning or amendment product and there are a number of potential uses of biosolids available within the geographical area. The soil-type, proximity to ground water protection zones, and land use, are important elements in estimating the amount of agricultural land available for biosolids opportunities.

4.2 Site Specific Impacts

Impacts to the natural features resulting from the construction of a biosolids facility are considered minimal. The Sudbury Wastewater Treatment Plant and Solid Waste Landfill Sites are developed properties that are currently in operation. Little impact to the localized environment is anticipated. Construction at a new site, although not specifically identified, would likely have a greater impact to the natural environment and would require additional investigations and study.

4.3 Human and Cultural Features

Social environmental impacts are those that relate to the quality of life of the people that occupy or use adjacent lands or access the area for travel or recreational purposes. Official Plans are tools municipalities use to ensure that development within the municipality meets the "quality of life" goals of the community.

The City's Official Plan is meant to establish goals, objectives and policies to manage and direct physical change and its effect on the social, economic and natural environment to the year 2026. Six vision statements were developed to encompass these values, namely Greater Sudbury is,

- a modern vibrant community
- a "City of Lakes"
- a green community
- a healthy and sustainable community
- open for business
- Downtown will be developed and sustained as a vibrant hub of a dynamic city.

The City of Greater Sudbury's Official Plan states that 59% of the 155,215 residents live in the former City of Sudbury, with the community of Valley East second at 12%; the remaining population live within smaller community centres, including Capreol, Dowling, Levack, Onaping, Coniston, Lively, Falconbridge, Azilda, Chelmsford, Garson, Copper Cliff, and Wahnapitae. All are fully serviced urban centres with wastewater treatment facilities.

Due to the historical development of industrial uses, the community of Sudbury has become the regional service centre for the City. The community of Sudbury contains all major commercial nodes including, educational, research and health facilities. High density residential uses are also concentrated in the community of Sudbury including 75% of the rental housing units.

4.4 Population Projections / Forecasts

Population in the communities that make up the City of Greater Sudbury recorded a peak of 170,000 persons in 1971. Over the years the City's population has gone through a number of cycles of decline and recovery. The population projections are based on the City's Official Plan and background / supporting documents.

Based on the referenced population projections presented in the City of Greater Sudbury Synthesis / Land Use and Settlement Report, and "Draft" Growth and Settlement / Development

Options Discussion Paper (Refer to **Appendix H**), the base population for the projections and basis for this Master Plan was 155,225 people, taken from the 2001 Statistics Canada Census data.

Four population projections were developed based on four growth scenarios for the City of Greater Sudbury. The four scenarios and their respective 20 Year population projection figures are listed below:

Table 4.4.1 - Population Scenarios

Projected 2021 Population		
Scenario	**People**	**Change In Households**
Out-Migration	135,407	(-750)
Natural Increase	150,012	4,837
In-Migration	169,579	12,256
High In-Migration	175,000	13,067

In the interest of developing a conservative design population for a biosolids management solution, the Out-Migration and Natural Increase scenarios were not considered.

The following descriptions, taken from Meridian Planning Consultants' discussion paper, briefly describe the two positive growth In-Migration Scenarios.

- **In-Migration Scenario**
  The In-Migration scenario assumes a return to the population peak of 1971 by 2021 with a population of 169,579 which equates to an annual population increase of 0.46%. The number of households resulting from this population is estimated to be 75,276, an increase of 12,256 households overall, with an average household size of 2.25 persons.

- **High In-Migration Scenario**
  The High In-Migration scenario assumes In-Migration will exceed out-migration from 2001 to 2021 and the City will grow to a population of 175,000 by 2014 which equates to an annual population increase of 0.64%. The projection after 2014 was held constant so the same figures exist for 2021 to allow a comparison among the scenarios. The number of households needed for this population is estimated at 76,087, an increase of 13,067 households from 2001. The average household size assumed at 2021 is 2.30 persons. This

scenario was considered unrealistic and dropped from the Final Synthesis / Land Use and Settlement Report which formed the basis of the Official Plan.

Based on the 2006 Census data, the population of the City of Greater Sudbury increased by 1.7% between 2001 and 2006, to 157,857 people, or approximately 0.34% annually. This increase is slightly lower than the 0.46% forecasted as part of the official plan review.

For the purpose of the Biosolids Master Plan we have assumed a 25 year planning life and an annual increase in growth of 0.46%, which is consistent with the In-Migration forecast and relative growth for the period of 2001 to 2006. This translates to an 11.5% population increase, and a projected population of 177,000 people by the year 2033.

It should be noted that this projection does not account for the cyclical nature of the City's growth, and for this reason is considered conservative.

4.5 Waste Activated Sludge Quantity Projection

Sludge quantity production was estimated based on Synthesis / Land Use and Settlement Report (2001 Census Data) which predict both growth and population served, in conjunction with the 2006 Census Data and the average annual sludge production data from the City's Annual Wastewater Reports.

Utilizing this data and the projected population an estimated serviced population and quantity of sludge was generated for each of the City's Wastewater Facilities. (Refer to **Appendix I**). **Table 4.5.1** summarizes the sludge production volumes based on the projected population.

Table 4.5.1: City of Greater Sudbury Sludge Quantity

Year	Population	Serviced Population	Projected/WAS Production (m3/d) @3% solids
2001	155,225	134,550	573[1]
2006	157,857	n/a	358[1]
2021	169,579[2]	148,343[2]	475[3]
2033	177,000[2]	157,500[2]	500[3]

[1] Waste activated sludge production based on City of Greater Sudbury Annual Wastewater Reports.
[2] Projected services population (based on Synthesis / Land Use and Settlement Report.
[3] Projected Sludge Volumes.

Considering the speculative nature of these projections, sludge production volumes were also generated based on the rated capacity of each wastewater facility. Total sludge production based on the combined rated capacity of the City's nine (9) Wastewater Treatment Plants is estimated at 780 m^3/d.

4.6 Required Biosolids Treatment Capacity

For the purpose of this study a sludge production quantity of 500 m^3/d was used to form the basis of the analytical calculations for protected handling, storage, processing, and cost estimation purposes.

Operational requirements were provided based on the City's desire to operate the Biosolids facility, 5 days per week, 10 hours per day.

Table 4.6.1 summarizes the estimated treatment capacity of the facility.

Table 4.6.1 – Estimated Treatment Capacity of the Facility

Year	Average Daily Sludge Production (m^3/d)	5 Day / Week Sludge Treatment Requirement m^3/d	Proposed Biosolids Treatment Capacity m^3/d
2003 - 2007	443[1]	600	700
2033	500	700	700
Combined Rated Plant Capacity	780 m^3	1100	700[2]/1400

[1] Waste activated sludge production based on City of Greater Sudbury 2003 to 2007 Annual Wastewater Report.

[2] Additional treatment capacity provided by operating the facility with two (2) 10 hr. shifts / day (i.e. 20 hours/day, 5 days / week).

Based on satisfying the sludge treatment requirements a biosolids treatment facility with a rated capacity of 700 m^3/d including provisions for redundancy was used as a basis to develop / review the various treatment technologies / alternatives. The municipality will have the flexibility to double the capacity of the treatment process by operating the treatment facility 20 hours per day or during weekends, if required. Alternatively a smaller facility could be developed and operated on a continuous basis. (i.e. 24 hours/day, 7 days/week). However consideration for maintenance downtime and redundancy would need to be incorporated into the operational plan for this scenario.

4.7 End Use / Disposal Alternatives

Disposal options are contingent upon the processes in place and the resulting biosolids quality. With the advent of more stringent biosolids criteria and the elimination of some of the historical practices for biosolids disposal, processes for the management of biosolids are coming under greater scrutiny by regulators including the Ministry's of Environment and Health, with regard to the resulting nutrient content, overall marketability, metals content and concentration of other constituents of concern. A wide variety of wastewater treatment processes are currently in use. The following end use/disposal alternatives were considered within the planning process.

Land Application (Agricultural)

Biosolids applied to agricultural land, at the regulated loading rates (mg/kg), can be of great benefit to the land. Biosolids acts as a soil conditioner to transport nutrients, increase water retention and improve soil tilth.

Sunlight and soil microorganisms are factors that continue to treat biosolids once applied. However, biosolids can only be applied when the weather and soil conditions permit. Biosolids cannot be applied in wet weather or when the soil is frozen, snow covered or waterlogged, due to risks to the environment and limitations of the spreading equipment.

Farmers want to receive biosolids only during specific periods in their cropping cycles, unless fallow land is available.

Although biosolids has been applied to agricultural lands for over 30 years, negative Public perception associated with this option is increasing.

Horticulture/Parks

Biosolids have been used to enhance the growth of sod. Biosolids intended for this use are generally in the dried (e.g. pellets) or composted form and must be "near pathogen-free" (equivalent to the Class A designation).

Application of composted biosolids to parkland has been implemented in Ontario in the past. End-users that utilize this beneficial product are golf courses / driving range facilities, landscaping industries and sod farms. However, the quality requirements for composted biosolids are much more restrictive than for other types of biosolids due to the regulations currently in place in Ontario.

Silviculture

Application of biosolids in forested areas can be of great benefit to the trees and plants. The biosolids can be applied in all stabilized forms, liquid digested, dewatered cake or dried pellets.

Forested areas have high infiltration rates, reducing the possibilities of runoff and ponding. However, due to the low nutrient uptake of forested soils, groundwater can be contaminated with nitrates if application rates of biosolids are not properly managed. Studies have shown that biosolids can accelerate the growth-rate of trees, in some cases pilot plots have revealed as high as twice the growth rate when compared to growth rates without biosolids[1].

Landfill Cover Amendment

In this disposal strategy, biosolids are used for daily landfill cover. A layer of stabilized and dewatered biosolids is applied over the municipal solid waste to reduce odours, deter unwanted animals and to minimize the waste from being blown away. The use of biosolids for landfill cover will enhance vegetative growth and sustain it for longer than if biosolids were not used. This method of biosolids disposal has gained popularity but requires stabilized and dewatered biosolids to avoid potential leachate problems.

Landfill (Monofilling of Biosolids)

Monofilling of biosolids is the disposal of stabilized biosolids in a dedicated landfill, usually in trenches. The recommended solids content of biosolids for narrow trenches is 15 percent to 30 percent so that solids can be spread evenly. Wide trenches, greater than three (3) metres wide, are required for biosolids with solids content of 30 percent or more. This practice has been used in arid or semi-arid regions where soil and groundwater conditions are suitable, and where the land is not suitable for agriculture. However, this method does not take advantage of the nutrient value of biosolids.

Co-disposal with Municipal Solid Waste

This disposal method simply involves spreading stabilized and dewatered biosolids in a layer, which is then immediately bladed into and mixed with the municipal solid waste. This has become the most prevalent land filling disposal method of biosolids in Canada. As with landfilling, this method fails to recover the nutrient value of biosolids.

[1] WEAO, Seminar, “Managing Biosolids Beyond 2010”
Ways of using biosolids other than land application in agriculture
- Ned Beecher, North Est Biosolids and Residuals Association
- Marc Hébert, Ministèrre du development durable, de l’environnement, et des parcs
- Mike Van Ham & Mark Teshima, Sylvis

Developed for the Water Environment Association of Ontario Biosolids Seminar October 1 & 2, 2007.

Land Reclamation

Land reclamation is the restoration of infertile or abandoned land by establishing a vegetative cover. Land reclamation projects using biosolids have been very successful in places such as: strip-mined areas, mine refuse piles, sand and gravel pits, hazardous waste sites, closed landfills, urban renewal areas, areas disturbed by construction activities, arid lands and dredge spoil sites.

Biosolids have been especially beneficial in reclamation projects because of the nutrient value of biosolids. In some mine reclamations, biosolids were used after conventional methods had failed to establish sufficient vegetative cover.

Land Farming

Land farming is the application of biosolids on designated land, which is dedicated as a permanent site for the disposal of biosolids only, similar to a solid waste landfill site. The land cannot be farmed or used for agricultural or food production purposes. Land farming of biosolids requires less land than agricultural land because application rates can be much higher. Ideally land-farming sites should be located next to the treatment plant, to reduce transportation costs. However, this method can pose problems such as unacceptable odours and high metal concentrations in the soil. The practice has been used in some U.S. States and by a few industries in Ontario, but is not widespread.

4.8 Regulatory Requirements – Metals

Selection of end-use or disposal alternatives will, in part, depend on the suitability of the biosolids for the specific alternative.

Regulatory requirements vary depending on the designated end-use of the product. The acceptable metal concentrations are stipulated in a number of regulations. For the City of Greater Sudbury the following regulations are relevant:

- Fertilizer Act (Canadian Federal Government)
- Nutrient Management Act (Ontario Provincial Government)
- Environmental Protection Agency Code of Federal Regulation Part 503: (US Federal Government)

The City under their current mode of operation samples the sewage sludge produced at their facilities once per year. Metal levels in the sewage sludge generated from the City's nine (9) wastewater treatment plants for the past ten (10) years are included in **Appendix O**.

Table 4.8.1 summarizes the highest observed regulated metals concentration (including metals such as copper, nickel, zinc, lead, etc.) for the years 2004 to 2008. A composite metal concentration was also calculated based on the combined sludge production of the nine (9) plants as a means to determine the overall or combined metal concentration of the sludge generated.

Table 4.8.1 – Highest Dry Metals Concentration Between 2004 – 2008

Regulated Metals	Highest Dry Concentration Between 2004-2008 (mg/kg)									Combined Weighted Metals Concentration (based on highest observed test results from 2004 to 2008) (mg/kg)
	Azilda	**Chelmsford**	**Coniston**	**Dowling**	**Levack**	**Lively**	**Sudbury**	**Valley East**	**Walden**	
Sludge Production (m3/day)	14.6	37.2	8.5	8.0	6.5	11.7	280.2	47.5	13.8	
Arsenic	6.7	5.8	1.8	4.8	3.0	3.8	4.8	3.9	4.3	4.7
Cadmium	2.0	0.7	3.2	1.5	2.6	2.2	1.9	1.4	1.4	1.8
Chromium	24.0	15.1	28.3	19.3	35.5	25.4	16.2	21.7	32.3	18.3
Cobalt	13.0	16.6	16.7	11.6	13.3	35.4	10.2	4.8	50.0	12.4
Copper	975.0	428.0	1166.7	754.0	1850.0	750.0	783.0	841.4	412.0	775.6
Lead	35.4	15.0	54.2	34.1	85.0	41.7	35.0	23.0	34.5	33.2
Mercury	1.8	2.3	1.9	0.4	1.4	2.1	4.8	1.0	2.3	3.7
Molybdenum	6.7	4.1	7.3	4.6	6.0	2.3	5.2	3.4	5.9	4.9
Nickel	108.3	98.5	491.7	133.0	280.0	266.7	136.0	77.6	272.7	142.5
Selenium	6.1	3.6	4.5	4.3	4.7	5.0	2.1	1.8	5.0	2.6
Zinc	520.8	299.0	833.3	447.0	650.0	541.7	410.0	482.8	377.3	427.5

Sludge Metal Concentration analysis results from the past five (5) years (2004 to 2008) were reviewed, and converted to concentration by dry weight of solids, using the highest observed value. Results of the analysis are included in **Appendix P**. **Table 4.8.2** summarizes the standard regulated metals concentrations and the composite metal concentration based on the highest recorded value for each plant.

Table 4.8.2 – Regulated Metals Concentration

Regulated Metal	Nutrient Management Act (Maximum metal concentration in materials applied to land that are sewage biosolids up to 8 tonnes / ha / 5 yrs)	Nutrient Management Act (Maximum metal concentration in materials applied to land that are sewage biosolids up to 22 tonnes / ha / 5 yrs)	Fertilizer Act. (T-493 – Standards for metals in fertilizers and supplements	U.S. Environmental Protection Agency Code of Federal Regulation Part 503: Standards for the use or disposal of sewage sludge (Average Concentration)	Lowest Maximum Regulated Concentration	Sudbury Biosolids Combined Metal Content Highest observed test result at each facility period 2004 To 2008
UNITS	**mg / kg Dry Solids**	**mg / kg Dry Solids**	**mg / kg Dry Solids**	**mg / kg Dry Solids**	**mg / kg Dry Solids**	**mg / kg Dry Solids**
Arsenic	170	75	75	41	41	4.7
Cadmium	34	20	20	39	20	1.8
Cobalt	340	150	150	--	150	12.4
Chromium	2800	1060	--	--	1060	18.3
Copper	1700	760	--	1500	760	775.6
Mercury	11	5	5	17	5	3.7
Molybdenum	94	20	20	--	20	4.9
Nickel	420	180	180	420	180	142.5
Lead	1100	500	500	300	300	33.2
Selenium	34	14	14	100	14	2.6
Zinc	4200	1850	1850	2800	1850	427.5

Metal levels in the City's sludge, both at the individual plants and the weighted combined values were found to be consistently below the allowable maximum concentrations of the regulated metals suggesting the City would have a number of end-use options available for further consideration.

To expand the existing database and assist in selecting the final disposal / end-use, we recommend the City consider expanding their sample program in accordance with the Nutrient Management Act and sample on a monthly interval.

4.9 Land Required / Available For Application

In calculating the area of land required for biosolids end-use, the maximum application rates prescribed under the Nutrient Management Act were used with reference to the maximum metal concentrations. Specifically;

- Eight (8) tonnes of biosolids / hectare / 5 year period with higher metal contents, and / or,
- Twenty-two (22) tonnes of biosolids / hectare / 5 year period with low metal content

The allowable application rate is dependent on the metal concentrations as outlined in **Table 4.8.2.**

Table 4.9.1 summarizes the land area required for the projected biosolids production under the current population, projected population and the combined rated capacity scenarios as outlined in Section 4.6.

Table 4.9.1 – Land Area Required for Biosolids Application

Year	Average Daily Sludge Production @ 3% Solids	Biosolids Production @ 60% Solids		Total Tonnes of Biosolids Produced / Year (tonnes)	Area Required for Biosolids Based on NMA (ha)	
	(m^3/d)	(m^3/d)	(kg/d)		8 tonnes / ha / 5 years	22 tonnes / ha / 5 years
2007	432	21.6	22600	8278	5173	1881
2033	500	25.0	26250	9582	5982	2178
Combined Rated Capacity	780	39	40950	14947	9342	3397

Based on the City's Official Plan (OP) and data from Statistics Canada, the City currently has 9264 ha of farmland of which includes 5330 ha of designated agricultural reserve under the OP, and roughly 4630 ha of active farmland which will satisfy the land required for immediate and future end use application. (Refer to **Appendix Q**)

4.10 Use of Biosolids on Land

City Staff are reviewing options of how best to dispose of the estimated volume of biosolids generated by their wastewater facilities. Several opportunities have been identified within the geographical area including possible agricultural applications. Emphasis has been placed on the economical and environmental benefits from biosolids application, specifically with regard to land reclamation and public health and safety. Land application on agricultural land has become increasingly regulated over the past few years, necessitating the development of site specific nutrient management plans for the application of biosolids materials. The increased competition for available land suitable for biosolids application by both municipalities and companies involved in the land application business has become a key consideration in the way municipalities approach biosolids treatment and forecast their long-term operational needs and capital / operating costs.

5.0 ALTERNATIVE SOLUTIONS

Development of alternative solutions for the City was conducted on two (2) fronts, **planning alternatives** and **technical alternatives**.

5.1 Planning Alternatives

Planning alternatives were developed to facilitate the siting of a new biosolids treatment facility. Consideration was given to a number of parameters to refine a short list of siting alternatives, namely;

- Environmental impacts
- Economic factors
- Odour management
- Haulage / distance
- On-site treatment requirements

Seven (7) planning alternatives, described below, were developed to facilitate the biosolids treatment facility(s).

Planning Alternative 1: Do Nothing

This alternative is presented solely to provide a comparative framework for preferable alternatives. It is intended to focus attention on the key drivers for initiating the Environmental Assessment Process, summarized as follows:

- Foul odours resulting from the current disposal practice are not acceptable to the community.
- The city recognizes that odour issues have a negative impact on quality of life.
- The Ministry of the Environment has expressed concern regarding the present disposal methods for unstabilized sludge.
- Vale Inco has given notice that use of its tailings pond cannot be considered in the final alternative to the City for the disposal of sludge. **(Appendix C)**

For the above reasons the "Do Nothing" solution is **not** considered a viable solution

Planning Alternative 2: Haul sludge to another Municipality

In 2007 this alternative was investigated by the City of Greater Sudbury as a short-term solution to alleviating odour issues. Seven communities including Hamilton, Barrie, Sault Ste. Marie, Ottawa Sarnia, Region of Niagara and North Bay were contacted regarding availability and willingness to accept waste activated sludge from the City of Greater Sudbury. Response from this informal survey indicates that this alternative is not practical. Expansion of treatment facilities in other municipalities would be necessary to accept the volume of sludge generated by the City of Greater Sudbury. The cost of either constructing or expanding treatment facilities in other municipalities, as well as the cost of hauling waste activated sludge, would be better applied to developing a local long-term solution. Environmental, jurisdictional, geographical, social, and economical factors were also taken into account.

Planning Alternative 3: Build only at the Sudbury Wastewater Treatment Plant Site

This alternative involves the construction of a new biosolids treatment facility at the wastewater treatment plant on Kelly Lake Road, in Sudbury. Three of the treatment technologies being considered have a small enough footprint that construction at the wastewater plant is possible. This has a number of logistical advantages and would have little impact on the current plant operation but will likely require additional odour control processes. The end-product would be a stabilized biosolids material safe for disposal or storage at the Sudbury Landfill site or for use as a soil amendment product.

Planning Alternative 4: Build only at the Sudbury Landfill Site

This alternative involves the construction of a new biosolids treatment facility at the Sudbury Landfill Site, in Coniston. Any of the proposed treatment technologies may be selected for this option. The end-product would be a stabilized biosolids material safe for disposal or storage at the Sudbury Landfill or for use as a soil amendment product. This alternative was considered as impractical since there would be no ability to treat the dewatered liquid waste streams at the Landfill.

Planning Alternative 5: Build Facilities at the Sudbury Wastewater Treatment Plant Site and Landfill Site

This alternative involves the construction of a new biosolids treatment facility at the Sudbury Landfill Site in Coniston. Technologies such as Composting (Gore™) and N-Viro™ tend to have larger footprints, requiring a larger construction area. Initial treatment in the form of dewatering would occur at the Sudbury Wastewater Treatment Plant to reduce haulage costs associated with hauling liquid sludge if the dewatering process was located at the landfill site. The final treatment and disposal or stockpiling of the stabilized end-product would be located at the landfill site. The end-product would be a stabilized biosolids material safe for end-use / disposal or storage at the Sudbury Landfill Site or for eventual use as a soil amendment product.

Planning Alternative 6: Build only at a New Site

This alternative involves the construction of a new biosolids treatment facility at a new site (yet to be determined). Any of the proposed treatment technologies may be selected for this option. The end-product would be a stabilized biosolids material safe for disposal or storage on site or for use as a soil amendment product.

Planning Alternative 7: Build Facilities at the Sudbury Wastewater Treatment Plant Site and at a New Site

This alternative involves the construction of a new biosolids treatment facility at a site yet to be determined. As discussed in “Alternative 5”, technologies such as Composting (Gore™) and N-Viro ™ require a larger area. Initial treatment in the form of dewatering would occur at the Sudbury Wastewater Treatment Plant with final treatment and disposal or stockpiling of the stabilized end-product at the new site. The final product would be a stabilized biosolids material safe for disposal or storage on site or for use as a soil amendment product.

5.2 Technical Alternatives

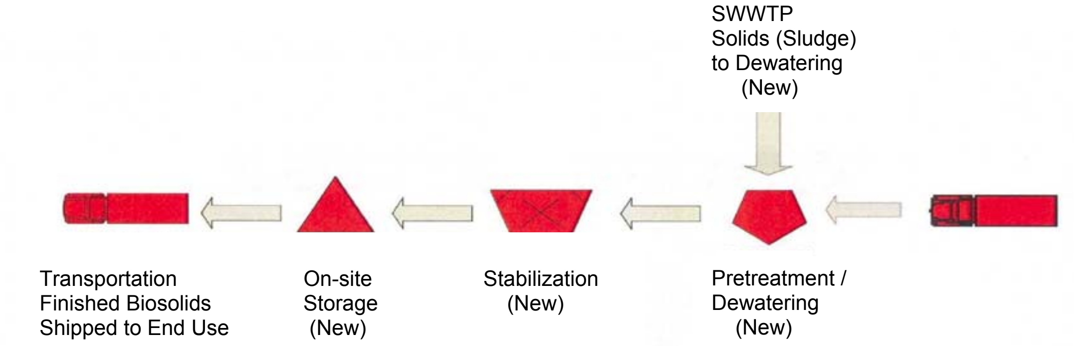
Biosolid Management or Treatment Programs vary from municipality to municipality, depending on size, regulations, public perception, and social economic and political factors.

Generally Biosolid Treatment Programs can be divided into the following key elements;

- Pretreatment including thickening and dewatering
- Stabilization
- Storage and Transportation
- End-Use / Disposal

A typical configuration of these processes and their relationship is depicted in **Figure 5.0.**

Figure 5.0 – Typical Process Schematic



Components of these elements and their application in various alternative treatment systems is described in detail in **Appendix R1**. The following briefly summarizes each component.

5.2.1 Pretreatment

Thickening and dewatering are important elements of a biosolids management program. Dewatering removes a significant quantity of water from the solids and producing a thickened sludge with 20 – 25% solids content, greatly reducing volumes for downstream handling and treatment. Dewatering produces a concentrated liquid side-stream that needs to be treated separately.

5.2.2 General Stabilization Alternatives

Biosolids stabilization can be divided into the following principal process types:

- Digestion
    - Anaerobic
    - Aerobic
- Alkaline stabilization
- Volume Minimizing Technologies
- Thermal processes
    - Thermal drying
    - Thermal oxidation (incineration)
    - Pyrolysis

- Composting
- Other

Based on RVA's experience and work on similar and related projects in Ontario and Canada, a general summary of the various sludge stabilization technologies and process can be found in **Appendix R3,** as well as numerous other municipal biosolids technologies currently in operation throughout North America.

More common municipal technologies are described below in greater detail as a prelude to the prescreening review.

Mesophilic Anaerobic Digestion

Mesophilic anaerobic digestion is the most common stabilization process for medium and large capacity wastewater treatment plants in North America. This process involves the natural breakdown of organic matter by bacteria in the absence of oxygen. The process occurs in a mixed vessel where the temperature is maintained between 30 to 35°C. Sludge is continuously or intermittently introduced into the reactor through a heat exchanger, while biosolids, with lower organic and pathogenic content, are displaced. A minimum hydraulic retention time (HRT) of 15 days is required but this can be as high as 30 days.

The sludge is biologically degraded in the digester through three (3) stages: hydrolysis (breakdown the organic material), acidogenisis (formation of acids) and methanogenisis (the formation of methane gas). The methane gas that is generated can be converted into heat and/or electrical energy. The digested biosolids meet the Class B designation.

Staged Mesophilic Anaerobic Digestion

Staged Mesophilic anaerobic digestion is a multistage anaerobic digestion process at mesophilic temperatures. Both stages are heated and mixed, providing enough solids retention time (SRT) in the first reactor for methane production. This process generates lower offensive odours and the biosolids produced are slightly easier to dewater. This process produces a Class B biosolid product.

Staged Thermophilic Anaerobic Digestion

Staged thermophilic anaerobic digestion is a multistage anaerobic digestion process at thermophilic temperatures. Unlike staged mesophilic anaerobic digestion, all reactors in this process operate as methane reactors to eliminate short circuiting. The flow from reactors is continuous flow, as opposed to a batch flow and provides a continuous source of methane gas. This process has the potential to produce a Class A biosolid product. There is a high construction cost associated with the tanks and additional heat input is required. There is also the potential for odours to be created.

Temperature Phased Anaerobic Digestion (TPAD)

Temperature phased anaerobic digestion (TPAD) is a two-stage reactor system. The first reactor operates at thermophilic temperatures and the second reactor operates at mesophilic temperatures. This two-staged system eliminates the shortfalls of the individual technologies when operated alone and maximizes the advantages of each process.

The thermophilic anaerobic digestion produces higher volatile solids and pathogen destruction is achieved with little foaming. However, the process can prove difficult to stabilize and can produce offensive odours and poor dewaterability. Achieving consistent Class A quality is not certain.

Aerobic Digestion

Aerobic digestion is similar to the activated sludge process in that micro-organisms consume the organics in the presence of oxygen at lower temperatures. Aerobic digestion, when operated in the mesophilic range of temperature (35°C - 37°C), rarely achieves the solids reduction observed in anaerobic digestion. The end-product is generally less odourous and the supernatant liquor is lower in BOD. Although aerobic digestion has a lower capital cost, the high power cost associated with the operation (mainly in the aeration) and reduced performance in cold weather has limited its popularity to smaller extended aeration plants. HRT varies between 45 and 50 days to achieve best results. In addition, the final biosolids product has a lower nitrogen content.

Autothermal Thermophilic Aerobic Digestion (ATAD)

Autothermal thermophilic aerobic digestion (ATAD) is an aerobic digestion process operating without external heat input at thermophilic temperatures between 50°C and 65°C. The process can be implemented in a single insulated vessel. The feed sludge should be more than three percent solids, and the process must take place in an efficient aeration vessel that minimizes heat loss, to support optimum thermophilic digestion.

An advantage of ATAD is the short retention time needed to achieve high solids reduction. Only six to 10 days of hydraulic retention time is required to achieve high levels of volatile solids destruction compared to a 45- to 50-day HRT for conventional aerobic digestion systems, for the equivalent destruction. The two-stage ATAD process can produce biosolids meeting Class A requirements and normally achieve a 40 percent volatile solids destruction as a minimum reducing the handling requirements.

ATTAD™

The ATTAD™ process is a type of 2nd generation Autothermal Thermophilic Aerobic Digestion (ATAD) technology which produces a high-solid pathogen-free product. The final product from the ATTAD™ process meets the US EPA "Class A" biosolids standard.

Unlike conventional ATAD systems however, the ATTAD™ process measures the oxygen uptake rate in the reactor and controls the air supplied to the system accordingly. Because of this, the process is seen as more efficient and eliminates the potential for anaerobic and odorous conditions. Due to the reduction of volatile organic matter during the aerobic decomposition in the reactor, the treated biosolids are lower in solids concentration (3-4%). The typical detention time of the biosolids in the reactor is about 12 days.

Dual Digestion (Two-stage aerobic-anaerobic)

Dual digestion consists of two stages; the first is aerobic and the second is anaerobic. The aeration of the sludge produces an exothermic bioreaction and the sludge is naturally heated by the oxidation of the volatile solids. No additional heat is required when the sludge is directed to the anaerobic reactor, which operates at mesophilic temperatures (35°C – 38°C).
Dual digestion requires smaller anaerobic digesters and eliminates the need for an external heat source. However, the disadvantages include odour problems in the aerobic stage, foaming in both stages, and some difficulties in maintaining the temperature of the sludge entering the anaerobic reactor. This process produces a Class B biosolid.

Lsytek ™

Lystek is a biosolids treatment technology, which produces a high-solid pathogen-free and nutrient-rich fertilizer product in liquid form, for beneficial use. The Lystek product meets the US EPA "Class A" biosolids standard. The Lystek process requires a controlled application of heat and alkali, along with high speed mixing.

High temperature and pH conditions maintained in the reactor kills pathogens. The nutrient value of the product is enhanced due to the addition of potassium (from the potassium hydroxide added for pH control).

Typical processing time in the reactor is approximately 40 – 60 minutes per batch. The finished product is then pumped to storage, where it can be kept for extended periods without concerns for odor, or land-applied as fertilizer using conventional equipment.

N-Viro™

The N-Viro™ process involves the addition of alkaline chemicals such as cement kiln dust (CKD), lime kiln dust (LKD), and lime materials to dewatered sludge. The pH of the sludge alkaline chemical mixture is raised to 12, and is dried in a gas or oil fired rotating kiln to drive off about one half of the moisture in the mixture. The material leaving the kiln is maintained above 52°C with a pH 12 for 12 hours before it is transferred into a staging area for curing to complete the 72 hours elevate pH phase. This process generates a Class A biosolid product.

N-Viro™ have plants operating locally for a number of years in Ontario at Sarnia, Leamington and, recently in the Niagara Region.

Taking biosolids from a waste product regulated under the MOE to a registered fertilizer considered safe under the Fertilizer Act creates an opportunity to regionally market the N-Viro™ product for some cost recovery. Concerns with the process include high-energy requirements, strong ammonia odours and dust within the storage facility.

Composting

Composting is a process in which organic material undergoes biological degradation, generating a stable end-product. Three types of microorganisms are mainly responsible for the degradation of the organic material, bacteria, actinomycetes, and fungi. The compost is naturally heated to temperatures between 50°C and 70°C by the decomposing activities of the microorganisms. At this pasteurization temperature range, enteric pathogenic organisms are destroyed.

Most composting operations will consist of the following steps:

- Mixing dewatered sludge with an amendment and /or bulking agent (usually wood chips, straw or sawdust)
- Aerating the compost pile either by the addition of air, by mechanical turning, or both
- Recovery of the bulking agent (if practical)
- Further curing and storage
- Final disposal

Appendix R1 describes the process steps in greater detail and includes a schematic of the process components. The more common composting options include:

- **<u>Composting – Open</u>**

  Open composting consists of a mixture of biosolids, bulking agents, and finished compost to achieve a solids content between 40% and 50%, which improves the structural integrity of the mixture. The main objection with open composting is due to the offensive odour generated. Precipitation (rain, snow, high humidity) also creates difficulties with the operation by slowing down the degradation process of organics due to excessive moisture and evaporative cooling.

  Generally, there are two types of open composting; aerated static pile and windrow composting. Aerated static pile is a mixture of dewatered sludge and bulking agent, which has been placed over exhaust piping or a grid of aeration pipes. The material is usually left to compost for 21 to 28 days and then cured for a minimum of 30 days. A layer of screened compost is usually placed on top of the compost for insulation. Aerated static piles are not mixed.

  Windrow composting, on the other hand, consists of long parallel piles called windrows, which are turned and mixed periodically during the compost period. During the turning operation, offensive odours are generated. Compost time ranges from weeks to several months before the compost is cured. Curing time depends on the stability required for the end use of the compost.

- **<u>In-Vessel Composting (Composting (Gore ™))</u>**

  In-vessel composting is composting within an enclosed container or vessel. The benefits of this are: easier process and odour control, faster throughput, lower labour costs and smaller footprint.

  In-vessel composting is typically a plug flow process, whereby the compost is moved via agitated bed towards the outlet whenever new material is added. The initial Carbon to Nitrogen (C:N) ratio should be from 25:1 to 35:1 by weight. Mixing and turning of the material should be carried out on a regular basis to prevent drying, caking and air channeling. The composting time normally lasts for 10 to 21 days followed by a 12 to 16 week curing period.

<u>Schwing Bioset™</u>

The Schwing Bioset™ system is a sludge stabilization technology offered by Schwing Bioset Technologies Inc., a joint venture of Schwing America Inc. and Bioset Technologies.

The Bioset™ process is a form of alkaline stabilization, employing high pH and high temperature conditions to kill pathogens and stabilize sludge. The end-product meets EPA's Class A standards for biosolids, for both pathogen destruction and vector attraction reduction (VAR).

Dewatered sludge is fed to a screw conveyor where it is homogenously mixed with quicklime and sulfamic acid. Sulfamic acid reacts with lime and organic material to generate heat. This serves to raise both the temperature and pH of the mixture as it is pumped to the insulated reactor using a piston pump.

The typical design detention time of the biosolids blend in the reactor is approximately 45 – 60 minutes, although for pathogen destruction and VAR only 30 minutes is required. The reactor is insulated and equipped with temperature sensors in order to ensure that required temperatures are maintained over the duration of the process. The process generates a Class A biosolids product.

RDP - Cambi Process

The Cambi process is a patented process that involves the hydrolosis of organics in a high pressure and temperature vessel before anaerobic digestion. The pressure cooking process of unstabilized sludge occurs for at least 30 minutes at 145°C before proceeding to mesophilic anaerobic digestion. The process reduces the volatile solids by at least 50%. The high temperature and pressure produces rich compounds in the sludge.

It is this intermediate product that provides significant advantages for the process as cell contents are broken down into simple short chain constituents and are readily digested by microorganisms. As a result of thermal hydrolysis and digestion, the dewaterability of the biosolids can easily reach 30 to 35% solids cake. The final product is fully sterilized and meets Class A standards for biosolids.

Heat Drying

Heat drying includes many types of mechanical drying systems. This process generates a dried biosolids product in a pellet form from a dewatered sludge. Solids concentration of the dried product is generally 90% to 95% but can be somewhat variable depending on the type of dryer.

Mechanical processes that have been used for drying sludge include: flash dryers, indirect dryers, tray dryers, spray dryers, multiple-hearth dryers, fluid-bed dryers, and multiple-effect evaporation. In all cases, considerable heat energy is consumed to drive off the water. The process generates a Class A biosolids product and like the N-Viro™ product can be distributed under the Fertilizer Act. In some cases the pellets have been known to undergo a phenomenon that causes reheating of the pellets that could eventually lead to fires.

Incineration

Incineration of biosolids is the thermal destruction of the organic content in the biosolids as well as the conversion of some of the inorganics from solids to gas. It is sometimes referred to as “Thermal oxidation” or “Combustion”. There are alternative forms of incinerators available, including the multiple hearth furnace, the fluidized bed furnace and the infrared furnace. Since the other technologies are considered to be out of date (multiple-hearth) or are not economic (infrared) most biosolids incinerators now being implemented are of the fluidized bed type,

Incineration is primarily a disposal process that achieves significant volume reduction and produces a sterile and inert product i.e. ash. It may also provide a source of heat for the facility. There are a number of installations in Canada and many more in Europe and the USA. In Canada fluidized bed incinerators are operated for biosolids destruction in Quebec City, Montreal, at the Duffin Creek WPCP (Region of Durham), at the Lakeview WPCP (Peel Region), and at the Greenway WPCP in London (Ontario).

Seasonal Air Drying

Seasonal air drying after long term lagooning can potentially help provide Class A biosolids. This process greatly reduces the biomass volume, is simple to operate, and requires low O&M costs. The disadvantages associated with this process, include odour potential and significant land area. This process is weather dependent.

Pyrolysis

Pyrolysis is the splitting of organic substances into gaseous, liquid, and solid fractions in an oxygen-free atmosphere. The resulting components of this process are a gas stream (primarily hydrogen, methane, carbon monoxide and various gases depending on the material pyrolyzed) a tar and/or oil, a liquid stream (containing chemicals such as acetic aid, acetone, and methanol) and a solid stream (a char consisting of almost pure carbon, plus inert material). Few operating plants exist that use this technology and thus the design is complex and costly.

The advantage is that there is the potential for no residues to dispose of and the end-product can be used in non-agricultural applications.

Pasteurization + Digestion

Pasteurization of sludge has been historically conducted at 70°C for 30 minutes to destroy pathogens. The US EPA's Part 503 Rules now allow flexibility in specific time/temp options. This technology is relatively new in North America but has been used frequently in Europe and one installation exists in Canada (Abbotsford, British Columbia). By combining pasteurization for pathogen destruction followed by mesophilic anaerobic digestion. This process generates a Class A biosolids product.

Irradiation

Irradiation is the application of high radiation energy that only inactivates the pathogens. The volume of the sludge remains unchanged and the odour potential is still strong. Two types of irradiation have been used in the past, electron (beta) and gamma. Both have been reported to produce nonradioactive biosolids. However, due to potential of risks to operator safety, public perception, and potential remaining odours, essentially no full-scale operations exist.

Long-Term Lagooning

Long term lagooning is simply storage and long-term anaerobic digestion of sludge in earthen lagoons. Lagoons can perform the functions of disinfection as well as storage and stabilization. Detention times vary from a few months to several years.

Lagooning is simple to operate, requires low Operating & Maintenance (O & M) costs, achieves high solids destruction and provides a highly stable end-product. However, lagooning requires considerable land and a substantial capital investment. (Serious odour problems encountered by Winnipeg in early 1980's). Class A biosolids can be achieved with perhaps 2 years of pure storage time in Winnipeg's climate.

5.2.3 New or Emerging Technologies

A number of newer and emerging technologies were reviewed for the City of Greater Sudbury's Master Plan. These technologies are listed below and described in detail in **Appendix R2**.

- Dryvac
- Miconair ™
- Thermo tech ™
- Ozone Treatment
- Brinecell ™ Process
- Liquid A

These technologies are in their infancy with no applications in Ontario and were deemed unsatisfactory for Sudbury's application, on this basis they were eliminated from further detailed consideration.

5.2.4 Short List of Alternative Treatment Technologies

A review of the aforementioned treatment technologies, selected criteria, and planning alternatives was undertaken utilizing the previously established screening criteria. This permitted the long list of alternatives identified to be refined to those more compatible to the City's requirements and current wastewater treatment technologies.

The rationale for short listing the options is explained as follows:

Many of the Anaerobic Digestive process including Mesophilic, Thermophilic Staged and Temperature Phased Digestion were dismissed at the pre-screening stage and were not recommended for further study.

Key factors in this decision process were the compatibility with the existing Wastewater Treatment Process, End Use Diversity, Construction Costs, Operating and Maintenance Costs.

In particular, the City's wastewater facilities produce an Aerobic Sludge; Anaerobic Digestion would not be recommended for an aerobic process. Furthermore the digestion processes, although producing a Class B Stabilized Sludge, would require additional treatment in the form of dewatering and drying to produce a product suitable for disposal only at the landfill.

Aerobic Digestion has a number of limitations such as, poor performance in cold weather, limited end-use diversity, high operating and maintenance costs, and poor dewaterability. Further treatment would be required. For these reasons Aerobic Digestion was dismissed.

Dual Digestion which incorporates both Aerobic and Anaerobic Digestion requires: additional tankage to accommodate both processes, has had a history of odour and foaming problems; and is relatively more costly than individual aerobic or anaerobic processes. The end-product is a Class B material and will require dewatering and drying for disposal at Landfill. There is limited large plant experience. Based on these limitations Dual Digestion was dismissed.

Autothermal Thermophilic Aerobic Digestions (ATAD) was also dismissed during pre-screening in favour of the 2nd generation process or ATTADTM which is viewed to be a more efficient and reliable process.

A Heat Drying facility is costly to construct, operate and maintain, prone to reliability issues and does not reduce the Volatile solids. This process would only be considered for a 25% or more dewatered sludge. There was some question as to whether consistently achieving this level of solid with 100% activated sludge was practical.

Few plants exist that use the Pyrolysis technology and questions arose regarding cost, complexity and reliability. This technology is very much in the research and development stage. For these reasons this process was dismissed.

Pasteurization is a relatively newer technology with only one installation in Canada and limited operational history. The process does raise concerns with odour control and operational costs.

Irradiation uses radiation energy to inactivate pathogens. Odour potential is strong. Public acceptance as well as safety of workers and the environment is skeptical. No full scale operation exists.

Incineration was ruled out due to the high capital construction costs and negative public perception of this process.

Seasonal Air Drying, Open Composting, and Long Term Lagooning are susceptible to odour problems, have high capital costs, negative public perception, and have significant land requirements that would require a new location to be investigated. Additional study and a full Schedule ‘C’ Environmental Assessment would be required.

Table 5.2.1 summaries the pass / fail ranking assigned to the various options considered. Options given a “pass” rating are described in greater detail below including a discussion of their advantages and disadvantages.

Table 5.2.1 – Prescreening Of Long List of Technologies Alternatives

Biosolids Treatment Technology Alternatives	Protection of Workers / Public Health	Environmentally Sustainability	Public Acceptance	Ease of Operation	Reliability / Flexibility (Controls Odours)	End Use Diversity	Suitability With Existing Wastewater Process	Total
Mesophilic Anaerobic Digestion	1	0	1	1	1	0	0	**Fail**
Staged Mesophilic Anaerobic Digestion	1	0	1	1	1	0	0	**Fail**
Staged Thermophilic Anaerobic Digestion	1	0	1	1	1	0	0	**Fail**
Temperature Phased Anaerobic Digestion	1	0	1	1	1	0	0	**Fail**
Aerobic Digestion	1	0	1	0	1	0	1	**Fail**
Autothermal Thermophilic Aerobic Digestion (ATAD™)	1	1	1	0	1	1	1	**Fail**
Autothermal Thermophilic Aerobic Digestion (ATTAD™)	1	1	1	1	1	1	1	**Pass**
Dual Digestion	1	0	1	0	0	0	1	**Fail**
Alkaline Stabilization - Lystek™	1	1	1	1	1	1	1	**Pass**
Alkaline Stabilization – N-Viro™	1	1	1	1	1	1	1	**Pass**
Composting - Open	1	0	1	1	0	1	1	**Fail**
In Vessel Composting (Composting (Gore™))	1	1	1	1	1	1	1	**Pass**
Alkaline Stabilization – Schwing Bioset™	1	1	1	1	1	1	1	**Pass**
RDP Cambi Process	1	0	1	1	0	1	1	**Fail**
Heat Drying	0	1	1	0	1	1	1	**Fail**
Incineration	1	0	0	1	1	1	1	**Fail**
Seasonal Air Drying	1	0	0	1	0	0	1	**Fail**
Pyrolysis	1	1	1	0	1	0	1	**Fail**
Pasteurization & Digestion	1	0	1	0	0	1	1	**Fail**
Irradiation	0	1	0	0	1	1	1	**Fail**
Long Term Lagooning	1	0	0	1	0	1	1	**Fail**

Alternative 1: ATTAD™

The ATTAD™ system is a 2nd generation Autothermal Thermophilic Aerobic Digestion (ATAD™) process that includes thermophilic aerobic digestion, nitrification/denitrification, followed by dewatering. The complete system, including a permanent dewatering facility, would be implemented at the wastewater treatment plant site. The finished product could be used for land reclamation at mine tailings, quarries or made into a soil product. A more detailed description of the ATTAD™ process is included in **Appendix R1**.

Equipment required for the ATTAD™ system includes tankage, a permanent dewatering facility, a truck loading area, and ancillary and support systems. Ancillary systems for this alternative include pipelines for conveying thickened sludge to the dewatering facility, the dewatered liquid waste or centrate from the dewatering facility and supernatant from the ATTAD™ digesters to the headworks of the wastewater treatment facility; a holding tank upstream of the centrifuges for proper feed; road work; site drainage; and electrical work for provision of power supply.

The ATTAD™ process generates a Class A product of approximately 25% to 30% solids which may be beneficially used as an additive to soil or artificial soils for horticultural, agricultural and landscaping purposes.

Advantages of the ATTAD™ system include:

- Efficient digestion process compared to conventional ATAD systems
- Reduced odour conditions due to efficient digestion, nitrification/denitrification, and the use of a biofilter
- Beneficial re-use of biosolids
- Produces a Class A biosolids product

Disadvantages of the ATTAD™ system include:

- Relatively large footprint, compared to other stabilization technologies such as Lystek™
- Higher capital costs, compared to other stabilization technologies being considered
- Requires additional drying to produce a 60% + solid

Alternative 2: Lystek™

Lystek™ is a process that employs high alkalinity and temperature conditions, coupled with high mixing speeds to stabilize sludge. The system generally includes:

- dewatering,
- storage tanks for dewatered cake and potassium hydroxide,

- a main reactor equipped with a high shear mixer and
- a small boiler to generate the high temperature required by the process.

A detailed description is included in **Appendix R1**.

The complete system, including a permanent dewatering facility, would be constructed at the wastewater treatment plant site. In addition, in accordance with Ontario's Nutrient Management Act, storage for the end-product would be required for at least 240 days during winter when it cannot be land-applied. Alternatively, if a different end use exists that remains available during the winter period the storage requirement would be reduced or be eliminated.

Two options exist for the Lystek™ alternative. Option A includes equipment and construction costs for a complete Lystek™ system including tankage, permanent dewatering facility, storage tanks for the end-product, truck loading area, and ancillary and support systems. For Option B, an alternative process is considered where the end-product is dried. In this case, winter storage is not required. Ancillary systems for this alternative, as well as the rest of the alternatives considered below, would include a pipeline for conveying centrate from the dewatering facility to the headworks of the wastewater treatment plant, a holding tank upstream of the centrifuges for proper feed, road work, site drainage, electrical work for provision of power supply, etc.

The Lystek™ process generates a Class A liquid end-product. As it is high in fertilizer value, the most suitable end-use is land application on agricultural land. There may also be a benefit to drying the end-product for use as part of a soil blend. This requires some research and if successful, may be implemented at a later stage.

Advantages of the Lystek™ system include:

- Relatively small footprint, compared to other sludge stabilization technologies
- Relatively low capital and operating cost, compared to other sludge stabilization technologies
- Beneficial re-use of biosolids
- Produces a Class A product
- Requires no specialized equipment
- Relatively easy to operate
- End-product can be easily conveyed using a conventional centrifugal pump.

Disadvantages of the Lystek™ system generally include:

- The end-product is liquid which limits end use options
- End-product aesthetics are not as appealing as some other products.

A detailed description is included in **Appendix R1**.

Alternative 3: N-Viro™

The N-Viro™ process is a form of alkaline sludge stabilization, where an alkaline admixture, typically cement-kiln dust, is blended with dewatered biosolids and is then dried. The system generally includes:

- dewatering,
- a mixing system,
- a rotary drum dryer,
- a cyclone and baghouse for dust control,
- curing and storage areas, and
- a scrubber and biofilter for odour control.

A detailed description is included in **Appendix R1**.

The system needs substantial process storage requirements resulting in a relatively large overall footprint. The dewatering facility could be located at the wastewater treatment plant site and dewatered cake could be hauled to a separate site to undergo the N-Viro stabilization process prior to end-use.

The capital cost for this alternative includes the N-Viro™ system, a permanent dewatering facility, a truck loading area, and ancillary and support works. The N-Viro™ system generates a Class A soil product. The final product may be sold for application to agricultural land, or as an additive for soil blends.

Advantages of the N-Viro™ system include:

- Beneficial re-use of biosolids
- Produces a Class A product
- Produces an easy-to-handle dry soil product
- The alkaline nature of the end-product makes it appropriate for use on mining lands, an application which may have widespread opportunity in Sudbury

- The final product may be sold
- Multiple end uses

Disadvantages of the N-Viro system include:

- Ammonia is generated as a by-product of the alkaline stabilization process
- The system has a relatively large footprint (including curing and storage areas)

<u>Alternative 4: Composting (Gore™)</u>

Composting (Gore™) is an aerated static pile process that uses specialized covers made from Composting (Gore™) semi-permeable membranes. The system generally requires:

- a dewatering facility,
- a main composting area with concrete pads and an entrenched aeration system,
- blower and control building, and
- a curing and storage area.

A detailed description is included in **Appendix R1**.

The composting facility would be constructed at the landfill site or a new site, subject to land availability. The permanent dewatering facility, however, could be located at the wastewater treatment plant site and dewatered cake would be hauled off site for composting prior to end-use.

The capital cost for the Composting (Gore™) alternative includes the Composting (Gore™) composting system, a permanent dewatering facility, a truck loading area, and ancillary equipment.

The Composting (Gore™) composting system produces a Class A product. The final product may be sold on its own or as a blend with other composts or added to soil to enhance growing properties. It can also be used for horticulture and landscaping purposes.

Advantages of the Composting (Gore™) system include:

- Beneficial re-use of biosolids
- Produces a Class A product
- System can accept other waste streams such as source-separated organics and industrial waste
- The final product may be sold to the public after review/acceptance by the Canadian Food Inspection Agency
- Can be manufactured into a topsoil product

Disadvantages of the Composting (Gore™) system include:

- The system has a relatively large footprint
- The mixing process can be odourous

<u>Alternative 5: Schwing Bioset™</u>

The Schwing Bioset™ process is an alkaline stabilization technology that produces a Class A product with minimal operator attention. Class A biosolids are achieved via the time vs. temperature equation and pH adjustment per the EPA 503 regulations. Temperature is achieved through the addition of Quicklime and Sulfamic acid and the high pH is achieved through the addition on the Quicklime. A twin screw feeder mixes the chemicals into a homogeneous mixture and the pumped through an insulted reactor with a piston pump. The system generally includes:

- Dewatering,
- Screw Conveyor,
- Piston Pump & Reactor,
- A scrubber and biofilter, and
- Curing / storage area.

Refer to **Appendix R1** for a more detailed description.

The odours released through the chemical reaction are contained within the pressurized reactor and are collected as a point source emission with a small scrubbing system. This virtually eliminates any odours.

Advantages of the Schwing Bioset™ system include:

- Beneficial re-use of biosolids
- Produces a Class A product
- Simple system that is easy to operate and requires little maintenance
- System that operates with little dust and odour

Disadvantages of the Schwing Bioset™ system include:

- Maintenance of the high pressure cake pump will require the system to be taken offline.

5.3 Planning / Technical Alternatives to Be Considered

Combining the short list of planning alternatives and technical alternatives was completed to refine the list of alternatives prior to initiating the detailed evaluation process.

This intermediate step allowed for the elimination of the planning / technical options which were not compatible with each other. For example biosolids processes requiring some dependence on a sewage treatment process such as ATTAD^{TM}, were not considered for construction at the Sudbury Landfill Site.

Table 5.3.1 summarizes the planning / technical alternatives.

Table 5.3.1 – Summary of Planning / Technical Alternatives

Technical Alternatives						
Planning Alternative	ATTAD ™	Lystek ™	N-Viro ™	Composting (Gore ™)	Schwing Bioset™	Comments
1. Do nothing						Not a viable alternative
2. Haul Sludge to another Municipality						Due to logistic issues and cost to develop other municipalities infrastructure ruled out
3. Build only at the SWWTP	√	√	√ **		√	Can product Class A or B biosolids
4. Build only at the Sudbury Landfill Site	√	√	√	√	√	Not practical, no treatment available for sidestreams
5. Build facilities at the SWWTP and Sudbury Landfill Site			√	√		Can product Class A or B Biosolids
6. Build only at a New Site	√	√	√	√	√	Not practical, no treatment available for sidestreams
7. Build facilities at the SWWTP and a New Site			√	√		Can product Class A or B Biosolids

SWWTP – Sudbury Wastewater Treatment Plant

** Revised to Reflect Alternative Configuration

The following eight alternatives/scenarios were considered for further detailed evaluation, namely:

- Scenario 0*: Existing conditions, status quo.
- Scenario 1: ATTAD™ and dewatering at Sudbury Wastewater Treatment Plant
- Scenario 2: Schwing Bioset™ and dewatering at Sudbury Wastewater Treatment Plant
- Scenario 3: Lystek™ and dewatering at Sudbury Wastewater Treatment Plant
- Scenario 4A: Composting (Gore™) at the Sudbury Landfill with dewatering at Sudbury Wastewater Treatment Plant
- Scenario 4B: Composting (Gore™) at New Site with dewatering at Sudbury Wastewater Treatment Plant
- Scenario 5A: N-Viro™ at the Sudbury Landfill with dewatering at Sudbury Wastewater Treatment Plant
- Scenario 5B: N-Viro™ and dewatering at the Sudbury Wastewater Treatment Plant
- Scenario 5C: N-Viro™ at a New Site with dewatering at Sudbury Wastewater Treatment Plant

* NOTE: For comparison purposes only, the City's existing disposal practices were included in the detailed evaluation.

5.4 Biosolids Storage / Disposal Impacts

Common to each planning / technical alternative is the need to store, haul and dispose of the sludge / biosolids end-product.

Storage options for biosolids need to be considered, not only for the final product, but also the steps along the process path that make up the program. These may include:

- Storage upstream of dewatering or thickening processes to provide flexibility or a facility to blend solids streams before further processing;
- Storage of dry biosolids, cake or liquid biosolids before haulage;
- Permanent bulk storage of sludge or biosolids as liquid or as cake, and as dry biosolids;
- Temporary storage of sludge in case of emergency conditions.

In addition to providing operational flexibility and contingency planning, storage options may further reduce transportation costs by eliminating haulage of part loads, and off site haulage during the winter months. Siting of biosolids storage facilities should also consider buffer zones, odour management and existing transportation networks and distance.

The Nutrient Management Act stipulates 240 days of required biosolids storage for agricultural uses. The table below summarizes the various storage requirements dictated by the end-use and technological alternatives.

Table 5.4.1 – Biosolids Storage Requirements

Alternative	Storage Required (Days)	Storage Provided (Seasonal Days)	Storage Volume Required (m^3)
Nutrient Management Act, (Agriculture Uses)	240		
ATTAD™	--	120	1,416
Lystek ™	240	240	18,600
N-Viro ™	60	120	3,108
Composting (Gore™)	--	120	3,108
Schwing Bioset™	--	120	3,468

5.5 Alternatives for Storage

Alternatives for storage vary, based on the type of product. Liquid storage includes options such as lagoons and covered steel tanks.

Consideration of the construction of new storage options offers a range of advantages and disadvantages. With the construction of a lagoon, odours may become an issue particularly in the spring time. This is difficult to control because of the large surface area. In addition, a large land base, including buffer strips, would be required. Covered storage, such as a steel or concrete tank, greatly reduces the possibility of odours escaping. They do not require a large land base but do have a large impact on the cost.

Some processes, which produce a drier product that, with reduced moisture content and different physical properties are more easily handled by a conveyor or loader instead of a pump. Composting (Gore**™**), Schwing Bioset**™**, and N-Viro**™** produce such a dry product.

Storage for these products will vary depending on the amount of moisture present in the product and the potential for dust or odours. In general, the storage will be in a covered structure and the material will be stored on a concrete or asphalt floor either in stacked piles or in cribs. The exterior walls of the structure should be concrete and extend at least 1.2 m above the floor.

Dry product storage structures include steel rigid-frame buildings with metal siding and roof, salt domes of the type used for highway maintenance, or concrete silos.

A review of the alternatives provided the following options for storage. The table also includes the estimated capital.

Table 5.5.1- Biosolids Storage

Alternative	Storage Volume Required (m^3)	Estimated Capital Costs
ATTAD™	1,416	$4 M
Lystek ™	18,600	$12 M
N-Viro™	3,108	$8 M
Composting (Gore ™)	3,108	$8 M
Schwing Bioset™	3,468	$8 M

Estimated costs for storage have been included in the overall capital estimate. Phasing and construction or offsite storage at landfill, may permit a reduction in the overall capital costs.

5.6 Sludge Storage Alternatives

The requirement for biosolids storage also prompts the need for an examination of the sludge storage requirements at some of the plants to reduce immediate trucking costs and avoid backing-up the treatment process. Temporary storage also affords the opportunity to increase solids concentration through decanting of the liquid, thereby reducing transportation requirements.

Table 5.6.1 summarizes the current and future temporary storage capacities.

Table 5.6.1 – Wastewater Plants Sludge Holding Tank Capacities

Facility	Tank Capacity m3	Sludge Production based on a Population of 177,000 (m3 per day)	Retention (days)	Sludge Production based on Rated Capacity (m3/day)	Retention (days)
Azilda	85	14.8	5.7	14.1	6.0
Chelmsford	216	36.7	5.9	55.3	3.9
Coniston	50	8.6	5.8	16.8	3.0
Dowling	68	8.1	8.4	9.7	7.0
Levack	100	7.1	14.1	16.5	6.1
Lively	156	13	12.0	17.6	8.9
Sudbury	1425	317.7	4.5	507.8	2.8
Valley East	330	49.3	6.7	73.3	4.5
Walden	120	15.6	7.7	23.4	5.1
Total Sludge Production Outlying Plants (excluding Sudbury)		153.2[1]		226.7	
Additional Storage – Old Sludge Thickening Tank @ SWWTP	340		2.2		1.5

* [1] Total volume of sludge generated by City Facilities to be hauled to the SWWTP based on a population of 177,000 people and a sludge production volume of 500 m^3.

With the exception of the Sudbury WWTP, sludge storage capacity ranges from 3.0 to 9.0 days when all plants are operating at their rated capacity. The SWWTP provides 2.8 days of storage in the lower sludge holding tank. An additional two days of storage can also be provided in the upper sludge thickening hoppers if required.

Based on discussions with City of Greater Sudbury wastewater plant staff, staff would prefer four (4) days of storage capacity to accommodate any process or maintenance issues with the biosolids facility. To accommodate this requirement additional storage capacity can be provided by utilizing the ‘old’ sludge thickening tank at the SWWTP as a sludge receiving facility for the outlying wastewater plants. This would provide 1.5 days for the combined sludge production of the outlying plants. Overall, an average total of four (4) days of combined storage is available assuming the worst case, rated capacity scenario.

5.7 Distance Cost Impacts

The location of the processing, storage and disposal sites will have a significant impact on the cost of the Biosolids Management Program. The greater the distance between sites, the more the transportation costs will be.

Early in the EA process three (3) possible locations were identified for storage and possible further processing:

- Sudbury Landfill Site
- Sudbury Wastewater Treatment Plant
- Other / new site (location unknown)

The majority (2/3) of the sludge volume generated for the City is generated at a single facility - the Sudbury Wastewater Treatment Plant (SWWTP). Logistically, dewatering the sludge at this location has the most impact on reducing the haulage costs for the planned program.

Furthermore, identification of a centralized storage site such as the Sudbury Landfill Site could have a large impact on the overall disposal / transportation costs.

Figure 5.8 (**Appendix N**) identifies the various haul routes considered for transporting varying states of treated dewatered sludge or biosolids. **Table 5.7.1** compares and groups the treatment scenarios based on haulage requirements and summarizes the haul distance, as well as the potential cost of hauling the volume of biosolids produced to the various locations.

Table 5.7.1 - Sludge Hauling Cost Estimates Based on 500 m^3 of Sludge Production per Day

Scenarios	Dewater and stabilize at the SWWTP and stockpile at the Sudbury Landfill				Dewater at the SWWTP and stabilize and stockpile at the Sudbury Landfill		Dewater at the SWWTP and stabilize and stockpile at a New Site	
Applicable Technologies	**ATTAD™**	**LYSTEK™**	**Schwing Bioset™**	**N-Viro™**	**N-Viro™**	**Composting (Gore™)**	**N-Viro™**	**Composting (Gore™)**
Round Trip to Sudbury Landfill (km)	26	26	26	26	70	70	44	44
Volume of Dewatered Sludge to Haul (m^3)					68.2	68.2	68.2	68.2
Volume of Dry Class A Material to Haul (m3)	11.5		37.6	25				
Volume of Liquid Class A Material to Haul (m^3)		75						
Number of "Open Pump" Triaxle Loads per day (19m^3/day)	1		2	1.5				
Number of Tanker Loads per day (44m^3/load)		2			2	2	2	2
Estimated Time for a Round Trip (hrs)	2	2	2	2	3	3	2.5	2.5
Hourly Cost of Trucking	$125.00	$175.00	$125.00	$125.00	$175.00	$175.00	$175.00	$175.00
Total cost of Trucking Per Day	$250.00	$700.00	$500.00	$375.00	$1,050.00	$1,050.00	$875.00	$875.00
Total Cost per Year	$91,250.00	$255,500.00	$182,500.00	$136,875.00	$383,250.00	$383,250.00	$319,375.00	$319,375.00
Cost per m^3 of Material	$21.74	$9.33	$13.30	$15.00	$15.40	$15.40	$12.83	$12.83

6.0 DETAILED EVALUATION OF ALTERNATIVES

Based on the outcome of the pre-screening and intermediate evaluation phase summarized in **Table 5.3.1**, eight (8) possible alternatives / scenarios were developed for further evaluation. Utilizing the criteria previously established during the initial stages of the EA (refer to Section 1) the scenarios were weighted by City staff according to importance, on a scale of 1 to 10 (10 being of highest importance). Each scenario was then screened as to how best it satisfied the City's criteria. The final scores were then multiplied by the weighting to generate a weighted score.

The matrix summarizing the options, comments, scoring and ranking is included in **Appendix J**.

Table 6.1.1 illustrates the scoring and weighting for each option.

Table 6.1.1 – Technical Evaluation Matrix

		Protection of Workers / Public Health		Environmental Sustainability		Public Acceptance		Ease of Operation		Reliability & Flexibility		End-Use Diversity		Operational/ Market Risks		TOTAL Weighted Score	RANK
	Weighting		***10***		***9***		***9***		***6***		***7***		***8***		***5***		
Scenario	Description	Score	Score	Score	Score	Score	Score	Score	Score	Score	Score	Score	Score	Score	Score		
0	Existing	4	40	2	18	2	18	7	42	5	35	4	32	4	20	**205**	**8**
1	ATTAD™ at the SWWTP	8	**80**	7.5	**67.5**	8	**72**	7.5	**45**	8.5	**59.5**	8.5	**68**	8	**40**	**432**	**2**
2	Schwing Bioset™ at the SWWTP	8	80	8	72	8	72	8	48	8	56	8.5	68	8.5	42.5	**438.5**	**1**
3	Lystek™ at the SWWTP	7.5	**75**	7.5	**67.5**	6	**54**	9	**54**	8.5	**59.5**	4	**32**	6	**30**	**372**	**6**
4A	Composting (Gore™) at the Sudbury Landfill	6	60	6	54	6.5	58.5	7.5	45	7.5	52.5	8	64	6.5	32.5	**366.5**	**7**
4B	Composting (Gore™) at the New Site	6	**60**	6	**54**	6.5	**58.5**	7.5	**45**	7.5	**52.5**	8	**64**	6.5	**32.5**	**366.5**	**7**
5A	N-Viro™ at the Sudbury Landfill	7	70	7	63	7	63	7.5	45	7	49	7.5	60	6.5	32.5	**382.5**	**4**
5B	N-Viro™ at the SWWTP	6.5	**65**	8	**72**	7	**63**	8	**48**	7	**49**	7.5	**60**	6.5	**32.5**	**389.5**	**3**
5C	N-Viro™ at a New Site	7	**70**	6	**54**	7	**63**	7.5	**45**	7	**49**	7.5	**60**	6.5	**32.5**	**373.5**	**5**

The results of the evaluation matrix indicate the following highest scoring technology/planning options:

- Schwing Bioset™ at the Sudbury Wastewater Treatment Plant
- ATTAD™ at the Sudbury Wastewater Treatment Plant
- N-Viro at the Sudbury Wastewater Treatment Plant
- N-Viro at the Sudbury Landfill with some treatment at the Sudbury WWTP

Each alternative produces a Class A, near pathogen free soil type end-product, with little health risk to the public or workers managing the process. The first three can be sited at the Sudbury Wastewater Treatment Plant and incorporate a 'closed' vessel process to reduce odour. Processing at the SWWTP has a number of advantages including reduced haulage of sludge, alleviation of odour emissions as well as the ability to treat the supernatant from the biosolids process. From the City's perspective the siting of the new facility at the SWWTP will greatly reduce related trucking through the City, therefore negating the siting of the options at the Landfill site.

End-use diversity was a key consideration of the evaluation process. Products more suitable to the local geography were deemed to have greater end-use diversity. Each of the three technologies produces a soil amendment-type product that may be used on agricultural lands, mine or land reclamation projects or sold as a topsoil product.

6.1 Scoring Rationale

The existing system (disposal of unstabilized sludge in the tailings ponds) is included for comparison purposes as a base line scenario. The rationale for scoring each of the options is presented below.

Scenario 0: Existing System (Rank 8th, Score 205)

The existing system receives low scores for a number of criteria. The system is not acceptable from the public viewpoint (scored 2/10) and from a public health perspective it presents some risks, in that liquid unstabilized sludge is being transported through built-up areas (scored 4/10). Accordingly, this scenario scored 2 out of 10 for environmental sustainability. End-use diversity and market risks are also of concern (both scored 4/10). Excluding issues related to odour, the existing system is, however, relatively simple to operate and scored 7 out of 10 in this category.

Scenario 1: ATTAD™ at the Sudbury Wastewater Treatment Plant (Rank 2nd, Score 432)

This process will generate a Class A product which can be used to recover the nutrients and benefits of the organic matter in the product. It thus scores well in the protection of public health, environmental sustainability and public acceptance: 8/10, 7.5/10 and 8/10 respectively. The quality of the product and the end uses yield high scores in end-use diversity and operational risks (8.5/10 and 8/10 respectively). The system is more complex to automate than the other options and thus scores 7.5/10. The process is stable and has sufficient redundancy built in which reflects a score of 8.5/10 for reliability and flexibility.

Scenario 2: Schwing Bioset™ at the Sudbury Wastewater Treatment Plant (Rank 1st. Score 438.5)

This process is very compact with relatively little equipment. The product, a soil-like material, offers multiple end uses. It scores high in all categories (8/10), and excels in end-use diversity and market risks, scoring 8.5/10 in both of these categories.

Scenario 3: Lystek™ at the Sudbury Wastewater Treatment Plant (Rank 6th, Score 372)

This is simple to operate and reliable but produces a liquid end-product which has limited end-use diversity (score 4/10) and appears less appealing to the public (6/10). It scores highest in ease of operations (9/10) and is also reliable and flexible (8.5/10). Most other scores are comparable 7.5/10 for both protection of public health and environmental sustainability, with a slightly lower score for market risks (6/10), because of the fear of not being able to readily and economically use or dispose of the product, and the concern that the liquid end-product would not meet the slump cone requirements for disposal at the Landfill.

Scenario 4A & B: Composting (Gore™) at the Sudbury Landfill or a New Site (Ranked 7th, Score 366.5)

While this option can produce high quality compost that would have a wide range of uses (score 9/10), the size of the facility restricts its development at the Sudbury Wastewater Treatment Plant. Further, there are concerns in regard to regulations pertaining to compost that have not been resolved. Current regulations restrict the options available for use of end-product, raising the possibility of marketing issues. Due to these regulatory uncertainties, this option scores low in market risks (6/10). Until the regulatory framework is decided, there is some concern for public health and environmental protection with regard to haulage of unstabilized material, both scoring 6/10.

Scenario 5A, B & C: N-Viro™ at the various locations (Ranked 3rd, 4th and 5th, Scores 389.5, 386.5, & 373.5)

The N-Viro process ranks 3rd when located at the SWWTP, with a fourth and fifth ranking respectively when located at the Landfill or at a new site. This process generates a Class A soil-like product but with some noticeable ammonia odours. The process is reliable and flexible (based on operating facilities in Ontario), with good end-use diversity and acceptable market risk (scoring 7/10, 7.5/10, 6.5/10 respectively), no matter where it is located. When located at the SWWTP the system scores higher for environmental sustainability (8/10) because there is no need to transport unstabilized sludge to another site for treatment which also eliminates the need to treat or store sidestreams resulting from a remote treatment process. There is also no need to have a crew operating the separate off-site biosolids facility. A centralized facility (SWWTP) scores 8/10 for ease of operation compared to 7.5/10 if located at the Landfill.

6.2 Impacts to the Sudbury Wastewater Treatment Plant

The impacts on the Sudbury Wastewater Treatment Plant were reviewed on a number of fronts, with assistance from XCG Consultants Ltd.

Estimated impacts were assessed using the proposed future rated capacity of the SWWTP (obtained from the EA Addendum (2008) being undertaken separately) and the total projected sludge production from the City's wastewater facilities including Vale Inco's Copper Cliff plant and Ontario Clean Water Agency (OCWA) facilities that are using the existing disposal site.

The recycle streams from N-Viro™ and Schwing Bioset™, both alkaline sludge stabilization processes, were deemed to have the greatest potential impact on the SWWTP. BOD and Ammonia loadings from these processes were estimated to assess their potential impact on the plant processes.

The impact assessment identified little or minimal effect on the liquid treatment stream and recommended equalization of the supernatant recycle streams to minimize the impact of the additional loading on the plant process. It is estimated that no additional pretreatment is required. (Refer to **Appendix K)**

As a result of this assessment no additional environmental impact is expected at the plant site. As noted previously, the current site is somewhat congested, and the siting of new works at the site will need to accommodate the future growth needs of the plant as identified through the plant EA process.

Odour management will need to be incorporated into the proposed facilities and should include provisions to deal with odours emanating from some of the existing works such as the sludge thickening tank and proposed sludge truck unloading areas. Tank covers, a separate truck loading building, air scrubbers, biofilters or other odour management provisions should be considered to control odours.

Future upgrades to the liquid treatment process may be necessary for compliance with current and future regulatory requirements. The addition of suspended media, Moving Bed Biological Reactor (MBBR) may be considered to provide sufficient nitrification, assuming the plant will need to nitrify in the future. (Refer to **Appendix L**). Tertiary treatment may also be required at the plant to meet future effluent requirements for phosphorous. The future plant upgrades will be addressed through the plant EA process.

6.3 Operating and Capital Costs

Associated program costs were established for each of the short listed alternatives and included the following elements:

CAPITAL COST TO CONSTRUCT THE BIOSOLIDS FACILITIES INCLUDING;

- Dewatering
- Biosolids Treatment
- Redundancy provisions
- SWWTP Upgrades necessary for the biosolids management program
- Storage
- Truck Loading Facility
- Odour Management
- Ancillary Facilities

OPERATIONAL AND MAINTENANCE COSTS

- Utilities
- Chemicals
- Haulage / Transportation
- Staffing
- Maintenance

Operational costs have been developed based on the expected life of the facility, estimated to be fifty (50) years, as opposed to the typical twenty five (25) year period used for master planning purposes.

General assumptions that formed the basis of the cost estimate and a detailed summary of the cost breakdown can be found in **Appendix M**. **Table 6.3.1** summarizes the capital cost, annual operating and net present value (NPV) for each alternative over a fifty (50) year operating life cycle. A cost per dry tonne was also generated for comparison purposes.

Table 6.3.1. – Capital Costs

		Capital Cost	Annual Cost	Net Present Value	Cost Per Dry Tonne
Scenario	Description	***CAD $***	***CAD $***	***CAD $***	***CAD $/Dry Tonne***
0	Existing	N/A	N/A	N/A	N/A
1	ATTAD™ at the Sudbury Wastewater Treatment Plant	$38,393,368.88	$1,297,772.55	$71,784,750.27	$418.33
2	Schwing Bioset™ at the Sudbury Wastewater Treatment Plant	$28,958,103.97	$1,408,732.19	$65,204,450.72	$379.98
3	Lystek™ at the Sudbury Wastewater Treatment Plant	$33,634,462.64	$781,196.23	$53,734,457.37	$313.14
4A	Composting (Gore™) at the Sudbury Landfill	$21,112,820.81	$925,137.73	$44,916,396.27	$261.75
4B	Composting (Gore™) at the New Site	$24,658,033.31	$945,196.69	$48,977,721.21	$285.42
5A	N-Viro™ at the Sudbury Landfill	$33,498,204.21	$1,264,714.75	$66,039,016.32	$384.84
5B	N-Viro™ at the Sudbury Wastewater Treatment Plant	$32,232,068.58	$1,252,505.93	$64,458,750.65	$375.63
5C	N-Viro™ at a New Site	$37,541,154.33	$1,288,885.65	$70,703,877.83	$412.03

Note: Refer to Section 5.3 for a description of the scenarios.

The costs per dry tonne were found to be consistent with those reported elsewhere in the province and throughout Canada and range from $300 to $500 / dry tonne (dewatering, treatment and haulage). At the time of writing this report detailed values were not obtainable.

6.4 Evaluation Summary

The final step in the evaluation process was to combine capital and operating costs with the technical evaluation matrix. The Net Present Value (NPV) of each option was ranked and scored based on a comparative basis, whereby the lowest NPV received a full score of 10.0. The remaining alternatives were then scored based on their cost relative to the lowest NPV.

As noted previously, weightings derived for each criteria were developed in consultation with City staff. Weightings for cost were assigned a value of ‘1’ for all options.

In assigning a low weighting to costs, concerns of the cheaper option out-scoring key environmental or public acceptance criteria, have been addressed.

Table 6.4.1 Summarizes the Technical Evaluation and Net Present Value Costs.

Table 6.4.1. - Technical Evaluation and Net Present Value Costs Summary

Evaluation Matrix

Scenario	Description	Protection Of Workers / Public Health	Environmental Sustainability	Public Acceptance	Ease Of Operation	Reliability & Flexibility	End-Use Diversity	Operational / Market Risks	Score w/o Costs	Weighted Score w/o Costs	Rank w/o Costs	Net Present Value NPV	Total Score Rank	Rank Score	Total Score	Rank
0	Existing	4	2	2	7	5	4	4	28	205	9					
1	ATTAD™ at the SWWTP	8	7.5	8	7.5	8.5	8.5	8	56	432	2	$71,784,750.27	8.0	6.3	438.3	**2**
2	Schwing Bioset™ at the SWWTP	8	8	8	8	8	8.5	8.5	57	438.5	1	$65,204,450.72	5.0	6.9	445.4	**1**
3	Lystek™ at the SWWTP	7.5	7.5	6	9	8.5	4	6	48.5	372	5	$53,734,457.37	3.0	8.4	380.4	**5**
4A	Composting (Gore™) at the Sudbury Landfill	6	6	6.5	7.5	7.5	8	6.5	48	366.5	7	$44,916,396.27	1.0	10.0	376.5	**7**
4B	Composting (Gore™) at the New Site	6	6	6.5	7.5	7.5	8	6.5	48	366.5	7	$48,977,721.21	2.0	9.2	375.7	**8**
5A	N-Viro™ at the Sudbury Landfill	7	7	7	7.5	7	7.5	6.5	49.5	382.5	4	$66,039,016.32	6.0	6.8	389.3	**4**
5B	N-Viro™ at the Treatment Plant	6.5	8	7	8	7	7.5	6.5	50.5	389.5	3	$64,458,750.65	4.0	7.0	396.5	**3**
5C	N-Viro™ at a New Site	7	6	7	7.5	7	7.5	6.5	48.5	373.5	5	$70,703,877.83	7.0	6.4	379.9	**6**

Note: Refer to Section 5.3 for a description of the scenarios

ATTAD™, N-Viro™ and Schwing Bioset™ once again produced similar scores, and relatively similar NPV costs, ranging from $68 million to $74 million over the fifty (50) year life cycle operating period. Capital costs for Schwing Bioset™ were marginally lower but were offset by higher operational costs. Redundancy and storage were key factors in developing the cost estimate and may provide sizeable savings should the City elect to scale down these items.

7.0 DESCRIPTION OF PREFERRED ALTERNATIVES

The preferred alternatives were developed in association with the long range view of the Master Plan exercise while addressing "project specific" requirements related to constructing a biosolids treatment facility.

Through the evaluation process, the ability to satisfy the following "key elements" was found to govern the selection of the preferred alternative.

- Public acceptance
- End the disposal of sludge or biosolids products into the tailings ponds
- Reduce or eliminate haulage of unstabilized (and odourous) material
- Reduce haulage costs and related truck traffic
- Reduce haulage of unstabilized (odourous) material
- Odour management / control (enclosed process)
- Generate Class A odour free end-product with minimal residual odour
- End-use /disposal diversity (landfill cover, mine reclamation, agricultural, land reclamation, marketable soil product)
- Proven technology installation in Ontario
- Reliability and ease of operation
- Treatment of recycle streams
- Capital costs and operating costs

The construction of a biosolids treatment facility, located at the SWWTP and generating a Class A topsoil amendment product was found to address these requirements. There are a number of components that are common to each treatment alternative and will be required as part of the implementation.

- Sludge receiving facility (outlying WWTP's)
- Thickened sludge pumping / transfer station
- Odour management – sludge thickening, receiving / pump facilities
- Dewatering facility
- Equalization tank / centrate pumping station biosolids treatment facility utilizing such technologies as; ATTAD™, N-Viro™, or Schwing Bioset™
- "Short term" treated biosolids storage facility (120 days of storage)

- Enclosed truck loading facility
- Odour management for biosolids treatment, storage, and truck loading facilities
- Various electrical, process, control and instrumentation upgrades to the SWWTP required to support the new solids handling and processing systems

Figure 7.0 illustrates the conceptual layout of the various biosolids structures and future works proposed for the SWWTP.

Figure 7.0 – SWWTP – Sludge Dewatering & Biosolids Management Study Site Plan

Insert Figure

Preliminary capital cost estimates to construct the biosolids facility, common ancillary components and associated operating costs for the facility utilizing the recommended technologies over a fifty (50) year period are summarized in **Table 7.1.1.**

Table 7.1.1 – Summary of Preferred Alternatives Costs

	Capital Cost	Annual, Operating Costs (50 year period)	Net Present Value	Cost Per Dry Tonne
ATTAD™	$38.3 M	$1.3 M	$71.0 M	$418
N-Viro™	$32.2 M	$1.25 M	$64.0 M	$375
Schwing Bioset™	$29.0 M	$1.4 M	$65.0 M	$379

Capital costs including the ancillary components are broken down and summarized as follows. (Refer to **Appendix M** for detailed cost estimates)

Table 7.1.2 – Breakdown of Capital Costs

	ATTAD™ (millions)	N-Viro™ (millions)	Schwing Bioset™ (millions)
SLUDGE HANDLING			
Sludge Transfer Station	$1.1	$1.1	$1.1
Sludge Thickening Tank Covers	$0.6	$0.6	$0.6
Dewatering	$1.1	$1.1	$1.1
Recycle Stream Pump Station	$0.2	$0.2	$0.2
SUB TOTAL	**$3.0**	**$3.0**	**$3.0**
SLUDGE STABILIZATION			
Biosolids Treatment Facility	$14.0	$6.0	$4.1
Biosolids Storage Facility	$4.0	$8.1	$8.1
SUB TOTAL	**$18.0**	**$14.1**	**$12.2**
RELATED PLANT UPGRADES			
Plant Upgrades, Yard Piping, Electrical, Etc.	$10.1	$8.4	$7.6
Odour Control	$1.1	$1.6	$1.6
Miscellaneous Construction Costs	$2.5	$2.1	$1.9
SUB TOTAL	**$13.7**	**$12.1**	**$11.1**
ENGINEERING			
Project Management, Pre-design, Design and Field Inspection	$3.6	$3.0	$2.7
SUB TOTAL	**$3.6**	**$3.0**	**$2.7**
TOTAL CAPITAL COSTS	**$38.3**	**$32.2**	**$29.0**

8.0 SUMMARY AND CONCLUSION

The planning of this project was completed as a Master Plan activity under the Municipal Class Environmental Assessment which incorporated “project specific” Schedule ‘B’ activities related to the construction of a biosolids treatment facility at an existing landfill site or wastewater treatment plant. A number of alternatives, both planning and technical, were considered and found to satisfy the proposed problem statement. Conclusions and recommendations from this study are as follows:

The City of Greater Sudbury should consider,

- Increasing sludge sample frequency for metals.
- Constructing a centralized biosolids treatment facility at the SWWTP.
- Short-term storage be provided at the plant site until such time as the Primary Clarifiers / Storm Tank are required.
- Long-term Storage Options at the Sudbury Landfill Site.
- End-Use / Disposal options be explored in detail to determine the safest and most economically beneficial options (i.e. landfill cover vs. land reclamation or soil amendment product or a combination thereof).
- Develop a nutrient management strategy for end-use / disposal as required.
- Incorporate technologies such as ATTAD^{TM}, N-Viro ^{TM}, and Schwing Bioset^{TM}, as part of the treatment solution.
- Consider implementing a Source Control Plan that would include a program designed to reduce metals at the source.

9.0 BIOSOLIDS MANAGEMENT MASTER PLAN IMPLEMENTATION

9.1 Alternative Delivery Options

As a result of the relatively short timeframe for ceasing the discharge of unstabilized sludge into the tailings ponds, the City may consider alternative delivery methods in lieu of the traditional design-tender-construction. The estimated timeline for a traditional design tender project is outlined below:

Implementation / Component Milestone	Estimated Duration in Months
Detailed design to 90%	10
Approvals (assuming submission of MOE application with 90% drawings	2.5
Complete Design	1.5
Tender Period	1
Evaluation and Award of Contract	1
Construction Completion	15
Operational Verification Test	6
Total Duration	**37**

Alternate delivery methods can take different forms. The most relevant methods for the City to consider are:

- Design-build
- Design-build-operate
- Design-build-operate-finance

These methods can offer savings in terms of time and involve different risks that have to be recognized and managed through the process.

9.2 Design-build

Design-build involves a contract that procures the detailed design services and the construction components of the facilities, with both components running simultaneously once basic design has been advanced far enough to fix site layout, main building elevations and dimensions, access considerations and foundation design.

The approach is intensive and has risks that the City must consider, these would include:

- Release of control over the detailed design of the facility
- Obtaining quality in the final product
- Requirement for streamlined decision-making
- Intense review of design submissions concurrent with construction

This approach will need a lengthy bid period followed by an evaluation period that is significantly longer than the traditional methods since the proposed design and equipment must also be evaluated. It is recommended that a period for negotiation be allowed so that any major alternatives proposed, or alternative methods that may benefit the City, be incorporate into the contract. It is estimate that a design-build approach would have the following timeline:

Implementation / Component Milestones	Estimated Duration In Months
Pre-qualify Potential Project Consultants	1
Issue EOI to Shortlist Preferred Contracting Firms/Consortiums	2
Issue RFP for a Design-build Solution	0.5
Receive RFP's / Response Period	3
Complete Evaluation of RFPs and Recommend Preferred	2
Negotiations Complete	1
Notice to Commence Construction	1
Construction Completion	14
Operation Verification Test (6 months)	6
Total Duration	**32**

9.3 Design-Build-Operate

In this approach the contract includes an operation component that requires the contractor to operate the facilities for a number of years, usually in excess of 10. This has the advantage of forcing the contractor to build to a certain quality as he will have the responsibility of meeting the compliance standards for operations. Thus, factors such as durability of equipment, degree of automation and maintainability of the components will need to be factored in. This is a trade-off against the transfer of operational risk to the contractor.

The project has much the same appearance in the “design” and “build” stages, but the final stage sees the project move into operation immediately after construction since the operations verification test is not required.

9.4 Design-Build-Operate-Finance

This approach adds a financial component, requiring the contractor to finance the project. There are various ways to achieve this, including whereby a payment for the capital portion of the work is collected as part of the operating fees.

The design-build portion of the project will have the same timeline as the other design-build options. The financial component will add additional time in the development of the RFP as the conditions of the financing scheme will need to be developed. As well a means to evaluate the contractor’s ability to finance the project as they propose will be required. The evaluation of the proposals will also include an extensive review of the financial component. This will add time to the evaluation and negotiation periods and there is the possibility that the finance rates proposed by the contractor may not be attractive to the City.

The construction completion for a design-build-operate-finance project could extend the project timeline by as much as two (2) months.

The consideration of which method is preferred and how to manage the risk of each must be evaluated by the City prior to proceeding to the next phase

10.0 REFERENCES

i) Ontario Ministry of Environment, Nutrient Management Act, 2002, Ontario Regulation 267/03

ii) Canadian Food Inspection Agency, Federal Fertilizer Act and Regulations, T-493 Standards for Metals in Fertilizers and Supplements, September 1997

iii) United States Environmental Protection Agency, Code of Federal Regulations, Part 503 – Standards for the Use or Disposal of Sewage Sludge, September 2008

iv) Ministry of Agricultural Food and Rural Affairs, Sewage Biosolids: A Valuable Nutrient Source, August 2008.

v) Federation of Canadian Municipalities and National Research Council, National Guide to Sustainable Municipal Infrastructure, Biosolids Management Programs, November 2003.

vi) City of Greater Sudbury, Official Plan, Agricultural Background Study, December 2004.

vii) City of Greater Sudbury, Infrastructure Background Study, December 2005.

viii) City of Greater Sudbury, Synthesis / Land Use and Settlement Report, November 2004

ix) Statistics Canada, 2006 Agricultural Community Profiles.