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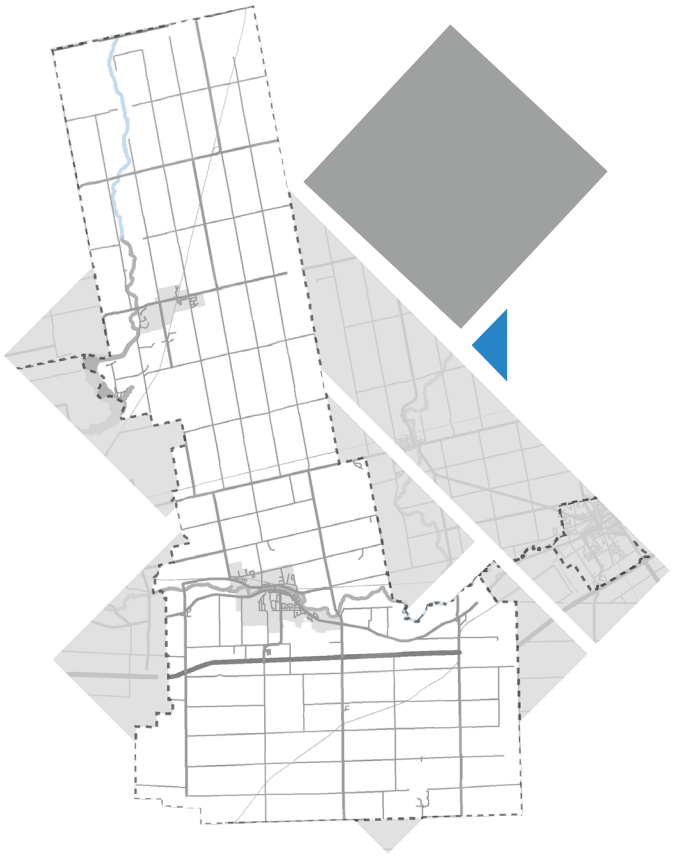
MUNICIPALITY OF THAMES CENTRE

APPENDIX C

COST ESTIMATING PAPER



BluePlan ENGINEERING

MUNICIPALITY OF Thames Centre

Cost Estimating Framework

Water and Wastewater Master Study

Prepared by:
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Municipality of Thames Centre

Project No. 418109
September 2019

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1 Introduction

The Municipality of Thames Centre retained GM BluePlan Engineering Limited to complete the Water and Wastewater Master Study which provides a review, evaluation and development of water and wastewater servicing strategies for servicing within the Town. The project scope included development of new frameworks and policies related to long-term planning, cost estimation at the Master Plan level, and updated linear and vertical unit rates. This memorandum presents the new Cost Estimation Framework, including updated unit rates, which will be applied to the Town's capital projects in the Water and Wastewater Master Plan.

This memorandum is intended to formalize and document a Cost Estimation Framework that provides a consistent, transparent, and auditable approach to costing capital projects.

The primary aims of this task are to:

- Provide a formal cost estimation framework for the Town; and
- Provide guidance to Town staff on the use of the framework.

To achieve the aims, the objectives of the task are to:

- Establish and define different levels or classes of cost estimates appropriate to the information that is available, which will relate to the type of study that is being undertaken; and
- Identify the key information requirements to generate each level of class estimate.

2 Cost Estimation Framework

The proposed Cost Estimation Framework for capital projects at the Master Plan level will be based on an overall project unit cost approach. In this approach, project costs are generated from unit rates with added contingency and other additional costs.

The goal of the Cost Estimation Framework is to provide a consistent and traceable approach for estimating capital project costs to minimize the variance between cost estimates and final project budgets. The approach will also improve communication and understanding between stakeholders.

2.1 Approach and Methodology

The total length or capacity needs of the required infrastructure is multiplied by a unit rate, applicable to the size or capacity and particular construction type (e.g., 5-metre depth sewer, 10-metre depth sewer, water main, wastewater force main, tunnelling). Additional costs are added to account for creek, road, railway or utility crossings, valves, tunneling requirements, etc., where applicable.

In cases where construction will occur in built up areas, such as intensification areas, a cost escalation factor is applied to the installation cost. This factor provides additional project costs to account for utility coordination/relocation, urban reinstatement, and urban construction impacts.

The sum of the base cost plus additional cost results in the *Base Construction Cost*.

Soft costs such as geotechnical/hydrogeological, property/easements, engineering and design, contract administration and contingency allowances, are added to the Base Construction Cost to arrive at the *Total Project Cost*.

Figure 1 shows the cost estimating process flow diagram. Each of the key components of the diagram is described below, including:

- Project Type,
- Cost Estimate Classification,
- Project Complexity,
- Unit Rates,
- Construction Uplift,
- Additional Costs,
- Construction Provisional Allowance,
- Other Project Costs (Geotechnical, Property, Design, In-house costs, etc.), and
- Project Contingency.

The unit costs and all the above components are contained in excel spreadsheets that include the Town's project sheets and the Water and Wastewater Capital Programs. The spreadsheet is the working tool that brings all the cost components together to create project cost estimates for the capital programs. The template spreadsheet is provided in Appendix A.

The following sections describe the methodology for each cost component.

Figure 1 - Cost Estimation Process Flow Diagram

Step 1. Define Project

Project Description
Define basic project details. Description can include: - Project status - new/replacement - Project infrastructure type (sewer, watermain, PS, WWPS, etc) - Geographic location and/or alignment(s) - Diameter or Capacity

Step 2. Define Project Classification

Estimate Class	Estimate Class Description	End Usage/Major Deliverables
Class 5	Conceptual Planning Cost Estimate	Concept ccreening, justification for project funding, minimal information requirements.
Class 4	Infrastructure Planning Cost Estimate	Study to support investment decisions based on sufficient knowledge to identify high-level risk.
Class 3	Conceptual Design Cost Estimate	Basis for budgeting and approvals.
Class 2	Preliminary Design Cost Estimate	Used for project cost control during design; initial design estimate.
Class 1	Detailed Design Cost Estimate	Final cost review in preparation for construction; tender-ready.

Step 3. Define Project Complexity

Project Complexity	Complexity Description
High complexity	Projects with high cost, broad scope of work, multiple alternatives/alignments, etc.
Moderate complexity	Projects with moderate cost, larger scope of work, several alternatives/alignments, etc.
Low complexity	Projects with low cost, defined scope of work, few if any altenatives

Step 4. Define Project Details

Project Detail	Detail Description
Diameter	Nominal diameter of the proposed water main to provide the required level of service.
Length	Approximate length of the proposed pipe based on the alignment (whether assumed or determine through more rigorous analysis).
Construction Methodology	The method by which the pipe will be installed (e.g., open cut, trenchless).
Construction Depth	The depth of excavation required to install the pipe assuming that open cut construction is chosen (e.g., normal, deep).
Construction Environment	The general environment within which the pipe will be constructed (e.g., greenfield, suburban, urban).
Crossings	Identification of the type and number of crossings associated with the pipe installation (e.g., creeks, roads, railways, major utilities).
Appurtenances	Identification of the type and number of appurtenances required for the proposed water main (e.g., valves, chambers, hydrants, etc.).
Capacity	Proposed capacity of vertical infrastructure (e.g. pump stations).

Step 5. Calculate Total Construction Cost

❶ INSTALLATION COST
Basic cost to install linear infrastructure and associated appurtenances calculated using various unit rates for pipe, valve and chamber sizes and type of crossings.

Includes: pipe installation (unit rate x length), crossings (count x unit rate for size and type of crossing), manholes and chambers (included in unit rate).

For vertical infrastructure, includes facility construction (unit rate x capacity).

❷ CONSTRUCTION UPLIFT
Allowance for the increased cost of constructing in built-up areas, applied to the base construction cost.

Construction Environment		
Greenfield	Suburban	Urban
0%	20%	40%

❸ BASE CONSTRUCTION COST
Total cost to construct the actual linear or vertical infrastructure and associated appurtenances, not including tasks such as traffic management, mobilization, inspections, etc.

❸ = ❶ + ❷

❹ ADDITIONAL CONSTRUCTION COSTS
Additional costs associated with construction not covered under the base construction cost or the construction uplift, including mobilization, traffic management, inspections, etc. A percentage is applied to the water main construction cost based on the complexity of the project.

Project Complexity		
Low	Moderate	High
5.0%	7.5%	10.0%

❺ PROVISIONAL ALLOWANCE
Provisional allowance for labour and materials over and above the construction cost, a standard item on construction tenders. A provisional allowance of 10% is applied to all projects.

❻ TOTAL CONSTRUCTION COST
Total cost of constructing the project including all items that make up a construction tender.

❻ = ❸ + ❹ + ❺

Step 6. Calculate Project Contingency

❼ PROJECT CONTINGENCY
An allowance for contingency that recognizes both the complexity of the project and the project classification in terms of the certainty regarding scope of work, alignment, construction methodology, property requirements, geotechnical/hydrogeological issues, etc. The contingency will become smaller as the project moves closer to implementation.

	Project Complexity		
	Low	Moderate	High
Class 4	15%	20%	25%
Class 3	10%	15%	20%
Class 2	5%	10%	15%
Class 1	0%	0%	5%

Step 7. Calculate Soft Costs

a) For new infrastructure (i.e., growth-related)

❾ GEOTECHNICAL/ HYDROGEOLOGICAL
Allowance for geotechnical/hydrogeological investigations during detailed design.

Project Complexity		
Low	Moderate	High
0.5%	1.0%	2.0%

❿ PROPERTY/EASEMENTS
Allowance for temporary and permanent easements and for property acquisition.

Project Complexity		
Low	Moderate	High
1.0%	1.5%	2.0%

⓫ ENGINEERING/DESIGN (INTERNAL)

Total Cost		
<$10m	$10-$50m	>$50m
4%	6%	8%

⓬ DESIGN/CONTRACT ADMINISTRATION (EXTERNAL)

Total Cost		
<$10m	$10-$50m	>$50m
10%	12%	15%

⓭ TOTAL SOFT COSTS (GROWTH)

⓭ = ❾ + ❿ + ⓫ + ⓬

⓮ NON REFUNDABLE HST
Non Refundable HST has been defined as 1.76%

Step 8. Total Project Cost

⓯ TOTAL COST ESTIMATE (2018 Dollars)
Total cost of the project including construction costs, additional project related costs and soft costs.

⓯ = ❻ + ❼ + ⓭ + ⓮

Step 9. Determine Funding Source(s)

Determine the funding source or sources based on the key driver(s) of the project.

2.1.1 Project Type

New Infrastructure

New infrastructure projects involve construction of new linear or vertical infrastructure that is are growth related and typically funded from Development Charges (DCs). The majority of the capital projects identified in the Master Plan fall into this category and their cost will be developed using the new cost estimation framework.

Replacement

Projects involving replacement, relining and other works on existing infrastructure. These projects are generally not growth related and fall in the State of Good Repair (SoGR) category.

2.1.2 Cost Estimate Classification

The cost estimation approach uses a classification system to categorize cost estimate classes. These classes represent different phases of planning and design and, therefore, different methods of cost estimation and levels of accuracy. This framework complements the generic approach developed by the Association of Advancement in Cost Estimating (AACE) International, and also has similarities to the Government of Canada (GOC) approach.

For the purposes of the Water and Wastewater Master Plan, the cost estimates that are derived using this methodology will mostly follow a **Class 4** estimate. If this methodology is further used through subsequent phases of the project, the Class can be updated to reflect the higher level of confidence in the estimate and the additional effort used to develop the estimate.

Table 1 provides descriptions of the proposed estimate classes and their end usage or deliverables. Appendix B includes expanded details on each Class, including the basis for the estimate and the associated accuracy range that can be expected based on the project complexity.

Table 1. Cost Estimation Classes

Estimate Class	Estimate Class Description	End Usage / Major Deliverables
Class 5	Order of Magnitude Estimate	Limited or no available information used in the cost estimate. Used at an early stage in absence of better information.
Class 4	Infrastructure Planning Cost Estimate	Infrastructure Planning/Master Planning. Justification for project planning funding. Limited available information used in the cost estimate.
Class 3	Conceptual Design Cost Estimate	Basis for budgeting and approvals.
Class 2	Preliminary Design Cost Estimate	Used for project cost control during design. Initial detailed estimate.
Class 1	Detailed Design Cost Estimate	Final cost review in preparation for construction; tender ready.

2.1.3 Project Complexity

A Master Plan level project can vary widely in scope. When developing the cost estimate within a Master Plan context, it should be recognized that not all project costs have the same level of complexity. As part of the new cost estimating framework, the project complexity is estimated during development of the project cost estimate. As the anticipated complexity of a project increases from low to high there is a greater risk of unforeseen costs. As such, the contingency and additional cost items are adjusted to reflect the project complexity.

Table 2 provides general definitions of project complexity – high, medium and low – as will be used in the Water and Wastewater Master Plan. An estimate of the complexity is made after reviewing the project details that are available at the Master Planning stage. The definitions of high, medium and low complexity are provided to maximize the consistency in complexity selection on a given project and to minimize the subjectivity of the estimate.

The complexity estimate is intended to represent the best assumption of the overall complexity of the project with details available at the time.

Table 2. Project Complexity Descriptions

Project Complexity	Complexity Description

High Complexity	• Large in scale, scope and, ultimately, cost.
	• Uncommon project, not frequently constructed.
	• Complex project details that, in general, have high uncertainty and may potentially change in later stages of the project (EA, scoping study, design, construction)
	• Multiple options and project details for design and construction (alignment, dimensions, facility layout, construction methodology) that are not yet confirmed
	• Other anticipated project details that can contribute to consideration as a High Complexity project:
	  ○ Existing utility and linear infrastructure conflicts, that may not be known at the Master Planning Stage
	  ○ Unknown subsurface conditions – Soil, rock, groundwater
	  ○ Significant restoration requirements
	  ○ Environmental features that may require additional approvals and/or mitigation during construction
	  ○ Potentially long construction duration
	  ○ Linear – Deep sewer/water main, force main
	  ○ Linear – Large Diameter
	  ○ Facility – Deep Wet Well
	  ○ Facility – Large Capacity (Reservoir, Elevated Tank, Pumping Station)
	
	The nature of the project details in a high complexity project (e.g. many unknowns, utility conflicts, large diameter, high base construction costs, etc.) necessitate the inclusion of further additional costs to account for the risk of construction cost increases.

Medium Complexity	• Moderate in scale, scope and. ultimately, cost. • Medium complexity projects where most project details generally fall in between high and low complexity. • Medium complexity projects may have some elements that fit the High Complexity category, while some elements falling within Low complexity category. (e.g., short section of small diameter water main constructed within a built-up area with several utility conflicts).

Project Complexity	Complexity Description

Low Complexity	• Smaller in scale, scope and, ultimately, cost.
	• Common project, frequently constructed.
	• Straightforward project details that, in general have low uncertainty and are not likely to change in later stages of the project (EA, scoping study, design, construction)
	• Most options and project details for design and construction (alignment, dimensions, facility layout, construction methodology) are generally confirmed at this stage
	• Other anticipated project details that can contribute to consideration as a Low Complexity project
	  ○ Few existing utility and linear infrastructure conflicts – generally associated with greenfield/rural construction
	  ○ Subsurface conditions are known or assumed with high level of certainty
	  ○ Minimal restoration required or restoration primarily to be coordinated with road construction/widening
	  ○ Little to no environmental features within project construction area
	  ○ Short anticipated construction duration
	  ○ Linear – Shallow sewer, water main, force main
	  ○ Linear – Small diameter
	  ○ Facility – Shallow wet well
	  ○ Facility – Small Capacity (Reservoir, Elevated Tank, Pumping Station)
	
	The nature of project details in a low complexity project (e.g., few unknowns, few utility conflicts, small diameter, low base construction cost, etc.) do not necessitate significant additional costs.

2.1.4 Unit Rates

Unit rates require periodic updating to ensure they are consistent with current market conditions. GM BluePlan compiled recent tenders for linear and facility projects within the GTA to provide guidance to the update of unit rates. Unit rates are estimated to be high level cost for construction, which is assumed to include General Contractor profit.

The linear unit rate for a given pipe diameter is made up of the following components:

- Excavation ($/m^3)
- Bedding ($/m^3)
- Pipe Supply ($/m)
- Pipe Install ($/m)
- Backfill ($/m^3)
- Restoration ($/m)
- Manhole Allowance ($/m)
- Valve Allowance ($/m)

Each component was broken down to a $/m linear unit rate to generate the total base construction cost for a given diameter of pipe. Unit rates for facilities are not broken down to the same level of detail as linear projects. Facility unit rates are based on $/L/s or $/ML.

The proposed Master Plan unit rates are provided in Appendix D. They are based on a combination of supplier material costs, tender analysis and historic project costs from multiple municipalities across southern Ontario. In this recommended approach, the unit rates are the starting point or base for a cost estimate. Many other factors and criteria are applied to the unit rates. Therefore, caution is advised when comparing recommended unit rates in isolation with those used for previous studies. Only full and complete costs estimates should be compared.

Creeks, roads, railways and utility corridor crossings are also identified during the cost estimating process. The costs associated with these crossings, where applicable, are part of the installation cost. The costs of crossings are calculated as follows:

- Major Creek / Major Road → 150 m x Trenchless Unit Rate
- Minor Road / Utilities Corridor → 60 m x Trenchless Unit Rate
- Minor Creek → 20 m x Trenchless Unit Rate

Cost for crossings are considered a premium over and above the installation cost for the project and, as such, the total length of the water main or sanitary sewer is not adjusted to remove the length of the crossing.

2.1.5 Construction Uplift

Construction uplift introduces an allowance for the increased cost of constructing in built-up areas and is applied to the installation cost. This uplift accounts for additional costs related to restoration, utility conflicts, traffic management and additional restoration that are often encountered in an urban or suburban area as opposed to greenfield construction.

Table 3 provides a definition and the construction uplift percentages applicable for the different area conditions in the Water and Wastewater Master Plan.

Table 3. Construction Uplift Descriptions

Construction Environment	Environment Description	Construction Cost Uplift %
Greenfield	Greenfield construction with limited environmental constraints.	0%
Suburban	Developed built-up environment.	20%
Urban	Heavily developed built-up environment (e.g., downtown area).	30%

2.1.6 Additional Construction Costs

Additional construction costs account for costs that are incurred but not included in the base construction cost. These costs generally include mobilization and demobilization, pipe inter-connections, inspection, hydrants, signage, traffic management, bonding, insurance, etc.

Additional construction costs are adjusted based on assumed project complexity, as follows:

- Low Complexity → Additional Construction Costs = 10%
- Medium Complexity → Additional Construction Costs = 15%
- High Complexity → Additional Construction Costs = 20%

2.1.7 Construction Provisional Allowance

A provisional allowance is applied to the base construction cost in the event of increased construction labour or material costs. The provisional allowance remains separate from the primary project cost but must be accounted for budgeting purposes. Regardless of estimate class or project complexity it is recommended that 10 per cent of the base construction cost is applied as a Provisional Allowance.

2.1.8 Other Project Costs

Other costs that can be included within a project in addition to the base construction costs are listed in Table 4. If available, actual quoted costs should be used. In the absence of this information, percentages are applied to the base construction costs. Some of these costs are related to project complexity. Table 4 shows the percentages to be applied for high, medium and low complexity projects.

Table 4 – Additional Cost Components

Cost Component	High Complexity	Medium Complexity	Low Complexity
Geotechnical / Hydrogeological / Materials	2.0% of construction cost	1.5% of construction cost	0.5% of construction cost
Property / Easements – (applicable to all projects)	2.0% of construction cost	1.5% of construction cost	1.0% of construction cost
Engineering / Design (Internal)			
Total Cost < $10M	8% of construction cost		
Total Cost = $10M - $50M	6% of construction cost		
Total Cost > $50M	4% of construction cost		
Design / Contract Administration (External)			
Total Cost < $10M	15% of construction cost		
Total Cost = $10M - $50M	12% of construction cost		
Total Cost > $50M	10% of construction cost		
Project Contingency	(See section 2.10)		
Non Refundable HST	**1.76%** of (construction cost + geotechnical/hydrogeological/materials + property requirements + consultant engineering + project contingency)		

2.1.9 Project Contingency

The associated risk and uncertainty of a project cost estimate is minimized with the addition of a contingency. Contingencies are allowances for risks that are known or anticipated at early stages of the project definition. That is, they represent probable events that are "known unknowns" and, experience has shown, are likely to occur. They cannot be attributed to specific items in the base cost estimate but need to be considered in addition to the base cost. A project contingency does not cover major changes in scope, which would require a re-assessment and re-costing of a project. Project Contingency is applied to all projects that are costed using this methodology.

The Project Contingency for this methodology is adjusted based on the cost estimate classification and project complexity as follow:

Table 5 – Project Contingency

	Project Complexity		
	Low	**Moderate**	**High**
Class 5	30%		
Class 4	10%	15%	25%
Class 3	10%	15%	20%
Class 2	10%	10%	15%
Class 1	10%	10%	10%

Appendix A – Cost Estimation Spreadsheet Template

Municipality of Thames Centre
Water and Wastewater Master Plan
Capital Program Cost Estimate

1	**PROJECT NO.:**	**W-T-WM-09**
	PROJECT NAME:	**Thorndale Watermain Upgrade - Industrial Lands Loop**
	PROJECT DESCRIPTION:	590m of 300mm watermain to connect Ideal Dr. and Gerald Pkwy. to complete loop

CAPITAL BUDGET YEAR:
VERSION:
DATE UPDATED:
UPDATED BY:

2	**Class Estimate Type:**	Class 4	Class adjusts Construction Contingency and expected accuracy
3	**Project Complexity**	Med	Complexity adjusts Construction Contingency, and expected accuracy
4	**Accuracy Range:**	40%	
5	**Area Condition:**	Suburban	Area Condition uplifts unit cost and restoration

	= Field has drop down
	= Field must be manually populated
	= Field auto-filled based on project details

6	**PROPOSED DIAMETER:**	300 mm	
	TOTAL LENGTH:	590 m	
7	**Tunnelled**	0 m	0%
	Open Cut	590 m	100%

CLASS EA REQUIREMENTS:	A+
CONSTRUCTION ASSUMPTION:	Watermain

COST ESTIMATION SPREADSHEET

	COMPONENT	RATE (%)	RATE ($)	UNIT	ESTIMATED QUANTITY	COST PER UNIT	SUB-TOTAL	COMMENTS
	Construction Cost							
	Pipe Construction - Open Cut			m	590 m	$777	$458,211	Existing road ROW
	Pipe Construction - Tunneling			m	0 m	$1,300	$0	
	Pipe Construction Uplift (Based on Area Conditions)	20%					$91,642	
	Minor Creek Crossings			ea.	0	$38,000	$0	
	Major Creek Crossings			ea.	0	$207,000	$0	
8	Road Crossings			ea.	0	$90,000	$0	
	Major Road / Rail Crossings			ea.	0	$207,000	$0	
	Utility Crossings			ea.	0	$90,000	$0	
	Valve and Chamber			ea.	1	$6,000	$6,000	2 valves minimum
	Additional Construction Costs	15%		ea.			$83,378	Includes Mod/Demob, connections, inspection, hydrants, signage, traffic management, bonding, insurance
	Provisional & Allowance	10%		ea.			$63,923	Provisional Labour and Materials in addition to base construction cost
	Sub-Total Construction Base Costs						**$703,000**	
	Geotechnical / Hydrogeological / Materials	1.0%					$7,000	
	Geotechnical Sub-Total Cost						**$7,000**	
	Property Requirements	1.5%					$ 10,500	
	Property Requirements Sub-Total						**$10,500**	
	Consultant Engineering/Design	15%					$ 105,500	includes planning, pre-design, detailed design, training, CA, commissioning
	Engineering/Design Sub-Total						**$105,500**	
	In House Labour/Engineering/Wages/CA	8%					$ 56,200	
	In-house Labour/Wages Sub-Total						**$56,200**	
	Project Contingency	15%					$132,000	Construction Contingency is dependent on Cost Estimate Class and Project Complexity
	Project Contingency Sub-Total						**$132,000**	
	Non-Refundable HST	1.76%					$16,900	
	Non-Refundable HST Sub-Total						**$16,900**	
	Total (2019 Dollars)						**$1,031,000**	Rounded to nearest $1,000
	Other Estimate							
	Chosen Estimate						**$1,031,000**	2019 Estimate

COST ESTIMATE SUMMARY - FOR PHASING ESTIMATING ONLY

PROJECT COMPONENT	PROJECT COMPONENT DESCRIPTION	PERCENTAGE	TOTAL	YEAR	COMMENTS
Study	Feasibility study, EA	2%	$20,620		
Design	Design fees, Town fees for design, contract admin	13%	$134,030		
Construction	Town fees, base costs and project contingency	85%	$876,350		
TOTAL			**$1,031,000**		

Appendix B – Cost Estimate Classes

CLASS 5 ESTIMATE: Order of Magnitude Estimate	
Description: Includes high level cost estimate with a long-term project horizon. Desktop level analysis based on previous similar projects and engineer's informed approximation formed on limited available information. **Example of Typical Study/Design Level:** Master Plan, Infrastructure Plan, Capital Budgeting **End Usage:** Concept screening and feasibility; used at an early stage in absence of better information.	**Estimating Methods Used:** Experience and judgement, historical values, rules of thumb, factor estimating base on similar projects, among other basic calculations. **Expected Accuracy Range:** Low Complexity → High Complexity +/- 40% → +/- 70%

CLASS 4 ESTIMATE: Planning Cost Estimate	
Description: Includes high level cost estimate with a long-term project horizon. Desktop level analysis based on preliminary investigations, anticipated project needs, and engineer's best judgement based on limited available information. **Example of Typical Study/Design Level:** Master Plan, Infrastructure Plan, Capital Budgeting **End Usage:** Concept screening; justification for project planning funding. Useful for planning purposes in preparation for project pre-design. Shall be included in Capital Projects List.	**Estimating Methods Used:** An approximate method of estimating using an inclusive "all in" unit rates, typically based on historic data. (e.g. sewer cost per meter) **Expected Accuracy Range:** Low Complexity → High Complexity +/- 20% → +/- 40%

CLASS 3 ESTIMATE: Concept Design Cost Estimate	
Description: Includes detailed costing for budgeting purposes. Includes more detailed knowledge of specific criteria to generate more component related costing. **Example of Typical Study/Design Level:** 5-Year Business Plan Conceptual Design **End Usage:** Basis for budgeting and approvals.	**Estimating Methods Used:** Uses features from both the unit rate method (for low risk items) and first principles method (for high risk items). **Expected Accuracy Range:** Low Complexity → High Complexity +/- 15% → +/- 20%

CLASS 2 ESTIMATE: Preliminary Design Cost Estimate	
Description: The cost estimate generated from this class can be used as a basis for fund appropriation. Uses more detailed knowledge and more costing components including more field investigations and preliminary design reports. **Example of Typical Study/Design Level:** Preliminary Design **End Usage:** Used for project cost control during design. Initial detailed estimate.	**Estimating Methods Used:** Uses features from both the unit rate method (for low risk items) and first principles method (for high risk items). **Expected Accuracy Range:** Low Complexity → High Complexity +/- 10% → +/- 15%

CLASS 1 ESTIMATE: Detailed Design Cost Estimate	
Description: This class will generate a cost estimate representing the Engineer's final estimate based on completed plans. The estimated cost will reflect current market conditions in the constructing community. The goal of this cost estimate is to match the median bid received during the bidding process. **Example of Typical Study/Design Level:** Detailed Design **End Usage:** Final cost review in preparation for construction; tender ready.	**Estimating Methods Used:** Project specific costs based on detailed study of work methods, resources and materials. For example, material costs based on current supplier quotes. All project components costed individually. **Expected Accuracy Range:** Low Complexity +/- 5% ⟹ High Complexity +/- 10%

Appendix C – Data Confidence and Availability for Cost Estimate Classes

Linear Projects

General Project Data	Class 5	Class 4	Class 3	Class 2	Class 1
Location	Assumed	Assumed	Preliminary	Defined	Defined
Project Complexity	Assumed	Assumed	Preliminary	Defined	Defined
Area Condition	Assumed	Assumed	Preliminary	Defined	Defined
Diameter/Capacity	Assumed	Preliminary	Defined	Defined	Defined
Length	Assumed	Preliminary	Defined	Defined	Defined
Tunnelled / Open Cut	Assumed	Assumed	Preliminary	Defined	Defined
Construction Assumption (water main, 5m sewer, 10m sewer, force main, tunnel)	Assumed	Preliminary	Preliminary	Defined	Defined
Crossings (Road, Creek, Utilities)	Assumed	Preliminary	Defined	Defined	Defined
Hydraulic Requirements (Valves, Chambers)	Assumed	Preliminary	Preliminary	Defined	Defined
Hydrogeological, Geotechnical	Assumed	Assumed	Preliminary	Defined	Defined
Property Requirements	Assumed	Assumed	Defined	Defined	Defined
Approval Requirements	Assumed	Assumed	Preliminary	Defined	Defined

Vertical Projects

General Project Data	Class 5	Class 4	Class 3	Class 2	Class 1
Location	Assumed	Assumed	Preliminary	Defined	Defined
Hydrogeological, Geotechnical	Assumed	Assumed	Preliminary	Defined	Defined
Building/Structural Type and Requirements	Assumed	Assumed	Preliminary	Defined	Defined
Hydraulic Requirements, Equipment Selection	Assumed	Preliminary	Preliminary	Defined	Defined
Technology	Assumed	Assumed	Preliminary	Defined	Defined
Building Schematics	Assumed	Assumed	Preliminary	Defined	Defined
Property Requirements	Assumed	Assumed	Preliminary	Defined	Defined
Approval Requirements	Assumed	Assumed	Preliminary	Defined	Defined

Appendix D – Updated Unit Rates

Table D.1 Sanitary sewer unit rates for 5-metre deep open cut construction

Diameter	Excavation			Granular Bedding			Pipe			Backfill			Subtotal Unit Cost	Restoration	Manhole Allowance	Total Unit Cost
	Volume	Cost	Unit Cost	Volume	Cost	Unit Cost	Supply Cost	Installation	Pipe Supply +Install	Vol	Cost	Unit Cost				
(mm)	(m^3/m)	($/$m^3$)	($/m)	(m^3/m)	($/$m^3$)	($/m)	($/m)	($/m)	($/m)	(m^3/m)	($/$m^3$)	($/m)	($/m)	($/m)	($/m)	(2019$/m)
200	6.0	32	$192	0.5	71	$35	$77	$47	$124	5.5	14	$77	$428	$113	$110	**$651**
250	6.0	32	$192	0.5	71	$37	$77	$47	$124	5.5	14	$77	$430	$113	$110	**$653**
300	6.0	32	$192	0.6	71	$39	$77	$47	$124	5.4	14	$76	$432	$113	$110	**$654**
375	6.0	32	$192	0.6	71	$42	$96	$47	$143	5.4	14	$76	$452	$113	$110	**$675**
450	6.0	32	$192	0.6	71	$46	$123	$47	$170	5.4	14	$75	$483	$114	$110	**$707**
525	6.0	32	$192	0.7	71	$49	$148	$47	$195	5.3	14	$74	$511	$115	$110	**$736**
600	7.0	32	$224	1.0	71	$68	$195	$47	$242	6.0	14	$85	$618	$115	$250	**$983**
675	8.5	32	$272	1.3	71	$89	$295	$56	$351	7.2	14	$101	$814	$130	$250	**$1,194**
750	9.0	32	$288	1.4	71	$100	$390	$56	$446	7.6	14	$106	$941	$131	$250	**$1,322**
825	9.5	32	$304	1.6	71	$112	$452	$56	$509	7.9	14	$111	$1,035	$132	$250	**$1,418**
900	9.5	32	$304	1.7	71	$117	$542	$56	$599	7.8	14	$110	$1,130	$133	$400	**$1,663**
975	10.0	32	$320	1.8	71	$130	$625	$56	$681	8.2	14	$114	$1,245	$147	$400	**$1,792**
1050	11.5	32	$368	2.2	71	$157	$715	$56	$771	9.3	14	$130	$1,426	$148	$400	**$1,974**
1200	12.5	32	$400	2.6	71	$183	$896	$56	$952	9.9	14	$139	$1,674	$150	$400	**$2,224**
1350	13.5	32	$432	3.1	71	$218	$1,096	$63	$1,159	10.4	14	$146	$1,954	$153	$333	**$2,441**
1500	14.0	32	$448	3.4	71	$240	$1,341	$63	$1,404	10.6	14	$149	$2,240	$168	$333	**$2,742**
1800	16.0	32	$512	4.4	71	$314	$1,942	$63	$2,005	11.6	14	$162	$2,992	$172	$333	**$3,498**
2100	17.5	32	$560	5.4	71	$386	$2,581	$63	$2,644	12.1	14	$169	$3,759	$176	$400	**$4,335**
2400	19.5	32	$624	6.8	71	$482	$3,433	$63	$3,496	12.7	14	$178	$4,780	$180	$400	**$5,361**
3000	23.0	32	$736	9.6	71	$679	$5,261	$63	$5,324	13.4	14	$188	$6,927	$188	$400	**$7,516**

Table D.2 Sanitary sewer unit rates for 10-metre deep open cut construction

Diameter	Excavation			Granular Bedding			Pipe			Backfill			Subtotal Unit Cost	Restoration	Manhole Allowance	Total Unit Cost
	Volume	Cost	Unit Cost	Volume	Cost	Unit Cost	Supply Cost	Installation	Pipe Supply +Install	Vol	Cost	Unit Cost				
(mm)	(m^3/m)	($/$m^3$)	($/m)	(m^3/m)	($/$m^3$)	($/m)	($/m)	($/m)	($/m)	(m^3/m)	($/$m^3$)	($/m)	($/m)	($/m)	($/m)	(2019$/m)
250	37	$45	$1,665	0.5	71	$37	$77	$47	$124	36.5	14	511	$2,337	$207	$200	**$2,744**
300	37	$45	$1,665	0.6	71	$39	$77	$47	$124	36.4	14	510	$2,339	$207	$200	**$2,746**
375	37	$45	$1,665	0.6	71	$42	$96	$47	$143	36.4	14	510	$2,359	$207	$200	**$2,766**
450	37	$45	$1,665	0.6	71	$46	$123	$47	$170	36.4	14	509	$2,390	$213	$200	**$2,803**
525	37	$45	$1,665	0.7	71	$49	$148	$47	$195	36.3	14	508	$2,418	$213	$200	**$2,830**
600	39	$45	$1,755	1.0	71	$68	$195	$47	$242	38.0	14	533	$2,597	$215	$350	**$3,162**
675	42	$45	$1,890	1.3	71	$89	$295	$56	$351	40.7	14	570	$2,901	$217	$350	**$3,468**
750	43	$45	$1,935	1.4	71	$100	$390	$56	$446	41.6	14	582	$3,064	$221	$350	**$3,634**
825	44	$45	$1,980	1.6	71	$112	$452	$56	$509	42.4	14	594	$3,194	$229	$350	**$3,773**
900	44	$45	$1,980	1.7	71	$117	$542	$56	$599	42.3	14	593	$3,289	$231	$600	**$4,120**
975	45	$45	$2,025	1.8	71	$130	$625	$56	$681	43.2	14	604	$3,440	$233	$600	**$4,273**
1050	48	$45	$2,160	2.2	71	$157	$715	$56	$771	45.8	14	641	$3,729	$237	$600	**$4,565**
1200	50	$45	$2,250	2.6	71	$183	$896	$56	$952	47.4	14	664	$4,049	$239	$600	**$4,887**
1350	52	$45	$2,340	3.1	71	$218	$1,096	$63	$1,159	48.9	14	685	$4,401	$239	$567	**$5,207**
1500	53	$45	$2,385	3.4	71	$240	$1,341	$63	$1,404	49.6	14	695	$4,723	$239	$567	**$5,529**
1800	57	$45	$2,565	4.4	71	$314	$1,942	$63	$2,005	52.6	14	736	$5,619	$247	$567	**$6,433**
2100	60	$45	$2,700	5.4	71	$386	$2,581	$63	$2,644	54.6	14	764	$6,494	$261	$733	**$7,488**
2400	64	$45	$2,880	6.8	71	$482	$3,433	$63	$3,496	57.2	14	801	$7,659	$269	$733	**$8,661**
3000	71	$45	$3,195	9.6	71	$679	$5,261	$63	$5,324	61.4	14	860	$10,058	$289	$733	**$11,081**

Table D.3 Watermain and force main unit rates for open cut construction

Diameter	Excavation			Granular Bedding			Pipe			Backfill			Subtotal Unit Cost	Restoration	Total Unit Cost
	Volume	Cost	Cost	Volume	Cost	Cost	Supply Cost	Installation	Pipe Supply +Install	Vol	Cost	Cost			
(mm)	(m3/m)	($/m3)	($/m)	(m3/m)	($/m3)	($/m)	($/m)	($/m)	($/m)	(m3/m)	($/m3)	($/m)	($/m)	($/m)	(2019 $/m)
150	6.0	$32	$192	0.5	$71	$33	$295	$61	$356	5.5	$14	$77	$659	$113	**$771**
200	6.0	$32	$192	0.5	$71	$35	$295	$61	$356	5.5	$14	$77	$660	$113	**$773**
250	6.0	$32	$192	0.5	$71	$37	$295	$61	$356	5.5	$14	$77	$662	$113	**$775**
300	6.0	$32	$192	0.6	$71	$40	$295	$61	$356	5.4	$14	$76	$664	$113	**$777**
350	6.0	$32	$192	0.6	$71	$42	$295	$61	$356	5.4	$14	$76	$666	$113	**$779**
400	6.0	$32	$192	0.6	$71	$44	$295	$61	$356	5.4	$14	$75	$668	$114	**$781**
450	6.0	$32	$192	0.7	$71	$47	$390	$61	$451	5.3	$14	$75	$764	$114	**$878**
500	6.0	$32	$192	0.7	$71	$49	$452	$61	$513	5.3	$14	$74	$829	$115	**$943**
600	6.0	$32	$192	0.8	$71	$57	$542	$172	$715	5.2	$14	$73	$1,036	$115	**$1,151**
750	8.5	$32	$272	1.3	$71	$91	$625	$172	$797	7.2	$14	$101	$1,261	$131	**$1,392**
900	9.5	$32	$304	1.6	$71	$115	$715	$172	$887	7.9	$14	$110	$1,416	$133	**$1,549**
1050	10.3	$32	$330	1.9	$71	$136	$896	$201	$1,097	8.4	$14	$117	$1,680	$148	**$1,828**
1200	12.1	$32	$387	2.4	$71	$174	$1,096	$234	$1,330	9.7	$14	$135	$2,026	$150	**$2,176**
1350	13.1	$32	$419	2.9	$71	$206	$1,341	$322	$1,663	10.2	$14	$143	$2,431	$153	**$2,584**
1500	14.0	$32	$448	3.4	$71	$239	$1,606	$369	$1,975	10.6	$14	$149	$2,810	$168	**$2,978**
1650	15.0	$32	$480	3.9	$71	$275	$1,942	$403	$2,345	11.1	$14	$156	$3,255	$168	**$3,423**
1800	15.8	$32	$504	4.3	$71	$308	$2,252	$423	$2,674	11.4	$14	$160	$3,646	$172	**$3,818**
2100	17.5	$32	$560	5.3	$71	$379	$2,581	$423	$3,004	12.2	$14	$170	$4,113	$176	**$4,289**

Table D.4 Trenchless construction unit rates for water mains or sanitary sewers

Diameter (mm)	Total Unit Cost ($/m)	Diameter (mm)	Total Unit Cost ($/m)	Diameter (mm)	Total Unit Cost ($/m)
150	$1,300	**500**	$6,300	**1200**	$9,800
200	$1,300	**525**	$6,300	**1350**	$13,000
250	$1,300	**600**	$6,300	**1500**	$15,000
300	$1,300	**675**	$6,300	**1650**	$16,000
325	$1,300	**750**	$6,300	**1800**	$18,000
350	$1,300	**825**	$9,800	**2100**	$20,000
375	$6,300	**900**	$9,800	**2400**	$23,000
400	$6,300	**975**	$9,800	**3000**	$28,000
450	$6,300	**1050**	$9,800		

Anticipated trenchless methodology is as follows:

- 1350 mm – 3000 mm: Microtunnel or TBM
- 825 mm – 1200 mm: Microtunnel, Auger Boring, Guided Auger Boring
- 375 mm – 750 mm: Axis Guided Boring, Auger Boring, Guided Auger Boring
- 150 mm – 350 mm: Axis Guided Boring, Horizontal Directional Drilling

Note: Trenchless Cost estimate table provides estimated high level cost for tunnelling, pipe installation and shafts for ranges of diameter. Tunnelling project costs can vary widely depending on project details that are not fully known at the Master Plan / DC stage (e.g., number of shafts, subsurface conditions, site conditions, contractor preferred tunnelling method, depth, location (urban, greenfield) etc.).

Table D.5 Facilities

Facility	Total Unit Cost	Unit
Reservoirs - **New Construction**	$900,000	($/ML)
New Water / Sewage Pumping Stations **≤ 50L/s**	$40,000	($/L/s)
New Water / Sewage Pumping Stations **> 50 L/s ≤ 150 L/s**	$30,000	($/L/s)
New Water / Sewage Pumping Stations **> 150 L/s**	$20,000	($/L/s)

Notes: Unit rate is intended to provide the base construction cost for a basic pumping facility. These costs are not assumed to account for force mains (for WWPS) or overflow storage tanks (WWPS) or unique items such as deep wet wells (WWPS), extensive architectural features or extensive site works.