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1 VOLUME 1: INTRODUCTION AND BACKGROUND

1.1 INTRODUCTION

The City of Greater Sudbury (CGS) has retained WSP to undertake the Water and Wastewater Master Plan (Master Plan) to identify long term replacements and/or expansion to the water and wastewater servicing networks. The CGS Master Plan defines the water and wastewater infrastructure required to service existing and future development to 2041. To fully understand the CGS and its existing communities, a review was conducted of the City's vision, mission and values which are summarized below.

VISION - **The City of Greater Sudbury is a growing, world-class community bringing talent, technology and a great northern lifestyle together.**

MISSION - **We provide excellent access to quality municipal services and leadership in the social, environmental and economic development of the City of Greater Sudbury.**

VALUES - **In fulfilling our roles we commit ourselves to:**

- **Providing high quality service with a citizen focus**
- **Managing the resources in our trust efficiently, responsibly and effectively**
- **Encouraging innovation and accepting risks**
- **Maintaining honest and open communication**
- **Creating a climate of trust and a collegial working environment**
- **Acting today in the interests of tomorrow**

Included in the CGS Master Plan is a review of background studies and guidelines, examination of historical data, as well as a gap analysis to identify existing and future capacity requirements. Additionally, water and wastewater alternative servicing solutions have been developed and evaluated in order to determine preferred servicing approaches. Sections 1.1.1 to 1.1.4 will outline the objectives of the Master Plan as well as relevant legislation, policies, guidelines, studies and documents that were reviewed at the commencement of the Study.

1.1.1 STUDY OBJECTIVES

There are four (4) main objectives that are addressed throughout the CGS Master Plan: 1) to plan for safe, robust servicing systems; 2) to accommodate planned growth within the community, 3) to ensure system performance and efficiency within the servicing systems is maintained, and 4) to comply with existing legal and regulatory requirements.

The first objective, not ordered based on priority, is **safety** which entails; safe and reliable water quality, adequate flow and pressure throughout the distribution system, reducing sanitary sewer backflow/overflow and by-passes, maintaining reliable infrastructure, and reducing vulnerability.

With focus on the second objective, **growth**, the CGS Master Plan can ensure the proposed land development, outlined by the City's Official Plan (City of Greater Sudbury, 2014), can be adequately serviced through infrastructure projects in conjunction with costing and phasing recommendations.

The third CGS Master Plan objective is **system performance and efficiency**. Sufficient water system flows and pressures can be maintained through attention to this goal by analysing system efficiency and operational procedures. Additionally this goal will confirm that the wastewater system has sufficient capacity for flows to be collected, treated and disposed responsibly. Rationalization of infrastructure as well as focus on energy efficiency and production optimization will lead to lower servicing costs in both the water and the wastewater systems.

Finally, complying with **legal and regulatory requirements** is a focus of the CGS Master Plan.

In order to ensure that these objectives were thoroughly applied throughout the Master Planning process, they were considered during every aspect of infrastructure planning (i.e. during alternative solutions development, during the determination of evaluation criteria used to assess servicing alternatives, etc.). In addition to these objectives, the City's corporate pillars were reviewed, and their relationship with the Master Plan are described in the following section.

CITY PILLARS

To ensure alignment with the City's Plans and objectives, the City's Greater Together 2015-2018 Corporate Strategic Plan was reviewed and key initiatives were compared with the Master Planning process. Table 1.1 identifies predominant relationships between the City's four (4) corporate pillars and the Master Plan.

Table 1.1 Alignment Between City's 2015-2018 Corporate Strategic Plan and the Master Plan

PILLARS	CORPORATE STRATEGIC PLAN	WATER AND WASTEWATER MASTER PLAN
Growth and Economic Development	Community Improvement Plans	Supports growth Prioritizes projects to service existing customers, including businesses Plan for projects to service future businesses
Responsive, Fiscally Prudent Open Governance	Increase transparency in communications	Consultation process for stakeholder engagement Clear and methodological decision making process Evaluates alternative servicing strategies based on economic impacts
Quality of Life and Place	Focus on clean, green living and the environment/invest in our future	Plans for infrastructure capacity increase to accommodate growth and development Sustainable plan for updating/maintaining existing infrastructure, including maximising its use Plan for investing into City's infrastructure which optimizes how financial resources are assigned
Sustainable Infrastructure	Prioritize, build, and rebuild our community's foundation	'Roadmap' to prioritize capital projects for rehabilitating, replacing, and/or improving water and wastewater infrastructure

1.1.2 RELATED POLICY DOCUMENTS AND PROVINCIAL PLANNING STUDIES

As part of the CGS Master Plan, Ontario government policy documents and planning studies were reviewed. The following sections summarize the policy and planning documents that were reviewed.

THE PLANNING ACT, 1990

The Planning Act (1990) establishes the mechanisms and rules for land use planning in Ontario, outlining how land uses may be controlled, and who may control them. The Act sets the basis for the preparation of Official Plans and planning policies for future development, and it provides municipalities with local autonomy to make decisions and streamline the planning process. The Act empowers local citizens to provide their input to their municipal council and, where permitted, to appeal decisions to the Ontario Municipal Board. Through the Act, the Province issues Provincial Policy Statements and plans.

ONTARIO WATER RESOURCES ACT, 1990

The purpose of the Ontario Water Resources Act (OWRA) (1990) is to ensure the conservation, protection and management of Ontario's waters by setting out requirements for the planning, design, siting, public notification and consultation, establishment, insurance, staffing, operation, maintenance, monitoring, and record-keeping of water (including wells) and sewage works. The Act specifies requirements that the City must satisfy in order for the provincial government to grant approval for establishing, altering, extending, or replacing water and wastewater system components.

Per Ontario Reg. 387/04, a Permit to take Water (PTTW) is generally required from the Ministry of the Environment and Climate Change (MOECC) to pump water in excess of 50,000 Litres per day (LPD). However specific types of construction related water takings at rates less than 400,000 L/d, including construction dewatering for groundwater control, and many construction related consumptive takings, are now instead to be authorized and monitored under the MOECC Environmental Activity and Sector Registry (EASR) process.

ONTARIO PLANNING AND DEVELOPMENT ACT, 1994

The Ontario Planning and Development Act (1994) established the general approach by which the Minister of Municipal Affairs and Housing may require Development Plans to be undertaken for development planning areas. The Development Plans may include policies for economic, social and physical development with relation to the distribution and density of population within the development area, the location of employment areas, the identification of land use areas, the management of land and water resources, the control of all forms of pollution of the natural environment, the location and development of servicing, communication and transportation systems, and the development and maintenance of educational, cultural, recreational, health and other social facilities. There may also be policies relating to the financing and programming of public development projects and capital works, and policies to co-ordinate planning and development among municipalities or planning boards within an area or within separate areas, among other considerations. Planning data is an important aspect of the infrastructure planning study encompassed through a Master Plan and therefore, although the Study is not a planning initiative, the Ontario Planning and Development Act was thoroughly reviewed.

SAFE DRINKING WATER ACT, 2002

The Safe Drinking Water Act (2002) was enacted by the Ontario government following the Walkerton Inquiry. The Act specifies the quality of drinking water that the City is responsible for producing and delivering, as well as how the City's drinking water treatment systems must be operated and managed.

Regulations made under the Act, such as Regulation 268/03 – Ontario Drinking Water Quality Standards, spell out detailed requirements regarding drinking water systems, testing services, drinking water quality standards, certification of drinking water system operators and drinking water quality analysts, and non-compliance penalties. During the development of water supply system deficiencies (gap analysis), as well as during the development and evaluation alternative supply solutions, this Act was referenced in order to ensure compliance by the Master Plan.

PLACES TO GROW ACT, 2005

The Places to Grow Act (2005) provides a framework for the Provincial government to coordinate planning and decision-making for long-term growth and infrastructure renewal in Ontario.

The Act gives the Province authority to designate geographical growth areas, and to develop growth plans in collaboration with local officials and stakeholders to meet specific needs across the Province. Growth plans developed under the Places to Grow Act may include population projections and allocations, policies, goals and criteria relating to issues such as intensification and density, land supply, expansions and amendments to urban boundaries, location of industry and commerce, protection of sensitive and significant lands (including agricultural lands and water resources), infrastructure development, affordable housing and community design.

Municipalities are required to bring their Official Plans into conformity with the growth plan for their area. Decisions made under the Planning Act and Condominium Act are also required to conform to applicable growth plans. Since the City of Greater Sudbury's Official Plan is one of the driving documents used for growth-and-development-related decisions throughout the Master Plan, it complies with the Places to Grow Act.

CLEAN WATER ACT, 2006

Ontario's Clean Water Act (2006) is intended to protect municipal drinking water supplies through collaborative, locally driven, science-based protection plans. The Act requires that local communities assess existing and potential threats to water quality, and actions to reduce or eliminate these threats have been implemented.

The Province of Ontario developed the Clean Water Act to protect drinking water through a "source to tap" policy. This policy is intended to provide necessary protection of drinking water resources through a multi barrier approach which includes protection of the source water prior to intake into the drinking water system. A key requirement of the Act is development of a Source Protection Plan specific to a respective watershed.

The three (3) main phases of developing a Source Protection Plan include: Assessment, Planning, and Management. Assessment involves taking an inventory of current conditions of and potential threats to drinking water sources. Planning ensures appropriate land use designations to prevent threats of existing and future land use activities to drinking water sources. Finally, Management aims to monitor to prevent threats to drinking water sources.

The CGS, in collaboration with its associated conservation authorities, has developed a Source Protection Plan for the Greater Sudbury Climate Change Consortium and the Nickel District Conservation Authority. The plan involves the implementation of policies to manage and prevent threats to municipal drinking water.

SAFEGUARDING AND SUSTAINING ONTARIO'S WATER ACT, 2007

The Safeguarding and Sustaining Ontario's Water Act (2007) is intended to ensure the conservation, protection and management of Ontario's waters and their efficient and sustainable use, in order to promote Ontario's long-term environmental, social and economic well-being. The principles of the Act incited the Premiers of Ontario and Quebec, and the Governors of Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania and Wisconsin to sign the Great Lakes-St. Lawrence River Basin Sustainable Water Resources Agreement in December 2005. This agreement recognizes that: 1) the water of the Basin are a shared public treasure and the parties to the Agreement have a shared duty to protect, conserve and manage the waters; 2) conserving and restoring the waters will improve them as well as the water-dependent natural resources of the Basin; and 3) continued sustainable, accessible and adequate water supplies for the people and economy of the Basin are important.

PROVINCIAL POLICY STATEMENT, 2014

The Provincial Policy Statement (PPS) is a key component of Ontario's planning system as it sets policy direction on matters of provincial interest related to land use planning, growth management, environmental protection, and public health and safety. It aims to provide a stronger policy framework that guides communities in Ontario toward a higher quality of life and a better long-term future.

The PPS establishes the various municipalities' roles in planning for growth, intensification and redevelopment. New settlement area policies will only permit expansions where it is demonstrated that opportunities for growth are not available through intensification, redevelopment or in designated areas. The PPS also requires municipalities to co–

ordinate and provide direction on policies with cross municipal boundaries, such as natural heritage systems and resource management.

- The PPS states that infrastructure planning must be coordinated and integrated with land use planning so that they are:
  - Financially viable over the lifecycle, which may be demonstrated through asset management planning
  - Available to meet current and projected needs

The PPS promotes optimizing existing infrastructure and public service facilities as well as using opportunities for adaptive re-use, where feasible.

In addition to the above, requirements for planning water and wastewater infrastructure specified in the PPS are listed below:

1. Direct and accommodate expected growth or development in a manner that promotes the efficient use and optimization of existing:
   a. Municipal sewage services and municipal water services
   b. Private communal sewage services and private communal water services, where municipal sewage services and municipal water services are not available
2. Ensure that these systems are provided in a manner that:
   a. Can be sustained by the water resources upon which such services rely
   b. Is feasible, financially viable, and complies with all regulatory requirements and
   c. Protects human health and the natural environment
3. Promote water conservation and water use efficiency
4. Integrate servicing and land use considerations at all stages of the planning process
5. The plan must be in accordance with the servicing hierarchy outlined in the PPS, which briefly identifies the following in order of descending preference:
   a. Municipal servicing
   b. Private communal servicing
   c. Individual on-site servicing
   d. Partial servicing

ONTARIO MINISTRY OF THE ENVIRONMENT AND CLIMATE CHANGE GUIDELINE F-5

Ontario Ministry of the Environment's (now Ministry of the Environment and Climate Change, MOECC) Guideline F-5 is a policy document, made under the legislative authority of the Ontario Water Resources Act (1990). The purpose of the guideline is to ensure that sewage treatment works are located, designed, constructed and operated in a manner to minimize pollution of receiving waters and interference with water uses. The guideline describes the levels of treatment required for municipal and private sewage treatment works, including outfall structures and emergency overflow facilities. The guideline states that the normal level of treatment required for sewage treatment works discharging to surface waters is secondary treatment, or equivalent.

The Guideline is supported by the following procedures:

- **Procedure F-5-1**: Determination of Treatment Requirements for Municipal and Private Sewage Treatment Works Discharging to Surface Waters
- **Procedure F-5-2**: Relaxation of Normal Level of Treatment for Municipal and Private Sewage Treatment Works Discharging to Surface Waters

- **Procedure F-5-3**: Derivation of Sewage Treatment Works Effluent Requirements for the Incorporation of Effluent Requirements into Certificates of Approval for New or Expanded Sewage Treatment Works
- **Procedure F-5-4**: Effluent Disinfection Requirements for Sewage Works Discharging to Surface Waters
- **Procedure F-5-5**: Determination of Treatment Requirements for Municipal and Private Combined and Partially Separated Sewer Systems

1.1.3 RELATED CITY OF GREATER SUDBURY STUDIES

In addition to provincial policies and planning studies, a review was conducted of studies that have been completed within the CGS and/or that relate to the CGS's water and wastewater networks. These studies were considered throughout the CGS Master Plan process and are listed below.

- Azilda Wastewater Treatment Plant and Collection System Class Environmental Assessment Final Milestone Report #3, R.V. Anderson Associates Ltd. (January, 2017)
- Condition Assessment and Capital Needs Plan – Valley East Wastewater Treatment Plant, AECOM (December, 2016)
- Draft Conceptual Design Report: Wanapitei WTP Future Plan Upgrades, AECOM (August, 2016)
- City of Greater Sudbury Official Plan (July, 2016)
- Azilda Wastewater Treatment Plant and Collection System Class Environmental Assessment Draft Milestone Report #3, R.V. Anderson Associates Ltd. (June, 2016)
- Azilda Wastewater Treatment Plant and Collection System Class Environmental Assessment Final Milestone Report #2, R.V. Anderson Associates Ltd. (February, 2016)
- Valley East Inflow and Infiltration Study – Final Report, R.V. Anderson Associates Limited (February, 2015)
- Greater Sudbury Source Protection Area Assessment Report, (September, 2014)
- The Sudbury Wastewater Treatment Plant and Sewage Collection System Environmental Compliance Assessment (ECA), Ministry of the Environment (May, 2014)
- City of Greater Sudbury Sanitary Sewer Flow Monitoring Study – Final Report, R.V. Anderson Associates Limited (January, 2014)
- Lively/Walden Environmental Summary Report, J.L. Richards (June, 2013)
- Growth Outlook to 2036, Hemson Consulting Ltd. (May, 2013)
- Valley Looping and Storage Class EA, R.V. Anderson (2012)
- Lively and Walden Inflow and Infiltration Study Report #1, J.L. Richards & Associates Ltd. (August, 2011)
- Groundwater Vulnerability Assessment Nickel District Conservation Authority Source Protection Area, WESA (January, 2010)
- Wastewater Treatment Options for the City of Sudbury and the Settlement of Garson in the Town of Nickel Centre – Environmental Study Report Addendum, Dennis Consultants (October, 2009)
- Biosolids Management Master Plan Environmental Assessment Document Summary Report, Dennis Consultants (March, 2009)
- Wanapitei WTP Hydraulic Capacity Report, AECOM (2009)
- Guidance Module 4: Surface Water Intakes – Inland Lakes and Ramsey Lake Study, AMEC Americas Limited (March, 2008)
- Final Report – Guidance Module 4: Surface Water Intakes – Inland Rivers, AMEC Americas Limited (January, 2008)
- City of Greater Sudbury Official Plan Review – Infrastructure Background Study, Dennis Consultants (December, 2005)
- Sudbury Reservoir Preliminary Design Report, UMA Engineering Ltd. (June, 1992)
- Sudbury Water Storage Reservoir – Environmental Study Report, Regional Municipality of Sudbury (February, 1990)

1.1.4 FEDERAL LEGISLATION

In addition to reviewing studies, policies, and guidelines under provincial and local echelons, Federal Acts were studied and followed concurrently with Master Planning activities. The following sections summarize the Federal Acts that were considered during the CGS Master Plan process.

CANADIAN ENVIRONMENTAL ASSESSMENT ACT, 2012

The Canadian Environmental Assessment Act (CEAA) (July, 2012) uses the Government's plan for Responsible Resource Development to benefit all Canadians by allowing the development of natural resources in a modernized, reliable, and time-effective manner. As listed in Section 4 of the Act, its purposes are:

a. To protect the components of the environment that are within the legislative authority of Parliament from significant adverse environmental effects caused by a designated project;

b. To ensure that designated projects that require the exercise of a power or performance of a duty or function by a federal authority under any Act of Parliament other than this Act to be carried out, are considered in a careful and precautionary manner to avoid significant adverse environmental effects;

c. To promote cooperation and coordinated action between federal and provincial governments with respect to environmental assessments;

d. To promote communication and cooperation with aboriginal peoples with respect to environmental assessments;

e. To ensure that opportunities are provided for meaningful public participation during an environmental assessment;

f. To ensure that an environmental assessment is completed in a timely manner;

g. To ensure that projects, as defined in Section 66, that are to be carried out on federal lands, or those that are outside Canada and that are to be carried out or financially supported by a federal authority, are considered in a careful and precautionary manner to avoid significant adverse environmental effects;

h. To encourage federal authorities to take actions that promote sustainable development in order to achieve or maintain a healthy environment and a healthy economy; and

i. To encourage the study of the cumulative effects of physical activities in a region and the consideration of those study results in environmental assessments.

Projects that are likely to require a federal environmental assessment should be described to the Canadian Environmental Assessment Agency (for projects that are not nuclear or international or interprovincial pipelines/transmission lines) to determine whether a federal level EA is required. The Act was reviewed during the CGS Water and Wastewater Master Plan and it was determined that no activity within the scope of the study would trigger a federal environmental assessment.

CANADA WATER ACT, 1985

The Canada Water Act concerns the management of Canadian water resources and includes information regarding programs concerning the conservation, development and utilization of water resources. It provides a structure that supports the collaboration, regarding water resources, between federal and provincial governments. Water resource monitoring/surveying as well as the planning/implementation of efforts regarding the conservation, development and utilization of water resources, are some examples of joint projects.

FISHERIES ACT, 1985

Canada's Fisheries Act provides the rules and regulations regarding fisheries to address threats to fish due to destruction of their habitat and changes to natural flow regimes. General prohibitions, guidelines relating to lobster fisheries and fishways, protection and pollution prevention, rules regarding marine plants, and offence and punishment are all examples of material contained within the Act.

CANADIAN ENVIRONMENTAL PROTECTION ACT, 1999

To contribute to sustainable development, the Canadian Environmental Protection Act outlines strategies regarding pollution prevention as well as environmental and human health protection. The Act includes assessment processes, details approaches to manage toxic substances as well as associated timeframes, and identifies harmful substances and ensures they are not present in the environment. Planning in conjunction with the Act should meet current needs without preventing future generations from meeting their own requirements.

1.2 ENVIRONMENTAL ASSESSMENT PROCESS

In order to be aware of and mitigate the negative effects infrastructure projects can have on the environment, an environmental assessment process is undertaken. The following sections describe the Environmental Assessment Act, the Municipal Class Environmental Assessment (MCEA) process for Master Planning (developed to streamline the Environmental Assessment Act), and the required compliance with the Canadian Environmental Assessment Act as introduced in Section 1.2.1.

1.2.1 ENVIRONMENTAL ASSESSMENT ACT

The Environmental Assessment Act codifies a planning process that requires the evaluation of potential environmental effects and benefits of a project before decisions are made about implementing the project. It applies to activities or projects of public bodies, and major commercial or business undertakings of non-public entities, if designated by regulation. The Act outlines the approach to planning water and wastewater servicing that the City must follow, including the types of impacts that must be assessed and the need to consult with stakeholders and incorporate stakeholder input into the planning process. In order to streamline the guidelines encompassed in the Act, a Municipal Class Environmental Assessment (MCEA) document was developed and is described in the following section.

1.2.2 MUNICIPAL CLASS ENVIRONMENTAL ASSESSMENT

The CGS Master Plan is prepared in accordance with the requirements of the Municipal Engineers Association's (MEA) MCEA document (October 2000, as amended in 2007, 2011 and 2015).

Class Environmental Assessments (EAs) were approved by the Ministry of the Environment and Climate Change in 1987 for municipal projects, including water and wastewater projects, having predictable and preventable impacts. The Municipal Class EA document was revised and updated in 1993, 2000, 2007, 2011, and again in 2015. The Class EA approach streamlines the planning and approvals process for municipal projects which have the following characteristics:

- Recurring
- Similar in nature
- Usually limited in scale
- Predictable range of environmental impacts
- Environmental impacts are responsive to mitigation

This Master Plan is prepared in accordance with the requirements of the *Municipal Class Environmental Assessment* document prepared by the Municipal Engineers Association (MEA) (October 2000, as amended in 2007, 2011 and 2015). The Municipal Class Environmental Assessment document outlines the procedures to be followed to satisfy Class EA requirements for municipal infrastructure projects. The process includes five (5) phases:

- Phase 1: Problem Definition
- Phase 2: Identification and Evaluation of Alternative Solutions to Determine a Preferred Solution
- Phase 3: Examination of Alternative Methods of Implementation of the Preferred Solution
- Phase 4: Documentation of the Planning, Design and Consultation Process
- Phase 5: Implementation and Monitoring

The Class EA process flowchart is provided in Figure 1-1.

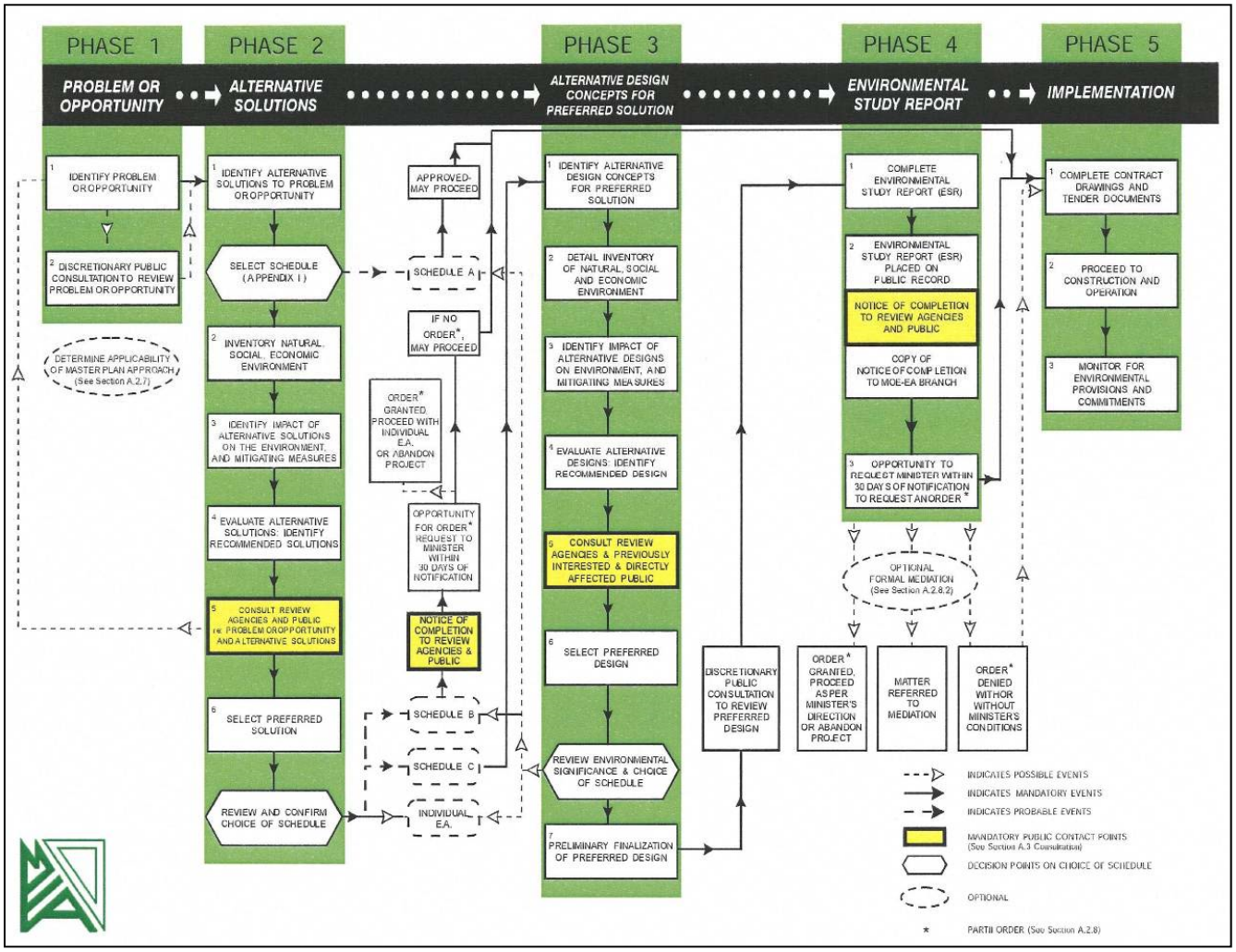

Figure 1-1 Municipal Class EA Planning and Design Process

Projects subject to the Class EA process are classified into four (4) possible "Schedules" depending on the degree of expected. Details for the different schedules are provided below.

SCHEDULE A

These projects generally include normal or emergency operational and maintenance activities.

The environmental effects of these activities are usually minimal and, therefore, these projects are pre-approved.

Typical projects that follow a Schedule A process will be the construction of watermains and sewers within existing road allowances where no watercourse crossings are required.

SCHEDULE A+

In 2007, the MEA introduced the Schedule A+ classification. These projects are pre-approved; however, the public is to be advised prior to project implementation. The manner in which the public is advised is to be determined by the proponent.

Typical Schedule A+ projects include retiring a water or wastewater facility that would have been planned under a Schedule A or A+ of the Municipal Class EA for its establishment.

SCHEDULE B

These projects generally include improvements and minor expansions to existing facilities.

There is the potential for some adverse environmental impacts as a result of implementing these projects and, therefore, the proponent is required to proceed through a screening process including consultation with those who may be affected.

Typical projects that follow a Schedule B process will include: watermains and sewers outside of existing road allowances, pumping stations and reservoirs.

These projects require completion of Phases 1 & 2 of the MEA Class EA process.

SCHEDULE C

These projects generally include the construction of new facilities and major expansions to existing facilities.

Typical projects that follow the Schedule C process include the expansion of existing or construction of new Water and Sewage Treatment Facilities.

These projects require completion of Phases 1 through 4 of the MEA Class EA process.

MASTER PLAN PROCESS

Master Plans are conducted under the framework of the MEA Class EA process. They are long-range plans that identify infrastructure requirements for existing and future land use within a larger study area, through the application of environmental assessment principals.

In general, it is recommended that a Master Plan be reviewed every 5 years, regardless of the approach followed, to determine the need for updating infrastructure recommendations. This review and update is required due to changing existing conditions. It is possible that existing legislation may change and therefore Master Plan components would be updated to reflect these changes, but generally the five-year update encompasses changes made to an Official Plan, which is also updated every five (5) years. As mentioned, planning projections are an integral part of a Master Plan, therefore any growth/development affect servicing requirements and changes need to be reflected through a Master Plan update. Other potential changes that may trigger the need for a detailed review include: major changes to original inputs, significant new environmental effects, and major changes in proposed timing of projects within the Master Plan.

PROJECT CLASS EA SCHEDULE

Master Plans can be conducted using various approaches and it should be noted that the CGS Water and Wastewater Master Plan will be conducted using Approach #1, whereby the study is conducted at a broad level of assessment and in which site-specific Class EA's for all recommended Schedule B and Schedule C projects are to be completed in the future, closer to the time of the projects' implementation. By using this approach, the final Master Plan produced will serve as a 'roadmap' for implementing future recommended infrastructure projects. More project-specific Class EA work will have to be completed on the future Schedule B and C projects identified within the Master Plan. The Master Plan can be referenced in order to justify an infrastructure project at the Class EA level. The identification of infrastructure projects within the Master Plan will serve as the justification for implementing infrastructure, in the case of Schedule A and A+ projects, and for carrying on with additional Class EA work, in the case of Schedule B and C projects. The Class EA schedule requirements for all recommended infrastructure projects is therefore identified as part of the Study.

1.2.3 CANADIAN ENVIRONMENTAL ASSESSMENT ACT COMPLIANCE

On July 6, 2012 the federal government released a revised Canadian Environmental Assessment Act (CEAA). Under the previous CEAA there were triggers that would have required the need to conduct an EA to meet the CEAA. However, since July 2012 the requirement is that there needs to be a physical activity (project) that falls under the "Regulations Designating Physical Activities" and specifically is in the "Schedule for Physical Activities".

In a review of the Schedule for Physical Activities there is no physical activity that matches the work proposed in this Master Plan. This means that since it is not one of the Physical Activities in the Schedule, it is not a designated project and meeting the requirements of the CEAA will not be necessary for the projects.

Section 14 of the CEAA does provide the Minister with the power, by order, to designate a physical activity that is not prescribed by regulations if, in the Minister's opinion, either carrying out of that physical activity may cause adverse environmental effects or public concerns related to those effects may warrant the designation. This is not the case for this project so meeting the CEAA will not be required.

1.3 PROBLEM DEFINITION

The Problem Statement for the Master Plan is as follows:

"To provide Water and Wastewater Customers of the City of Greater Sudbury with safe, reliable, and environmentally responsible municipal water and wastewater services with a sustainable, cost effective approach. Delivery of water and wastewater services will be integrated with the City's other infrastructure, planning, and growth management responsibilities to ensure a holistic approach".

1.3.1 STUDY AREA

The Water and Wastewater Master Plan that has been completed encompasses all areas within the CGS's core urban areas as well as its satellite communities. The Study Area is the entire area receiving water and wastewater servicing, as well as any area that is under consideration for siting additional water and wastewater infrastructure. The Study Area can be seen in Figure 1-2.

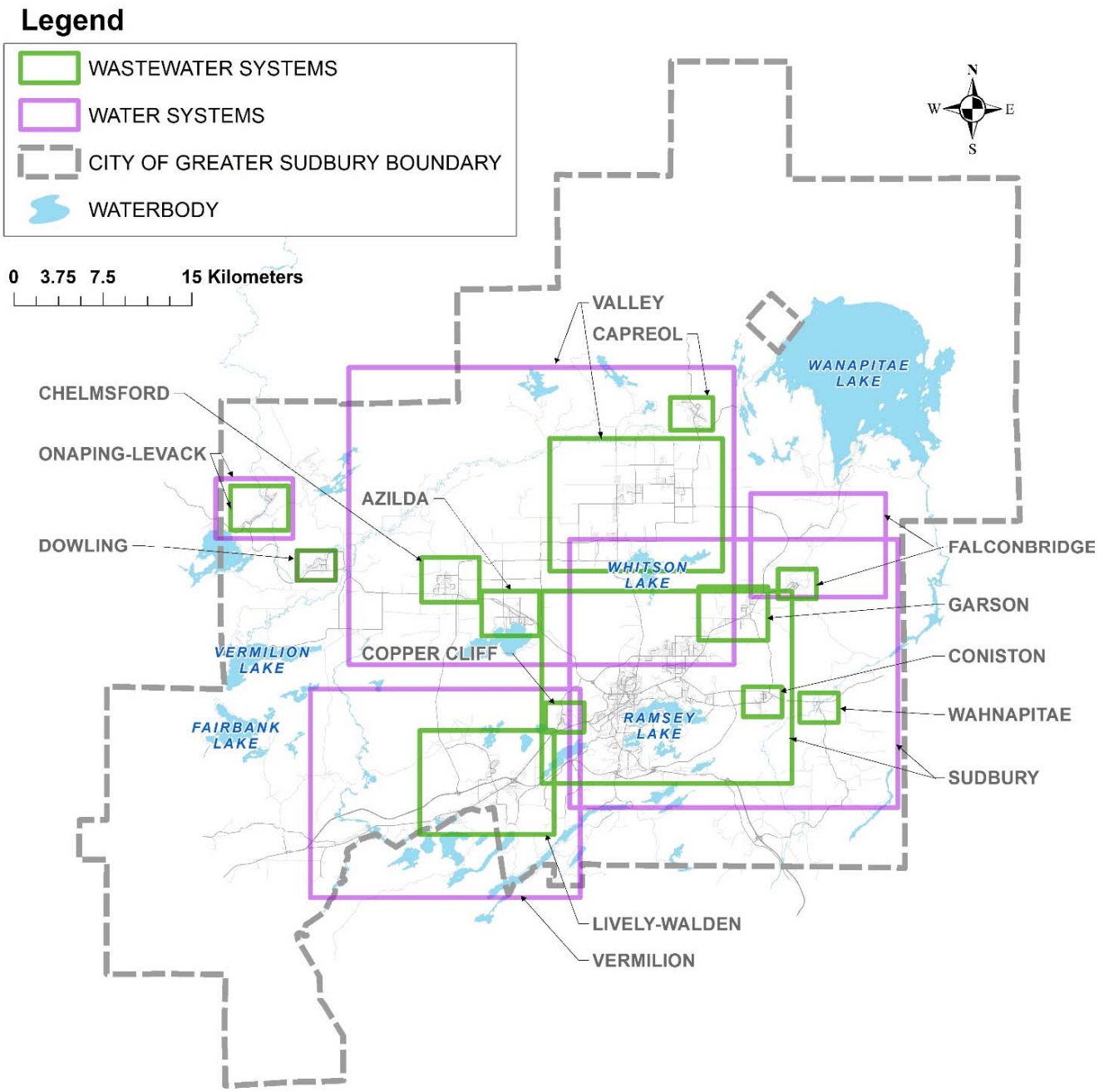

Figure 1-2 Master Plan Study Area

1.4 SYSTEM REQUIREMENTS

As part of the CGS Master Plan, population projections were obtained from the City, and water and wastewater unit rates and design criteria were developed for use throughout the Master Plan. These criteria and rates were determined in order to assess future system requirements to 2041. The following sections summarize the projected servicing populations that were provided by the City, as well as the water demand and wastewater flow criteria and rates that were developed for the Master Plan and used for analysis of the CGS water and wastewater infrastructure.

A Technical Memorandum (TM) was also developed during this stage of the Master Plan titled Population Projections and Development of Unit Rates (WSP, Population Projections and the Development of Unit Rates, 2015), and can be found in Appendix 1-A. The TM is summarized within the following sections and should be referenced for additional details regarding population projections, as well as demand and rate development.

1.4.1 SERVICING POPULATIONS

Population projections were summarized by reviewing information provided by the City, and growth scenarios were assigned up to the year 2041, in five (5) year increments. Consideration was made with regard to the City's current land use designations, their inventory of vacant land, and their planning data to 2041. Additionally, a review of the City's Official Plan was launched in 2012 to which Hemson Consulting Limited provided assistance. Data obtained from the Draft Growth Outlook to 2036 report (Hemson Consulting Ltd., 2013) and Supplementary Household Creation Projection Sheets (Hemson, 2014), that were developed as part of their input to the Official Plan review, were used during WSPs review and summary of the City's planning projections.

The Water Baseline Review Report (WSP, 2015) and the Wastewater Baseline Review Report (WSP, 2014), summarized in Volumes 2 and 3 of this report and contained in Appendix 1-B, describe the six (6) individual water systems and the thirteen (13) individual wastewater systems that exist in the CGS. Table 1.2 and Table 1.3 summarizes the existing and projected populations for the various communities within the City.

Table 1.2 Population Projections by Water System

WATER SYSTEM	2011	2016	2021	2026	2031	2036	2041
Dowling	1,773	1,837	1,903	1,965	1,997	2,017	2,016
Falconbridge	707	724	743	759	769	775	776
Onaping-Levack	2,112	2,123	2,135	2,146	2,154	2,159	2,159
Sudbury	94,868	95,826	97,059	98,330	99,056	99,506	99,450
Valley (Including Capreol)	36,382	37,235	38,142	38,965	39,451	39,737	39,764
Vermilion	10,359	10,845	11,303	11,686	11,912	12,050	12,085

Table 1.3 Population Projections by Wastewater System

WASTEWATER SYSTEM	2011	2016	2021	2026	2031	2036	2041
Sudbury (Including Garson)	91,243	92,182	93,391	94,640	95,352	95,795	95,739
Copper Cliff	2,696	2,703	2,713	2,724	2,729	2,737	2,736
Onaping-Levack	2,112	2,123	2,135	2,146	2,154	2,159	2,159
Dowling	1,773	1,837	1,903	1,965	1,997	2,017	2,016
Lively	2,197	2,348	2,491	2,607	2,676	2,716	2,728
Walden	5,178	5,501	5,804	6,059	6,209	6,299	6,324
Azilda	4,449	4,624	4,807	4,959	5,050	5,099	5,103
Chelmsford	7,400	7,517	7,639	7,763	7,838	7,886	7,891
Coniston	2,225	2,242	2,260	2,277	2,287	2,293	2,294

WASTEWATER SYSTEM	2011	2016	2021	2026	2031	2036	2041
Falconbridge	707	724	743	759	769	775	776
Wahnapitae	1,397	1,402	1,408	1,413	1,416	1,418	1,418
Capreol	3,392	3,396	3,412	3,435	3,447	3,456	3,450
Valley East	19,119	19,644	20,219	20,728	21,028	21,205	21,231

1.4.2 WATER DEMAND RATES

To determine the water demand criteria for use in the CGS's water network assessment, the City's Engineering Design Manual (City of Greater Sudbury, 2012) was reviewed and compared with recommendations made in the MOECC guidelines (MOECC, 2008). Furthermore, historical CGS water consumption data was analyzed. These analyses, along with comparison to other municipalities, lead to the development of water demand criteria and rate recommendations for use in the Master Plan. The following section summarizes the criteria used. Additionally, the subsection, Fire Flow Criteria is a summary of a Technical Memorandum developed during the Master Plan, titled Impact of Fire Flow Demands on Water Quality (WSP, 2016) which can be found in Appendix 1-C.

WATER DEMAND CRITERIA

The recommended water rates and peaking factors are summarized in Table 1.4. It should be noted that for ICI water demand rates, historical data was not used as a predictor of future consumption. Demand among ICI users depends on the end user's process and industry-specific water needs, and cannot be based on historical consumption for a different user. Therefore, for the Master Plan it was recommended to continue to use the ICI peak unit rates in the City's design guidelines, which coincide with those in the MOECC Guidelines. They are, for all communities:

Institutional: 28 m^3/ha/d

Commercial: 28 m^3/ha/d

Industrial: 35 m^3/ha/d (assumed to be light industrial)

One exception was the Vermilion Water System. An Environmental Summary Report was completed for Lively/Walden by J.L. Richards & Associates which suggested that the Walden Industrial Park water rate should be divided into heavy water usage and light water usage. Details can be found in Volume 2 of this report.

Table 1.4 Recommended Domestic Water Consumption Unit Rates and Peaking Factors

SERVICE AREA	RECOMMENDED UNIT RATE (L/CAP/D)	RECOMMENDED MAXIMUM DAY FACTOR	RECOMMENDED PEAK HOUR FACTOR
Dowling	200	2.71	3.75
Falconbridge	300	2.12	3.47
Onaping-Levack	350	1.70	3.27
Sudbury	350	1.39	1.58
Valley	250	1.46	2.18
Vermilion	250	1.90	2.85

To calculate future demands, the following equation was used for each community:

$$\text{Future Flow} = \text{Base Flow} + (\text{ICI Rate})(\text{Development Area}) + (\text{Residential Rate})(\text{Growth Population})$$

where base flow was calculated using an average (2009 to 2013) of historical average day production flows.

FIRE FLOW CRITERIA

Computer modelling was completed as part of the Master Plan to predict the available fire flow (AFF) for different communities and/or zoning; now and for future scenarios based on the City's planning forecasts. This document explains the required fire flow (RFF) targets used in this Master Plan, based on a framework that is:

a. Informed by current Ontario guidelines and trends in similar municipalities;

b. Calculated to contribute to public safety without adding an excessive additional flow to reduce property damage; and,

c. Balanced against the need to avoid a negative impact on water age and quality that can result from over-sizing distribution mains to provide larger fire flows.

RFF targets were used to evaluate the current state of the system in terms of its ability to supply the AFF, by producing maps that compare the AFF for each property to the RFF based on zoning. These maps are included in Volume 2 of this report. The overall goal was to rationalise and improve the system over a period of years to decades, improving the level of service and the AFF to multiple properties on a cost-benefit and prioritisation basis. The objective of the Master Plan is not to comment on specific properties or to impose requirements on a lot-by-lot basis.

RESIDENTIAL

For residential RFF, WSP recommended using a rate of 75 L/s which was used as the baseline against which AFFs (simulated using the City's water model) was compared for residential zones. This rate is in-line with the City's Engineering Design Manual (City of Greater Sudbury, 2012) which stipulates a required fire flow of 75 L/s, including local demand at the node(s) where the fire occurs. The corresponding fire duration for this amount of fire flow needed is approximately 2 hours, per the Water Supply for Public Fire Protection (Fire Underwriters Survey (FUS), 1999). A fire flow rate of 75 L/s is commonly used for residential zones and is also in line with the FUS, which suggests a range of 67 to 83 L/s for a modern residential subdivision.

The following numerical categories have been used for the maps and statistics in this Master Plan:

— ≤ 65 L/s: Needs Improvement
— 65 - 75 L/s: May be Achievable by Improved Operations or Maintenance
— ≥ 75 L/s: Meets Design Criteria

INSTITUTIONAL, COMMERCIAL, INDUSTRIAL (ICI)

Since the City's Engineering Design Manual (City of Greater Sudbury, 2012) does not specify a RFF for ICI zones, other sources were considered. The Water Supply for Public Fire Protection (FUS, 1999) provides general estimates for ICI buildings as follows (brackets show WSP comments):

— Institutional building: 83 - 250 L/s (can be reduced using sprinklers and fire separations)
— Commercial building: 233 - 417 L/s (larger values are for older business districts only)
— Industrial building/park: 233 L/s (can be calculated for each building to avoid over-sizing mains)

For each of these, a case-by-case calculation may reduce RFF and smarter construction may significantly reduce RFF for new construction. The ICI RFF criterion should not strive to reflect older buildings in a municipality but should instead focus on future buildings.

Based on WSP's review of existing and future development in the City, an RFF of 150 L/s was recommended for ICI zones, and was used as the baseline against which AFFs (simulated using the City's water model) was compared against for ICI zones. This recommendation was based on calculations for typical buildings and is achievable for modern commercial and industrial developments. It is also approximately mid-way along the FUS range for institutional buildings.

The following numerical categories have been used for the maps and statistics produced to date for this Master Plan:

— ≤ 130 L/s: Needs Improvement

— 130 - 150 L/s: May be Achievable by Improved Operations or Maintenance
— ≥ 150 L/s: Meets Design Criteria

ZONE SPECIFIC

The City has constructed and operated its water supply and distribution system over decades, resulting in an existing capacity to supply fire flows to each location in its system. To scrutinise the recommended RFF targets, WSP undertook a comparison of RFF and AFF for critical buildings (i.e. buildings that would present 'worst case fires') in Sudbury. If the AFFs met the RFFs, it would suggest that the recommended RFF were acceptable for these existing properties.

To gather real-world examples in Sudbury, representative buildings were selected and their respective RFFs were calculated. The criteria for selecting critical buildings that would present a 'worst case' fire in each zone were that the buildings had to be:

— Remotely situated from the source of supply or from large mains; and/or,
— Located at high elevations

Computer modelling analysis conclusions are detailed in Volume 2 of this report, and recommendations are made in Volume 6 based on alternatives evaluation presented in Volume 4.

1.4.3 WASTEWATER GENERATION RATES

To determine wastewater criteria for use in the CGS's wastewater network assessment, the City's Engineering Design Manual (City of Greater Sudbury, 2012) was reviewed and compared with recommendations made in the MOECC guidelines (MOECC, 2008). Furthermore, historical CGS water consumption data was analyzed as an additional comparison basis. These analyses, along with comparison to other municipalities, lead to the development of wastewater criteria and rate recommendations for use in the Master Plan. The following section summarizes the criteria used.

WASTEWATER FLOW CRITERIA

The wastewater rates and peaking factors are summarized in Table 1.5 for each of the wastewater systems in the CGS.

Table 1.5 Recommended Wastewater Generation Unit Rates and Peaking Factors

SERVICE AREA	RECOMMENDED RESIDENTIAL UNIT RATE (L/CAP/D)	RECOMMENDED MAXIMUM DAY FACTOR
Azilda	400	5.76
Capreol	650	2.69
Chelmsford	450	3.95
Coniston	400	3.67
Copper Cliff	500	4.05
Dowling	900	1.79
Falconbridge	400	2.25
Garson	Included with Sudbury (Therefore Uses the Same Rates)	
Levack	200	3.20
Lively	450	4.05
Walden	450	3.36
Sudbury	500	3.86

SERVICE AREA	RECOMMENDED RESIDENTIAL UNIT RATE (L/CAP/D)	RECOMMENDED MAXIMUM DAY FACTOR
Valley East	250	2.69
Wahnapitae	500	3.67

1.4.4 WATER FACILITY DESIGN CRITERIA

Another consideration of the Master Plan was the design criteria for facility capacities. Water treatment facilities and pumping stations are typically designed to supply maximum day demands, with peak demands (maximum hour) supplied by system storage. The firm capacity of each pumping station is based on the largest pump out of service. Design criteria for water pumping stations and storage facilities are presented in Table 1.6 and details can be found in the following sections.

Table 1.6 Water Pumping and Storage Facility Design Criteria

ITEM	DETAILS	CRITERIA
Pumping Stations	With adequate zone storage available	Maximum day flow to zone and all subsequent zones
	Without adequate storage available	Peak hour flow to zone and maximum day flow to all subsequent zones
Storage	A – Fire Storage	Largest expected fire volume
	B – Equalization Storage	25% of maximum day demand
	C – Emergency	25% of (A+B)
	Total	A+B+C
Fire Flow	Residential / ICI	150 L/s for 2 hr duration
System Pressure	Normal operating conditions	275 - 690 kPa (40 - 100 psi)
	Fire Demand	140 kPa (20 psi)

TREATMENT CAPACITY

As mentioned, water treatment facilities are designed to supply the maximum day demands of the system.

Additionally, treatment facilities must be designed in accordance with the Procedure for Disinfection of Drinking Water in Ontario (Ontario, 2006). Drinking water treatment systems that obtain water from a surface water or GUDI supply must achieve an overall performance providing as a minimum a 2-log (99%) removal or inactivation of *Cryptosporidium* oocysts, 3-log (99.9%) removal or inactivation of *Giardia* cysts, and 4-log (99.99%) removal or inactivation of viruses. At least 0.5-log removal or inactivation of *Giardia* cysts and 2-log removal or inactivation of viruses must be provided through disinfection, while the remaining removal may be achieved through filtration or other equivalent treatment processes.

PUMPING CAPACITY

Pumping stations are rated based on their firm capacity. If sufficient floating storage is available in a particular pressure district, the MOECC defines firm capacity as the capacity of the station with the largest pump out of service. If there is insufficient or no floating storage, firm capacity is defined in the MOECC Guidelines (MOECC, 2008) as the capacity with the two (2) largest pumps out of service.

For each pressure district, the pumping stations have to be designed to provide peak hour or maximum day plus fire demands (whichever are greater), if no floating storage is available. If sufficient floating storage is available, then the pumping station only needs to be designed to provide maximum day demands.

STORAGE CAPACITY

Storage requirements are based on the requirement to meet water demands that exceed the capacity of the treatment plant and to satisfy fire flow demands. When the capacity of the supply system is only capable of satisfying maximum day demands, storage requirements are determined using the following formula from the MOECC Guidelines (MOECC, 2008).

$$\text{Storage} = A + B + C$$

Where: A = Fire Storage, B = Equalization Storage = 25% of maximum day demand, and C = emergency storage = 25% of (A+B).

Fire storage is the product of the maximum fire flow required in the system and the corresponding fire duration based on Fire Underwriters requirements (FUS, 1999).

When the system can supply more than just the maximum day demand (but less than the peak demand), the fire storage requirements can be determined using the following formula:

$$A = (\text{Peak Demand} - \text{Pumping Station Firm Capacity}) \times \text{Fire Duration}$$

Where: peak demand is the greater of the peak hour demand and the maximum day plus fire demand.

Per MOECC Guidelines (MOECC, 2008), floating storage should be designed such that the elevation of the equalization volume (B) is such that a minimum pressure of 275 kPa (40 psi) can be maintained in the system under peak hour flow conditions. The fire (A) and emergency (C) volumes should be at elevations that produce 275 kPa (40 psi) during peak hour demand conditions, and 140 kPa (20 psi) under the maximum day plus fire flow condition (MOECC, 2008).

DISTRIBUTION CAPACITY

Watermains have to be sized to carry the greater of the maximum day plus fire flow or peak hour demand. The range of acceptable pressures under normal conditions (average to peak hour flows) is 275 kPa (40 psi) to 690 kPa (100 psi), while during fire flow conditions pressures may drop to 140 kPa (20 psi) (MOECC, 2008). The maximum allowable water velocity in the distribution system is 3 m/s (MOECC, 2008).

1.4.5 WASTEWATER INFRASTRUCTURE DESIGN CRITERIA

Like the Water System, another consideration of the Master Plan was the design criteria for the Wastewater facilities.

Table 1.7 Wastewater Design Criteria

ITEM	CRITERIA
Sewer Capacity	Ratio of flow depth to conduit diameter of ≤ 0.8 Ratio of flow to flow capacity of ≤ 0.8
Sewer Velocity	Flow Velocity ≥ 0.6 m/s
Lift Stations	Must be able to pump peak instantaneous flows

TREATMENT CAPACITY

As mentioned, wastewater treatment facilities are rated for average day flows. Plant effluent limits and objectives are established in the Certificate of Authentication (CA) or in other terms, in the Environmental Compliance Approval (ECA), for each facility.

PUMPING CAPACITY

The firm capacity of the lift station (with the largest pump out of service) must allow pumping of peak wet weather flows corresponding to its catchment area (MOECC, 2008).

COLLECTION CAPACITY

The sewer system is sized to convey peak instantaneous (peak wet weather) flows. Wastewater flows are made up of wastewater discharges from residential, commercial, institutional and industrial establishments, plus extraneous flow components from such sources as groundwater and surface runoff.

In addition to being able to convey peak flows, sufficient flow velocity should be maintained to transport the wastewater solids to avoid deposition and the development of nuisance conditions under lower flow conditions. The minimum acceptable flow velocity in sewers is 0.6 m/s, per the City's Engineering Design Manual (City of Greater Sudbury, 2012).

To identify surcharged sewers, WSP followed the rules and criteria provided below, in their general order of importance:

- Sewers should have a ratio of flow depth to conduit diameter of 0.8 or less;
- Sewers should have a ratio of flow to flow capacity of 0.8 or less. However the ratio of flow depth to conduit diameter (item 1) took precedence as it represents flooding risk more directly;
- Where possible, conduits that had a shallower depth of cover were considered for upgrades before conduits that had a deeper depth of cover;
- Where possible, conduits that had shallower slopes were considered for upgrades before conduits that had steeper slopes.

In order to systematically assess the existing conditions of the hydraulic model, by applying the criteria above, WSP categorized various stretches of sewer conduits as "Primary Sewers", "Secondary Sewers" and "Tertiary Sewers". A stretch of sewer was deemed to be "Primary" if it was a major trunk sewer upstream of a wastewater treatment plant, while "Secondary" sewers branched off from "Primary" sewers. Additionally, a sewer was named "Secondary" if it led to a lift station. Finally, "Tertiary" sewers branched off of "Secondary" Sewers. Figure 1-3 depicts the sewer categories.

The categories were used to define the precedence by which the sewers were analyzed. As an example, "Primary" sewers were analyzed first, since they are downstream all the other sewers. If issues were addressed in the primary sewers, this would have potentially alleviated issues in the "Secondary" and "Tertiary" sewers.

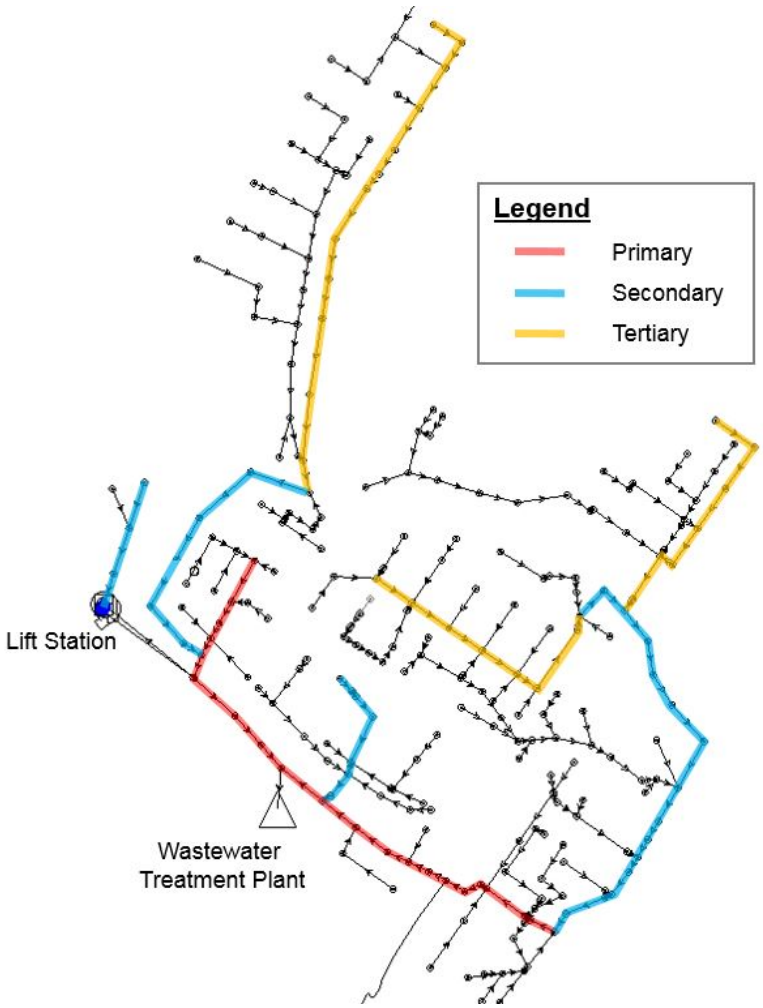

Figure 1-3 Sewer Categories Used for Wastewater System Analysis

1.5 PROCESS FOR THE EVALUATION OF ALTERNATIVES

Upon completion of the analysis of existing CGS water and wastewater systems and determining capacity requirements, alternative servicing solutions were outlined and evaluated based on specific criteria developed as part of the Master Plan process. The following sections detail the evaluation methodology and criteria that were used in order to obtain a preferred recommended solution for servicing the CGS to 2041.

1.5.1 APPROACH TO THE EVALUATION OF ALTERNATIVES

As mentioned, several water and wastewater servicing alternatives have been developed and subsequently evaluated to determine the preferred approach to servicing the communities of CGS. Each alternative has been evaluated using the same set of criteria which have been developed in order to consider the natural environmental, the social and cultural environment as well as technical suitability and cost. The criteria are used to objectively assess the impacts and determine the preferred solution. A comparative assessment of alternatives, in the form of an evaluation matrix, was conducted to determine which solution has the least overall impact. The following alternatives were considered as the three (3) main solutions to water and wastewater infrastructure concerns throughout the CGS:

1 Do nothing

2 Optimization of Existing Systems
3 Expansion of Existing Systems

Volume 4 and Volume 5 of this report contain the water and wastewater systems' detailed alternative solutions evaluation, respectively. The section below summarizes the methodology used and the criteria considered to evaluate the alternatives.

EVALUATION METHODOLOGY

The methodology used to determine the preferred water and wastewater servicing solution for existing and future development is as follows:

Step 1: Determine Evaluation Criteria – Criteria upon which the alternatives will be evaluated was defined at the beginning of the process. The evaluation criteria for this project will include (1) impact on the natural environment, (2) impact on the social and cultural environments, and (3) technical suitability and economic vitality. The individual impact will typically fit into one of these general categories. A breakdown of the impacts included under each criterion is defined in Table 1.8.

— **Step 2: Create an Evaluation System** – An evaluation system was then created, whereby each set of alternatives can be evaluated against one another. In order to be impartial, this system was developed prior to determining the potential impacts associated with each alternative. During the evaluation, each of the alternatives was assigned a colour rating: green for "most preferred", yellow for "less preferred" and orange/red for "least preferred", for each of the evaluation criterion. The colour rating reflected how the alternative performs with respect to that criterion. The evaluation criteria categories were assigned equal weighting as they were considered to have equal importance in this evaluation.

Step 3: Document Potential Impacts – The individual impacts associated with each alternative were determined and documented. These impacts were categorized under one (1) of the three (3) evaluation criteria described above, based on whether they impact the natural environment, social and cultural environment, or the technical suitability and cost. A matrix was created to document the impacts, weigh the alternatives qualitatively, and ultimately determine the preferred solution. The matrix has the alternatives listed by column and the evaluation criteria by row.

— **Step 4: Evaluate the Alternatives** – Each of the alternatives was assigned a colour rating for each of the three (3) evaluation criteria using the methodology established in Step 2. The evaluation was based on a qualitative assessment of the individual impacts documented in the table created during Step 3.

Most Preferred/Least Negative Impact	Less Preferred/Medium Negative Impact	Least Preferred/Most Negative Impact

The colour green rating indicates that the alternative had a low impact (most preferred) with respect to that particular criterion. An orange/red colour indicates that the alternative had a high impact (least preferred) with respect to that particular criterion. A yellow colour indicates a moderate impact (less preferred).

— **Step 5: Determine the Preferred Alternative** – The servicing alternative with the least overall impact was recommended for implementation.

EVALUATION CRITERIA

As described in Step 1 of the evaluation methodology, each alternative solution was evaluated against a set of criteria developed as part of the Master Plan. The evaluation criteria are summarized in Table 1.8.

Table 1.8 Evaluation Criteria for the Water and Wastewater Master Plan

NATURAL ENVIRONMENT

Healthy Watersheds	Managing discharges to stressed or sensitive receiving waters
	Managing annual loadings to receiving watercourses Reducing number of wastewater bypasses

	Impact to land considered an established or potential groundwater recharge or discharge areas
Natural Heritage	Impact on designated natural areas
SOCIAL AND CULTURAL HERITAGE	
Community Well Being	Managing construction impacts
	Supporting future growth
	Consistency with Official Plan land use
	Limiting impacts to First Nations traditional land use
Safe and Clean Drinking Water	Maintaining or enhancing security of supply
	Maintaining or enhancing drinking water quality
TECHNICAL SUITABILITY AND ECONOMIC VITALITY	
Cost Effectiveness	Capital costs
	Relative operation and maintenance costs
Constructability and Ease of Integration	Ease of construction
	Ease of integration with existing water and wastewater infrastructure
Operability	Simplicity of water and wastewater systems (consolidation and optimization of existing systems)
	Ease of operation
Sustainability	Reduce annual energy utilization
	Reduce vulnerabilities to future climate changes (I&I, pipe depth, flood-proofing facilities, etc.)

1.5.2 APPROACH TO COST ESTIMATION

In order to develop costs associated with the various infrastructure recommendations made through the Master Planning process, the projects were divided into linear and vertical infrastructure, and costs were assigned based on the methods and assumptions described in the following sections.

LINEAR WATER INFRASTRUCTURE COST ESTIMATION

Linear projects have been categorized into three (3) densities:

RURAL: Comparable to a country road. Watermains will be placed in a roadside ditch. There will be minimal impact to the existing ground surface.

URBAN: Watermains can be placed in the boulevard. There will be an increased disruption to the area and existing road surface.

DENSE URBAN: The existing roadway will require removal and reconstruction. There will be an increased disruption to the area. Projects will have additional associated costs caused by project complexity.

For each of the above densities, unit costing has been determined for various pipe diameters. Watermain unit costs are based on the following criteria:

— **Depth to invert** will be equal to the outer pipe diameter plus minimum cover. The Sudbury design standards require a minimum cover between 2 and 2.6 m, depending on location. An average value of 2.3 m was used for this analysis

- **Minimum trench width** will be equal to the outer pipe diameter plus a minimum buffer on each side of the pipe. The buffer will be 0.225 m for pipe diameters between 300 mm and 600 mm. The buffer will increase to 0.3 m for pipes greater than 600 mm.
- **Excavation Volume** has been calculated per unit length of excavation and is dependent on the depth to invert and outer diameter of the given pipe. All trench boxes will have invert depths of 2.4.
- **Bedding Volume** has been calculated per unit length of the excavation and is dependent on the outer pipe diameter. Bedding will include areas under and surrounding the pipe.
- **Pipe Unit Cost** has been determined from previous contracts. Factors of 1.25 and 1.5 are applied in Urban and Dense Urban areas to determine an **Adjusted Pipe Unit Cost** which will account for the increase in project complexity.

The following additional items were incorporated into the **Total Open Cut Unit Cost**:

- **Valve/Valve Chambers** were costed based on valve and chamber list prices. It is assumed that valves will be direct buried for diameters of 100 mm to 350 mm and chambers will be used for diameters of 400 mm and greater. All direct buried valves will require two (2) units. Chambers will be cast-in-place for diameters of 500 mm and greater. Unit costs were determined based on the following approximate spacing:
  - 75 m for diameters of 100 mm to 250 mm
  - 200 m for diameters of 300 mm to 500 mm
  - 500 m for diameters of 600 mm and greater
- **Hydrant** costing was converted to per meter value based on an approximate spacing of 80 m. It is assumed that hydrants will only be considered for pipe diameters from 150 mm to 400 mm.
- **Service Connections** were converted to a per meter value based on an approximate spacing of 20 m. It is assumed that service connections will only be considered for pipe diameters of 100 mm to 350 mm.
- **Additional Restoration** costs have been included to account for the increased cost to repair Urban and Dense Urban roadways.

The total open cut unit cost was calculated as follows:

Total Open Cut Unit Cost
= Excavation + Bedding + Backfill + Restoration + Adjusted pipe unit cost + Valve/Valve Chambers + Hydrants + Service Connections + Additional Restoration

The following items were incorporated to specific projects or development areas:

- **Dewatering** costs have been applied to areas with high groundwater levels (Azilda and Chelmsford), as indicated by the City of Sudbury.
- **Rock Excavation** is assumed to be necessary in all areas. Sudbury will require rock excavation from the surface, while other areas will assume half the excavation volume will be rock.
- **Directional Drilling/Tunneling** has been evaluated on a project-by-project basis using Google Earth to determine where creeks and railways exist. Costs will range from $1500/m to $3000/m with increasing pipe diameter. Small pipes will be directional drilled and larger pipes will be assumed tunneling.
- **Lining** costs have been applied where necessary. This will be a stand-alone cost with no additional costs for excavation, restoration, etc.

The project **subtotal cost** was calculated as follows:

Subtotal = Total Open Cut Unit Cost + Dewatering (where applicable) + Rock excavation + Directional Drilling/Tunneling (where applicable) + Lining (where applicable)

Additional engineering and contingency costs were added to the subtotal as follows:

- 2% Planning and EA
- 13% Design and Construction

The EA and Design/Construction costs were applied to determine the **capital cost:**

$$\text{Capital Cost} = 1.15(\text{Subtotal})$$

A contingency of 30% was added to the capital cost to determine the **total project cost**:

$$\text{Total Cost} = 1.3(\text{Capital Cost})$$

The following should be noted:

- The cost estimates presented in the Master Plan are Class D Estimates and have been established for budgetary purposes.
- It is expected that individual project estimates will vary by +/- 30% due to certain anomalies that cannot be accounted for in the unit cost rates.
- Cost estimates assume only the replacement cost of the watermain. The coordination of sewer projects and road reconstruction is not considered in these estimates.

LINEAR WASTEWATER INFRASTRUCTURE COST ESTIMATION

SEWER UNIT COST

The unit costing has been determined for various pipe diameters, ranging from 150 mm to 1050 mm. Sewer unit costs consider the following criteria:

- **Depth to invert** for proposed projects were kept consistent with existing conditions. For the purpose of cost estimates, the measurements were rounded to the nearest 0.5 m, with a minimum invert of 2.5.
- Trench box depth will be 2.4 m, 3.6 m, or 4.8 m, dependent on depth to invert. Trench boxes will be used up to an invert of 6 m.
- **Vertical support depth** will be equal to the depth to invert. Vertical supports will only be used for depth to invert of 6.5 m and greater
- **Minimum trench width** will be equal to the outer pipe diameter plus a minimum buffer on each side of the pipe. The buffer will be 0.225 m for pipe diameters between 300 mm and 600 mm. The buffer will increase to 0.3 m for pipes greater than 600 mm. For greater depths, where vertical supports are used, the minimum trench width will be equal to the outer pipe diameter plus 1 m.
- **Excavation Volume** has been calculated per unit length of excavation and is dependent on the outer diameter of the pipe, depth to invert, and either the trench box depth (for more shallow sewers) or vertical support depth (for deeper sewers).
- **Bedding Volume** has been calculated per unit length of the excavation and is dependent on the outer pipe diameter. Bedding will include areas under and surrounding the pipe.
- **Backfill Volume** has been calculated per unit length of the excavation and is dependent on the excavation volume, bedding volume, and the outer pipe diameter.
- **Restoration Area** has been calculated per unit length of the excavation and is dependent on the depth to invert, trench width, and the trench box depth. For greater depths, where vertical supports are used, the restoration area will be equal to the minimum trench width plus 1 m. Restoration area will have a minimum value of 2.1 m^2.
- **Pipe Unit Cost** has been determined based on published price from suppliers. PVC pipes will be used for diameters of 150 mm to 525 mm. Concrete pipes will be used for pipes of 600 mm and greater. Class IV concrete pipes will be used for depths up to and including 4.5 m. Depths to invert of 5 m and greater will implement Class V concrete pipes. It is assumed that all upgrades will be replace in-place and will have no additional costs for relocation.

ADDITIONAL SEWER ITEMS

The following additional items were incorporated into the **Total Open Cut Unit Cost**:

- **Precast Manholes** were costed per unit length of excavation, based on the purchase price of manholes and an assumed spacing of 100 m. The manholes were sized between 1200 mm and 1800 mm and include the cost of an

average of 3 maintenance hole adjusters and a manhole cover. Manholes were sized under the assumption that flow will be straight-through from the inflow to outflow pipes.

- **Manhole Excavation** cost has been calculated per unit length of excavation and is dependent on the associated manhole diameter and depth to invert.
- **Manhole Backfill** has been calculated per unit length of excavation and is dependent on the associated manhole diameter and depth to invert
- Total Manhole Unit Cost was determined by taking the sum of the material costs, additional excavation, and backfill.
- **Additional Restoration** costs have been included to account for the increased cost to repair Urban and Dense Urban roadways. For the purpose of this analysis, it is assumed that all areas will be categorized as dense urban areas

The total open cut unit cost was calculated as follows:

$$\text{Total Open Cut Unit Cost} = \text{Excavation} + \text{Bedding} + \text{Backfill} + \text{Restoration} + \text{Pipe Unit Cost} + \text{Total Manhole Unit Cost} + \text{Additional Restoration}$$

PROJECT SPECIFIC SEWER ITEMS

The following items were incorporated to specific projects or development areas:

- Dewatering costs have been applied to areas with high groundwater levels (Azilda and Chelmsford), as indicated by the City of Sudbury, as well as depths to invert of 5 m or greater.
- Rock Excavation is assumed to be necessary in all areas, where half the excavated volume will be rock.
- Soft Directional Drilling/Tunneling will be applied where directional drilling/tunneling is required in soft ground. The cost has been evaluated on a project-by-project basis using Google Earth to determine where recommended projects will cross creeks or railways. Costs will range from $1500/m to $3000/m with increasing pipe diameter and depth to invert. Small pipes will be directional drilled and larger pipes will be assumed tunneling.
- Lining costs have been applied where necessary. This will be a stand-alone cost with no additional costs for excavation, restoration, etc.
- Rock Tunneling will be applied where tunneling is required through rock. The cost has been evaluated on a project-by-project basis using Google Earth to determine where projects will cross creeks or railways. Costs will range from $3,500/m to $12,000/m with increasing pipe diameter. It is assumed that all tunneled areas will require tunneling through rock to maintain consistency with other assumptions.

The project **subtotal cost** was calculated as follows:

$$\text{Subtotal} = \text{Total Open Cut Unit Cost} + \text{Dewatering (where applicable)} + \text{Rock excavation} + \text{Soft Directional Drilling/Tunneling (where applicable)} + \text{Rock Tunneling (where applicable)}$$

Additional engineering and contingency costs were added to the subtotal as follows:

- 2% Planning and EA
- 13% Design and Construction

The EA and Design/Construction costs were applied to determine the **capital cost:**

$$\text{Capital Cost} = 1.15(\text{Subtotal})$$

A contingency of 30% was added to the capital cost to determine the **total project cost**:

$$\text{Total Cost} = 1.3(\text{Capital Cost})$$

The following should be noted:

- The cost estimates presented in the Master Plan are high level and have been established for budgetary purposes.

— It is expected that individual project estimates will vary by +/- 30% due to certain anomalies that cannot be accounted for in the unit cost rates.
— Cost estimates assume only the replacement cost of the sewer. The coordination of water projects and road reconstruction is not considered in these estimates.

VERTICAL INFRASTRUCTURE

The cost of recommended vertical infrastructure projects and studies were determined on an individual basis. A more detailed analysis can be found in the following Technical Memorandums:

— City of Greater Sudbury – Non revenue Water Technical Memorandum (WSP, 2016)
— Water and Wastewater Master Plan – System-Wide Alternative Solutions – Water Supply Systems Technical Memorandum (WSP, 2016)

1.6 EXISTING CONDITIONS

A review was conducted of the existing CGS conditions. The information gathered consisted of the City's community, as well as its natural and socio-cultural environments. The following sections will summarize the knowledge gathered.

1.6.1 EXISTING COMMUNITY

Formed on January 1, 2001, the City of Greater Sudbury represents an amalgamation of communities. As described in Section 1.3.1 the area of study encompasses all communities serviced by the CGS water and wastewater infrastructure. These areas are Azilda, Capreol, Chelmsford, Coniston, Copper Cliff, Dowling, Falconbridge, Onaping and Levack, Lively and Walden, Sudbury, Valley, Vermilion, and Wahnapitae.

1.6.2 NATURAL ENVIRONMENT

The CGS is a 3,228 square kilometer city located in Northeastern Ontario on the Canadian Shield. Surrounded by major highways, it has become composed of not only rural and wilderness environments, but urban developments as well. The CGS also comprises many lakes, including the largest lake contained within a City. Figure 1-4 outlines the main natural features that exist in the CGS.

Figure 1-4 CGS Natural Environment Map

1.6.3 SOCIO-CULTURAL ENVIRONMENT

The city is mainly bilingual in the French and English languages, but non-official languages that are spoken by CGS habitants include German, Italian, Ukrainian, Polish, and Finnish. The CGS is truly multicultural and over 6 percent of the population self-recognize as being First Nations. The city has a major economic influence from the mining market, but is also a main location for services, tourism, education, government, and health care.