VOLUME 3

DRAINAGE

VOL. 3-01

DEVELOPMENT PLANNING PROCEDURE AND FRAMEWORK

APRIL 2025

TERMS OF USE

The “City of Edmonton Design and Construction Standards Volume 3: Drainage”, henceforth known as “Volume 3”, is made available for use in the City of Edmonton effective as of August 2025. Volume 3-01: Development Planning Procedure and Framework has been developed to establish standards and guidelines which align with EPCOR’s expectations in the design and construction of drainage infrastructure within the City of Edmonton. Volume 3-01 is presented as accurate and complete as of the effective date and all care has been taken to confirm the accuracy of the information contained herein. The views expressed herein do not necessarily represent those of any individual contributor. No part of these standards absolves any user from the obligation to exercise their professional judgment and follow good practice. Should any user have questions as to the intent or accuracy of any specification or drawing herein, or concern that conflict may exist between the manufacture’s or suppliers’ recommended installation procedures and Volume 3-02, the user is advised to seek clarification by sending an email to DRENG@epcor.com.

LIST OF REVISIONS

The following is a list of revisions in **Vol. 3-01: Development Planning Procedure and Framework**.

Section	Changes
	Deleted the tables of Vol 3-01, 3-02, 3-03, 3-04, 3-05, and 3-06 which showed the description of each sub-volume when split Volume 3 in 2021.
Vol. 3-01 wide	Bulleted lists are converted to numbered list for easy reference of the sections.
Vol. 3-01 wide	Replaced “manhole(s)” with “maintenance hole(s)”, “MH” is still used for the abbreviation of “maintenance hole”.
Vol. 3-01 wide	Replaced “EPCOR Drainage Services” with “EPCOR Water Services”.
4.8.1.xxxi	Deleted 2012 storms
8.5.2.iv	Deleted “The July 12, 2012 storm event”
8.5.3	“…a minimum freeboard provision of 300 mm from the design high water level…” updated to “…a minimum freeboard provision of 0.5 m from the design high water level…”
8.5.4	“…the freeboard provided is to be at least 0.5 m.” updated to “…the freeboard provided is to be at least 1.0 m.”

TABLE OF CONTENTS

APPENDICES

1.0 PLANNING

Sections 1 to 6 summarize the procedure and framework developed by the City (the **City** may refer to, as appropriate to the context, the City of Edmonton, a Municipal Corporation, and includes all City Departments, as well as EPCOR Water Services, where applicable) to coordinate the resolution of urban sanitary sewerage and storm drainage serviceability issues in conjunction with and parallel to the evolution and implementation of general urban land development plans and other infrastructure components.

The various sanitary sewer and drainage design studies and reports which are required throughout the planning process are identified and their objectives and content described.

Specific requirements for the scope and content of the studies and reports to be prepared in support of development proposal applications on behalf of Developers are contained within Sections ***4.0*** to ***6.0*** of this Volume.

2.0 PLANNING APPROVAL PROCESS - GENERAL

2.1 Sewer and Drainage Planning in Relation to Land Use Planning

Levels of analysis and report requirements are identified to correspond with and precede the Area and Neighbourhood Structure Plan (NSP) and Subdivision levels included in the Land Use Planning and Development approval process. Section ***2.3*** illustrates the process and the precedence relationship between the reports required and the identified land use planning documents. Objectives for the sewer and drainage studies, plans and reports and the responsibility for their preparation are noted on the figure and further outlined in this section. The reports identified are to be prepared and approved as prerequisites to the subsequent stages of planning and development. Preliminary planning studies will usually be undertaken by the City. More detailed analysis and design studies are to be undertaken, normally by consulting engineers on behalf of private developers wishing to obtain approval of land development proposals.

2.2 Purpose of Reports

2.2.1 The reports required are intended to establish technical backup to demonstrate the viability of the respective structure plans and development proposals. They will ultimately provide the basis for detailed system designs, which will be finalized in the form of detailed engineering drawings prepared by the Developer's engineers and to be approved by the City prior to the signing of Servicing Agreements between the Developer and the City. Specific sewer and drainage servicing concerns are to be addressed to an appropriate and increasing level of detail as the planning and development process proceeds and more detailed site-specific information becomes available.

2.2.2 The availability of recognized studies at each level of the planning process will determine whether the City will support applications to the City for approval of Area and NSPs, redevelopment proposals and subdivisions.

2.3 Relationship between Land Use Planning and Sewer and Drainage Planning Process

Land Use Planning Process	Sewer and Drainage Planning Process	Prime Responsibility
	1. Regional Master Plan (RMP) A concept plan to define strategies and alternatives for storm and sanitary system extensions	the City
General Municipal Plan	**2. Watershed Plan (WP)** To determine existing constraints and best management alternatives for development within each storm drainage watershed in the City. **- OR -** **3. Preliminary Drainage Report (PDR)** To review existing data, identify potential problems, formulate preliminary servicing plans and set the framework for the Area Master Plan in the context of storm drainage.	Private Developer Or the City
Area Structure Plan (ASP)	**4. Area Master Plan (AMP)** To develop servicing schemes respecting the long term user requirements, justify the selection of solutions proposed and define the characteristics of selected alternatives for sanitary and storm drainage servicing of the area.	Private Developer Or the City
	4a) Area Hydrogeotechnical Impact Assessment	Private Developer
	4b) Area Environmental Impact Assessment	Private Developer
Neighbourhood Structure Plan (NSP)	**5. Neighbourhood Design Report (NDR)** To define detailed design requirements for storm and sanitary sewer facilities required to service the development area.	Private Developer
	5a) Neighbourhood Hydro-Geotechnical Impact Assessment	Private Developer
Detailed Subdivision Plan	**5b) Neighbourhood Environmental Impact Assessment**	Private Developer
	6. Detailed Engineering Drawings	Private Developer
Standard Servicing Agreement		

3.0 <u>PLANNING AND DESIGN STUDIES</u>

3.1 Regional Master Plan (RMP)

3.1.1 The RMP is an overall drainage plan for the Edmonton Area that defines the short, medium and long-term storm and sanitary servicing strategy. It is prepared and periodically updated by the City. This plan includes conceptual strategies for siting, sizing, preliminary layouts and designs of the storm, sanitary and combined sewer systems. This servicing plan provides a basis for orderly, economic growth by defining the optimal use of existing sewerage systems, extensions of these systems and possible alternatives. The creation and updating of the RMP is a prerequisite to the General Municipal Plan for the City prepared under the Municipal Government Act for Council approval.

3.1.2 Sanitary planning is required to identify, as part of the RMP, the practical conditions for sanitary serviceability, limiting factors in terms of capacities and elevations and the strategy for implementation of the necessary additions or extensions to the sewer network and sewage treatment systems. Capacity requirements must be defined that address inflow/infiltration contributions and provide a reserve for future flexibility. Sanitary planning is formulated on the contributing basin concept. Basic considerations applying to individual sanitary basins are identified to establish the basis of the next level of analysis, undertaken as part of the AMP.

3.1.3 Stormwater drainage planning at this level is formulated on the watershed concept and will identify the conditions of drainage normally prevailing for runoff events including rainfall and snow melt runoff. Alternative means of stormwater management are defined. These planning efforts should include proposals for handling the storm drainage from undeveloped areas in the interim period until developments gradually substitute storm sewer networks in these areas. Particular attention should be paid to ensure that new developments are not adversely impacted by drainage from surrounding undeveloped areas due to changes or obstruction of existing drainage patterns in these areas. The RMP is to provide a basis for the more detailed evaluation of storm servicing alternatives to be undertaken as part of the WP.

3.1.4 The RMP is also required to address the environmental impact of stormwater and treated sewage effluents, to ensure the need for pollution abatement and protection of receiving waters is recognized. Appropriate control strategies are to be recommended.

3.2 Watershed Plan (WP)

3.2.1 A WP deals mainly with storm drainage issues and is required for any drainage basin either totally or only partly within the city boundary, including both areas proposed for development and those expected to remain undeveloped. WP is normally prepared by the City and provides the conceptual framework for evolving the AMPs formulated in conjunction with AMPs.

3.2.2 Sanitary sewer system planning devolves from the RMP directly to the AMP level of analysis. Some considerations of the sanitary servicing alternatives must, however, be part of each WP to ensure compatibility of servicing schemes, alignments, staging and implementation strategies.

3.2.3 A WP identifies the existing drainage and environmental constraints and defines options for the management and development of alternatives, considering environmental and economic issues, developmental staging, the impact of hydrogeotechnical conditions, major utility corridors, Restricted Development Areas, power and pipeline rights-of-way.

3.2.4 The analysis of alternative drainage systems must be at a broad conceptual level since the details of the development are unlikely to be finalized at this stage. However, general proposed land use patterns must be evaluated in order to identify suitable trunk sewer and major system outfall points to receiving waterways. While the principal emphasis is on post-urbanization flow rates, quantities and quality, the analysis should include the use of stormwater management facilities (SWMFs) for urban conditions as well as servicing concepts to be implemented during the transition stage from rural and undeveloped to fully developed conditions, a process which may take a long period of time.

3.2.5 Watershed drainage planning is generally carried out by considering various alternatives for the major drainage system. The requirements for minor conveyance systems can then be defined in relation to the major system. The degree of protection provided by the major system can influence the level of conveyance required in the minor system.

3.2.6 The impact of the major and minor system components and their performance on the integrity of the sanitary sewage system should be evaluated and specific recommendations made to minimize potential overloading of the sanitary system due to stormwater related inflow and infiltration.

3.2.7 The finished plan and staging recommendations are incorporated in a preliminary engineering report for approval and implementation by the City. At later design stages, drainage services for individual developments must be considered in the frame of the WP.

3.3 Preliminary Drainage Report (PDR)

3.3.1 The City normally prepares a WP covering any potential development area of the City. However, for those areas where WPs are not available, a Developer may have a PDR prepared by a Consultant to address the storm drainage planning requirements as necessary to establish the framework and terms of reference for an AMP Study and preliminary Environmental and Hydrogeotechnical Impact Assessments. These terms of reference must be approved by the City before an AMP is undertaken.

3.3.2 The PDR should review existing data, identify potential problems related to future drainage servicing and potential conflicts with other infrastructure plans and propose a conceptual plan for the orderly servicing of new developments.

3.4 Area Master Plan (AMP)

3.4.1 The AMP develops and proposes the optimum sewer and drainage servicing schemes that meet the short- and long-term servicing needs of the development area. The selection of the proposed alternatives are to be justified by considering the cost of the sewer and drainage system components, financing and cost sharing relationships and assessing the economic viability of alternatives.

3.4.2 The approval of an AMP for both storm and sanitary servicing is a prerequisite for the support by the City of any related AMP proposals. The Developer concerned with the study area is responsible for having the AMP undertaken by a qualified engineering consultant. However, in some cases the City may initiate and conduct the study on the Developer's behalf when deemed necessary to accommodate area planning needs.

3.4.3 The sanitary sewer servicing component of this analysis must consider the planning and servicing objectives, resolve all concerns and address constraints, including any specific issues identified through the RMP with respect to the study area, which in this case relates to the contributing sanitary basin.

3.4.4 For storm drainage, the analysis considers the study area as defined in the WP or the PDR. The AMP must justify the selection of the proposed stormwater management alternative in terms of its suitability to address all constraints including those identified in the previous studies. If the WP or the PDR has identified any specific problems such as critical pollution loadings, sedimentation or erosion, the AMP would propose solutions to these problems. The AMP should also explore the potential of incorporating Low Impact Development (LID) as a best management practice (BMP) for stormwater management. LID should not be viewed as a redundant system, but as a necessary part of the integrated stormwater management system that helps to meet the environmental objectives.

3.4.5 The terms of reference for the AMP study for a development area must be approved by the City before the work is started.

3.5 Neighbourhood Design Report (NDR)

3.5.1 The NDR defines the basis for detailed design of servicing system components selected in the course of the AMP study, the costs of the sewer and drainage system components, and the financing and cost sharing relationships and requirements necessary to implement the servicing systems.

3.5.2 The preparation and presentation of a NDR is the responsibility of the Developer, and the approval of the NDR is a prerequisite for support by the City of NSP proposals within the subject servicing area. Subdivision proposals and detailed engineering drawings related to the area are not accepted for review and approval in the absence of an approved NDR. Where subdivision proposals are different in substance from an approved NSP, or finalized servicing proposals vary from those defined in the NDR, then an amendment of the NDR needs to be approved before detailed engineering drawings are reviewed for approval.

4.0 TYPICAL AREA MASTER PLAN REQUIREMENTS

4.1 Scope of Study

4.1.1 The storm drainage component of the plan should be based on the concepts developed in the overall RMP and the WP, should resolve any specific concerns raised in those studies and address any significant constraints. The RMP should identify basic considerations for sanitary sewer system planning, to be addressed on a similar basis

4.1.2 Area master planning is carried out by identifying and comparing alternative facility locations, sizes and type and includes the selection of the most suitable alternative. While the AMP need not include a rigorous comparison of alternatives considered, the selection of the proposed servicing schemes are to be adequately justified on the basis of relative merit, considering technical issues, short-term and long-term economic viability, and equity for those parties who eventually share in the costs of the facilities.

4.2 Requirements for Systems Analysis

4.2.1 The analysis of servicing systems for the AMP is necessarily at a broad and conceptual level. However, proposed land use patterns and arterial roadway alignments must be evaluated in order to plan for location of suitable sewer trunks, outfalls, storage and stormwater quality enhancement facilities.

4.2.2 Hydraulic analysis of proposed servicing schemes is required only to the extent that is necessary to demonstrate the technical feasibility of servicing concepts for the specific area. Simple systems proposed to operate under free flow conditions may be analysed using hand calculation methods to determine post-development hydrographs. Systems anticipated to operate under surcharged conditions during the design event would typically require analysis using computer simulation techniques, as would systems with interconnected storage elements.

4.2.3 For systems proposed to use real time control of outflow from SWMFs, dynamic simulation of operation may be delayed until a later more detailed stage of the design process, provided that the system operating rules and control parameters are clearly set out in the AMP.

4.2.4 At the AMP level, the hydraulic analysis should be conducted using lumped modelling techniques, on simplified representations of the systems components comprising only the principal conveyance and storage elements and appropriate approximations of relative locations and elevations. The objective is to confirm the magnitude of flows and volumes which must be accommodated and the general adequacy of the proposed system to satisfy the level-of-service objectives (refer to Sections ***7.0*** and ***8.0***).

4.3 General Report Requirements

4.3.1 The AMP is to document, clearly describe and justify the selected sewer and drainage systems; identify significant constraints and issues; describe assumptions and design criteria; provide simulation results; present recommendations and conclusions.

4.3.2 Scales for layout plans and mapping

Conceptual scale: For presentation of concept information, plans to a common scale of 1:20,000 are preferred.

Detail scale: More detailed information should be presented on plans to a scale of 1:5,000 on an orthophoto base. Larger scales may be utilized for specific details as is appropriate.

4.4 Identification of the Study Area and Existing Characteristics

4.4.1 The study area's topography, existing drainage patterns, existing land use and proposed land use, are to be shown on plans to conceptual or detailed scales as appropriate.

4.4.2 The location and capacities of outfalls for the storm, sanitary and other major drainage systems are to be shown on plans. The City normally provides this information from the RMP and WP.

4.4.3 The report is to include a description of soils and groundwater conditions to the depth affecting drainage utilities, highlighting any constraints these conditions pose to drainage design and construction. See Hydrogeotechnical Impact Assessment requirement, Section ***4.10***.

4.5 Preliminary Layout and Conceptual Design of the Selected Alternative

4.5.1 The following plans are to be provided:

i. Plans showing preliminary alignments, pipe locations, subcatchment boundaries, pipe sizes, SWMFs, LID facilities, and other facilities for the selected alternative. Maintenance hole or node locations and pipe numbers to correlate with a system analysis are to be included as necessary.

ii. Separate plans for storm and sanitary trunk systems, to conceptual or detailed scales as appropriate.

iii. A surface drainage plan showing drainage directions, collector routes, surface storage sites and subcatchment boundaries.

iv. Conceptual profiles showing pipe invert and crown, ground profile, pipe size, maintenance hole or node locations and numbers as well as normal and high water levels and freeboard for SWMFs. Similar profiles are required for sanitary trunks and the major drainage system.

4.5.2 Tabulated data to describe the proposed systems are required, as follows:

i. Table of subcatchment properties showing inlet maintenance hole, drainage area, land use, population and imperviousness or runoff coefficient.

ii. Table of pipe properties indicating:

a. pipe number or ID;

b. upstream and downstream maintenance hole with number or ID;

c. "n" value;

d. diameter;

e. slope;

f. pipe-full capacity;

g. design flow;

h. design velocity.

iii. design calculation sheets (rational method and sanitary trunks) or computer model schematic and summary output; and

iv. continuous modelling of a recorded series of storms may be required in specific circumstances such as where severe restrictions are imposed by downstream system capacities.

4.6 Documentation of Design Criteria

The design basis for the selected alternative is to be documented, including identification of the following information:

i. design storm;

ii. performance criteria: flow, pipe-full design, velocity restrictions, allowable street ponding depths, storage drawdown time, real time control operating rules and control parameters;

iii. sewage generation factors;

iv. population densities;

v. storm runoff factors, imperviousness and ground slopes;

vi. weeping tile drainage methods proposed (not permitted to sanitary sewers);

vii. stormwater handling and treatment facilities and contaminant removal capabilities;

viii. pump station vs. gravity sewer option analysis (refer to ***Appendix A:*** Pump Stations Decision Model);

ix. pollutant/contaminant possibilities; and

x. any proposed exception to the City standards. Such proposals are to be adequately justified and will require specific approval by the City.

4.7 Declaration of Sufficiency of Standards and Professional Responsibility

The report is to include a statement that the proposed design standards provide an appropriate level of service and safety and adequately deal with any known special or unique conditions in the study area. The submission is to be sealed and signed with regard to professional responsibilities.

4.8 Typical Requirements

The following checklists are provided to assist the Consultant in identifying the typical scope of issues to be addressed in the AMP.

4.8.1 Storm Portion Checklist

i. Watershed and development in relation to it;

ii. Summary of PDR or Watershed Study;

iii. Topography;

iv. Details of watercourse crossings, for instance culverts, bridges and roads;

v. Details of watercourse and valley reaches including typical x-sections;

vi. Natural storage and drainage;

vii. Street layout, location of parks;

viii. Present land ownership;

ix. Present land use;

x. Identification of pre-development flows;

xi. Proposed land use;

xii. Subcatchment boundaries;

xiii. Develop and justify a servicing scheme respecting the long-term user requirements;

xiv. Description and discussion of storage requirements including storage volume and location, SWMF overflow alternatives, real time control operating rules and control parameters;

xv. Proposed major drainage system;

xvi. Proposed minor drainage system;

xvii. Use of natural features, for example sloughs;

xviii. Identification of unusual factors affecting operation and maintenance costs;

xix. Identification of potential surcharging;

xx. Address Erosion and Sedimentation Controls (ESC) by presenting all ESC Information identified in Figure 4.1 – ESC Framework of the ESC Guidelines;

xxi. Simulated normal water level (NWL) and high water level (HWL) for SWMFs;

xxii. 100 Year flood lines for ravines;

xxiii. Identification of the need for water quality control;

xxiv. Description of constructed wetlands; wet ponds or dry ponds;

xxv. Description or concept plan of BMPs including LID (if applicable);

xxvi. Description of water quality impacts and its improvement;

xxvii. Provide wetland; including existing natural wetlands; to watershed ratio;

xxviii. Identification of requirements for pollutant control and determination of allowable pollutant loads;

xxix. Review of outlet operating constraints and sufficiency of depth;

xxx. Determine outlet arrangement and review hydraulics to ensure adequate rates of drawdown can be achieved at all levels of storage;

xxxi. Hydraulic analysis by suitable methods is to be carried out to provide post-development hydrographs for the minor 5-year design storm event and appropriate major historical design events; considering the following options:

a. 100 year storm;

b. 1937 storm;

c. 1978 storm; and

d. 2004 storm.

xxxii. Alternatively, for SWMFs sized to accommodate 120 mm of runoff over the basin, assuming zero discharge for the length of the storm event, system drawdown curve should be provided;

xxxiii. Outline the proposed staging and/or implementation plan.

4.8.2 Sanitary Portion Checklist

i. Study area/drainage basin;

ii. Review of the RMP and the previous studies;

iii. Identify points of servicing availability and downstream system capacity and depth constraints per information to be provided by the City;

iv. Feasibility of gravity system extensions versus pumping;

v. Topography;

vi. Existing developments;

vii. Projected land development;

viii. Populations;

ix. Present land ownership;

x. Present land use;

xi. Future land use;

xii. Subcatchment boundaries;

xiii. Summary of design criteria;

xiv. Peak flows;

xv. Average flows;

xvi. Conflicts with existing and proposed utilities;

xvii. Develop and justify a servicing scheme respecting the long-term user requirements;

xviii. Identify potential environmental impacts;

xix. Identify unusual factors affecting operation and maintenance costs;

xx. Identification of potential surcharge;

xxi. Identification of land requirements/easements;

xxii. Outline the proposed staging/implementation plan;

xxiii. Outline any storage and real time outflow control requirements.

4.9 Site-Specific Requirements

Depending on circumstances relevant to a specific ASP area, additional requirements may apply. These are determined on a case-by-case basis and may include: an environmental impact assessment, if discharging to natural watercourses or environmental reserve lands; a soils and groundwater investigation, and an analysis of downstream capacity constraints.

4.10 Hydrogeotechnical Impact Assessment

4.10.1 A Hydrogeotechnical Impact Assessment is required to define constraints, imposed by soil and groundwater conditions, which will affect the choice of design philosophy and construction practices to be applied.

4.10.2 The undertaking of a preliminary Hydrogeotechnical Assessment study is a requirement of the AMP and terms of reference for this study are to be addressed when establishing the terms of reference for the AMP. In cases where this requirement is not fulfilled in conjunction with a previous AMP, it must be addressed in association with the NDR.

4.10.3 Where the preliminary assessment identifies constraints of concern, more specific hydrogeotechnical investigations to provide detailed site-specific recommendations may be required, either as part of the AMP or to be addressed at the NSP stage as part of the NDR. The determination of the scope and staging of such additional investigations is subject to the discretion of the Engineer and is to be based on the potential impact of the identified constraints on the viability of the development and the proposed servicing schemes.

4.11 Environmental Impact Assessment (EIA)

A preliminary EIA is required for each development area in conjunction with the AMP. Where the preliminary assessment has identified environmental concerns which may have a bearing on the suitability of sewer and drainage servicing proposals, more detailed and specific investigations may be required, either as part of the AMP or in conjunction with the NDR. The determination of the requirements and staging of investigations with respect to the sewer and drainage systems planning reports are subject to the discretion of the Engineer. Usually, EIA reports describe the natural features, topography, special historic, archaeological and other aspects of the proposed development area, evaluate the impacts from development and define methods and action plans to minimize or mitigate such impacts. The Developer has the responsibility for conducting an EIA. The City will review EIA reports required pursuant to the River Valley Bylaw No. 7188 and other authorities and provide comment and/or support for approval from a drainage perspective. The City will undertake this review in conjunction with reviews by Alberta Environment and Parks (AEP) and others.

5.0 TYPICAL NEIGHBOURHOOD DESIGN REPORT REQUIREMENTS

5.1 Scope of Study

5.1.1 The NDR is to define the basis of detailed design of the principal components of the sanitary sewerage and storm drainage infrastructure. The NDR will propose methods and procedures for overcoming all constraints identified in the AMP. The NDR will identify all constraints to implementation of the facilities, including financial, design, hydrogeotechnical and construction approvals.

5.1.2 The NDR presents the design of the permanent facilities. However, if large facilities are required, they are rarely constructed to their ultimate form in the first stages of development. In this situation, an addendum to the NDR is required to detail the design of interim stages for facilities and the impacts on the implementation plan. Addenda to the NDR may be required by the Engineer under the following circumstances:

i. significant changes to the AMP;

ii. significant changes in design standards;

iii. significant changes to the schedule of land development; and

iv. significant changes to the implementation plan.

5.1.3 An ESC Strategy is an essential component of storm drainage in the NDR. The strategy shall build on the ESC Information presented in the AMP and address all items presented on Figure 4.1 – ESC Framework of the ESC Guidelines.

5.2 General Requirements

5.2.1 Plans showing topography, existing drainage patterns and facilities, existing land uses, land uses as per the NSP, hydrogeotechnical information, constraints on implementation and land ownership.

5.2.2 Plans showing anticipated land development, with schedules and supporting documentation in tabular format.

5.2.3 Plans showing the layout of the proposed drainage facilities and conformance with the AMP, and if in regard to an addendum to a previously approved NDR, conformance and variations with that NDR.

i. All SWMFs, storm and sanitary pumping stations and forcemains, storm sewers and sanitary sewers;

ii. layout of roads, private property limits, land use and other utilities, noting environmental and hydrogeotechnical constraints and differences from previously approved reports;

iii. location of the systems in relation to adjacent systems and drainage basins; and

iv. location of the systems and the study area showing the development relative to existing and future developments.

5.3 Documentation of Design Criteria

5.3.1 Plans and tables showing subcatchment boundaries, land use, imperviousness, runoff coefficients, sewer pipe roughness, design performance criteria, sewage generation factors, population, service arrangement practices and wet-weather flow generation factors.

5.3.2 Studies to justify any use of design criteria different from those set out in these standards.

5.4 Documentation of Methodology for Analyses and Design

5.4.1 Design calculations in support of the proposals.

5.4.2 Description of computer models and their use;

5.4.3 Calibration and verification studies for models which have not been calibrated to conditions in the City of Edmonton;

5.4.4 Description of activities and procedures for undertaking design and analyses of the drainage systems.

5.5 Documentation of Input to Computer Model

5.5.1 Plans and tables relating input parameters to the layout of the drainage systems;

5.5.2 Subcatchment numbers, area, imperviousness, depression storage, grades, servicing arrangement, subcatchment width, infiltration parameters, node locations and numbers, gutter sizes/slopes/width, pipe sizes/slope/capacity/roughness coefficient/number/sub-catchment/gutter connections/node connections, outfalls, node inverts/ground elevations/ pipe connections, inlet numbers/capacity/ connection, road grades and major system grades/configuration/capacity/connections.

5.6 Documentation of Analyses of Drainage Systems

5.6.1 Plans and profiles of the sanitary sewer and storm drainage facilities.

5.6.2 Profiles showing pipe invert and crown, pipe size, ground profile, pipe slope, node locations and numbers, SWMFs.

5.6.3 Profiles of storm trunk sewers showing hydraulic grade lines under each design event and calculated flow rates.

5.6.4 Plans and profiles of the major systems showing flow rates, depth capture by the minor system, capacity, inlet hydrographs to SWMFs and existing sewers, drainage area and rating curves.

5.6.5 Pump and system curves showing staged performance of pumping systems.

5.6.6 Details of constructed wetlands and/or wet ponds.

5.6.7 Details of vegetation in constructed wetlands and/or wet ponds.

5.6.8 Comparison of flows and water quality under pre-development and post-development conditions and at all proposed stages of the implementation plan.

5.6.9 Consideration of using BMPs for stormwater runoff improvement.

5.6.10 Inspection of existing infrastructures (the tie-in points and one facility upstream and downstream of existing infrastructure which has passed 10 years after final acceptance certificate) that proposed work is to be connected to or that has potential to be affected by construction activity (refer to Section 1.1.2 - Vol. 3-05: General Drainage Drawing Requirements, Approvals and Asset Acceptance/Transfer).

5.7 Documentation of Costs

5.7.1 Complete documentation of design, construction and long-term operation, maintenance and replacement costs for each of the principal components of the systems in accordance with the implementation plan.

5.7.2 Costs for land purchase and/or easement acquisition.

5.8 Documentation of Implementation Plan

5.8.1 Definition of all constraints to implementation of the permanent facilities.

5.8.2 Discussion of alternative means of meeting constraints, methods of evaluating alternatives and decision criteria.

5.8.3 Report documenting the activities undertaken and the results in a clear, concise, logical format including conclusions and recommendations.

5.8.4 The report is to contain an assertion that the design standards criteria applied are suitable and appropriate, provide an adequate level of service and address any special or unique characteristics or conditions of the area.

5.8.5 Submissions are to be sealed and signed by the responsible professional.

5.9 Detailed Requirements

The following checklists are provided to assist the Consultant in ensuring that typical requirements are met. Specific requirements are to be reviewed during preparation of the terms of reference for the study. Requirements may vary from area to area, depending of the constraints identified in the AMP and the complexity of the systems.

5.9.1 General Information Checklist:

i. Detailed description of the study area;

ii. Proposed land use;

iii. Present land ownership;

iv. Summary of conclusions/recommendations of hydrogeotechnical assessments, including recommended means of foundation drainage and roof drainage.

5.9.2 Sanitary Portion Checklist:

- Include technical summaries, for example details of pumping stations;
- Financing considerations regarding cost shareable trunk sewers and facilities.

5.9.3 Storm Portion Checklist:

i. Outfall locations;

ii. Overland flows;

iii. Ponding depths;

iv. Flood profiles for SWMFs and ravines for 5yr, 10yr, 25yr, 100yr and critical historical storm events for interim and ultimate development;

v. Details of minor drainage system;

vi. Alignments;

vii. Pipe sizes;

viii. Pipe grades, profiles and invert elevations;

ix. Pipe capacities;

x. 25 Year and 5 Year peak flows for interim and ultimate development;

xi. Maintenance holes;

xii. Catch basins;

xiii. Road grades;

xiv. Calculation of flows captured by minor system during 100-year storm and associated hydraulic grade lines, with particular attention to locations where there is increased potential for outflows from the system (maintenance holes and inlets at relative low points);

xv. Unusual factors affecting operation and maintenance costs;

xvi. Proposed flood control;

xvii. Land requirements - easements, public utility lots;

xviii. Controlled discharges from SWMFs;

xix. Hydrographs at outfalls;

xx. Pre-development versus controlled post-development flows at outfalls;

xxi. Determination of type of storage, e.g. constructed wetland, wet or dry ponds;

xxii. Details of storage facilities, including landscaping and vegetation in SWMFs;

xxiii. Proposed SWMFs maintenance;

xxiv. Details of constructed wetlands;

xxv. Earthwork balance assessment;

xxvi. Vegetation plan for constructed wetlands;

xxvii. Vegetation management plan for constructed wetlands;

xxviii. Proposed water quality control;

xxix. LID site plan (refer to Section 5.13 - Vol. 3-02: Stormwater Management and Design Manual);

xxx. An ESC Strategy according to Figure 4.1 – ESC Framework of the ESC Guidelines;

xxxi. Hydraulic aspects of pond inlets and outlets for example spillways;

xxxii. Staging/implementation plan;

xxxiii. Details of any oversizing for adjacent areas;

xxxiv. Preliminary costs of trunk sewers and major system components;

xxxv. Financing considerations regarding cost-shareable trunk sewers and facilities.

6.0 TYPICAL REQUIREMENTS FOR HYDROGEOTECHNICAL IMPACT ASSESSMENTS

6.1 Intent

The intent of a hydrogeotechnical impact assessment is to establish with respect to soil and groundwater conditions, the feasibility and viability of the implementation of the development proposals and associated utility infrastructure. The hydrogeotechnical assessment must, therefore, establish that conditions are suitable for the establishment of functional and maintainable sanitary sewer and storm drainage systems to serve the development area and also quantify potential problems that the hydrogeotechnical conditions may pose to the development. The Developer should engage the services of a qualified geotechnical engineer and the geotechnical engineer's recommendations shall be addressed by the Developer’s consultant in the design of the improvements, including the identification, development and implementation of any performance standards recommended by the geotechnical engineer.

6.2 General Approach and Levels of Investigation

Hydrogeotechnical impact assessments should be conducted in two phases. The preliminary assessment generally associated with an AMP and conducted prior to the submission of an AMP, should compile readily available information and draw conclusions based on that data. Where indicated, due to the lack of existing data or to confirm questionable information, preliminary field investigations and office evaluations are to be conducted to provide a basis for conclusions. In the event that the preliminary assessment identifies significant cause for concern, a detailed assessment involving more in-depth field investigations and evaluations is to be undertaken. Depending on the specific nature of concerns, these detailed investigations may be required to be undertaken as part of either the AMP or the NDR.

6.3 Scope of Work - Preliminary Assessments

6.3.1 Acquisition of Existing Data

Two main sources of existing data should be reviewed to identify the hydrogeotechnical conditions of the study area.

i. The first consists of all published reports in either the public domain or from private developers. Areas which should be reviewed to gather existing published data include the City of Edmonton’s geotechnical library; the Alberta Research Council, AEP, Alberta Energy; hydrogeotechnical and geotechnical reports conducted by other consultants; construction records of previous developments; water well logs; environmental impact assessments.

ii. Another source of valuable information is personnel who have conducted work in the study area. This would include developers, owners, contractors, utility companies, hydrogeologists, geologists and other professional geotechnical engineers.

6.3.2 Field Investigations

Where sufficient existing data is not available to support the preliminary assessment, an appropriate program of drilling of boreholes should be undertaken, subject to a geotechnical engineer's review and direction. Holes should be relatively deep, preferably to bedrock. Starting at investigations for the AMP level of planning, groundwater level monitoring should be included at all boreholes and should be continued for up to two years or as long as is possible, to accurately establish the seasonal variability of the groundwater table. Standpipes should be installed as permanent installations, so that they may be utilized as part of a long-term groundwater monitoring program.

6.3.3 Preliminary Assessment Reporting

i. The results, conclusions and recommendations of the preliminary hydrogeotechnical assessment should be consolidated into a report, which may be appended to the AMP or NDR as appropriate. The report should summarize the existing data collected under ***6.3.1*** above and present the results of any field investigation undertaken. The report is to summarize the magnitude and severity of any hydrogeotechnical or geotechnical problems identified and the need for additional data acquisition.

ii. In the event that additional data or further investigations are considered necessary, a recommended program for acquisition of additional data is to be presented within the preliminary review report.

iii. The preliminary report is to include consideration of the design aspects of future developments within the study area, inflow/infiltration concerns and the design of SWMFs.

iv. The Consultant should identify potential problem areas and recommend solutions to reflect specific areas of concern with construction standards and procedures such as pipe installation techniques, compaction in the pipe zone, trench backfill and the impact of groundwater table on foundation drainage/weeping tiles. Special consideration should be given to construction techniques, timing and equipment. Any requirements above and beyond the standard construction/engineering specifications should be identified.

v. The preliminary report should be reviewed with the City to establish if further investigation is to be required in advance of subsequent planning or design stages.

6.4 Scope of Work - Detailed Assessments

6.4.1 Where there are significant concerns regarding hydrogeotechnical conditions identified through a preliminary assessment, more detailed assessments are to be undertaken, normally associated with the NSP level of planning and attached to the NDR. Field investigations associated with this level of review should involve a program of drilling at a minimum density of five boreholes per legal subdivision, subject to a geotechnical engineer’s review and discretion. The detailed assessment is to investigate any specific areas of concern that could affect the construction and/or long-term performance of subsurface utilities, drainage, cuts and fills. Detailed information on groundwater levels will also be required, to assess the potential impact of groundwater on the development. The responsibility for determining an adequate scope of work rests with the Developer and the engineering consultants.

6.4.2 Report Content

The following checklist identifies what issues should typically be addressed in detailed hydrogeotechnical impact assessments.

i. Construction of utilities:
   - a. trench construction and stability (especially for trunk sewers);
   - b. compaction and settlement;
   - c. feasibility of tunneling and boring techniques;
   - d. alignments and depths;
   - e. dewatering requirements and impacts;
   - f. special design and construction measures; and
   - g. frost penetration.

ii. Constructed wetlands, wet ponds and dry ponds:
   - a. construction methods;
   - b. stability of side slopes;
     - o under rapid drawdown conditions;
     - o during dewatering for maintenance;
   - c. use of spoil for fill;
   - d. groundwater levels, infiltration, exfiltration;
   - e. SWMF bottom lining requirements;
   - f. pre-draining requirements;
   - g. foundations for buildings;
   - h. bearing capacity;
   - i. potential settlement;
   - j. design constraints; and
   - k. seepage through walls (waterproofing requirements).

iii. Fill areas:
   - a. underlying soils;
   - b. compaction;
   - c. settlement potential; and

d. drainage.

iv. Roads and streets:

a. potential settlement;

b. potential frost heaving; and

c. typical design sections.

v. Drainage design:

a. weeping tile flow rates;

- dry weather;
- under storm conditions.

b. pipe infiltration;

c. soils and groundwater conditions relevant to roof leader discharge (spill on ground versus storm service connections ;

d. soil infiltration and runoff factors

e. lot grading; and

f. requirements for waterproofing of building basements.

vi. Effect on regional aquifers:

a. existing and potential groundwater users;

b. possibility of impact on quality or quantity due to interception or recharge; and

c. locations of artesian conditions in the study area.

vii. Operation and maintenance impacts on sewer and drainage facilities.

7.0 SANITARY SEWER - POLICY, GOALS AND OBJECTIVES

7.1 Level of Service

7.1.1 The goal of the City is to have 100% of the sanitary sewage generated in new development areas collected and conveyed to wastewater treatment facilities for treatment. In order to accomplish this new systems must be designed and constructed with reliable conveyance capacity and minimal potential for rainfall and groundwater inflows, such that system backup is limited to cases of unforeseeable blockage. To achieve this objective, new system extensions will be sized to flow at less than full and with reasonable allowances for extraneous inflows. It is recognized that these criteria provide a safety factor compared to previously constructed systems, which will flow full at the design flow rate. Where at the point of a proposed connection to an existing sanitary sewer system and within the system immediately downstream, capacity was deemed to be adequate based on the Servicing Standards applicable prior to 1990, but does not satisfy the capacity requirement as projected using current design standards, the theoretical deficiency will not be a reason for disallowing upstream development or for requiring the upgrading of the immediate downstream system.

7.1.2 Where an actual capacity deficiency has been identified, the Developer and the City will jointly resolve the issue through the development approval process.

7.2 Provision for Future Extension of Development

The design for each sanitary system extension shall include provision for further extensions to adjacent and future development areas in accordance with the RMP, AMP and/or NDR, as they apply to each development area.

7.3 Separation of Storm and Sanitary Systems

7.3.1 All new systems or extensions from existing systems are to be designed on a separated basis. Run-off from roofs, lots, streets and other outside areas including yards and parking areas and infiltration water from foundation drains and other sources, is to be excluded from the sanitary sewer system.

7.3.2 To protect the functional integrity of the sanitary sewer system, extraneous inflows must be prevented or controlled to match the design criteria and performance expectations.

7.4 Economic Objectives

7.4.1 A prime consideration in the selection of alternatives for the sanitary servicing of new development areas must be minimization of the long-term cost to the public. Economic analysis must include evaluation and comparison of life cycle cost. Extension of sanitary servicing by means of gravity sewer systems to the maximum extent possible is preferred and the utilization of pumping systems is permitted only when insurmountable constraints cannot be resolved otherwise. Economics alone is not the only deciding factor in the City's evaluation of the acceptability of servicing proposals. Detail evaluation of pump station versus gravity sewer proposals shall be undertaken as described in ***Appendix A:*** Pump Stations Decision Model.

7.4.2 The City wishes to promote an orderly process of development with the objective of achieving permanent sanitary sewer system extensions in the most cost-effective manner. For this reason, the City does not permit the proliferation of temporary servicing schemes in lieu of permanent system extensions. Further, extensions of systems and developments are discouraged when they involve the construction of downstream connections through undeveloped areas (leapfrogging) solely for the purpose of advancing service extensions to upstream areas.

7.5 Environmental Objectives

The City wishes to promote environmental consciousness in the design of sanitary sewerage facilities. The objective is to prevent the escape or discharge of untreated sewage to receiving watercourses, public or private lands or to the environment in general, either directly or through overflow to storm drainage systems.

8.0 STORM DRAINAGE SYSTEM - POLICY, GOALS AND OBJECTIVES

8.1 Level of Service

8.1.1 The City stormwater management goal is to provide adequate drainage for urban areas that preserves and promotes the general health welfare, security and economic wellbeing of the public and to protect and enhance the water quality of receiving watercourses.

8.1.2 To meet this goal the storm drainage system must include SWMFs that meet the following level-of-service objectives:

i. Avoid all property damage and flooding and to minimize inconvenience to the public due to runoff from 1:5 year and more frequent rainfall events;

ii. Avoid significant property damage from a 1:100 year return frequency rainfall event;

iii. Avoid loss of life and injuries and minimize damage to property, through control of runoff during unusual or infrequent storm events with high-intensity rainfall and large runoff volume;

iv. Avoid degradation of receiving watercourses, by implementing the requirements of the ESC Guidelines.

8.1.3 Where the capacity of existing downstream sewers was deemed to be adequate in accordance with the City of Edmonton Servicing Standards in effect prior to 1990, the theoretical design deficiency created downstream under later standards would not become a reason to stop the upstream development.

8.1.4 Where an actual capacity deficiency is identified, the Developer and the City will jointly resolve the issue through the development approval process.

8.2 Major/Minor System Concept

8.2.1 New development areas in Edmonton shall be designed using the major/minor system concept, with each system planned and designed to achieve specific level-of-service objectives.

8.2.2 The term the "minor system" is applied to the network of local and trunk sewers, inlets and street gutters which are provided as a conveyance system to rapidly carry away storm runoff from road surfaces. Minor systems have generally been designed with capacity to remove runoff from minor rainfall events.

8.2.3 Runoff in excess of the capacity of the minor system ponds in depression areas or follow whatever overflow escape route is available. This network of planned or unplanned ponding areas and overland flow routes is the "major system". If a major system is adequately planned and designed and incorporated into the urban infrastructure, it should alleviate the potential inconvenience, property damage and loss of life, which could otherwise result from major rainfall events.

8.3 Minor System

8.3.1 General Requirements

Minor-system elements serving drainage areas of 30 ha or less shall be designed to accommodate the rate of runoff which would occur in a 5-year return period rainfall event;

i. without surcharge of storm sewers;

ii. with ponding of water to a depth no greater than 150 mm at depressions and at drainage inlets;

iii. with depths of flow and ponding on roadways limited such that no over-topping of curbs occurs on local roadways, a width equivalent to one traffic lane remains free from inundation on collector roads and one traffic lane in each travel direction remains free from inundation on arterial roads;

iv. with storm water quality BMPs prior to discharging into the piped system.

8.4 Sewers Servicing Areas Greater than 30 ha

8.4.1 Storm sewer trunks, for this purpose being those storm sewer pipes proposed to serve drainage areas of greater than 30 uncontrolled ha, shall be designed with a reserve capacity to account for unanticipated changes in land use and runoff and to ensure downstream storm sewer trunks do not surcharge in advance of the upstream lateral storm sewers.

8.4.2 To achieve the objective the subject storm sewers are to be designed to accommodate, without surcharge, 1.25 times the rate of flow which would occur in a 5-year return period rainfall event.

8.4.3 In cases where the storm sewer trunk receives both uncontrolled flow from areas 30 ha or larger and controlled discharges from SWMFs, the sewer is to be designed so as to accommodate, without surcharge, 1.25 times the 5 year design flow from the uncontrolled lands plus the maximum design SWMF outflow rate.

8.5 Major System

8.5.1 Conveyance Elements

Major-system conveyance elements shall be designed to accommodate runoff rates and volumes for a 100-year return period rainfall event such that:

i. The depth of peak flows and ponding in developed area streets, conveyance channels and swales, are to be limited so that major system flows do not constitute a significant hazard to the public, or result in significant erosion or other property damage. Where erosion is anticipated, an ESC Plan should be designed to suit site specific situations.

ii. The maximum water surface level of surface flows and ponding in streets is below the lowest anticipated landscape grade or opening at any adjacent buildings, with a freeboard provision generally in the order of 350 mm with a minimum of 150 mm.

iii. Depths of flow and ponding are less than 350 mm in roadways and other public rights-of-way. Roadway ponding should be minimized in a way that prevents encroachment on private property and ensure best practices to minimize flooding on private property.

iv. For arterial roadways, the water depth at the crown of the road shall not exceed 150 mm.

8.5.2 Storage Elements

i. Major-system storage elements shall be designed such that no over-topping of the storage facilities occurs due to storm events equal to or less severe than the critical storage event for the catchment served.

ii. The default requirement for the retention volume to be provided is to be the equivalent of 120 mm of water over the total catchment area draining to the facility. This requirement is based on the estimated volume of runoff from the recorded July 14 - 15, 1937 storm event, being 155 mm of rainfall with a runoff/rainfall ratio of 0.62 and including a 25% volume safety factor allowance. Where justified on the basis of a risk analysis, or in consideration of provision of a safe overflow, reduced storage volume requirements may be approved.

iii. Where a stormwater management storage facility is located such that minor and/or major system outlet capacity is guaranteed to be available for all design runoff events, due to proximity to a ravine or river, the outflow from the facility which occurs during any runoff events is considered in the determination of the required storage volume. i.e. if the outlet capacity cannot be guaranteed to be available, then the storage facility must be sized assuming zero discharge for the duration of the event.

iv. The performance of each storage facility design is to be verified by computer simulation of its response, considering the outflow rate as limited by control elements or downstream conditions, to the most critical of any of the design rainfall events from the following listing:

a. 1:100 year, 24 h synthetic design event based on the Huff distribution;

b. The July 14 - 15, 1937 storm event;

c. The July 10 - 11, 1978 storm event; and

d. The July 2 - 3, 2004 storm event.

Refer to Section 2.0 - Vol. 3-02: Stormwater Management and Design Manual for rainfall data references.

v. SWMF inlets and outlets should be physically separated around the perimeter of the facility. The inlet and outlet should be distanced as far from each other as possible to avoid hydraulic short-circuiting.

8.5.3 A high level emergency overflow is to be provided wherever feasible and each facility design is to include an evaluation of the impact of over-topping of the facility and the probability of exceeding the design high water level. The design of SWMFs which are provided with a high-level overflow to a safe outlet shall include a minimum freeboard provision of 0.5 m from the design high water level to the lowest anticipated landscape grade or opening at any adjacent buildings.

8.5.4 In the absence of an emergency overflow, the freeboard provided is to be at least 1.0 m.

8.5.5 Except for constructed wetlands, sufficient outlet capacity is to be provided to permit post-event drawdown of water levels in storage facilities such that the availability of storage capacity is restored within the following time frames:

i. 1:5 year runoff capacity to be available within 24 h;

ii. 1:25 year runoff capacity to be available within 48 h; and

iii. 90% of the facility full volume to be available within 96 h.

8.5.6 This is to be evaluated using the Huff distribution design storms for SWMF drawdown analysis provided in Table 2.8 in Section 2.7 - Vol. 3-02: Stormwater Management and Design Manual.

8.5.7 Where storage facilities are connected in series or where the provisions of post-event outlet capacity to satisfy the above drawdown requirements is not feasible, the satisfactory performance of the storage facilities to accommodate sequential rainfall events shall be verified by computer simulation using continuous rainfall records. Multiple Event Time Series' and Long Duration Time Series' are available from EPCOR Water Services.

8.6 Provision for Areas beyond the Limits of Presently Proposed Development

8.6.1 Provisions for Future Development

The design for each storm sewer system extension shall include provisions for further extensions to future developments in accordance with the WP and AMP for the development area. The design must also account for the interception, conveyance and storage requirements as necessary to accommodate runoff flows from undeveloped contributory areas for the indefinite future or for an interim period until development of those areas occurs.

8.6.2 Overland Drainage

i. The Developer shall make provisions for the interception of all overland drainage runoff which would enter the Developer's subdivision and may result in a nuisance, flooding, or maintenance problem.

ii. The Developer shall also ensure that the development does not adversely affect existing drainage in the vicinity of the development site resulting in a nuisance or maintenance problem.

8.6.3 Separation of the Storm and Sanitary Systems

Storm sewers shall be designed as a separate system to convey rainfall and snow melt runoff from roof drains, streets, parking lots and other areas and shall not receive effluent from any sources which may contain industrial, agricultural or domestic waste or sewage. Storm sewers shall not discharge into a sanitary system.

8.7 Economic Objectives

8.7.1 A prime consideration in the selection of alternatives for the storm servicing of new development areas must be minimization of the long-term cost to the public. Economic analysis must include evaluation and comparison on the basis of operations and maintenance costs as well as capital cost differences.

8.7.2 The City desires to promote an orderly process of development with the objective of achieving permanent storm system extensions, in the most cost-effective manner, that meet the City’s environmental objectives. Extensions of systems and developments is discouraged when they involve the construction of downstream connection, through undeveloped areas (“leapfrogging”) solely for the purpose of advancing service extension to upstream areas.

8.8 Environmental Objectives

The City requires storm drainage facilities to be designed to meet the following environmental objectives:

i. The protection and enhancement of aquatic environments through the use of appropriate BMPs, such as constructed wetlands, LID, and Oil and grit interceptors, etc.

ii. The prevention and abatement of the degradation of natural channels, ravines, river banks and valley slopes and environmental reserves in any way which might inhibit or detract from their recreational and aesthetic uses;

iii. For new and re-developed areas, all stormwater runoff is to be treated prior to discharge to receiving watercourses;

iv. For new industrial roadways, stormwater quality treatment is required prior to discharge into any existing storm drainage system;

v. Dry ponds are not considered a treatment facility for water quality improvement, and shall not be accepted unless a wet pond is provided downstream of the dry pond;

vi. Implementing a project specific ESC Plan is one way of stemming the decline in the quality of stormwater.

Appendix A

Pumping Stations Decision Model

TABLE OF CONTENTS

The following decision model will be used when a pump station is proposed. The model can be used at any stage of the development process. It is intended to assist both the owner's design consultant and the City Engineer to conduct value/risk-based analysis in order to recommend the best value option for sanitary servicing.

The process includes the following steps:

1. Initiation
    a. Opportunity/need for a pump station
    b. Motivation/reasoning
2. Option description
3. Options life cycle cost analysis
4. Options risk analysis
5. Options evaluation criteria
6. Options value
7. Recommendation

1.0 INITIATION

1.1 Timeline: Any point in the development process.

1.2 Motivation: The Design Consultant defines an opportunity/need to propose a pump station instead of a gravity system due to one or more of the following:

- The expected value of the pump station is higher than the gravity system due to lower life cycle cost and equal functionality.
- There is a physical barrier (e.g., ravine, river) for servicing the area that makes a gravity system unfeasible due to the vertical alignment requirement and unavailability of a discharge location.
- Environmental constraints deem a gravity system unfeasible (e.g., wetlands, environmental reserve).
- Geotechnical conditions (e.g., gravity profile goes through silt/unsuitable material)
- Economic reasons deem a gravity system unfeasible (e.g., tunneling vs. shallow forcemain).
    - The return on investment is higher for the developer (cash flow – ROI is a function of time).
- Downstream constraints deem a gravity system unfeasible (i.e., need storage on the system).
    - Implementation must occur in a built-up area.
- Staging and development requirements (for either temporary or permanent) deem a gravity system unfeasible.
- The service should be scheduled to facilitate development; if servicing is required within a short time frame during construction, the gravity option is not feasible.

1.3 Output: Proposal to change gravity option to pump station option. This proposal shall include the following information:

i. Options description
ii. Options life cycle cost analysis
iii. Options risk analysis
iv. Option evaluation

2.0 OPTIONS DESCRIPTION

A pump station is a deviation from the preferred gravity system therefore as part of the process for approval the design consultant proposing the pump station must provide a complete description of a gravity option and the pump station option. The level of detail will be of an acceptable level associated with the design stage.

For the gravity option, the following details are required:

1. Horizontal alignment
2. Vertical alignment or the proposed depth of installation
3. Pipe diameter and proposed construction method
4. Connections and any other typical components, including utility crossings
5. Geotechnical information
6. The option's level of service

For the pump station option, the following details are required:

1. Pump station structure and storage requirements
2. Pump station equipment
3. Location and land requirements
4. Forcemain (size, number, staging)
5. Discharge location
6. Level of service
7. Future upgrade plan, if any exists

The two options should have the same level of service; if the level of service is different, then the applicant should indicate that in the description of the options.

3.0 OPTIONS LIFE CYCLE COST ANALYSIS

Life cycle cost analysis is a well-established and well-defined financial analysis to evaluate the net present value (cost) of options, which can then be used in evaluations that include all future expenditure in the analysis.

For the gravity option, the following are the cost items:

1. Estimated Project Capital Cost: This cost includes the cost estimate, inclusive of engineering and construction, for all work to provide the required conveyance and storage.
2. Operation and maintenance cost/year: This cost needs to be updated based on Drainage Operation's cost per km of pipe

For the pump station option, the following are the cost items:

1. Estimated Project Capital Cost: This cost includes the construction of the new pump station and forcemain, the land cost, and any other component required to provide service, including the engineering cost.
2. Pump Station Rehabilitation: This includes mechanical, electrical, and process components that require replacement after 15 years due to deterioration and change of technology.
3. Pump Station Upgrade: This includes any planned future upgrades for the pump station.
4. Pump Station Operation and Maintenance: This includes regular maintenance costs, electricity costs, and any other maintenance and operation activities.

The items mentioned above should be adjusted based on the project requirements. The other inputs required to conduct life cycle cost analysis are the financial parameters and analysis duration.

1. Financial parameters: This includes the real interest rate, which is the difference between the interest rate and inflation rate. A real interest rate around 3% is acceptable for such analysis. The design consultant could conduct a sensitivity analysis to show the impact on the decision if the real interest rate is different than 3%.
2. Analysis duration: The analysis is to be conducted over 75 years.

4.0 OPTIONS RISK ANALYSIS

Risk analysis typically includes identification of risk factors, risk quantification, and risk mitigation. The analysis utilizes risk analysis to estimate the expected cost of risk, which results from the multiplication of the probability of occurrence and the impact of that risk factor.

4.1 Risk analysis needs to be conducted for the two options.

4.2 The following initial list of risk factors shall be considered by the consultant/applicant, and any other risk factor that is not included in the list below may be added:

4.2.1 If the system fails (either gravity or pump station) (e.g., power & generator failure), then

a. Interruption of service/flooding could occur to adjacent residences (basement flooding).
b. Discharge into the environment could result in environmental violations/fines.
c. High operating costs could result due to emergency response.
d. There may be an interruption of traffic.
e. Operation costs may increase.
f. Odour problems during repair may occur.

4.2.2 If the process of selection between a gravity and pump station system fails, then

a. The developer may not be satisfied with the process outcome.
b. It may create political and management pressure to reverse decision.
c. There will be a loss of time and effort.
d. Development may be hindered, and growth would be stalled.
e. A low-value option may be selected.
f. Lot prices may increase.

4.2.3 If the front-end cost of a gravity system is too high for a developer, then

a. Development won’t happen.

4.2.4 If operations capacity is not adequate to maintain additional pump stations in the system, then

a. There is an increased possibility of failures due to less maintenance.
b. There may be an increase in the operation cost due to less maintenance or adding staff/equipment (safety regulations could also increase the number of staff required).

4.2.5 If pump station is selected, then

a. There is a higher potential for corrosion and odour.
b. Residents may complain.
c. There may be an increase in cost, which will be borne by the city and taxpayers.
d. Corrosion might cause sewer collapse and flooding failure.

4.2.6 If the geotechnical condition is not favourable for the selected system (gravity or pump station), then

a. The cost of construction will be higher.

b. There may be a longer schedule of implementation.

4.2.7 If there are long forcemains, then

a. The condition assessment of the forcemain is difficult to attain.

b. The odour and corrosion in downstream areas will increase.

4.2.8 If pump station is selected and development is slow, then

a. Retention times will increase and cause odour and corrosion, impacting the downstream system.

4.2.9 If a gravity system is selected and debris/grease/corrosion/collapse gets into the system and plugs it, then

a. Flooding could occur.

4.2.10 If land can't be secured for the pump station, then

a. The cost of the pump station will be higher.

4.2.11 If, for the gravity option, right-of-way/working easement is not available, then

a. The gravity option will be too expensive or not possible.

b. We may be forced to attain strata easement through court, which would add time/cost; or expropriate land.

4.2.12 If the selected option does not promote stageability, then

a. Upfront costs will be high, and building the ultimate system will occur earlier than it is required.

b. We might build less than what is needed.

4.2.13 If the design of a long forcemain does not account for transience and water hammer, then

a. Failure and leaking could occur.

4.2.14 If dangerous chemicals for odour control are used, then

a. Mishandling of chemicals may cause safety issues.

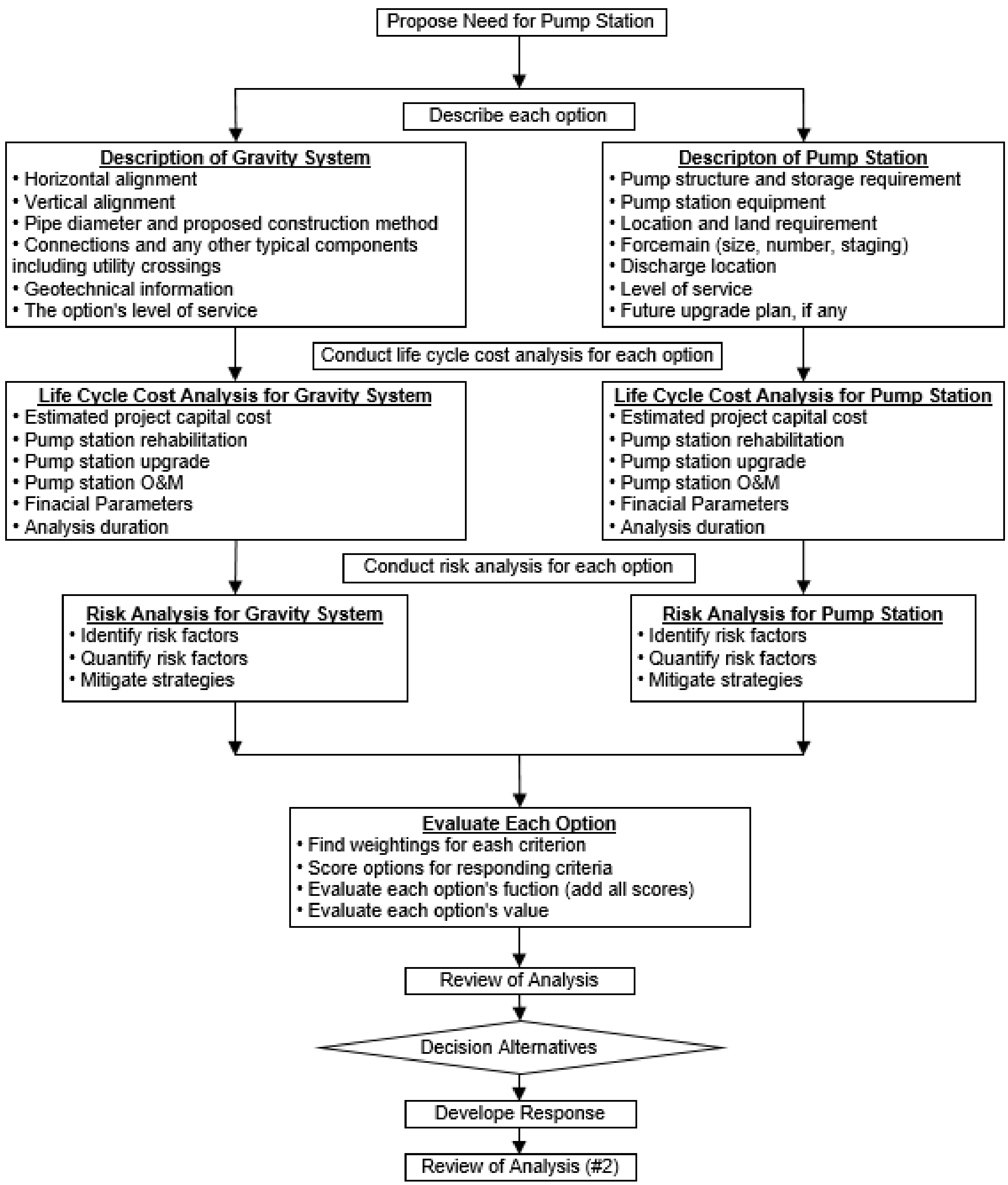
5.0 OPTIONS EVALUATION CRITERIA AND FUNCTIONS:

Once the expected cost of risk and life cycle cost analysis are completed, the City and the Consultant/Applicant participate in the project-specific identification and weighting of evaluation criteria. The following initial list of evaluation criteria could be used in the analysis, and can be adjusted depending on the project constraints and limitations.

1. Constructability: the ease of construction and suitability from a geotechnical point of view and topographic impact; e.g., open cut vs. tunneling, etc.
2. Operation: operability: ease of operation leads to certain well-defined costs reliability: frequency and consequences of failure (e.g., flooding)
3. Impact on public: short-term and long-term impact (odour impact on residents; impact on commuters during construction)
4. Stageability/flexibility: providing service when needed and deferring unneeded costs until later (e.g., non-participating landowners)
5. Impact on existing infrastructure: impact on infrastructure due to corrosion, H_2S

After identifying and defining the evaluation criteria, the team needs to conduct a pairwise comparison to establish the criteria's relative weights, and then each of the criteria needs to be scored for each option. The tally of the weight multiplication with the criteria score for each option represents the option functionality. Then, the division of the function over the total cost, which includes life cycle cost and the expected cost of risk, represents the option's value. The highest value option shall be accepted and carried forward for implementation or further design, depending on the project design level.

The following flow chart/checklist, illustrates the overall process, including the items that must be addressed at each stage during the evaluation of each option. The checklists are not necessarily exhaustive, as indicated in the more detailed description above.



The RACI diagram illustrates the various stakeholders and their types of involvement in the base process. As a format of the Responsibility Matrix, a RACI diagram precisely details the roles and responsibilities of various teams or people in delivering a project or operating a process. It is especially useful in clarifying roles and responsibilities in cross- functional/departmental projects and processes. The RACI diagram splits tasks into four participatory responsibility types, which are then assigned to different roles in the project or process. These responsibilities types make up the acronym RACI.

Responsible:	Those who do work to achieve the task. There can be multiple resources responsible.
Accountable: (Approver)	The resource is ultimately answerable for the correct and thorough completion of the task. There must be exactly one A specified for each task
Consulted:	Those whose opinions are sought. This involves two-way communication.
Informed:	Those who are kept up to date on progress. This is one-way communication.

RACI Diagram

Activity	One Water Planning	Development Engineering and Drawing Review	Drainage Operations	Drainage Engineering	Developer	Developer Consultant
Propose pump station	C	I	I	I	R	A
Analysis	C	I	I	I	R	A
Review of analysis	R&A	C	C	C	I	I
Decision on alternatives	R&A	C	C	C	I	I
Developer response	C	I	I	I	R&A	R
Review of 2nd analysis if required	R&A	C	C	C	C	R