Design Criteria for Sewers and Watermains

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TORONTO

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TORONTO

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City of Toronto Sewer and Watermain Design Criteria Manual:
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Table of Contents

Appendix

Glossary

Index

Introduction

We have written *Design Criteria for Sewers and Watermains* manual for City of Toronto staff and consulting engineers. The purpose of this manual is to ensure there is consistency in our operations. Clients—that's you—want to be instructed in the same way each time you come to us, regardless of which office you may visit. This manual will help ensure that the information provided by staff is the same in all offices.

This manual is written for City staff and consulting engineers working on capital improvement projects and for consulting engineers working for the development industry preparing engineering designs and drawings for private developments.

This manual takes you step by step through all the criteria you will need in the design of a sewer or watermain and the requirements for submission. If you are going to be preparing a servicing study or designing a sewer or watermain in the city of Toronto, this manual is for you.

This manual is available in both print and online formats.

What This Manual Contains

Chapter 1 – Engineering Submissions – covers the requirements for submitting drawings for plans of subdivision or site plans, soils reports, Ministry of the Environment approvals and requirements of the Transfer of Review Program, easement widths and as-built drawing requirements.

Chapter 2 – Sanitary Sewers – covers types of sanitary sewer systems, population densities, peak flow design parameters, sanitary sewer design requirements, maintenance holes, service connections, connecting to sanitary sewers, and inverted syphons.

Chapter 3 – Storm Sewers – covers choosing a hydraulic model, evaluating the receiving system capacity, levels of protection in storm and combined sewer areas, design storms, requirements for the minor and major system; sewer location, size, capacity, velocity, clearances; maintenance holes, storm sewer connections, catchbasins, outfalls, and weir structures.

Chapter 4 – Watermains – covers hydraulic modelling requirements; watermain sizing, location and depth, valve locations and direction to open valves, valve boxes and chambers, hydrant spacing, and water service connections.

Chapter 5 – Lot Grading – covers requirements for lot grading, swales, driveway slopes, grading constraints and information to show on the grading plans.

Chapter 6 – Material Specifications – covers material specifications for watermains and sewers, and their appurtenances.

Appendix A – As-built Drawings – contains requirements for consulting engineers and city staff preparing as-built drawings.

Appendix B – General Notes – contains standard general notes for consulting engineers and city staff to use as a tool to develop their own notes.

Appendix C – Maps – contains a map showing which direction to open a watermain valve based on the district you are working in and a map showing the combined sewer areas.

Appendix D – Utility Separations – contains minimum vertical and horizontal separations for various buried utilities.

Appendix E – Unit Conversion Table – contains measurement conversion factors between SI units and Imperial units.

Appendix F – Reverse Slope Driveway Guidelines – contains submission requirements for a report when a reverse slope driveway is proposed.

Appendix G – Bibliography – contains a listing of design criteria and guidelines published from current city of Toronto departments, former cities and boroughs of Toronto, and other neighbouring cities.

Glossary – an alphabetical list of technical terms relating to the design of sewers and watermains and their definitions.

Index – an alphabetical list of topics, keywords and synonyms used in this manual.

Feedback Form – a form for telling us what you think of this manual.

Acknowledgements

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Thank you!

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Chapter 1 – Engineering Submissions

The design of municipal services will be based upon the guidelines, criteria, and standards in effect at the time the engineering drawings are sealed, signed and dated. The Technical Services division is responsible for the review and acceptance of all engineering drawings but such approval is not to be construed as verification of engineering content.

All sanitary sewers, storm sewers, watermains, their appurtenances and all roadways being constructed within the city of Toronto, will be in accordance with the latest edition of the standards and specifications which are available from the Technical Services division.

Development Engineering Applications

New development and redevelopment submissions that relate to applications submitted in accordance with the Planning Act should follow "*Building Toronto Together – A Development Guide*". This guide is to be used by property owners, developers, builders, and others interested in obtaining approvals from the City. It outlines the City's development review process and expected time frames for obtaining approvals from the City. The guide describes the application review process and its submission requirements for:

- official plan amendment, rezoning and combined applications
- plans of subdivisions
- plans of condominium
- site plan control applications
- part lot control exemption applications
- terms of reference for various types of reports

The latest edition of the guide can be found at website: www.toronto.ca/developing-toronto/darp_guide.htm .

Engineering Drawing Requirements

- All drawings will be neat and legible.
- All drawings will be in metric units.
- Sheet size will be 609 mm x 914 mm (24 inch x 36 inch), 609 mm x 1219 mm (24inch x 48 inch), or 609 mm x 1524 mm (24 inch x 60 inch). External sanitary and storm drainage area plans for overall catchment areas may be submitted on a larger size sheet for convenience of presentation.
- The horizontal datum will have the northing and easting referenced to Zone 10 of the Ontario Coordinate System, NAD 1927, 1968 adjustment, 3 degree MTM, central meridian of 79 degrees 30 minutes west longitude. For details and additional information see R.R.O. 1990, Regulation 1028 under the Survey Act. The vertical elevations will have orthometric heights referenced to the GSC 1928 datum, pre 1977 readjustment.
- The lot and block numbering on all engineering drawings will be the same as shown on the plan of subdivision (66M–) plan registered in Land Titles.
- All sewer and watermain appurtenances such as maintenance holes, hydrants, valves, related design information such as pipe diameter, direction of flow, length, grade, material type, pipe class, pipe bedding, inverts and service connections, and existing basement elevations will be shown on the applicable drawings. All engineering drawings must clearly identify utilities in the line of construction, plant being removed, abandoned but not removed, existing plant that will remain, proposed plant, and future plant.
- All sanitary, storm, and combined sewer maintenance holes will be numbered. All numbers will be shown on the engineering drawings—plan and profile, general plans, and drainage plans—and the sewer design sheets.
- When streets require more than one plan, match lines will be provided with no overlapping of information. The centreline chainage of the match line will be shown in the plan and profile on the adjoining drawings.
- All engineering drawings submitted for approval will be sealed, signed, and dated by a professional engineer licensed to practice in the province of Ontario.

Capital Improvement Projects

- All engineering drawings for capital improvement projects will be prepared in Microstation DGN format.
- The consulting engineer will use a title block design approved for capital improvement related projects. For district engineering capital improvement projects the "*DES–CADD Specification Manual*" will be used.
- The plotting film for final engineering drawings submitted for signature and for as-built purposes will be 4-mil thick mylar with matte finish.

Development Engineering Projects

- All engineering drawings for development engineering projects can be prepared in Microstation or AutoCAD. However, all as-built drawings must be provided in Microstation DGN format.
- The developer's consulting engineer will use a title block design approved for development engineering related projects.
- The two different title blocks in digital format for engineering drawings are available from the district supervisor, design/CADD/plans administration.
- Mylars are not required during submission and distribution stages. However, as-built drawings will be 4-mil thick mylar with matte finish.

Engineering Drawings – Utility Site Plans

The Municipal Consent Requirements (MCR) will apply to all utility site plan applications. The policies and procedures set out in the MCR document applies to all utility companies, commissions, agencies, city departments and private applications proposing to do work within the city of Toronto right-of-way. For detailed information, go to website www.toronto.ca/engineering/mcr .

This document details the construction permit application process for work requiring excavation. The requirement for a full-stream utility cut application required by the Technical Services division is described in detail.

The requirements for full-stream application discussed in this section is not to be confused with full-stream applications as part of the STAR process from the development guide.

Drawings accompanying full stream permit applications will:

- Include a plan view plotted to a scale of 1:200 horizontal and profile view plotted to a scale of 1:100 vertical and be dimensioned in metric units.
- Include a north arrow pointing up or to the right along with a key map in the top right corner of the drawing sheet. Title block will include the name of the engineer together with the sheet title, date, and current revision status.
- Include street names and building addresses near the proposed work. If the municipal address is not available, provide distance from the location of the work to the nearest intersection of street lines.
- Show horizontal control monuments within 5 metres of the proposed work. All elevations will relate to a geodetic datum and the benchmark will be described on all the drawings.
- All drawings will use a cadastral base completed by land surveyor licensed to practice in the province of Ontario.
- Illustrate and clearly label street lines, road pavement, sidewalks, driveways, boulevards, and curbs. Identify street furniture including vaults, transformers, pedestals, gas regulators, hydrants, valve boxes or chambers, poles, and so on and so forth. Identify structures such as areaways—structures under the sidewalk, Toronto Transit Commission (TTC) tracks and entrances, tunnels, encroachments, and so on that may impact on the work.

- Identify, either in the body of the drawing or in the legend box, the plant or service to be put into the ground. Identify plant to be abandoned.

- Where above ground plant is proposed, show all existing above ground plant within 10 metres.

- Provide the distance from the proposed work to adjacent street lines. Define start and end of construction with tie-in dimensions to the nearest intersection.

- Show proposed work with a bold line on the drawing and identify it as such in the legend.

- Show typical depth of cover. Indicate any proposed deviation in depth, approximate length and outer dimensions of plant, including duct size and configuration.

- Show existing and proposed landscaping such as trees, tree pits, and planters, including irrigation systems.

- Indicate construction method and related details for the installation of the underground plant.

- Provide cross-sections of proposed plant below grade where required for clarity.

- Illustrate existing underground services within a 2 metre zone of influence around the proposed underground plant. In lieu of a composite drawing, copies of adjacent utilities' up to date as-built drawings may be attached to the application. Include in the general conditions that the minimum clearances from other services as outlined in Appendix D, *Utility Separations* are maintained.

- All easements for city underground plant and other utilities will be shown on the drawing including the plan number (66R-) and instrument number.

Subsurface Underground Engineering

The use of subsurface underground engineering (SUE) investigation is encouraged when there is insufficient underground information and the congestion of utilities is present.

Test Pits for Locating Utilities

Test pits, where requested, are to be performed for obtaining information about the location and depth of existing utilities prior to commencing construction. The dimensions of the test pits should be approximately 1.5 metres x 1.5 metres x 3 metres in depth.

Engineering Drawings – Plan of Subdivision

The detailed engineering drawings submitted by the developers engineer will consist of the following:

1 title sheet

2 general notes

3 general plan of services

4 drainage area plans

5 subdivision grading and building siting control plan

6 plan and profile drawings

7 erosion and sedimentation control plan

8 composite utilities plan

9 other drawings as required for project review

Title Sheet

A title sheet is required if there are three or more sheets included in the plan of subdivision submission—can also apply to capital improvement projects. The title sheet will contain the following:

- city logo and project number
- key plan of site
- name of the development or developer
- name of owner, address and phone number
- name of engineering company, address, and phone number
- list of drawings

General Notes

General notes describe the standards and specifications used in the construction of the underground and above ground services. For larger subdivisions, it is preferable to have the notes on a separate page. A sample of the standard general notes to be used on all construction projects is included in Appendix B, *General Notes*. The engineer should use only the notes applicable to the project that is current at the time of design and construction. The most recent OPSD and City standards and specifications will be referenced in the notes.

The engineer is responsible to review the standard general notes and to modify the wording to suit the requirements of their design.

Typical road cross-sections will be as per Development Infrastructure Policy & Standards (DIPS) and along with the pavement design, will be shown on the plan and profile drawings.

For more information on DIPS, go to website:
www.toronto.ca/wes/techservices/involved/transportation/future_streets/index.htm

General Plan of Services

A general plan of services will be prepared for every engineering submission as part of a development application.

A scale of 1:500 will be used. For larger subdivisions, a scale of 1:1000 will be used or with City approval a scale deemed reasonable to ensure the limit of construction is shown from all ends.

The following information will be shown on the general plan of services:

- All road allowances, lots, and blocks along with street names in the plan of subdivision and those immediately neighbouring the subdivision.

- Proposed sanitary and storm sewers including diameter of pipe and direction of flow, maintenance holes, house and block service connections, culverts, road catchbasins and rear yard catchbasins, if applicable.

- Proposed watermains including diameter of pipe, valves, hydrants, and appurtenances.

- Proposed curbs, sidewalks, and retaining walls.
- Geodetic benchmark will also be shown and described.
- All easements for city plant and other underground utilities will be shown on the drawing.
- General plan showing drawing number and area covered by each plan and profile sheet.
- Include north arrow pointing up or to the right along with key map.

Drainage Area Plans

The drainage area plan will be drawn at the same scale as the general plan of services.

It will include the following information:

- All rights-of-way with street names, lots, blocks, easements, and other lands within the plan of subdivision or capital improvement project.
- Existing and proposed sewers, including size, length, grade, maintenance holes, maintenance hole numbers, direction of flow, and details of the receiving sewer, outlet sewer, or receiving watercourse or storm water management facility.

Sanitary Drainage Areas

The drainage areas within the sanitary sewer shed and the limits of any external areas, and contributing flows into the proposed system. The area contributing to each sanitary maintenance hole will be clearly outlined. The area in hectares and the population density in persons per hectare will be indicated on all drainage areas.

If the contributing area to a sanitary maintenance hole is comprised of areas with different land uses or population densities, the sub-areas showing the individual area in hectares and the population density will be clearly shown.

Storm Drainage Areas

The drainage areas within the storm sewer shed and the limits of any external areas draining into the proposed system along with areas, flows, and time of concentration. The area contributing to each storm maintenance hole will be clearly outlined. The area in hectares and the runoff coefficient will be indicated on all drainage areas.

If the contributing area to a storm maintenance hole is comprised of areas with different runoff coefficients, the sub-areas individual area in hectares along with each runoff coefficient will be clearly shown along with a composite runoff coefficient and time of concentration.

Subdivision Grading and Building Siting Control Plan

For details and additional design information, see Chapter 5, *Lot Grading*.

Plan and Profile Drawings

Plan and profile drawings are required of all streets, easements, and watercourse crossings and for all plant to be assumed by the City.

- Plan and profile drawings shall be to a scale of 1:200 horizontal and 1:100 vertical. For less congested areas or when city base mapping is not available, or where work is on a local street, a scale of 1:500 horizontal and 1:100 vertical may be accepted by the City.
- Road stations or centreline chainage must be shown in the plan view at a maximum spacing of 25 metres.
- Show the north arrow in each plan view.
- Relate all datum to a geodetic bench mark.
- Show all existing and proposed lot numbers and blocks.
- Show all existing and proposed curbs, road allowances, and street names indicating them as such.
- Show all existing and proposed watermain sizes, valve boxes, and hydrants and other appurtenances. Water service connections to proposed lots are to be shown on all plans from street line to the existing or proposed watermain.

- Show on the profile view the pipe material, class or dimension ratio and bedding for the watermains shown along the bottom of the profile.
- Show location of cathodic protection test stations and drain cables where metallic watermain or sewer forcemain pipe is installed.
- Show all existing and proposed sewer lengths, sizes, class of pipe, grades, and maintenance holes. The slopes are to be shown to two decimal places in percent.
- On all plans and profiles, the type of bedding and class of pipe for the sewers must be shown along the bottom of the profile, as determined from the City standard drawings.
- All sewers to be terminated at the subdivision limits where outside drainage areas are to be considered in the design of same. All sewers to be designed so that they extend at least halfway across the frontage or flankage of any block or lot in the subdivision, so that the service connections can be constructed in a standard location.
- Show all existing and proposed catchbasins and indicate them as such.
- Show all house connections at street line.
- All maintenance holes must be indicated with the proper symbols and the sanitary maintenance hole numbers must be followed by the letter 'A' on both plan and profile. For more information on symbols, see the *DES–CADD Specification Manual*.
- Project the maintenance hole location perpendicular to the centre line chainage and indicate the maintenance hole at this chainage in the profile view.
- All maintenance hole benching details will be shown on the plan view and must be drawn at a minimum scale of 1:50.
- All maintenance holes must refer to a City standard on the profile above the centre line of the road profile of each maintenance hole, along with the rim elevation and maintenance hole chamber diameter.
- All maintenance holes shown in the profile must indicate all existing and proposed inverts with each having reference to the compass direction such as north, south, east or west.

- Indicate on all drawings any areas of engineering fill.

Cul-de-sacs

- Temporary turning circles are required where the road is to continue in the future and designed with a combination of deeded right-of-way and easements over the lots. The street line radius will equal 15 metres. The curb radius will equal 12.5 metres. A temporary turning circle will have complete services to the future proposed street line.
- Where a road is not to be extended in the future, the radius of the street line equals 15.25 metres as shown on drawing DIPS-5. The curb radius equals 12.5 metres.
- All existing and proposed services, curbs, sidewalks, and so on, within the street line must be dimensioned.
- Sidewalk "fillets" to be constructed with concrete at all "tee" and "cross" intersections. Sidewalks and curbs to be constructed with radii related to street line radii as per City standard T-310.020.

Erosion and Sedimentation Control Plan

For details to include in an erosion and sedimentation control plan, see Appendix B, *General Notes.*

Composite Utilities Plan

Comprised of information from Public Utility Coordinating Committee (PUCC) drawings, individual utility company drawings, and topographical surveys and by subsurface utility engineering (SUE) investigations, if required.

Sign off from all affected utility companies such as Bell Canada, Rogers Cable, Toronto Hydro, Edenbridge Gas, Enwave, Canada Post and so on is required.

Storm and Sanitary Design Sheets

In the future, the SPQA unit will develop standard sanitary and storm design sheets. Will then append to this criteria manual.

Standard City sanitary and storm sewer design sheets will be used.

Geotechnical Investigation and Soils Report

This section is written for capital improvement projects. This section can also be used as a guide for development engineering projects, if desired.

For the construction of new roads or underground utilities, a geotechnical investigation will be required. The purpose of the investigation will be to determine the type of soil, its engineering properties, bearing capacity, soil permeability, location of groundwater, and to verify whether contamination is present. Soil investigation work is to take place after determining the proposed sewer or watermain alignment, so that the required boreholes and test pits follow the same alignment.

Soil test borings will be placed at suitable spacing to provide adequate representation of the soil conditions. Soil classification and ground water levels will not be recorded, if absent. Additional boreholes may be required to establish the water table for storm water management ponds and to design the foundations of outfall structures.

In waterfront or fill areas, piles may be required to achieve satisfactory bearing strength to support any proposed infrastructure. Bedrock profiles will be required and submitted.

The soil report will make recommendations for the design of the road base, pipe bedding, construction methods, and soil percolation rates to determine the feasibility of stormwater management infiltration works.

One paper copy of the geotechnical report will be submitted together with an electronic copy in PDF format to be catalogued and stored by the City for future reference.

Site Investigation Requirements

The following items describe the tests and investigation work which should be undertaken and provides the engineer with a summary of geotechnical requirements for a typical industrial or residential subdivision, and for any City capital improvement project.

Borehole Log Report

Keep a continuous log of materials encountered during the sinking of each borehole. All sample descriptions in the report will follow the Ontario Ministry of Transportation's soil classification system. The borehole log report, among other relevant information, will include the following:

- Project description, location, date and time of test, and drill type.
- Detailed description of the type of soil encountered, its soil classification, depth, and delineated soil stratigraphy in accordance with the Ontario Ministry of Transportation's soil classification system.
- Record the thickness of asphalt or concrete and granular road base in the borehole log report, where boreholes are located within an asphalt or concrete roadway.
- Describe colour, consistency, and moisture content of soil.
- Make specific reference to soil colour stains, odours where present, and any metal, wood, debris or organic materials encountered. Record any observations that indicate contamination of excavated material with petroleum products, garbage or other wastes.
- Record 'N' values from any standard penetration tests and the penetration depth of a split spoon sampler.
- Record groundwater and free standing water table in the boreholes encountered during and upon completion of boring.
- Report cave-in depth, if a cave-in is found.
- Describe the degree of weathering of shale, if shale is encountered.

Borehole Depths

Boreholes will be according to the following minimum depths:

- sewer construction—6 metres deep
- watermain construction—3 metres deep
- laneway construction—4 metres deep in at least one lane area and one metre deep in remaining lanes within the same area—a lane area is one or more interconnected individual lanes
- pavement reconstruction—one metre
- sidewalk construction—one metre

Should tunnelling or directional drilling be proposed, the borehole logs will be increased in depth, accordingly. Surface elevations at all borehole locations are to be included with the borehole logs.

Coring Samples

All corings at the same locations according to the following minimum depths: For pavement cores the depth will be half metre with 50 mm diameter cores. For streetcar track cores, the depth will be 0.7 metre with 100 mm diameter cores. Surface elevations at all coring locations are to be included with the core logs.

Standard Penetration Resistance with Codes

Determine and record the number of blows, of a 65 kilogram hammer, falling 760 mm, required to drive a 50 mm diameter spoon sampler 300 mm into the material. Do this for every 750 mm of depth and near the top of each layer of new material. Record the relative elevation of the above tests.

Soil Sampling

Note and log the type of soil at various levels from the geodetic datum provided by the City, to the depth of the borehole or from the road or ground surface as specified. Take the first sample before the hole is 250 mm deep and the second sample between 250 mm and 1000 mm in depth. Thereafter, take samples with a sampling spoon of approved type, every 750 mm and at every level where there is a change in character of the soil. Immediately upon removal from the hole, samples will be tightly sealed in air tight containers, to be supplied by the engineer. Take care to ensure all fine materials are retained and that materials are well mixed and truly representative of the soils to be encountered during construction. Assemble and label samples separately for each borehole to give a complete record of each boring, including name of project, order number, borehole number, and depth at which the sample was taken.

Installation of Piezometer

If requested, piezometers will be installed in all boreholes that are not dry upon completion of drilling. Water inside a borehole should be pumped out before a piezometer is installed prior to backfilling. Nested or clustered installations may be required to assess the hydrogeological conditions.

The geotechnical engineer should return to the site to record the free standing ground water level inside the borehole after 24 hours. Each piezometer assembly will include a proper piezometer tip, an appropriate length plastic tubing of 12.7 mm outside diameter, couplings, and protective plastic caps.

Laboratory Tests

Laboratory tests will be made on undisturbed soil samples. Only the laboratory tests which are deemed necessary by the contract administrator will be required. The tests that may be carried out shall include the following:

- natural moisture content
- void ratio
- liquid limit
- plastic limit
- plasticity index
- unconfined compression test
- consolidation test

Soil Classifications

The soils will be classified as follows:

- rock
- broken rock
- boulders
- coarse gravel
- gravel sand
- coarse sand
- fine sand
- silty sand
- silt
- clay silt
- clay
- organic silt
- peat
- rock flour
- Infiltration Tests

When requested, in situ infiltration tests will be performed in a separate 5 metre deep borehole by inserting a perforated casing with the bottom 3.5 metres of pipe perforated, filling the hole with water and measuring the time required for the water to infiltrate into the soil surrounding the pipe.

Estimated Permeability of Sub-Grade Materials

Pavement investigations to address the permeability of the sub-grade materials will be performed to facilitate drainage design. The permeability of the sub-grade material will be estimated by comparing the particle size distribution of the material with the established permeability correlation data. Combined sieve and hydrometer analyses will be carried out on representative samples of the subgrade material(s) to obtain the particle size distribution curves for comparison.

Soil Chemical Analysis

Major tasks will include the following:

- Consult with MOE or the receiving site owners and develop a work program to analyze and classify the material, which is intended for excavation during construction. The proposed work program must be satisfactory to MOE or the receiving site owners. The work program may include only the analysis of soil samples already collected and collection and analysis of additional soil samples as considered appropriate to the site and the project at hand.

- Conduct sufficient laboratory analysis to classify soil samples for landfill disposal options in accordance with "*Guidelines for Use at Contaminated Sites*" June 1996 and MOE Regulation 558.

The following parameters should be included in the chemical analysis for each sample tested:

- antimony
- arsenic
- barium
- beryllium
- cadmium
- chromium
- cobalt
- copper
- lead
- molybdenum
- nickel
- selenium
- silver
- zinc

- mercury
- vanadium
- electrical conductivity
- sodium absorption ratio
- pH
- petroleum hydrocarbons (F4 > C34)

Prepare a final report outlining the work program undertaken, test results, and commenting on the suitability of excavated material for on-land disposal. Where test results indicate that the material will not be suitable for on-land disposal at residential/parkland or industrial/commercial lands, include alternative landfill disposal options consistent with Ontario Regulation 558 and MOE guidelines for disposal at a licensed landfill.

Geotechnical Investigation Report and Delivery

All findings from the geotechnical investigation, including the borehole log report, chemical analysis results, comments, and recommendations should be presented in a street by street or street grouping report format. Recommend the appropriate pavement section based on the pavement structural design matrix. Recommendations will also make reference to all relevant city standards or guidelines such as City standards and specifications, wet weather flow management guidelines, Ministry of the Environment guidelines and so on. Annual average daily traffic (AADT) volumes required for the pavement design will be supplied by the City.

The geotechnical engineer will submit preliminary soil reports for each location of the investigation to the City for review and comment. The geotechnical engineer will compile the final reports according to the comments received from the City.

Location Plan

Borehole locations with three tie in measurements from permanent structures in the vicinity with offset from curb lines.

Prepare a key plan indicating the position of boreholes and attach the plan to form an integral part of the borehole log report.

Pavement Structure Design

Recommend the pavement structure design that will meet or exceed the minimum requirements specified by the City's transportation infrastructure asset management and programming unit. The pavement structural design matrix can be found at website: http://insideto.toronto.ca/techserv/spqa/pavement.htm .

Report Delivery

The consultant will prepare and submit to the City three complete reports including borehole and test pit information. The engineering report will include a plan, general discussions, comments, and recommendations, as follows:

- field work carried out
- soil classifications
- borehole log
- pavement core details
- borehole and corehole location plan
- grain size analysis curves
- type and hardness of bedrock—if encountered
- depth of overburden
- ground water elevations
- soil proctors for overburden material
- bearing capacity of soils

Recommendations should be made for the following:

- pipe bedding—materials—requirements with respect to City's standards
- soil parameters to be used for calculation of thrust blocks and restrained joints, including coefficient of friction, shear angle, and bearing capacity
- concerns as to trench bottom uplift
- dewatering, if required, describing available methods including well points
- open trench excavation, type of shoring system, methods of tunnelling or jacking and boring
- use of native backfill, placement depth of layers and compaction specification for same
- results of infiltration testing
- findings from test pits

The geotechnical consultant will submit all reports to the City.

Ministry of the Environment Approval

The client, who is the individual or corporation requesting the approval, will submit the required Ontario Ministry of the Environment (MOE) applications to obtain certificates of approval for sanitary sewers, storm sewers and watermains.

The City of Toronto is an agent of the ministry for processing sewage and water works applications under the *Ontario Water Resources Act* and *Safe Drinking Water Act*. The onus is on the applicant in consultation with city staff to determine if the proposed work can be reviewed under the Transfer of Review Program or if it should be submitted directly to the Ministry of the Environment.

Note: The Municipal Drinking Water Licensing Program will replace the existing approvals program for municipal drinking water systems. In 2010—planned—the City will be issued its first drinking water works permit/licence which then the Transfer of Review Program will no longer process drinking water system applications.

Sanitary sewage collection and stormwater management applications will continue to be processed through the existing Transfer of Review Program.

Two complete sets of engineering drawings individually folded plus supporting design documentation will be provided to the City to accompany the MOE application under the Transfer of Review Program between the City and MOE. Review and administration fees specified in the MOE application for sewage works and water works are separate from the City's development review processing fees. The cheque for review made under the Transfer of Review Program will be made payable to the 'Treasurer, City of Toronto'.

Projects that involve municipally owned stormwater management facilities require an MOE application to be submitted directly to the MOE for approval; however, the application forms will be submitted to the City for signature as the operating authority. The engineer's client will be responsible for any fees payable to the MOE for this review. The cheque will be made payable to the 'Minister of Finance' as noted on the application form.

The submission requirements are noted on the MOE web site under the publication: "*Guide for Applying for Approval of Municipal and Private Water and Sewage Works*". To download a copy of the guideline and application form, go to website www.ene.gov.on.ca/envision/gp/4063e.pdf .

Each MOE submission that includes engineering drawings must be stamped by the engineer responsible for the preparation of the application and design of the municipal services for which approval is sought. The engineer's stamp must be signed and dated on all engineering drawings and any accompanying documentation.

What the City is authorized to review?

The ministry currently authorizes the City of Toronto to review the following:

Water Works

- watermains
- water booster pumping stations

Sewage Works

- storm and sanitary sewers—except for new stormwater outfalls
- sewage pumping stations and forcemains—except for those pumping directly to a sewage treatment plant
- rehabilitation of existing combined sewers—excluding outfalls
- replacement of existing combined sewers where there is no increase in combined sewer overflows
- use of roof top gardens as a stormwater management facility located on and servicing one lot or parcel of non-industrial lands that discharges into a storm sewer—that is not a combined sewer
- inlet control devices used in existing developments to control sewer surcharging and basement flooding provided that there is no increase in the stormwater collection area

What the City is not authorized to review?

The City of Toronto is not authorized to review the following:

Water Works

Water intake pipes, water supply and treatment works, high and low lift pumping stations, water storage facilities at water treatment plants and chemical feeding equipment.

Sewage Works

- sewage treatment works and outfalls
- storm water management works requiring storm water quality control other than specific installations of oil/grit interceptors/separators
- pumping stations discharging directly to sewage treatment works
- sewers with overflows, combined sewers with overflows
- combined sewers in new areas, combined sewage storage facilities
- sewer connections from land filling sites for leachate transport

More information can be obtained from City's internal intranet web site: http://insideto.toronto.ca/techserv/eswfs/about.htm .

Expanded Transfer of Review Program

The City of Toronto's current Transfer of Review Program is expanded to include additional types of sewers and stormwater management works for quantity control, which meet the following criteria:

1 Works must discharge to either the existing municipal storm sewage collection system, or to an existing stormwater works which has a Certificate of Approval and which has an adequate amount of approved design capacity to treat the additional flow, and

2 Works that only receive drainage from non-industrial lands, where industrial lands are defined by Ontario Regulation 525/98.

Examples of the types of sewers and stormwater works for quantity control to be included are:

- Over-sized/super-sized sewers.
- Oil/grit interceptors/separators and hydrocyclones on any or new storm sewers where the drainage area does not exceed two hectares. These sewers must discharge either to the existing municipal storm sewage collection system or upstream of a stormwater management pond which has sufficient capacity, currently achieves an adequate level of treatment and complies with an existing Certificate of Approval.
- Surface ponds for the retention of stormwater runoff from roof tops and parking lots, with defined control structures, such as, rooftop drains.
- Dry ponds for new developments designed to attenuate peak flows during wet weather events.

In addition, the Transfer of Review Program is expanded to include the replacement outfalls which meet the following criteria:

1 The outfall being replaced has an existing Certificate of Approval.

2 The replacement outfall has a similar size, dimensions, and performance criteria and is in the same or approximately the same location as the existing outfall, and

3 The description of the works in the Certificate of Approval drafted for a replacement outfall will identify the receiving watercourse, if it discharges into the Rouge River—one of the four provincially-recognized sensitive receivers and/or their tributaries.

Facilities on Private Property

The expanded program also permits the City to review facilities for attenuating stormwater runoff peak flow rate or volume; sanitary sewage detention chambers or oversized sewer; and oil/grit separators provided that they are not located within the fill regulation line of the Toronto and Region Conservation Authority.

The client is also requested to review Ontario Regulation 525/98 which lists approval exemptions for work under Ontario Water Resources Act. An exemption can be applied to a proposed stormwater management facility on an individual lot or parcel of land. However, there are conditions to applying this exemption and approval shall be sought whenever the conditions cannot be met.

Approval by the Toronto and Region Conservation Authority

The outfalls of replacement storm sewers located on land under the jurisdiction of the (TRCA) require a permit under Ontario Regulation 166/06 made under the Conservation Authorities Act.

Easement Requirements

Easements are required for all underground infrastructure that will be assumed by a city which is not located within a public road allowance. The easement agreement documents both the rights of the city and the rights of the property owner. The easement agreement is also registered on title of the affected property.

An easement is required to ensure that municipal services and utilities crossing the site can be properly installed and maintained by the appropriate authority. An easement provides the right to use the lands for a specific purpose which is in the public's interest.

Types of Easements

Municipal Easements

Required for underground municipal infrastructure that crosses private property and which is owned and maintained by a city.

Utility Easements

Utility easements are required for telecommunications, hydro, gas, and cable television services. Each utility company should be consulted for their specific requirements when city infrastructure crosses a utility company's lands.

Private Easements

Private easements are required for private underground infrastructure, drainage purposes or private access roads that cross a parcel of land to service other private lands. A joint access and maintenance agreement between the interested parties will be required. It should be noted that a city has no role in private easements.

Temporary Easements and Working Easements

Temporary easements are required during the construction of city underground infrastructure and access roads that cross a site temporarily. The services in the easement are to be maintained by the respective owner.

Minimum Easement Widths

Easement widths are determined by the depth from the centreline elevation of the road or ground to the invert of the sewer or watermain. The City will determine the placement of the plant—on centre or offset—within the easement. Subsurface or strata easements may be specified for certain tunnelled infrastructure. The minimum easement widths required for sewer and watermain infrastructure is as follows:

Rear lot catchbasin lead crossing multiple properties will require a private easement. Private easement is not required if catchbasin lead is on the same lot.

Table: Easement widths

If service, size and depth is …	Then easement width is …
Rear lot catchbasin lead regardless of diameter and depth	3 m
Single sewer or watermain equal or less than 600 mm diameter and less than 3.7 m deep	6 m
Two sewers in the same trench	7.5 m
Single sewer in excess of 3.7 m deep or single watermain equal or larger than 750 mm diameter	9 m
A combination of two mains, either sewer or water, less than 3.7 m deep	9 m
A combination of two mains, either sewer or water, in excess of 3.7 m deep and no closer than 3 m to easement limit	12 m
Major trunk sewer or transmission watermain	20 m [a]
Three or more mains, no closer than 3 m to easement limits	Add 3 m for each additional sewer or watermain

[a] Sewer or watermain will be located off centre in the easement for future infrastructure

If the expected loading condition is not known at the time of the design, sewer pipes exceeding 900 mm in diameter within any easement, the pipe class will be increased one classification.

As-built Drawing Submission Requirements

One complete hardcopy set of as-built engineering drawings along with as-built storm and sanitary sewer design sheets must be submitted and accepted by the City. The hard copy drawings must be prepared in accordance with the as-built drawing requirements detailed in Appendix A, *As-built Drawings*.

For plan of subdivision development projects, that includes the construction of new roads or mains, or both, the as-built drawings must be provided and accepted before the City will consider the "Assumption of Services" as described in the subdivision agreement.

For site plan development projects, the as-built drawing showing all service connections to street line must be included as part of the "Completion Certificate" prepared by the consulting engineer and forwarded to the City or prior to condominium registration, if it is a condominium project.

For capital improvement projects, the as-built drawings must be provided no later than 60 days following substantial performance.

As-built sewer design sheets must be scanned and placed on a drawing sheet included with the as-built drawing set.

Development Engineering Projects

The developer’s consulting engineer typically performs work required for completion of the as-built drawing. The developer’s consulting engineer will be required to submit to the City one set of white prints redlined to clearly indicate all field changes.

The developer’s consulting engineer will also incorporate all remarks provided by the City’s development engineer. Two sets of prints will then be made from the revised construction or tender drawings for review. Mylars will not be produced or supplied to the City until all changes are incorporated and accepted by the development engineering section.

After the development engineering section is satisfied that all remarks have been included, the City will request the drawings be submitted on mylar and in a digital format acceptable to the technical services division.

Only plotting film of 4-mil thickness mylar with matte finish will be accepted. Each sheet will have "As-built" in the revisions box initialled by the developer's consulting engineer.

As-built drawings will use the original size of the approved drawings or will be 609 mm x 914 mm (24 inch x 36 inch) in size.

The submission to the development engineering section will include a revised electronic file in MicroStation (.DGN) format and Tag Image File (.TIF) format on a compact disk (CD). Each CD shall be labelled with the project name, company name, engineering company's name and telephone number.

Capital Improvement Projects

City personnel typically perform the work required to complete the as-built drawings. In some cases the City will instruct the design engineer, contracted by the City, to perform the work required to complete the as-built drawings.

City personnel from district engineering services section will proceed with the completion of the as-built drawings incorporating all field changes as required. If the City proceeds with having the as-built drawings completed by the design engineer, the consulting engineer carrying out the field work and inspection will supply the information required to complete the as-built drawings. One set of reproductions will be submitted showing all field changes on the final as-built drawings.

After the City contract administrator is satisfied that all remarks have been addressed and included, the City will request the mylar of the drawings to be submitted. Only plotting film of 4-mil thickness mylar with matte finish will be accepted. Each sheet will have "As-built" in the revision box initialled by the design engineer.

As-built drawings will use the original size of approved drawings or will be 609 mm x 914 mm (24 inch x 36 inch). Larger sheet sizes are unacceptable.

The submission to the City contact administrator will include a revised electronic file in MicroStation (.DGN) format and Tag Image File (.TIF) format on a CD. Each CD will be labelled with the project name, company name, design engineer's name and telephone number.

Other Drawings as Required

Shop drawings for factory manufactured infrastructure such as concrete pressure pipe, feeder mains or retaining walls should be included.

Chapter 2 – Sanitary Sewers

The sanitary collection system transports liquid wastes from residences, commercial buildings, institutions, industrial developments, along with ground water and stormwater that find its way into the sanitary sewer system.

Level of Protection

Hydraulic Grade Line Requirements

Sanitary sewers will be designed to operate under free flow conditions at all times unless the receiving sewer is experiencing surcharge due to outlet conditions. The impact of downstream surcharge on the new system must be addressed when connecting to an existing system. If tailwater conditions cause a surcharge of the system being designed, a freeboard of one metre between the new basement floor elevation and hydraulic grade line is desirable with an absolute minimum of one half-metre.

Types of Sewer Systems

Separated

A separated sewer system is a system in which all municipal sewage is conveyed to sanitary sewers and all surface runoff is conveyed to storm sewers.

Partially Separated

A partially separated sewer system consists of storm sewers that conveys surface runoff, primarily from roadways, and sanitary sewers that receives municipal sewage as well as foundation drains and some driveway drains. These systems typically are found in older subdivisions prior to the introduction of fully separated systems.

Combined

A combined sewer system is a system that conveys both surface runoff and sanitary sewage. These systems are generally located in the older parts of the city. The construction of new combined sewers is no longer permitted other than for the replacement of existing combined sewers within the city's defined combined sewer area.

New storm drainage systems cannot be connected to existing combined sewers except as an interim measure where sewer separation is to be ultimately implemented or where circumstances allow no other alternative.

The discharge of roof drains to combined or storm sewers in the combined sewer area of the city will be prohibited. Exemptions will be at the sole discretion of the General Manager, Toronto Water as set out in the Sewer Use Bylaw, Chapter 681 of the Toronto Municipal Code.

New Sanitary Sewers

Separated sewer system is currently the standard for all new subdivisions and infill developments. Roof drains will be discharged at grade away from the buildings. Foundation drains are not connected either to the sanitary or storm sewer systems.

The discharge of non-contact cooling water or uncontaminated water to a sanitary sewer or combined sewer from any new residential properties is prohibited as described in the Sewer Use Bylaw, Chapter 681 of the Toronto Municipal Code.

The discharge of roof drains to combined or storm sewers in the combined sewer area of the city will be prohibited. Exemptions will be at the sole discretion of the General Manager, Toronto Water as set out in the Sewer Use Bylaw, Chapter 681 of the Toronto Municipal Code.

Sanitary Trunk Sewer

Sanitary trunk sewers collect discharges from local separated sanitary sewers. Sanitary sewers convey sanitary sewage and some storm runoff that gain entry through infiltration or intercepted flow from combined sewers to the treatment plants.

The current inventory of sanitary trunk sewers in the city of Toronto was established under the former *The Municipality of Metropolitan Toronto Act* and are sewers that serve more than one municipality or areas in excess of 405 hectares. Contact should be made with the City for additional information prior to undertaking any design work.

Combined Trunk Sewer

Combined trunk sewers collect discharges from local combined sewers. Combined sewers carry both sanitary sewage as well as storm runoff. The combined trunk sewers were assumed by the former Metropolitan Toronto from the area municipalities in 1954. They have capacity for the peak dry weather flow plus the runoff from a 2-year storm event. This capacity is much more than that required for the 0.26 litre/second design value for infiltration and inflow. The dry weather flows represent less than 10 percent of the sewer capacity. The remainder of the capacity is for storm runoff. Contact should be made with the City for additional information prior to undertaking any design work.

Population Densities

Population Equivalents Based on Land Use

When lands are zoned for a specific use and detailed information is not available, the following population densities will apply:

Table: Equivalent populations

If development type is …	Then equivalent population density is …
townhouse (RM1)	170 persons/ha
medium density (RM3–RM5)	270 persons/ha
apartments—if < 148 units/ha	400 persons/ha
apartments—if > 148 units/ha	2.7 persons/suite
schools, churches (R1–R4, RM2)—lot area known	86 persons/ha
schools, churches (R1–R4, RM2)—lot area unknown	GFA (m^2) x 0.0258 persons/m^2
offices	3.3 persons/100 m^2
commercial or retail	1.1 persons/100 m^2
industrial—lot area known	136 persons/ha
industrial—lot area unknown	GFA (m^2) x 0.0272 persons/m^2
institutional—nursing home, group home, hospitals, home for the aged, hostels–number of beds known	1 person/bed
institutional—nursing home, group home, hospitals, home for the aged, hostels–number of beds unknown	GFA (m^2) x 1 bed/30 m^2 x 1 person/bed

Population Equivalents Based on Type of Housing

When the number and type of housing units within a proposed development is known, calculating the population for the proposed development will be based on the following:

Table: Persons per unit

If type of housing is …	Then persons per unit is …
single family dwelling	3.5
semi-detached	2.7
townhouse	2.7
duplex	2.3
triplex	3.7
apartments or condominium:	
bachelor	1.4
1 bedroom	1.4
2 bedroom	2.1
3 bedroom	3.1

Rezoning Applications

All residential, commercial, institutional, and industrial rezoning applications must include a review of available downstream capacity with respect to the sanitary sewer. If it is found that the public sewer system is inadequate, the developer will be responsible to fund the necessary upgrades to the system, unless the City requests over sizing, in which case the project will be considered a development charges project.

Site Plan Applications

All permitted as-of-right uses or intensification—that is to say complying with the current zoned designation—such as commercial, institutional, and industrial site plan applications must determine the expected sanitary flow discharge from the site.

Design Flows

The design of sanitary sewers will be based on the sewage flows from the ultimate development permitted by the zoning and expected from the tributary area. The design of sanitary sewers must account for all flows contributing in determining the appropriate design peak flow capacity for sizing the sewer pipes.

Calculation of Peak Design Flows

Sanitary sewage flows are calculated from the following parameters: average daily flow per capita, contributing population, peaking factor for the domestic flows plus an infiltration allowance.

Design flow for sanitary sewers will be based on the following formula:

> *design flow* = *average daily dry weather flow* x *peaking factor* + *infiltration allowance*

The formulae and parameters to be applied in the calculation of peak design flows for new or infill developments is described in the table below as follows:

Table: Peak flow design parameters

Average wastewater flows for new local sewers	
average wastewater flow	450 litres/capita/day
commercial average flow	180,000 litres/floor ha/day [a,b]
industrial average flow	180,000 litres/floor ha/day [a,b]
institutional average flow	180,000 litres/floor ha/day [c]
Peaking factors	
residential peak factor	Harmon equation: $PF=1 + (14/(4+(P/1000)^{½}))$ Where P=population in thousands
commercial peak factor	included in average flow
institutional peak factor	included in average flow
industrial peak factor	included in average flow
Extraneous flows	
infiltration allowance	0.26 litre/second/ha (all areas)
Foundation drain allowance	
Less than 10 ha	5 l/s/ha (if necessary for existing partially separated and combined areas only)
10 ha–100 ha	3 l/s/ha (if necessary for existing partially separated and combined areas only)
Greater than 100 ha	2 l/s/ha (if necessary for existing partially separated and combined areas only)

[a] Floor space index is one half of the gross land area, unless designated other wise in the secondary plan.

[b] The area is calculated using the number of gross hectares of the site or lot. The flow criteria will apply unless evidence shows there will be additional flow volume.

[c] Where the total floor area does not exceed the size of the lot, the area is calculated using the number of gross hectares included in the institutional site.

Residential Developments

Where new sewers are planned or when a greenfield development is proposed, all local sanitary sewers will be designed using 450 litres/person/day. The Harmon equation will be used for the peaking factor.

Commercial and Institutional Flows

The sewage flows from commercial and institutional businesses vary greatly with the type of water-using facilities present in the development, the population using the facility, the extent of extraneous flows entering the sewers and so on. If approved actual flow records are not available, a unit rate value of 180,000 litres/floor area in hectares/day should be used which includes any extraneous flows. This value can be used at the functional design level, for example as in a servicing study.

The peaking factors applicable for sewage flows from commercial and institutional businesses already have a built in peaking factor and applied to the average dry weather flow calculations.

Industrial Flows

Peak sewage flow rates from industrial areas vary greatly with the extent of the area, the types of industry present, the provisions on in-plant treatment or regulation of flows, the presence of cooling waters in the discharge and so on.

If the water usage of the proposed industry is known, the data should be used in the design of the system at the site plan application stage. If water usage for the proposed industry is not known, a unit rate value of 180,000 litres/floor area in hectares/day should be used which includes any extraneous flows and peaking factor. This value can be used at the functional design stage, for example as in a servicing study.

Extraneous Flows – New Areas

In computing the total peak flow rates for the design of new sanitary sewers, an allowance of 0.26 litre/second/gross hectare will be applied, irrespective of land use classification to account for ground water infiltration and wet weather inflow into the pipes and maintenance holes. Assume no roof drains or foundation drains are connected directly or indirectly to the sanitary sewer.

Extraneous Flows – Existing Areas

The connection of foundation drains to the sanitary sewer system is not permitted for new developments, therefore, a specific allowance for foundation drain flow to sanitary sewers is not required. However, the engineer is required to account for foundation drain flow when computing sanitary design flows from existing areas that may contain partially separated sewers. In absence of specific monitored data, the figures in Table: *Peak flow design parameters* should be used in calculating the design flows.

Analysis of Existing System Flows

Average wastewater flows in fully separated storm and sanitary sewer areas where no downspout and foundation drains are connected to the sanitary sewer and where inflow and infiltration has been establish by the a city sponsored study can use the following flow rates with agreement from the city.

- 240 litres/capita/day—residential
- 250 litres/capita/day—industrial/commercial/institutional

Monitored Flows

If flow monitoring data is available showing the actual dry and wet weather flow rates, the engineer will take the measured flow into account to determine available capacity in the existing trunk sewer system and in basement flooding areas only.

The flow data and any applicable parameters must be provided to the City prior to being used in any computation.

Wet weather flow monitoring will take place during the late spring, summer and early fall in order to collect data during severe summer storm events.

Sanitary Sewer Design

Pipe Capacities

Sewer capacities will be computed by using the Manning formula. Generally, sanitary sewers will be designed to flow at a maximum of 80 percent full flow design capacity of the pipe size. The sewer will be designed for sub-critical flows.

Roughness Coefficients

In a new sewer design, the value of 'n' using Manning formula will be:

Table: Manning 'n' value

If pipe material is …	Then value of 'n' is …
concrete (CONC)	0.013
polyvinyl chloride (PVC)	0.013
high density polyethylene (HDPE)	0.013

Pipe Size

The minimum allowable size for a sanitary sewer will be 250 mm diameter.

Minimum Velocity

The minimum actual velocity permitted in a sanitary sewer when flowing full will be 0.6 metre/second to ensure the flow is self-cleansing.

In cases when the flow depth in the sewer will be 30 percent of the diameter or less, the actual peak flow velocity should be calculated using the hydraulic elements chart and the pipe slope increased to achieve adequate cleansing velocities.

To determine sewage velocities based on actual flow, refer to the Figure: *Hydraulic Elements Graph for Circular Pipe.*

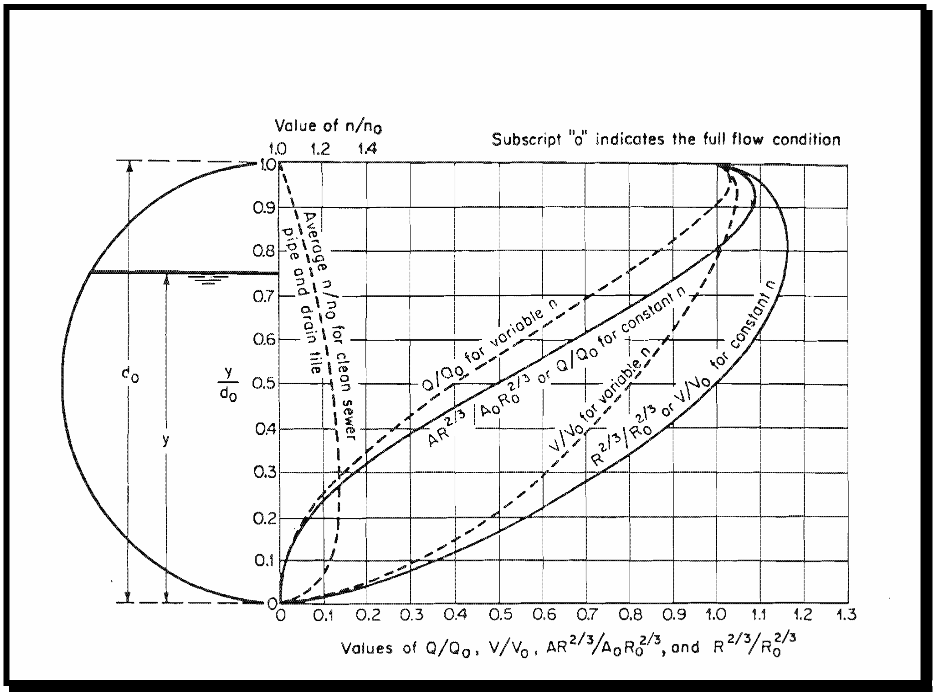


Figure: Hydraulic elements graph for circular pipe

Maximum Velocity

The maximum velocity permitted in sanitary sewers is 3 metres/second. Where steeper grades are unavoidable, additional design factors will be taken to protect against pipe displacement and erosion.

Minimum Grades

The first leg of the top end of sanitary sewer will be sized at 250 mm with a minimum grade of one percent unless advised otherwise by the City. All remaining downstream sections of sanitary sewer will have a minimum diameter of 250 mm and a minimum grade corresponding to a minimum self-cleansing velocity of 0.6 metre/second.

Table: Minimum grades for sanitary sewers

If diameter or condition is …	Then minimum slope is …
first 25 upstream dwelling units	1 %
first leg—mh to mh [a]	1 %
250 mm	0.5 %
300 mm and larger	MOE guidelines

[a] If length is less than 50 metres use 2 percent.

The minimum grade on all sewer sizes will be established by determining the minimum grade necessary to achieve an actual velocity of at least 0.6 metre/second.

However, the engineer shall investigate the actual velocity in the sewer for instances where the design flows are low, such as in cul-de-sacs, and make a technically viable attempt to obtain self-cleansing velocities.

Bedding Requirements—Flat Sewers

In cases—usually existing small diameter sewers— where sewers have flat slopes, the bedding for the replacement sewer pipe will be concrete or concrete encased so it can hold its grade. For details and additional design information, see City standard T-802.032-1.

Reinforced concrete pipe is only available for diameters 300 mm and larger and is manufactured with a lay length of 2.29 metres. Diameters 250 mm and smaller are only available in non-reinforced concrete and manufactured with a lay length of 0.91 metre. Therefore, if a 250 mm diameter sewer pipe is required, non-reinforced concrete will not be accepted.

Pipe Material

Both rigid and flexible pipe are permitted in the construction of sanitary sewer systems including municipal service connections. These materials include reinforced concrete, PVC, and vitrified clay. The bedding design, however, must be compatible with the type of pipe material used.

Rigid pipe is recommended in areas of high utility congestion, where bedding may be undermined in the future.

In non-industrial areas, the pipe material of the sanitary sewer depends on the diameter.

Table: Sanitary sewer preferred material

If diameter is …	Then pipe material to use is …
less than or equal to 375 mm	PVC
equal to 450 mm	PVC or CONC
greater than 450 mm	CONC

For flat grade installations, additional review may be required by the City. PVC pipe is not permitted to be connected to a trunk sewer as per City standard T-1006.01-1.

Only PVC and vitrified clay pipe material will be allowed for industrial areas.

Ultra-rib pipe is not approved for use as a sanitary sewer.

For more information regarding acceptable materials, reference should be made to Chapter 6, *Material Specifications*.

Bedding Requirements

The class of pipe and the type of bedding will be selected to suit loading and proposed construction conditions.

Flexible pipe bedding will be as per OPSD 802.010, 802.013 and 802.014.

Rigid pipe bedding will be as per OPSD 802.030, 802.031, 802.032 802.033 and 802.034.

The pipe material, class, and type of bedding will be shown on the profile drawing for each section of sanitary sewer.

Pipe Class

Pipe class will be selected to suit the bedding class, final buried depth and surface loading.

Mainline PVC sewer pipes installed at grades of half percent and greater will have a dimension ratio (DR) of 35 and be green in colour.

Mainline reinforced concrete sewer pipes will be a minimum class of 65-D.

Minimum Depth of Cover

The minimum depth of a sanitary sewer will be 2.75 metres measured from the centre line elevation of the road to obvert of the sewer.

If the standard depth for a residential sanitary sewer is not possible the sewer inverts must be at least 0.9 metre to 1.5 metres below the basement floor levels.

When the standard depth is not possible, all basement slab elevations of a depth up to one metre above the sanitary pipe obvert will be shown on the profile drawing and the lot grading plans.

In new commercial areas, sewer depths should be a minimum of 3.5 metres below the centre line of road, where possible.

Where existing sewers are present, for proposed buildings with basements substantially below street level, the installation of ejector pumps from the building into the sewer are acceptable.

Table: Sanitary sewer minimum depths

If land use …	Then minimum depth is …
residential	2.75 m
industrial	2.75 m
commercial	3.50 m

Maximum Depth of Cover

Maximum depth of cover for concrete pipe will be in accordance with OPSD 807.010, 807.030 and 807.040. For PVC gravity sewer pipe, the maximum cover will be in accordance with OPSD 806.040.

Location and Alignment

Sanitary sewers will be located 1.5 metres—as measured from the centre line of pipe—on either the north side or the east side of the road centre line unless a conflict with other utilities requires a revised location. Exceptions will occur on curved streets. In order to avoid excess surface water entering sanitary sewer maintenance holes, they should be located at least 1.5 metres from the curb line and away from low points. Sanitary maintenance holes must be located in the asphalt area of the road, for maintenance purposes.

Pipe Crossing Clearances

The minimum clearances required when sanitary sewers cross other services will be measured from outside wall to outside wall of pipe. Clearances with respect to watermains will be as per MOE procedure F-6-1.

Table: Pipe clearances

If crossing is …	Then minimum clearance is …
Over or under a storm sewer	300 mm
Under a watermain 450 mm diameter or less	300 mm
Over a watermain 450 mm diameter or less	500 mm
Over or under a watermain greater than 450 mm diameter	500 mm

The minimum horizontal separation between a sewer and watermain is 2.5 metres. In cases where it is not practical to maintain separate trenches or the recommended horizontal separation cannot be achieved a deviation may be allowed. For more information go to Chapter 4, *Watermains*, section *Crossings and Parallel Trench Installations*.

Minimum Distance between Sewers

The minimum distance between new parallel sewers in a separate trench will be 3 metres, as measured from centre line of pipe to centre line of pipe. Exceptions can be made for site specific design constraints and depths such as dual maintenance hole installations.

It is preferred that a one metre minimum separation from outside wall to outside wall will be provided to permit installation of service connections and the future maintenance of the underground servicing.

When sanitary and storm sewers are constructed in a common trench, the storm sewer will be constructed parallel to the sanitary sewer with 600 mm minimum separation between the outside wall of the two pipes as specified in a dimension table on City standard T-701.013-1, T-701.013-2 or T-701.013-3.

High Water Table Conditions

When there exists a possibility that groundwater may be diverted and follow the path of the new sewer, groundwater barriers should be constructed in adequate numbers to prevent groundwater migration down sewer trenches. Should the conditions require the need for clay seals, it should be discussed with the engineer on a specific pipe location basis.

For details and additional design information, see OPSD 802.095 and OPSS 1205.

Gaskets in Contaminated Soil Conditions

Prior to specifying the pipe material, the soils should be assessed for contamination. Should the assessment reveal that there is contamination—even in trace amounts—the longevity of ordinary rubber gaskets becomes a concern. Therefore, when locating sewer pipes in areas of soils contaminated with hydrocarbons, nitrile gaskets will be specified for the installation.

Drawings must show locations of all nitrile gaskets.

Deflection Testing

Plastic sewer pipes will be tested for deflection as per OPSS 410. Ring deflection testing will be performed on all sewer pipes constructed using plastic pipe.

Pipes in sizes 250 mm to 450 mm in diameter will have an allowable deflection of 7.5 percent of the base inside diameter of the pipe.

The test will be carried out a minimum of 30 days after the sewer trench has been backfilled and installation of service connections or prior to paving the roadways.

Maintenance Holes

Spacing of Maintenance Holes

Maintenance holes will be located at each change in alignment, pipe size, grade or pipe material, and at all junctions with lateral sewers.

Generally, the maximum allowable horizontal spacing between maintenance holes is as follows:

Table: Sanitary maintenance hole spacing

If diameter of sewer is …	Then maintenance hole spacing is …
250 mm–450 mm	90 m to 120 m
525 mm–750 mm	up to 150 m
greater than 750 mm	150 m

Larger diameter sewers may use a greater maintenance hole spacing. The design will be made in consultation with the City.

Maintenance Hole Sizing

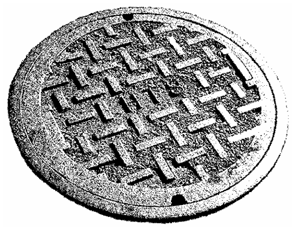
All sizing of sanitary precast maintenance holes are based on incoming and outgoing pipe sizes and will be sized as per City standard T-701.021. The minimum diameter for maintenance holes is 1200 mm.

The construction of maintenance holes will be in accordance to City standards T-701.010, T-701.011, T-701.012-1, T-701.013 and the pre-cast manufacturer specifications.

The type and size of the maintenance hole will be specified on the profile drawing.

When any dimension of a maintenance hole differs from the standard, the maintenance hole will be individually designed and detailed.

Maintenance Hole Frame and Covers



Maintenance hole frame and covers are required for all maintenance holes and will be in accordance with OPSD 401.010 type 'A' closed.

Where there is an existing type 'B' open maintenance hole cover, adequate ventilation of the combined sewer may be necessary. In this case, replace with OPSD 401.010 type 'B' open.

Maintenance hole frame and cover will be clear of curb and gutters and clear of bends in the road for new construction.

All maintenance hole chamber openings will be located on the upstream side of the maintenance hole.

Watertight Maintenance Hole Lids/Covers

Watertight bolt down covers are required when sanitary maintenance holes are located within storm low points, ponding areas and overland flow routes. Overland routes can include flood plain areas, walkways within an easement, open space areas, gutter locations or any other location where overland flow is directly over and adjacent to the maintenance hole lids. Watertight maintenance hole lids will also be required to be installed at locations where it is necessary to guard against sanitary surcharge conditions.

In the future SPQA unit will develop standard drawing for extended vents.

Where significant sections of sanitary sewers are provided with watertight covers, extended vents will be required at every third maintenance hole to prevent excessive sulphide generation. The elevation of the vents will be above the regional flood elevation as determined by the Toronto and Region Conservation Authority (TRCA). When possible, maintenance holes will be positioned in a suitable location to allow venting.

For details and additional design information, see OPSD 401.030.

Lockable Maintenance Hole Covers

Lockable maintenance hole covers are required to control access and to protect the public. We recommend that they be located through park blocks, open space blocks, pumping stations or water pollution control plants.

Maintenance holes located within easements in parks, open space or other locations as deemed necessary will be equipped with lockable watertight maintenance covers.

For details and additional design information, see OPSD 401.060.

Maintenance Hole Steps

For pre-fabricated maintenance holes, steps will be solid circular steps as per OPSD 405.020.

For cast-in-place maintenance holes, steps will be solid rectangular steps as per OPSD 405.020.

Drop Structure

External drop pipes will be provided when the difference in invert elevations is greater than 1.22 metres. The external drop pipe will be one size smaller than the sewer line—minimum 200 mm diameter. The alternative of providing a deeper sanitary sewer instead of a drop maintenance hole may be considered at the City's discretion. City standard T-1003.01 Type 'C', is preferred. However, the use of Y's and 45 degree bends for drops, Type 'A' and 'B', respectively, may be accepted.

When the difference in elevation between the maintenance hole inlet and outlet pipes exceed 1.22 metres, a drop structure will be provided. When the drop is between 200 mm and 1220 mm, the pipe grades will be adjusted such that the maximum drop is 200 mm.

Internal drop pipes—if considered—requires the maintenance hole diameter to be increased by one size, unless it is shown that access and maintenance is not compromised. Internal drop pipes must be secured to the interior wall of the maintenance hole. They will only be used if the use of an external drop pipe is not possible. For details and additional design information, see City standard T-1003.01-2.

Maintenance Hole Safety Landings

When the depth from invert to top of maintenance hole exceeds 5 metres, a safety platform will be provided. Safety grates will not be more than 5 metres apart. The platform will be located 2 metres below the maintenance hole cover and 2.8 metres above the maintenance hole invert. Access hatches in safety gratings are to line up to allow proper use of fall arrest equipment.

Benching

Benching of maintenance holes will conform to City standard T-701.021. Benching height will extend from the pipe obvert to improve hydraulic performance.

A benching detail is to be shown on the plan portion of the engineering drawing when the proposed benching differs from the City standard.

Steps in Benching

Steps in maintenance hole benching will be required when the pipe diameter is greater than 450 mm. The last step will be 300 mm above benching or 600 mm above the invert, if no benching.

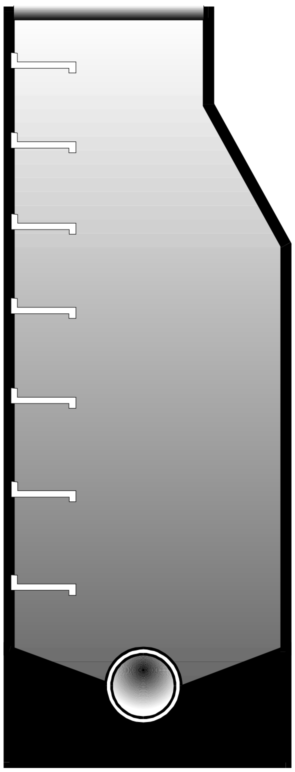
Hydraulic Losses at Maintenance Holes

Suitable drops will be provided across maintenance holes to compensate for the energy losses due to the change in flow velocity and to accommodate the difference in depth of flow in the upstream and downstream sewers. When the pipe size does not change through a maintenance hole and the upstream flow velocity does not exceed 1.5 metres/second, the following allowances will be made to compensate for hydraulic losses.

Table: Allowance for hydraulic losses

If alignment change is …	Then drop required is …
straight run	grade of sewer or 0.03 m
15°–45°	0.030 m – MOE minimum 0.075 m – preferred
45°–90°	0.06 m – MOE minimum 0.15 m – preferred
junctions and transitions [a]	MOE calculations

[a] For all junctions and transition maintenance holes and when the upstream flow velocity exceeds 1.5 metres/second, the drop required will need to be calculated using the MOE guidelines; "*Hydraulic Calculations for Junction and Transition Maintenance Holes*". Calculations for hydraulic losses will be included in the design submission.



The engineer will adhere to the following guidelines:

- Endeavour to keep entrance and exit velocities equal in order to reduce the amount of drop required, the engineer will try to restrict the change in velocity. Velocity change from one pipe to another in a maintenance hole will not exceed 0.6 metre/second.
- No acute interior angles will be allowed.
- No decrease in pipe diameter from a larger size upstream to a smaller size downstream will be allowed regardless of an increase in grade.
- Where an increase in pipe size occurs at the downstream side of the sanitary maintenance hole, maintain obvert elevations of the incoming and outgoing pipes or have incoming pipe obverts higher than outgoing pipe obverts.

Alignment of Pipe in Maintenance Holes

When two lateral sewers connect at a maintenance hole and are aligned opposite to one another such that the flows impinge on one another, the losses are extremely high. The flow is restricted causing back-ups. Therefore, aligning 600 mm and larger lateral sewers opposite one another in a maintenance hole is to be avoided. In order to reduce the losses, the installation of an upstream maintenance hole to turn the flow 45 degrees prior to intersecting the mainline sewer is preferred.

Pipe Connections to Maintenance Holes

Sewer connections at maintenance holes will be obvert to obvert. If this is not possible, the downstream pipe obvert will be lower than the obvert of the upstream pipe. Invert to invert connections will not be allowed.

The connection of the sewer pipe at the maintenance hole will utilize a flexible joint for either rigid or flexible pipe. A concrete cradle may be used for rigid pipe. For details and additional design information, see City standard T-708.020.

Flexible Rubber Connectors

Flexible rubber connectors can also be used for connecting pipe to maintenance holes. Rubber connectors are either cast-in-place during manufacture of the pre-cast product or installed into a cored or preformed hole in the finished maintenance hole.

Pipe Connections to Existing Sanitary Sewer

For connecting sewers greater than 375 mm in diameter, a new maintenance hole is required over the collector sewer provided the collector sewer is no larger than 1050 mm in diameter. In such cases, place the off-line maintenance hole outside of the main traffic corridor in the street being serviced by the local sewer.

The exception is works constructed in accordance with City standard T-1006.01-1 for connections to the City's trunk sewer system which can be applied to rigid pipe connections.

Municipal Sanitary Service Connections

Sanitary service connections to single family and semi-detached dwellings will be individual service connections. No dual connections are permitted.

No new connections for foundation drains, weeping tile drainage, or roof drains are permitted to connect to the sanitary sewer in accordance with Sewer Use Bylaw, Chapter 681 of the Toronto Municipal Code.

Location

In the future SPQA unit will develop drawing to show this.

Sanitary service connections will be installed at the mid-point of the frontage of a single family lot to the left of the water connection—when facing the lot—and ending inside the property line on private property. The location of the sanitary sewer service connections for semi-detached lots will suit the house style.

Minimum Size and Grades

Table: Service connection minimum size and grades

If development is …	Diameter of sanitary sewer is …	Then diameter and slope of the connection is …	Preferred method of connection
Residential, single family and semi-detached	250 mm	125 mm or 150 mm @ 2 % (desirable)	125 mm pipe – service saddle, 150 mm pipe – prefabricated "T"
	250 mm	125 mm or 150 mm @ 1 % (minimum)	

Service connections for multi residential, commercial, industrial, and institutional buildings will be individually sized according to the intended use and the requirements of the Ontario Building Code—Section 8.2, *Design Standards*. New minimum size sewers and service connections shall be PVC. Service connections to existing sanitary sewers other than PVC pipe, such as concrete, asbestos cement, clay, and brick may require the connection to be made to the existing stub connection with the approved flexible connector and reviewed on a case-by-case basis.

Pipe Class of Laterals

PVC service laterals 100 mm to 150 mm in diameter will be class DR 28.

Depth of Cover

The minimum cover at street line will be 2.3 metres below the finished centre line road elevation.

The maximum cover at street line will be 2.75 metres below the finished centre line road elevation.

Sanitary Service Connections to Sewers

Connections to Existing Mainline Sewer

No service connection of a size greater than half the diameter of the mainline sewer will be cut into the main sewer. For retrofit installations, a maintenance hole must be installed on the main sewer at the intersection of a service connection, which has a size greater than half the diameter of the main sewer.

A 150 mm service connection will only be permitted to connect to an existing 250 mm main line sewer if a manufactured tee is installed and provided that the invert of the service connection is above the spring line of the main sewer.

In neighbourhoods where there are existing 200 mm diameter mainline sewers, a 100 mm diameter service connection will be permitted to connect to the mainline sewer with a strap and saddle.

New Residential Service Connections

Sanitary service connections up to 150 mm in diameter must be connected to the sanitary sewer. No sanitary service connections will be constructed into any sanitary maintenance hole with the exception of connections to the upstream maintenance hole in cul-de-sacs. The connection to the mainline sewer will be made with a manufactured tee or a saddle for large diameter sewers. All service connections to the mainline sewer will be made above spring line on the main pipe.

The colour of the sanitary service connection pipe will be green. White will be used for storm service connections.

Using this rule of thumb will reduce the number of maintenance holes in the roadway.

Rule of thumb

If the service connection diameter is less than or equal to half the diameter of the main sanitary sewer, then no maintenance hole is required.

Residential Service Connections in Cul-de-sacs

A maximum of three connections will be permitted into the upstream maintenance hole in cul-de-sacs. The connection should be aligned within 15 degrees of the main sewer. Lateral service connections must be benched as per City standard T-701.021. Lateral service connections and downstream mainline sewer obverts are to be equal. The City will not accept drop structures for the sanitary service connections into the maintenance holes.

Connections to Existing Sewers for Lot Infill Situations

When connecting a sanitary service connection to an existing sewer in an infill situation, the connection must be sized appropriately and made utilizing a saddle or manufactured tee. To determine if the area you are working in is a combined sewer area, see Appendix C, *Maps*.

Multi-family, Commercial, Institutional and Industrial

Sanitary service connections 250 mm in diameter and larger will be connected to the mainline sewer with maintenance holes for new sewer construction, if the service connection is greater than half the pipe diameter. Where the sanitary sewer is existing, a tee will be installed on the mainline sewer and a maintenance hole will be placed on private property as close to the property line as possible.

Control Maintenance Hole

The City requires a control maintenance hole located on the property of the owner, as close to the property line as possible as per Section 681-10-A.(1) of the Toronto Municipal Code. This requirement will apply to all multi-family, commercial, industrial and institutional developments.

Sanitary Service Connection Risers

In the case of deep sewers, vertical service risers from the main sewer at depths exceeding 4 metres should be installed at an angle not less than 45 degrees from the vertical. When the sanitary service connection is installed between 45 degrees and 67.5 degrees, an approved controlled settlement joint is required at the tee. The riser will not exceed 3 metres in height without approval from the City. The riser will be installed so that the elevation is 2.75 metres below the centre line road elevation. For details and additional design information, see City standard T-708.01.

Residential Sanitary Service Connection Cleanouts

In the future, SPQA will prepare a second drawing to specify clean out pipe to be 100 mm in diameter.

Sanitary service connection cleanouts are required within the right-of-way and will conform to City standard T-708.01-2. The vertical cleanout pipe will be 150 mm in diameter and capped with a cast iron cover in heavy traffic areas such as driveways. Plastic cleanout caps are suitable for sodded areas.

Where sanitary service connections exceed 20 metres, a cleanout is required within the right-of-way as per City standard T-708.01-2.

Service Connections in Easements

Sanitary sewer service connections in an easement will only be allowed subject to the satisfaction of the General Manager, Toronto Water as per Section 681-11-B of the Toronto Municipal Code. An easement encroachment agreement stipulating the conditions of the encroachment will be required for all sanitary sewer service connections.

A service connection to a trunk sanitary sewer is not allowed. Any application for an exemption must be approved by the General Manager, Toronto Water.

Slope Anchors

Sewers at a 20 percent grade, or greater, should be anchored securely with concrete blocks or equivalent, spaced as follows:

- grades 20 to 35 percent – not over 11 metres centre to centre
- grades 36 to 50 percent – not over 7 metres centre to centre
- grades over 50 percent – not over 5 metres centre to centre

At steep grades, air jumpers may be required to ensure hydraulic performance.

Flexible pipe such as PVC is not permitted to have rigid concrete anchor blocks as it creates a shear point.

Inverted Syphons

Inverted syphons should be avoided and only be used when crossing an obstacle such as a river or pedestrian tunnel, and when lowering the downstream system is impractical. Due to the additional maintenance costs associated with this type of system, a cost effectiveness analysis is to be prepared by the engineer. The use of this pipe system will be reviewed on a case-by-case basis and require approval by the General Manager, Toronto Water.

Number of barrels – minimum of two barrels to convey various flow conditions. One barrel is to be designed to be used for low to average flows and the additional pipes added for higher flow conditions. Syphon barrels will be installed in a casing using low strength grout.

Minimum pipe size and pipe strength – the minimum barrel diameter will be 150 mm. Pressure pipe will be specified at the required pipe strength for the anticipated internal pressures resulting from excessive surcharging.

Velocity at design – for each barrel should have a minimum velocity of one metre/second.

Uplift protection – syphon pipes and chambers, when subject to hydrostatic uplift forces, must have sufficient weight or anchorage to prevent their flotation when empty.

Chamber design – special attention should be taken for the design of the inlet and outlet chambers on any syphon installation. For details respecting the design of inlet and outlet chambers reference should be made to "*Wastewater Engineering: Collection, Treatment, Disposal* " by Metchalf and Eddy, Inc. and "*WPCF Manual of Practice No. 9 – Design and Construction of Sanitary and Storm Sewers* ".

Maintenance provisions – provisions will be made at all syphon installations for routine maintenance or flushing of the barrels. These flushing facilities are to be located at the inlet end of the syphon.

To avoid the accumulation of odourous, hazardous and corrosive gases such as hydrogen sulphide in the syphon, the designer should consider the need for an air jumper pipe.

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Chapter 3 – Storm Sewers

The storm drainage system is designed to limit flooding and minimize hazardous conditions under major storm events. The storm drainage system shall provide a reasonable level of convenience and safety for pedestrians and motorists by removing lot and street surface runoff under the minor storm event.

Calculation Methods

There are numerous planning and design tools available to perform hydrologic and hydraulic analyses on a sewer system. The tools range from steady state manual calculations with spreadsheet type models to more complex dynamic models that are more representative of actual conditions.

Rational Method

Historically when designing a storm sewer system under steady state and free flow conditions, most designers use a model based on the Rational Method and Manning's formula to determine peak flows and pipe capacity, respectively. Under certain circumstances, these types of models are acceptable provided that the drainage area is less than 40 hectares and the outlet isn't submerged. The Rational Method cannot be used for dual drainage analyses. For larger areas such as collector sewers, a dynamic computer model analysis must be undertaken.

Dynamic Computer Models

When stormwater management is included in designing a storm sewer system, a dynamic computer model that simulates inflow hydrographs and the effect of storage attenuation should be used. A dynamic model will help ensure that a 2-year level of protection with no storage is provided for the 2-year storm and will also ensure that the sewer system is protected against critical surcharging during the 100-year storm event. Also when a system is at risk of experiencing surcharge, the use of a dynamic hydraulic model is preferred.

When analyzing the capacity of an existing system, a dynamic computer model will provide more realistic results since it can account for effects of limited catchbasin capture, depression storage, times of concentrations, diurnal flow patterns and so on.

When designing large collector storm sewer systems with drainage areas greater than 40 hectares, computer models or similar hydrograph based simulation methods must be used unless the engineer can provide adequate justification as to why an alternative method should be used. For smaller developments—less than 15 hectares—simplified methods based on the results of detailed modeling is acceptable.

In choosing a computer model, it is important that the engineer consider the data and model limitations.

Similar to sanitary sewers, the use of more complex models is recommended for the analysis and retrofit of existing combined sewer systems.

Calibration of Models

If a hydrologic or hydraulic model is being used to determine the capacity of an existing system, it is recommended that the model be calibrated using actual flow data.

Existing Models

Many storm and sanitary sewer sheds throughout the city have previously been modeled. The City may already have calibrated dynamic or static models for these sewer sheds. The consulting engineer for the developer should contact the development engineering section prior to undertaking any work to confirm whether existing models or existing data sets are available for the study area.

Receiving System Capacity

When determining the capacity of an existing storm sewer system or combined sewer system, flow monitoring information may be used to calibrate a hydrologic or hydraulic model.

Infill Development

All infill development or re-development such as developments within an existing built-up subdivision must adhere to the drainage requirements of the Wet Weather Flow Management (WWFM) guidelines. If the existing subdivision is partially separated, that is the foundation drains are connected to the sanitary sewer system, any new development must drain its foundation drain to the surface via sump pump.

Where an exemption has been granted by the General Manager, Toronto Water, any new foundation drain connections to a storm sewer must have a backwater prevention valve.

The valve will be installed in an accessible location and maintained by the property owner.

Rezoning Applications

All residential, commercial, institutional, and industrial rezoning applications must manage storm wet weather flow at the source according to the WWFM guidelines. If this is not possible, a review of available downstream capacity with respect to the storm sewer is required. If it is found that the public sewer system is inadequate, the developer will be responsible to provide the necessary upgrades to the system, unless the City requests over sizing, in which case the project will be considered a development charges project.

Site Plan Applications

Refer to the Wet Weather Flow Management Guidelines for water balance targets and recommended stormwater management strategies.

All commercial, institutional, and industrial site plan applications must include on-site stormwater management measures to minimize the impact on the downstream storm system. However, in certain situations it may be ineffective or impractical because of physical constraints and maybe fully exempted. For more information, see the WWFM guidelines.

Connecting to Existing Combined Sewer System

New development within the city's combined sewer area must incorporate measures to reduce the volume of runoff to the combined sewer system.

Residential Areas

Direct roof drain connections to the combined sewer system are not permitted. Rather, the roof drain will discharge to the surface as far away as is practical from the foundation wall to help minimize seepage into the foundation drains.

Commercial and Industrial Areas

Commercial and industrial areas will use on-site detention techniques to limit the runoff from the subject site to a maximum predevelopment 'C' coefficient of 0.5.

New storm drainage systems from infill developments will not be permitted to connect to existing combined sewers except as an interim measure, where sewer separation is to be ultimately implemented, or where circumstances allow no other alternative. An application is to be made to the General Manager, Toronto Water for review and approval.

Greenfield Development

All green field developments draining to an existing outlet must ensure that the downstream system has adequate capacity for the additional flows.

Storm and Combined Sewer Design

The total design flow for a combined sewer will include the total domestic flow, including extraneous flow plus the storm flow for the required design period.

Dual Drainage Considerations

The accepted best practice for the collection of urban storm drainage systems consist of two separate and distinct systems—the minor system and the major system. This two system approach is called a "dual drainage system". The minor system consists of ditches and underground storm sewer system which provides the first response level of protection by conveying flows from the more frequent, lower intensity rainstorms, with minimal overland flow for traffic convenience. The major system, which consists of specially engineered overland flow routes along the street network, swales, high capacity water courses and so on, is designed to convey runoff from the less frequent high intensity storm events that are in excess of the minor system design capacity to an engineered receiving point.

Flow to the minor system is restricted to the capacity of the pipes, which is typically the runoff from a storm event with a 2-year return period. During the greater than 2-year up to the 100-year events, which exceed the capacity of the minor system, inlet control devices limit the flow into the pipes causing excess flow to stay at the surface where it is controlled and conveyed overland.

If there are no outlets available for the major system, flow storage areas may be created to detain water and allow it to flow through the minor system once the storm subsides, thus reducing the risk of surface flooding. These flow storage areas can be street low points, park storage—subject to approval from parks department—or stormwater management ponds or underground tanks. When designing a dual drainage system the designer must consider that the streets will act as open channels during severe events and that they must be designed accordingly.

Hydraulic Grade Line Calculations

For minor flow, storm sewers must be designed to convey design flows when flowing full with the hydraulic grade line (HGL) at or below the crown of the pipe. In some cases, the HGL may be elevated due to boundary conditions.

Storm sewers must be designed to account for hydraulic losses due to bends, junctions, and pipe transitions.

HGL calculations are required where surcharge conditions may occur due to backwater from stormwater ponds, outlets, downstream systems or as required by the City.

Levels of Protection in Existing Separated Areas

Existing separated areas are defined as all currently developed areas other than combined sewer areas that have been designed and constructed with minor drainage systems only. When designing a storm sewer system in existing separated areas, the following should be considered:

Minor System in Existing Separated Areas

- In existing separated areas, the minor system for local and collector roads shall be designed to accommodate the runoff from a storm with a return period of 2 years under free flow conditions. The flow must be controlled to meet the existing level of protection of the existing system if it is less than 2 years.
- For urban arterial roads the minor system shall be designed for a 10-year return period under free flow conditions.
- For road underpasses the minor system shall be designed for a 10-year return to 25-year return period under free flow conditions. Due to the low elevation, overland flow away from the depressed areas will not normally be possible.
- If a new pipe or an upgraded pipe receives flow from areas where the existing storm system is designed with a return frequency greater than 1:5 years such as arterials, road underpasses, and so on, the engineer must accommodate the increase in the flow contributions from these areas in the new design.
- Connecting new storm drainage systems and associated flows to existing combined sewers will not be permitted except as an interim measure where sewer separation will ultimately be implemented or where circumstances allow no alternative. In all cases, the impact on the combined sewer overflow must be determined.

- For up to the minor system design storm, flow spread within the right-of-way is to be controlled without flow storage. The presence of bike lanes is to have no effect on the flow spread criteria.

Typical allowable flow spreads are as follows:

Table: Minor system flow spread in existing separated areas

Type of road	**Minor storm**	**Criteria to follow**
local	2 year	No barrier curb overtopping.[1] Flow spread not to exceed one half of the lane width.
collector	5 year	No barrier curb overtopping.[1] Flow spread must leave at least one lane free of water.
arterial	10 year	No barrier curb overtopping.[1] Flow spread must leave at least one lane free of water in each direction.
highway	10 year	No encroachment is allowed on any traffic lanes.
road underpass	10–25 year	No barrier curb overtopping.[1] Flow spread must leave at least one lane free of water in each direction.[2]

[1] When no barrier curb exists, encroachment onto adjacent private property is not to occur.

[2] For road underpasses of importance and or on a case-by-case basis alternate means such as pumping may be considered to increase the storm level of protection beyond the minor system capacity.

Major System in Existing Separated Areas

Most storm sewers in older neighbourhoods have been designed with the minor system only. Most do not have inlet control devices or watertight maintenance hole covers to control inflow and prevent sewer surcharge. In addition, most do not have engineered overland flow routes or defined outlets to control surface water depths. If a storm event occurs in excess of the minor system capacity, depending on the intensity and duration of the storm, the minor system can be expected to surcharge.

When considering rehabilitating or upgrading an existing storm sewer system, consideration must be also given to upgrading the major system drainage, if possible. The engineer should contact Toronto Water – sewer asset planning unit to find out if overland flow routes are being planned for the design area. Otherwise, without the availability of an outlet, favourable topography, and level controls; setting maximum depths for flow control during events in excess of the minor system capacity will not be practical or affordable.

The major system will be reviewed to ensure that any new development will not have a negative impact on an existing major system.

Levels of Protection in Greenfield Developments

All new storm sewers in greenfield developments will be designed based on the principles of dual drainage. The following shall be considered when designing a storm sewer system in a greenfield development.

Minor System in Greenfield Development

- Storm sewers must be designed to convey design flows when flowing full with the hydraulic grade line at or below the crown of the pipe. The maximum hydraulic grade line elevation for the minor system is half metre below the basement floor elevation or 1.8 metres or more below the crown of the road for the 100-year event.

- New sewers must incorporate inlet control measures to prevent surcharge and thereby prevent basement flooding for events up to a 100-year return frequency. This is to provide for the possibility that a service connection will be connected to the storm sewer. If installed, a backwater prevention valve will required to provide additional basement protection for storm sewer backups during these rare events.

- The minor system for local and collector roads will be designed to accommodate a 2-year and 5-year return period under free flow conditions, respectively.

- Collector sewers will be designed to accommodate the flow they receive under free flow conditions. If a new pipe receives flow from areas where the existing storm system is designed with a return frequency greater than 1:2 years, the engineer must accommodate the increased flow contribution from these areas in the new design under free flow conditions.

- If the downstream receiving system has capacity restrictions, the new system must be controlled to the available capacity and in a manner that will not cause adverse impacts downstream.

- For the minor system design storm, flow spread across the right-of-way is to be controlled without flow storage. The presence of bike lanes is to have no effect on the flow spread criteria. Typical allowable minor storm flow spread are as follows:

Table: Minor system flow spread in greenfield developments

Type of road	Minor storm	Criteria to follow
local	2 year	No barrier curb overtopping.[1] Flow spread not to exceed one half of the lane width.
collector	5 year	No barrier curb overtopping.[1] Flow spread must leave at least one lane free of water.
arterial	10 year	No barrier curb overtopping.[1] Flow spread must leave at least one lane free of water in each direction.
highway	10 year	No encroachment is allowed on any traffic lanes.
road underpass	10–25 year	No barrier curb overtopping.[1] Flow spread must leave at least one lane free of water in each direction.[2]

[1] When no barrier curb exists, encroachment onto adjacent property is not to occur.

[2] For road underpasses with high traffic volumes and or on a case-by-case basis alternate means such as pumping may be considered to increase the storm level of protection beyond the minor system capacity.

Major System in Greenfield Development

The major system must be able to convey the flow resulting from a 100-year event without causing damage to private property and with minimum inconvenience to the public. The maximum permissible overland flow depth for each type of road is listed below.

Table: Major system flow spread in greenfield developments

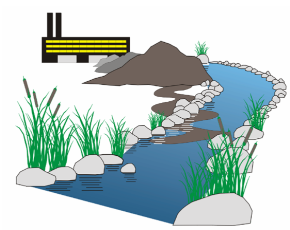
Type of road	Major storm	Criteria to follow Overland flow depth
open spaces	greater than 2 up to 100 year	As required for overland flow outlets.
local	greater than 2 up to 100 year	Maximum depth of flow shall be the lesser of 15 cm above the crown of the road or the water level up to the right-of-way.
collector	greater than 2 up to 100 year	Maximum depth of flow shall be the lesser of 10 cm above the crown of the road or the water level up to the right-of-way.
arterial	greater than 10 up to 100 year	No barrier curb overtopping.[1] Flow spread must leave at least one lane free of water in each direction.
road underpass	greater than 10 or 25 up to 100 year	Since there is no overland flow route possible, water can be expected to accumulate for the event.[2]

[1] When no barrier curb exists, encroachment onto adjacent property is not to occur.

[2] For road underpasses with high traffic volumes and or on a case-by-case basis alternate means such as pumping may be considered to increase the storm level of protection beyond the minor system capacity.

Major System Flow Routes in Greenfield Development

Major system flow routes must be unobstructed with continuous slopes such as no sags or low points, leading to a stormwater management facility, outlet structure or receiving watercourse.



Flow routes for the major system consist of roadways, open channels, roadside ditches, rear yards or swales in easements on private property.

Velocities in overland flow channels should be minimized as the force of moving water on objects in its path increases with the square of velocity. If the public has access to the flow routes, the velocities and depths of flow for the major overland flow system should not exceed the values indicated in the following table. The table lists the flow depths that a child weighing 20 kilograms would be able to withstand in a concrete lined channel at the selected velocities. Values outside of these limits must be approved by the General Manager, Toronto Water.

Table: Permissible depths for submerged objects

Water velocity (m/s)	Permissible depth (m)
0.5	0.80
1.0	0.32
2.0	0.21
3.0	0.09

If a pathway between houses is used as a major system flow route, the pathway must be designed according to the principles of open channel flow. Basement windows will not be permitted on the side of the dwelling abutting the overland flow route.

Major system flow routes must be fully contained within public right-of-ways, walkways and so on. No part of the major system flow should be allowed on private property or close to the finished floor elevation of a building.

In order to prevent water from accumulating at or near buildings and not adversely affecting adjacent properties, an overflow must be provided from all sags or depressions. This overflow must control the maximum water elevation to a vertical separation—freeboard—of 0.15 metre below the finished floor elevation of the building or below the top of foundation for homes.

Levels of Protection in Combined Sewer Areas

The level of protection within a combined sewer system area is similar to those identified for existing storm and sanitary sewer systems. The combined sewer system is subject to a higher risk of property damage compared to separated and partially separated sewer systems due to the direct capture of storm flows and the presence of direct private property connections to the minor system.

Combined sewer system renewal or upgrade projects shall be designed to improve the level of protection in that area, to the greatest extent possible. Contact Toronto Water – sewer asset planning unit to find out if overland flow routes are being planned for the design area. If cost effective, provide a dual drainage system as outlined above. Otherwise the level of protection targets in combined sewer areas are the following:

A minor conveyance system must be designed to convey a least a 2-year storm event without surface ponding or basement flooding for the replacement or rehabilitation of existing sewers and a minimum of a 1:2 year return period for any new extension of a sewer. Sewers designed to a 2-year level of protection may still require flow restrictions to a 1:2 year level, if downstream capacity restrictions exist.

The ultimate level of protection provided should minimize the risk of basement flooding and maintain acceptable levels of convenience related to the use of roadways as well as public open spaces, that is to say surface flow storage or conveyance.

Surcharge of a combined sewer system is not permitted as the impacts are not predictable without detailed hydraulic modeling of the system in question and all upstream areas. The total accumulated capture rates should be no greater than the free flow capacity of the pipe.

Surcharge of the combined sewer may be allowed in situations where the vertical distance between the sewer and basement floors is greater than normal, at the discretion of the General Manager, Toronto Water.

Without the availability of an engineered major system—that is favourable topography, a suitable outlet, and level controls—setting maximum depths for flow control during events in excess of the minor system capacity will not be practical or affordable.

The construction of combined sewer systems is permitted within the designated combined sewer area. Confirmation as to whether a given sewer renewal or upgrade project falls within the boundaries of the designate combined sewer area is to be confirmed with the City on a case-by-case basis.

Currently the Ontario Ministry of the Environment (MOE) sewer design guidelines do not permit the design of combined sewers for new construction, however the MOE states that existing combined sewers may undergo rehabilitation or be replaced by new combined sewers provided that the municipality has met the requirements set out in MOE procedure F-5-5.

Service connections to combined sewers will comply with Chapter 681 of the Toronto Municipal Code.

Design Flow and Hydrology

All design flows for storm and combined sewer systems will meet the level of protection return period requirements outlined in this chapter.

Run-off Calculation

Rational Method

The Rational Method is a runoff estimation method based on relating the peak flow to the discharge area, rainfall intensity, and a runoff coefficient.

The Rational Method is expressed as:

$$Q = 2.78\ C\ I\ A$$

where:

Q	=	flow in litres per second
A	=	drainage area in hectares
C	=	run-off coefficient, dimensionless
I	=	intensity of rainfall in mm/hr

Storm sewers shall be designed to drain all lands for individual catchment areas based on the Rational Method. For drainage areas greater than 40 hectares, the Rational Method will not be accepted where storage, flooding, storm water quality and design of watercourses is involved. In those cases, only computer modeling methods will be acceptable.

Modified Rational Method

The modified Rational Method can also be used to obtain design flows.

Combined Sewer Design Flow

The total design flow for a combined sewer will include the total domestic flow—including extraneous flow—plus the storm flow for a required design period. All new sewers draining to a combined sewer system or the rehabilitation of existing combined sewers must follow the principles of dual drainage, if an adequate major system is available.

In all cases, the impact of combined sewer overflow must be determined.

Storm Design Requirements

IDF Curves and Equations

The following intensity duration frequency (IDF) curves will be applied to all districts across the City.

The equation of IDF curves is expressed as:

$I = A\,T^{C}$

where:

I = intensity of rainfall in mm/hour
T = time of concentration in hours
(use 10 minutes inlet time or initial time of concentration)

Parameters of A and C are as follows:

Table: Parameters of A and C

Return period (year)	A	C
2	21.8	-0.78
5	32.0	-0.79
10	38.7	-0.80
25	45.2	-0.80
50	53.5	-0.80
100	59.7	-0.80

Note: The parameter C is a negative value because the equation is written in a "multiplication" instead of "reciprocal" format. It can also be written in the familiar format as $i = a/(t + b)C$, where for a 2-year storm, a = 21.8, b=0 and c=0.78.

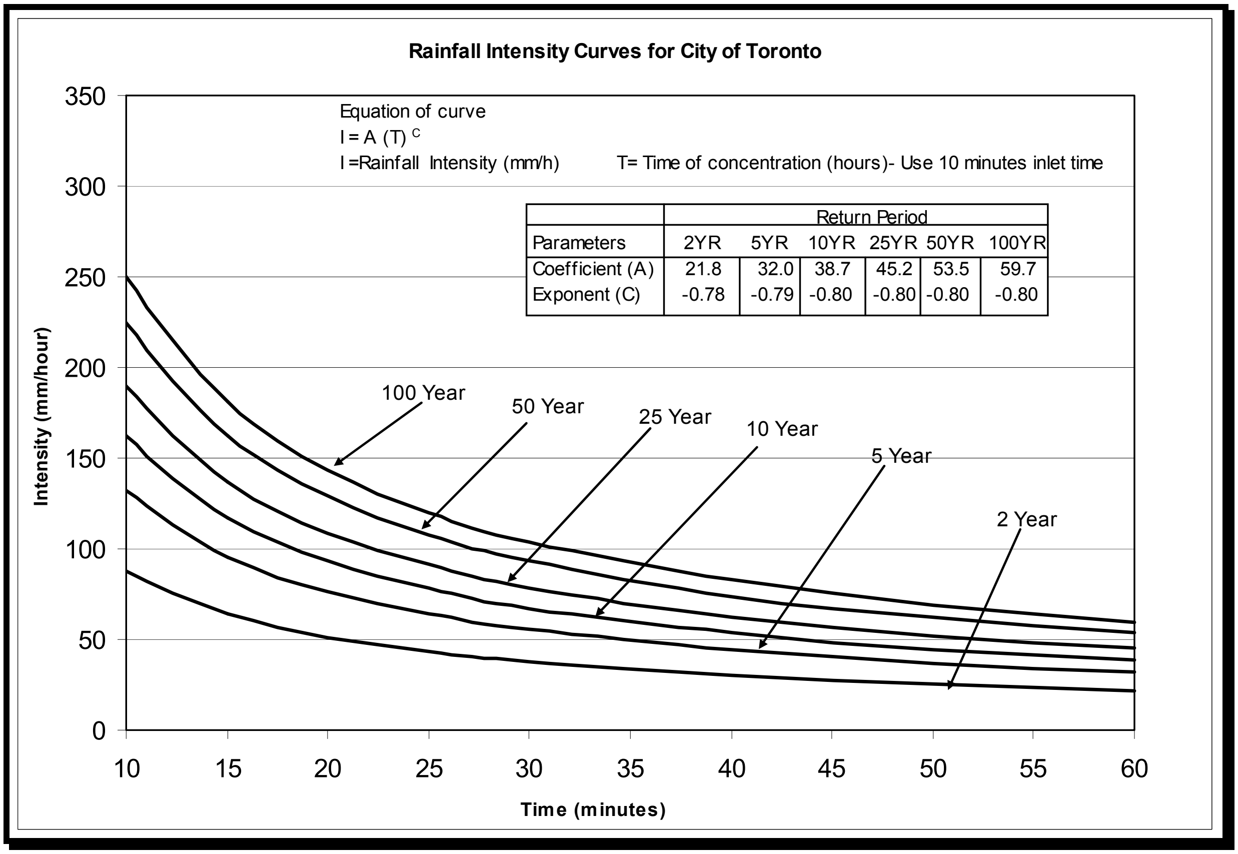


Figure: Rainfall intensity curves for City of Toronto

Storm (Minor System)

Storm sewers shall be designed to convey a 2-year return frequency storm and shall be designed to not surcharge during this storm event.

Storm (Major System)

Runoff flows in excess of the design capacity of the minor system will be conveyed via streets, open channels, and walkways to a public outlet. The overland flow system will be designed for a 100-year return frequency storm, to prevent flooding of private property.

Road grading must direct flows from the right-of-way to a safe outlet at specified low points. Outlets can be walkways or open sections of roads leading to open spaces or river valleys. Roads may be used for major system overland flow conveyance during the 100-year storm.

Runoff Coefficients

Runoff coefficients are based on the amount of impervious area for a particular land use:

Table: Runoff coefficients

Land use	Runoff coefficient
forest and dense wooded areas	0.10–0.25
parks, open space and playgrounds	0.25
single family residential	0.65
semi-detached residential	0.70
townhouse or rowhouse	0.75
apartments or hi-rise residential	0.75–0.85
industrial	0.85
commercial	0.90
institutional	0.75
densely built, paved	0.90
asphalt, concrete, roof areas—without green roofs	0.90

The above runoff coefficients are provided in absence of actual runoff coefficients. When the development consists of a mix of land uses, a weighted average value of the runoff coefficient should be calculated and its respective percent impervious.

Pre-Development Runoff

The allowable release rate to the municipal storm sewer system—minor system—from the development site during a 2-year design storm event must not exceed the peak runoff rate from the site under pre-development conditions during the same storm event or existing capacity of the receiving storm sewer, whichever is less.

When the percent imperviousness of a development site under pre-development conditions is higher than 50 percent, regardless of what the post-development condition is, the runoff coefficient 'C' to use in calculating the pre-development peak runoff rate is limited to a maximum value of 0.5.

Controlling Runoff from Developments

Potential increases in runoff rates resulting from new development must be controlled as required by the City and according to the WWFM guidelines before being discharged to an approved outlet. A stormwater management report must be prepared in support of development applications. This report must demonstrate how the development meets the requirements for stormwater quantity control, quality control, and water balance as specified in the WWFM guidelines. The use of non-structural measures to control runoff such as rear lot swales, grass filter strips, and the preservation of existing trees are encouraged.

Storm Trunk Sewers

Storm trunk sewers convey storm runoff. They provide an outlet for local storm sewers which crossed a former municipal boundary to an outlet. Storm trunk sewers also provide drainage for some former Metropolitan Toronto owned roads. The engineer should contact the City for additional information prior to undertaking any design work.

Storm Sewer Design

Storm sewer systems in the city will be designed in accordance with the City's WWFM guidelines and this criteria manual.

Pipe Capacities

Sewer capacities shall be computed by using the Manning formula. Generally, storm sewers shall be designed to flow at the full design capacity of the pipe. The sewer shall be designed for sub-critical flow.

Roughness Coefficient

For a new storm sewer design, the value of 'n' using the Manning formula will be:

Table: Manning 'n' value

If pipe material is …	Then value of 'n' is …
concrete (CONC)	0.013
polyvinyl chloride (PVC)	0.013
high density polyethylene (HDPE)	0.013
corrugated steel pipe (CSP)	0.024

Pipe Size

The minimum allowable size for a storm sewer will be 300 mm diameter.

Minimum Velocity

The minimum full bore velocity permitted in storm sewers will be 0.8 metre/second.

Maximum Velocity

The maximum full bore velocity permitted in storm sewers will be 6 metres/second.

Where velocities in excess of 3 metres/second are proposed, additional design factors shall be taken to protect against pipe displacement, scouring, erosion, and hydraulic jumps.

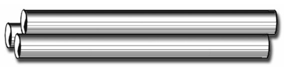
Supercritical flow should not occur.

Minimum Grades

The minimum grade on a 300 mm diameter storm sewer will be half percent.

For replacement of pipe sections of existing storm sewer systems, a minimum flow velocity of 0.8 metre/second shall be achieved.

Pipe Material



Both rigid and flexible pipe are permitted in the construction of storm sewer systems including municipal service connections and catchbasin leads. These materials include reinforced concrete and polyvinyl chloride. However, the bedding design must be compatible with the type of pipe material used.

Table: Storm sewer preferred material

If diameter is …	Then pipe material to use is …
less than or equal to 375 mm	PVC
equal or greater than 450 mm	CONC

Rigid pipe is recommended in areas of high utility congestion, when bedding may be undermined in the future.

Ultra-rib pipe is not approved for use as a storm sewer.

For more information regarding acceptable materials, see Chapter 6, *Material Specifications*.

Bedding Requirements

The class of pipe and the type of bedding will be selected to suit loading and proposed construction conditions.

Rigid pipe bedding will be as per OPSD 802.030, 802.031, 802.032 802.033 and 802.034.

Flexible pipe bedding will be as per OPSD 802.010, 802.013 and 802.014.

The pipe material, class, and type of bedding will be shown on the profile drawing for each section of storm sewer.

Pipe Class

Pipe class will be selected to suit the bedding class and height of fill. The minimum pipe class for reinforced concrete storm sewer will be 65-D.

Minimum Depth of Cover

The minimum depth of a storm sewer on roadways will be 1.7 metres measured from the centre line road elevation to obvert of the pipe. For storm sewers located in open space such as parks, the minimum depth of cover will be 1.2 metres from finished ground elevation to obvert of the pipe.

Maximum Depth of Cover

Maximum depth of cover for concrete pipe will be in accordance with OPSD 807.010, 807.030 and 807.040. For PVC gravity sewer pipe, the maximum cover will be in accordance with OPSD 806.040.

Location and Alignment

Storm sewers will be located 1.5 metres—as measured from the centre line of pipe—on either the south side or the west side of the road centre line in a separate trench unless a conflict with other utilities requires a revised location. Exceptions will occur on curved streets. Storm maintenance holes must be located within the asphalt area of the road for maintenance purposes.

Pipe Crossing Clearances

The minimum clearances required when storm sewers cross other services will be measured from outside wall to outside wall of pipe. Clearances with respect to watermains as per MOE procedure F-6-1 are as follows:

Table: Pipe clearances

If crossing is …	Then minimum clearance is …
Over or under a sanitary sewer	300 mm
Under a watermain 450 mm diameter or less	300 mm
Over a watermain 450 mm diameter or less	500 mm
Over or under a watermain greater than 450 mm diameter	500 mm

The minimum horizontal separation between a sewer and watermain is 2.5 metres. In cases where it is not practical to maintain separate trenches or the recommended horizontal separation cannot be achieved a deviation may be allowed. For more information go to Chapter 4, *Watermains*, section *Crossings and Parallel Trench Installations*.

A minimum clearance of 0.6 metre between the obvert of the sanitary sewer and the invert of the storm sewer must be provided if any sanitary service connections are required to go under the storm sewer.

Minimum Distance between Sewers

The minimum distance between new parallel sewers in separate trenches will be 3 metres as measured from centre line of pipe to centre line of pipe. Exceptions can be made for site specific design constraints and depths as in the case of dual maintenance holes installations.

It is preferred that a one metre minimum separation from outside wall to outside wall will be provided to permit installation of service connections and the future maintenance of the underground servicing.

When sanitary and storm sewers are constructed in a common trench, the storm sewer shall be constructed parallel to the sanitary sewer with 600 mm minimum separation between the outside wall of the two pipes as specified in the dimension table in City standards T-701.013-1, T-701.013-2, or T-701.013-3.

Radius Pipe

As of January1, 2009 OCPA producers will no longer offer radius pipe for sale.

Prefabricated concrete pipe bends will be allowed for storm sewers 1050 mm in diameter and larger provided that a manhole is located at the beginning and at the end of the radial section. The minimum centre line radius allowable will be in accordance with the minimum radii table as provided by the pipe manufacturer.

Roof Drains

Roof drains will be discharged to the ground surface onto splash pads with flows directed away from the building onto grass filter strips, where possible and towards the road. Any above ground discharge will be contained on the property in a manner that is not likely to cause damage to any adjoining property or create a hazardous condition on any stairway, walkway, street or boulevard.

Lot grading will be finished to prevent ponding. The slope of the grading should be away from the building.

Reverse Driveway Drainage

The City discourages the installation of reverse driveways. Should they be installed, drainage will comply with the Sewer Use Bylaw, Section 681-11-O of the Toronto Municipal Code.

Reverse slope and below grade driveways are susceptible to surface flooding in low lying areas and should be discouraged.

Where a catchbasin is installed on private property to drain storm water from a driveway that slopes towards any structure located on the property, the catchbasin will be connected to the city storm sewer where such is available and the installation will include:

- A flap gate backwater valve installed directly downstream of the private catchbasin, so that no storm water may back up from the city storm sewer into the private catchbasin; and
- A sump pump, located in the overflow sump, to discharge any storm water which has collected in the catch basin while the above noted flap gate backwater valve has closed to prevent a backup of storm water.

For report submission guidelines for reverse slope driveways, see Appendix F, *Reverse Slope Driveway Guidelines*.

Storm Backwater Prevention Valves

Storm backwater prevention valves or backflow prevention devices are required on all foundation drain systems connecting to storm or combined sewer systems to minimize backup of stormwater, where an exemption has been made by the City to allow foundation drain connections. Backwater prevention valves will be located inside the building, if there is a sump pump or outside the building with a riser to allow ease of access and maintenance—if a sump pump is not part of the system.

Sewer Inlet Controls

To reduce surcharging of the storm sewer, if required, storm sewer inlet controls such as flow controls installed in roadside catchbasins, restricting the stormwater runoff entering the sewer system to the system design capacity, be installed in cases where the overland flow can be routed away from low lying areas or where stormwater detention facilities are proposed.

Gaskets in Contaminated Soil Conditions

Prior to specifying the pipe material, the soils should be assessed for contamination. Upon determination that there is contamination, even in trace amounts, the longevity of ordinary gaskets becomes a concern. When locating sewer pipes, rubber gasket inserts, and service lines in areas of soils contaminated with hydrocarbons, nitrile gaskets will be specified in the area of contamination.

Drawings must show locations of all nitrile gaskets.

Maintenance Holes

Maintenance holes will be located at each change in alignment, pipe size, grade, material and at all pipe junctions, at the beginning or end of radius pipe sections and at intervals along the pipe to permit entry for maintenance to the sewer.

Spacing of Maintenance Holes

Generally, the maximum allowable horizontal spacing between maintenance holes shall be as follows:

Table: Storm maintenance hole spacing

If diameter of sewer is …	Then maintenance hole spacing is …
300 mm–975 mm	110 m
1050 mm–1350 mm	130 m
1500 mm–1650 mm	160 m
1800 mm and larger	305 m

Larger diameter sewers—larger than 1800 mm—may use larger maintenance hole spacing. The design will be made in consultation with the City.

Maintenance Hole Sizing

All sizing of storm precast maintenance holes are based on incoming and outgoing pipe sizes and will be sized as per City standard T-701.021. The minimum diameter for a maintenance hole is 1200 mm.

The construction of maintenance holes shall conform to current City standards T-701.010, T-701.011, T-701.012-1, T-701.013 and the pre-cast manufacturer's specifications.

The type and size of the maintenance hole will be specified on the profile drawing.

When any dimension of a maintenance hole differs from the current standard, the maintenance hole will be individually designed and detailed by the design engineer.

Manufactured Maintenance Hole Tees

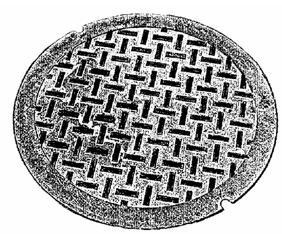
On straight through installations only, precast manufactured maintenance hole tees can be installed instead of regular maintenance holes on 1200 mm diameter or greater trunk sewers. No deflections or lateral connections will be constructed within the proposed maintenance hole tee. Tees are to be located upstream of a deflection or change in sewer size.

For details and additional design information, see OPSD 707.010.

Maintenance Hole Frame and Covers

Maintenance hole frame and covers are required for all maintenance holes and shall conform with OPSD 401.010, Type 'A' closed or Type 'B' open.

Maintenance hole chamber openings must be located on the upstream side of the maintenance hole.



Lockable Maintenance Hole Covers

Lockable maintenance hole covers are required to control access and to protect the public. They are recommended to be located in park blocks and open space blocks. For details and additional design information, see OPSD 401.060.

Maintenance Hole Steps

For pre-fabricated maintenance holes, steps will be solid circular steps as per OPSD 405.020.

For cast-in-place maintenance holes, steps will be solid rectangular steps as per OPSD 405.020.

Drop Structures

External drop pipes will be provided when the difference in invert elevations is greater than 1.3 metres. The external drop pipe will be one size smaller than the sewer line—minimum 250 mm diameter. The alternative of providing a deeper storm sewer instead of a drop maintenance hole may be considered at the City’s discretion. Type 'C' is preferred as per City standard T-1003.01. However, the use of Y’s and 45 degree bends for drops, Type 'A' and 'B', respectively, may be accepted.

When the difference in elevation between the maintenance hole inlet and outlet pipes exceed 1.30 metres, a drop structure will be provided. When the drop is between 200 mm and 1300 mm, the pipe grades will be adjusted such that the maximum drop is 200 mm.

Maintenance Hole Safety Landings

When the depth from invert to top of the maintenance hole exceeds 5 metres, a safety platform will be provided. Safety grates will not be more than 5 metres apart. The platform will be located 2 metres below the maintenance hole cover and 2.8 metres above the maintenance hole invert. For details and additional design information, see OPSD 404.020.

Benching

All benching of maintenance holes will conform to City standard T-701.021. Benching height will extend from the pipe obvert to improve hydraulic performance. Catchbasin maintenance holes will not be benched so that a 0.3 metre sump remains.

A benching detail will be shown on the plan portion of the engineering drawing when the proposed benching differs from the City standard.

Steps in Benching

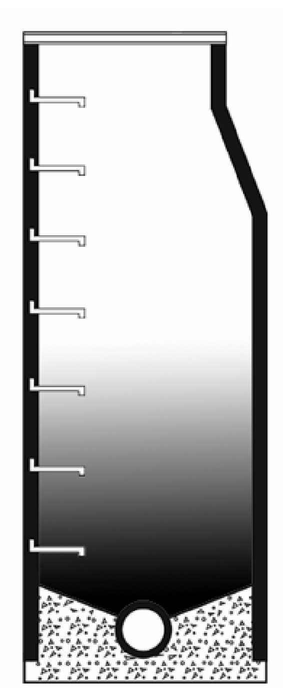
Steps in maintenance hole benching will be required when the pipe diameter is greater than 450 mm. The last step will be 300 mm above the benching or 600 mm above the invert, if no benching.

Hydraulic Losses at Maintenance Holes

Suitable drops will be provided across maintenance holes to compensate for the energy losses due to the change in flow velocity and to accommodate the difference in depth of flow in the upstream and downstream sewers. When the pipe size does not change through a maintenance hole and the upstream flow velocity does not exceed 1.5 metres/second, the following allowances will be made to compensate for hydraulic losses.

Table: Allowance for hydraulic losses

If alignment change is …	Then drop required is …
straight run	grade of sewer or 0.03 m
15°–45°	0.030 m – MOE minimum 0.075 m – preferred
45°–90°	0.06 m – MOE minimum 0.15 m – preferred
junctions and transitions [a]	MOE calculations



[a] For all junctions and transition maintenance holes and when the upstream flow velocity exceeds 1.5 metres/second, the drop required will need to be calculated using the MOE guidelines; "*Hydraulic Calculations for Junction and Transition Maintenance Holes*". Calculations for hydraulic losses will be included in the design submission.

The engineer shall adhere to the following guidelines:

- Endeavour to keep entrance and exit velocities equal. In order to reduce the amount of drop required, the engineer will try to restrict the change in velocity from one pipe to another in a maintenance hole to less than 0.6 metre/second.
- No acute interior angles will be allowed.
- No decrease in pipe diameter from a larger size upstream to a smaller size downstream will be allowed regardless of an increase in grade.
- When an increase in pipe size occurs at the downstream side of the storm maintenance hole, match obvert elevations of the incoming and outgoing pipes or have incoming pipe obverts higher than outgoing pipe obverts.

Changes in Pipe Alignment

The maximum change in direction for pipe sizes 675 mm and larger is 45 degrees. For 675 mm and larger diameter pipes where the change in direction is greater than 45 degrees, additional maintenance holes 1200 mm in diameter will be required to reduce the angle.

Municipal Storm Service Connections

New Private Sewer Connections

The direct connection of any new private storm sewer to a municipal storm sewer system is prohibited for any new or reconstructed residential, industrial, commercial, or institutional buildings. Application for an exemption must be supported by a stormwater management report identifying the storm water quantity and quality control measures being proposed for the site. A proposed connection may be approved for a connection to the municipal storm sewer system, where the report successfully demonstrates that there is no practical alternative means of drainage available on the site and the proposed method is satisfactory to the General Manager, Toronto Water.

Roof Water Drains or Downspouts

No new connections to a sanitary, combined, or storm sewer will be permitted for roof water drains or downspouts.

Storm water collected from roof water drains or downspouts will be directed to pervious areas for infiltration or other areas for reuse on site. Storm water collected by a down pipe from an eavestrough will be discharged at grade with provisions to prevent soil erosion and will be conveyed away from the building in such a manner that the storm water will not accumulate at or near the building and will not adversely affect adjacent properties.

The discharge of roof drains to a combined sewer or storm sewers in the combined sewer area of the city will be prohibited. Exemptions will be at the sole discretion of the general manager as set out in the Sewer Use Bylaw, Chapter 681 of the Toronto Municipal Code.

Existing Roof Drain Connections

Existing roof drain or downspouts connections to the combined sewer system will be eliminated except under exceptional circumstances. Exceptional circumstances may be when it is not practical or affordable or when it is a capital sewer replacement project and the contractor will have to work on private property. If necessary due to site constraints, existing roof or drainage connections to the combined sewer system may be permitted to reconnect to the storm sewer system, where road sewer separation from the combined sewer system has been implemented. Any application for an exemption will be at the sole discretion of the General Manager, Toronto Water.

Foundation Drains

All new foundation drains or weeping tiles will be pumped to grade, subject to soil conditions with respect to environmental impacts and soil permeability. The foundation drains will not be connected to any municipal sewer. If necessary due to site constraints, foundation drains may be permitted to reconnect to the storm sewer systems, where road storm sewer separation from the combined sewer system has been implemented.

When foundation drains are connected to the storm sewer system, the elevation of the basement floor will be at least one metre above the elevation of the storm sewer obvert at that point and preferably 150 mm above the hydraulic grade line generated by the 1:100 year storm. For building connections located close to the point where the storm sewer discharges into the major system, the basement floor elevation must be above the 1:100 year flood elevation at this same point.

Any application for an exemption must be approved by the General Manager, Toronto Water.

Minimum Size and Grades

The minimum diameter and grade of a municipal storm service connection is 150 mm diameter at 2 percent slope. The actual size of the storm service connection required for non-residential, commercial, institutional, and high rise condominiums is determined by the maximum flow permitted from the development.

For non-residential sites, commercial, high rise condominiums, and so on, the service connection can not act as the orifice control for the site. All controls will be contained within the site.

Storm service connections will be white in colour to distinguish it from surrounding sanitary municipal service connections.

Depth of Cover

The minimum cover at street line will be 1.5 metres as measured from the finished road elevation to obvert of the storm service connection.

The maximum cover at street line will be 2.4 metres from the finished centre line road elevation to obvert of the storm service connection.

Storm Service Connections to Sewers

For multi-family, commercial, institutional and industrial land use, a maintenance hole will be required when the service connection is of a size greater than half the diameter of the main storm sewer—except in cases where the main sewer is 900 mm in diameter or larger, in which case the storm service connection may be directly connected into the sewer.

Using this rule of thumb will reduce the number of maintenance holes in the roadway.

Rule of thumb

If the service connection diameter is less than or equal to half the diameter of the main storm sewer, then no maintenance hole is required.

Pipe Connections to Maintenance Holes

Match obvert elevations of the incoming and outgoing pipes or have incoming pipe obvert higher than outgoing pipe obverts. Invert to invert connections will not be allowed.

The connection of the sewer pipe at the maintenance hole will utilize a flexible joint for either rigid or flexible pipe. A concrete cradle may be used for rigid pipe. For details and additional design information, see City standard T-708.020.

Flexible Rubber Connectors

Flexible rubber connectors can also be used for connecting pipe to maintenance holes. Rubber connectors are either cast-in-place during manufacture of the precast product or installed into a cored or preformed hole in the finished maintenance hole.

Control Maintenance Hole

The City requires a control maintenance hole located on the property of the owner, as close to the property line as possible as per Section 681-10-A.(1) of the Toronto Municipal Code. This requirement will apply to all multi-family, commercial, industrial, and institutional blocks.

Service Connections in Easements

Storm sewer service connections in easements will only be allowed subject to the satisfaction of the General Manager, Toronto Water as per Section 681-11-B of the Toronto Municipal Code. An easement encroachment agreement stipulating the conditions of the encroachment will be required for any storm service connection.

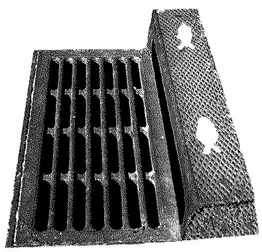
Catchbasins

Catchbasins will be provided to collect drainage from both pervious and impervious areas. The engineer will limit the number of catchbasins connected to each section of sewer so that the minor system is not overloaded.

Location

Street

At street intersections, catchbasins will be located immediately upstream of sidewalk or pedestrian crosswalks when the road grade falls towards the intersection.



Catchbasins will not be located within one metre of a driveway or walkway curb depression.

Catchbasins and its lead connections will be designed to capture the expected maximum flow.

Double catchbasins will be required when drainage is received from more than one direction.

Rear Lot/Yard

The catchbasin and lead will be offset 0.6 metre from the property line, entirely on one lot or block. Pipe will be concrete encased to avoid possible penetration from fence posts. The lead will not be the responsibility of the City, and therefore no easement is required.

When a catchbasin lead passes through two or more adjoining lots, a 3 metres wide private easement is required.

Parks/Landscaped Areas

Catchbasins will be located adjacent to walkways or bike paths to minimize flow and to provide positive drainage from park facilities and to minimize impacts on surrounding playfields. The location of catchbasins shall be subject to the approval of the parks, forestry and recreation division.

Minimum Lead Diameter and Grade

Street

For a single catchbasin, the minimum lead connection diameter will be 200 mm and the minimum grade will be 1.0 percent.

For double catchbasins, the minimum lead connection diameter will be 250 mm and the minimum grade will be 0.7 percent.

Rear Lot/Yard

The minimum diameter of a catchbasin lead in a rear yard will be 250 mm and the minimum grade will be half percent.

Parks/Landscape Areas

The minimum diameter of a catchbasin lead in a park or landscape area will be 250 mm and the minimum grade will be 0.7 percent.

Spacing

Catchbasins should be provided at adequate intervals to ensure that the road drainage is able to be intercepted up to the capacity of the storm sewer which will be the basis to determine the type, location, and spacing of the catchbasins. The spacing will vary with the road width, grade, and cross fall and with the design storm frequency. The spacing will also be affected by the location of pedestrian crossing points, intersections, major depression points, driveway depressions, and so on. The recommended maximum spacing is as follows:

Table: Catchbasin spacing

Pavement width	Grade < 4 % grade	Grade > 4 % grade
7.3 m–8.5 m	90 m	60 m
8.5 m–9.8 m	82 m	55 m
9.8 m–12.2 m	73 m	50 m
12.2 m–14.0 m	60 m	40 m

The spacing of catch basins may be altered for grades greater than 4 percent, by using side inlet catchbasin.

The desired maximum distance between catchbasins from a crest in a road to a catchbasin is 90 metres, measured along the curb line for each side of the road.

The maximum area to be serviced by any catchbasin shall be 0.2 hectare of paved area or half hectare of sodded area.

Types of Catchbasins

Single Catchbasin

Single catchbasins will be constructed on all streets. For details and additional design information, see City standard T-705.010.

Double Catchbasin

Double catchbasins will be constructed at sag points when the catchment area is greater than 100 square metres and received from more than one direction in the road way or in cul-de-sacs. For details and additional design information, see City standard T-705.020.

Catchbasin Maintenance Hole

No combination of a maintenance hole and catchbasin will be installed on private property as per Section 681-10-D.(3) of the Toronto Municipal Code. The use of catchbasin maintenance holes in public laneways is permitted.

Single Catchbasin without Sump

Single catchbasins without a sump will be constructed in all rear lots and yards. For details and additional design information, see City standard T-705.010-1.

Ditch Inlet Maintenance Holes/Catchbasins

Ditch inlet maintenance holes/catchbasin will be constructed along arterial roads which have ditch drainage. They can also be constructed for temporary block drainage in a new subdivision and for outlets or inlets within a stormwater management pond. For details and additional design information, see OPSD 702.040 Type 'A', and OPSD 702.050 Type 'B' or OPSD 705.030 and OPSD 705.040.

Infiltration Trench with Catchbasin

Infiltration catchbasins can be constructed in laneways where no storm sewer is near by. This installation is considered to be stormwater management works and requires approval of the MOE. For details and additional design information, see City standard T-705.010-5.

Depth of Cover

The minimum depth of cover over a catchbasin lead is 1.5 metres within the traveled portion of the road and 1.2 metres within the boulevard.

Allowable Ponding

No surface ponding is allowed to accumulate for a 2-year design storm event within a public road allowance.

Maximum water depth allowed on major overland flow routes is up to 0.3 metre over street catchbasins and 0.3 metre over rear yard catchbasins.

Catchbasin Frame and Grates

Cast Iron Square Frame with Square Flat Grate

To be used on catchbasin maintenance holes in laneways and single and double catchbasins on private property. For details and additional design information, see OPSD 400.020.

Cast Iron Raised Square Frame with Circular Flat Grate

To be used on local, collector and arterial roads with single and double catchbasins. For details and additional design information, see OPSD 400.070.

Galvanized Steel, Honey Comb Grate

To be used with a ditch inlet catchbasin. For details and additional design information, see OPSD 403.010.

Cast Iron, Square Frame with Square Overflow Type Flat Grate

To be used on rear lot/yards and in parks with single catchbasins. For details and additional design information, see OPSD 400.110.

Catchbasin Lead Connections

Catchbasin Connection – Rigid Pipe Sewer

To be constructed in connection with a catchbasin–600 mm x 600 mm. For details and additional design information, see City standard T-708.01.

Catchbasin Connection – Flexible Pipe Sewer

To be constructed in connection with a catchbasin–600 mm x 600 mm. For details and additional design information, see City standard T-708.03.

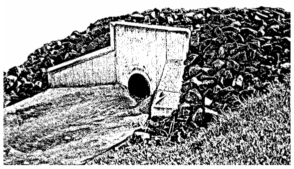
Culverts

Driveway culverts will be designed to accommodate the minor flow unless otherwise indicated. The minimum culvert diameter will be 300 mm for driveways and 600 mm for roadway crossings.

Outlet Structures

Provincial approval and permits are required for all outfalls discharging into a watercourse. In order to minimize erosion, outfalls will extend to the bottom of drainage courses or to the edge of streams. Discharging onto steep slopes will not be accepted.

Hydraulic Requirements



Exit velocities must be designed to minimize potential erosion or damage in the vicinity of the outfall from maximum design flows.

In an instance where the discharge velocity is high or supercritical, prevention of erosion of the natural channel bed or banks in the vicinity of the outlet requires an energy dissipating structure, such as rip rap, concrete slab, gabions, or headwalls and wing wall with stilling basins.

Outfalls to natural watercourses should discharge at or above the average water elevation of the watercourse. If high water levels cause the submergence of the outlet, the impact of the submergence on the sewer system must be assessed.

The obvert of the outlet is to be above the 25-year flood elevation of the receiving channel.

Clay Seals

When there exists a possibility that groundwater may be diverted and follow the path of the new sewer, groundwater barriers should be constructed in adequate numbers to prevent groundwater migration down sewer trenches. The following conditions are to be considered as sufficient reasons for discussing the need for clay seals with the engineer on a specific pipe location basis.

- the natural sub-base and culvert foundation materials are of a granular nature
- the embankment material is of a non-cohesive nature
- significant hydraulic head between ends of the culvert.

For details and additional design information, see OPSD 802.095 and OPSS 1205.

Safety and Aesthetics

All outfalls will be constructed with safety provisions to prevent unauthorized access or debris accumulation as per OPSD 804.05. Grates shall be installed with means for locking. Provisions must be made for opening or removing the grate for cleaning purposes. Grates should be designed to break away or swing open under extreme hydraulic loads due to blockage.

Outfalls should be made as safe as possible by utilizing fencing along the headwalls and wingwalls to prevent accidental falls. Submerged outfalls need to be specifically designed to withstand freeze-thaw cycles and ice dams.

Chapter 4 – Watermains

The water distribution system must be designed to deliver potable water without appreciable degradation of quality for domestic consumption while having sufficient capacity at all times to deliver adequate quantities of water at adequate pressure for fire fighting purposes.

Water Demand

The water demand used for watermain size selection should be sufficient to satisfy maximum day demand plus fire flow or the peak hour demand, whichever is greater.

The common demand factors used in defining water supply requirements are as follows:

Average day – is the total amount of water demand within a certain time period, usually one year, divided by the number of days within that time period.

Maximum day – is the average water demand over the day—midnight to midnight—of highest water demand day within any one year.

Minimum hour – is the smallest short term—1 hour—demand in one day.

Peak hour – is the highest short term—1 hour—demand within a system not including fire flow in one day.

Domestic – is any residential or industrial non-fire water use.

Per Capita Demand

The residential demand can be divided into single family residential per capita demand and multi-unit residential per capita demand.

Table: Residential per capita demand

Sector	Per capita demand
single family: single-detached, semi-detached, row housing (3–6 units), plexes (2–6 units)	320 litres/capita/day
multi-unit: high-rise or low-rise apartment buildings, condominiums, co-operatives, each with greater than six units	191 litres/capita/day

Hydraulic Model

A hydraulic network model simulation should be carried out as required to determine if the demand flow exceeds the capacity of the supply and to demonstrate that the studied system will not adversely affect the surrounding system in terms of pressure and supply.

Peaking Factors

The peaking factors used to calculate minimum hour, peak hour and maximum day must be based on:

- historical information
- Ministry of the Environment guidelines, or
- as directed by the City

Table: Peaking factors

Land use	Minimum hour	Peak hour	Maximum day
residential 75,000–150,000 population range	0.70	2.48	1.65
commercial	0.84	1.20	1.10
industrial	0.84	0.90	1.10
institutional	0.84	0.90	1.10
apartments	0.84	2.50	1.30

Whenever possible, peaking factors based on usage records for the water supply system should be used. The developer's consulting engineer should contact the development engineering unit of Technical Services division to determine whether there is an up-to-date calibrated hydraulic model available. A request to Toronto Water, through the development engineering unit will advise if the development site is in an area experiencing problematic static and residual pressures along with any deficiencies in meeting fire flow requirements.

Friction Factors

Hazen Williams 'C' values to be used for the design of new water distribution systems, regardless of pipe material, will be:

Table: C factors

Diameter of main	'C' factor
150 mm	100
200 mm or 250 mm	110
300 mm to 600 mm	120
larger than 600 mm	130

When evaluating existing systems, the 'C' factor should be determined by actual field tests, whenever possible.

Fire Protection Considerations

In accordance with the Fire Underwriters Survey (FUS), fire flows for residential areas will not be less than 4,800 litres/minute for a 2 hour duration in addition to maximum daily domestic demand, delivered with a residual pressure of not less than 140 kilopascals. For commercial, institutional and industrial areas, the minimum fire flow available will not be less than 5,000 litres/minute for 4 hours, delivered with a residual pressure of not less than 140 kilopascals.

Rule of thumb

The number of hydrants required from a fire protection perspective for a building or complex of buildings is based on the formula:

required fire flow = [number of hydrants] x [5,690 litres/minute]

Fractions greater than or equal to one-half are rounded to the next higher whole number, while fractions less than one-half are dropped.

Estimated fire flow requirements compiled from the International Standards Organization (ISO) is shown in the table below:

Table: Fire flow requirements

Use categories	Fire flow (litres/minute)	Duration (hour)	Number of hydrants
single family and two family dwellings	3,800	2	1
community facilities	5,680	2	1
multi-family—one and two stories—and closely built residential	7,570	2	2
multi-family—three stories or more—and closely built residential	9,460	3	2
multi-family attached residential	11,360	3	2
commercial—up to two stories	11,360	3	3
commercial—over two stories	19,000	5	4
high-rise residential	19,000	5	4
industrial park	19,000	6	4
shopping centre	22,700	6	4

In keeping with the Uniform Fire Code (UFC), fire hydrants should be spaced and numbered as shown below:

Table: Fire hydrant spacing and location

Fire flow Requirements (l/min)	Minimum number of hydrants	Average spacing between hydrants [a,b,c] (m)	Maximum distance from access point of a building or lot to a hydrant [d] (m)
6650 or less	1	150	75
7600–8550	2	135	70
9500	3	135	70
11,400	3	120	70
13,300–15,200	4	110	65
17,100–19,000	5	90	55
20,900	6	90	55
22,800	6	75	45
24,700–26,500	7	75	45
28,500 or more	8 or more [e]	60	40

[a] Reduce by 30 metres for dead-end roads or streets.

[b] Where streets are provided with median dividers that can be crossed by firefighters pulling hose lines or arterial roads with four or more traffic lanes having a traffic count of more than 30,000 vehicles per day, hydrant spacing should average 150 metres on each side of the street.

[c] Where new watermains are extended along streets where hydrants are not needed for the fire protection of structures or vegetation, fire hydrants should be spaced at intervals not exceeding 300 metres to provide for protection from transportation hazards.

[d] Reduce by 15 metres for dead-end roads or streets.

[e] One hydrant for each 3,800 litres/minute or fraction thereof.

Lastly, where a hydrant serves a building(s) that is provided with a siamese connection, the hydrant will be located not more than 45 metres unobstructed from the siamese connection(s) and where the building(s) other than residential, is not provided with a siamese connection, all portions of the exterior wall shall be no more than 90 metres unobstructed from a fire hydrant.

The door to the furthest dwelling unit in a residential structure such as single family dwellings, apartments, condominiums, hotels, motels and so on must be no more than 90 metres from a fire hydrant.

Fire Flow Testing

The City of Toronto carrys out fire flow tests on its water distribution system only for its own design and maintenance purposes. The results of such testing can be made available to anyone for the purpose of designing or checking the adequacy of their private fire protection system, but users may not reference the City information in their design or proposal.

Any person wishing to carry out a fire flow test will make the necessary arrangements with the appropriate Toronto Water district operations and maintenance yard. The charge to provide the necessary labour to operate the valves for each fire hydrant flow test is $100 as per Chapter 851–12A.(2) of the Toronto Municipal Code as amended. The person or their representative requesting the test will provide all gauges and test equipment necessary to carry out the test and shall make all necessary calculations. A copy of all test results will be submitted to the watermain asset planning unit of Toronto Water.

Results of previous fire flow tests carried out by others will be made available to any interested party—upon written request—on the understanding that the results are not warranted by the City and are not to be construed as a definitive statement of actual conditions. Users of such data must be aware that the conditions in a water distribution system vary continuously, depending on the demand on the system, as well as with the age and condition of the various system components and any maintenance or rehabilitation work occurring at the time.

Fire flow testing is required for all development engineering applications to confirm static and residual pressures. If any operational problems are discovered during the fire flow testing, it should be brought to the attention of the City.

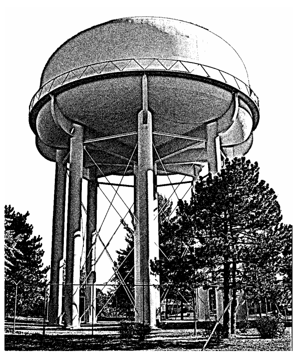
Maximum Velocity

All distribution watermains must be able to supply the greater of maximum day plus fire flow or peak hour.

The maximum velocity; under normal operating conditions will not exceed 2 metres/second, while during fire flow conditions, the maximum velocity will not exceed 5 metres/second.

The maximum head loss allowed in the distribution system under peak hour operating conditions—excluding fire flow situations—is 2–5 metres/1000 metres.

Pressure Range



The preferred design pressure ranges for:

- average day and maximum day is—350 kilopascals to 550 kilopascals
- minimum hour and peak hour is—275 kilopascals to 700 kilopascals

Pressures outside of these ranges are acceptable to the limits outlined below but are not desirable.

Minimum Pressure

Non-Fire Scenarios

The minimum pressure under any non-fire demand scenario will not be less than 275 kilopascals.

Fire Scenarios

The minimum residual pressure during maximum day plus fire scenarios will not be less than 140 kilopascals at any location in the water distribution system.

Maximum Pressure

The maximum static pressure in the watermain system should not exceed 690 kilopascals.

In cases where all services are protected by an individual pressure reducing device, the maximum pressure in the watermain system will not exceed 825 kilopascals.

Unless otherwise required, all watermains will be designed for 1000 kilopascals test pressure.

Watermain Design

Both metallic and plastic pipe are permitted in the construction of distribution watermains. These materials include ductile iron, polyvinyl chloride (PVC), high density polyethylene and type 'K' soft copper tubing. In general, all distribution watermains up to and including 300 mm diameter will be PVC, with copper tracer wire and ductile iron fittings.

Sizing

The minimum diameter for single family residential subdivisions will be 150 mm.

For high density residential, industrial, and commercial developments the minimum diameter will be 300 mm.

The standard diameters for distribution watermains are 150 mm, 200 mm, 300 mm, and 400 mm. Watermains, fittings, appurtenances, and connections will be as indicated in Chapter 6, *Material Specifications*.

Watermains Ending in Cul-de-sacs or Dead Ends

In the future, SPQA unit will develop detail for cul-de-sacs.

Watermains in cul-de-sacs will dead end with a fire hydrant. No water services will be connected after the fire hydrant. Each property will be serviced with a separate water service. Any water service exceeding 20 metres in length within the cul-de-sac will have a minimum diameter of 25 mm.

Location

The location of the watermain in a new road allowance will be on the north or east side of the street. Watermains will be offset from street line as indicated in the City's typical standard road cross-section from DIPS.

Table: Watermain offset from street line

Street type	Right-of-way width	Distance from north or east street line
major local street – option a	20.0 m	5.0 m
major local street – option b	20.0 m	5.0 m
intermediate local street – option a	18.5 m	4.3 m
intermediate local street – option b	18.5 m	4.3 m
minor local street – option a	16.5 m	4.7 m
minor local street – option b	16.5 m	4.7 m

When the location for a new watermain is being chosen on an existing street, it may be necessary to adjust the standard offset location having regard for existing services and utilities, traffic management during construction, and future construction within the road allowance.

For more information on DIPS, go to website: www.toronto.ca/wes/techservices/involved/transportation/future_streets/index.htm .

Crossings and Parallel Trench Installations

Sewers and watermains located parallel to each other will be constructed in separate trenches maintaining a minimum clear horizontal separation distance of 2.5 metres from closet pipe edge to closet pipe edge.

Parallel Installations

Under unusual conditions where congestion with other utilities will prevent a clear horizontal separation of 2.5 metres, a watermain may be laid closer to a sewer, provided that the elevation of the crown of the sewer is at least half metre below the invert of the watermain. Such separation will be of in-situ material or compacted backfill.

Crossings

Under normal conditions, watermains will cross above sewers with sufficient vertical separation to allow for proper bedding and structural support of the watermain and sewer main. Where it is not possible for the watermain to cross above the sewer, the watermain passing under a sewer will be protected by providing:

- A vertical separation of at least half metre between the invert of the sewer and crown of the watermain.
- Adequate structural support for the sewers to prevent excessive deflection of joints and settling.
- That the length of water pipe be centred at the point of crossing so that the joints will be equidistant and as far as possible from the sewer.

Refer to MOE procedure F-6-1 "Procedures to Govern the Separation of Sewers and Watermains."

Shallow Cover Crossing Sewers and Utilities

Watermains which cannot be constructed with the specified minimum cover will be insulated in accordance with MOE document "*Guidelines for Servicing in Areas Subject to Adverse Conditions.*"

For below grade insulation, rigid foam slab insulation placed above the watermain can be used. The insulation material will be polystyrene foam. In general, the thickness of the insulation should be 25 mm for every 300 mm reduction in the depth of cover. A maximum reduction of 0.6 metre in depth will be permitted before other alternatives must be considered.

For insulation details for watermains and service connections adjacent to ventilated underground structures or where there is insufficient ground cover, see City standard T-708.01-4.

Bedding Requirements

The class, material type, and pipe bedding will be indicated on the profile for each section of the watermain pipe.

The engineer must ensure that the class or pressure rating of the pipe is not exceeded given the expected dead and live loadings and anticipated maximum water pressures.

The class of pipe and the type of bedding will be selected to suit loading and proposed construction conditions. Class of pipe will conform to OPSD 806.060 and bedding type as per City standard T-708.04.

Minimum Slopes

There are no minimum slope requirements for distribution watermains. However, the minimum slope for a transmission watermain installation is half percent. This is to prevent the accumulation of trapped air and to avoid localized high points

Thrust Blocks and Mechanical Restraints

Adequate restraint must be provided to the water distribution systems to prevent pipe movement and subsequent joint failure. In the case of bell and spigot or push-on joint, this restraint should be provided by an adequately sized concrete thrust block or mechanical thrust restraint positioned at all fittings, bends, tees, valves, hydrants, crosses, reducers and plugged or capped dead ends, horizontal or vertical bends deflecting 11¼ degrees or more, and connections ranging in size from 100 mm to 300 mm in diameter. For details and additional design information, see City standard T-1103.01, T-1103.020 and T-1103.020-2.

Where thrust blocks cannot be laid on undisturbed ground due to excessive excavation or fill conditions, mechanical thrust restraints will be used.

In areas of engineered fill such as reconstruction projects or when congested works are exposed, mechanical thrust restraints will be installed and shown on the drawings. The joints will terminate at least one pipe length into undisturbed ground.

In areas subject to possible future settlement, the bedding design must be such that it will minimize pipe movement. Mechanical thrust restraints must be installed throughout the limits of the possible settlement area.

The minimum number of restraints required after a fitting on a watermain pipe 300 mm in diameter and smaller will be:

Table: Mechanical thrust restraint required (dia ≤ 300 mm)

If watermain pipe …	Then restraint is required at…
has a tee or cross	fitting [1]
has 45 degree bend	fitting [1]
has 90 degree bend	fitting and next pipe joint [1]
is placed on engineered fill	fitting and all pipe joints
is 300 mm in diameter	fitting and next pipe joint [1]

[1] If pipe length less than 6.1 metres, then any joint within 6.1 metres of a fitting will be restrained.

All valves on 300 mm diameter and greater PVC watermains will be restrained. Use the approved restraining devices as indicated in Chapter 6, *Material Specifications*.

All valves installed in chambers will be tied down as per City standard T-1100.010-2 and T-1100.010-3.

Pipes greater than 300 mm in diameter

For plastic watermain pipes 350–400 mm in diameter, mechanical thrust restraints on all fittings and valves will be shown on the shop drawings as recommended by the pipe manufacturer.

Depth of Cover

Curb and Gutter Roads

The minimum depth of cover will be 1.8 metres measured from the top of watermain to the centre line of road to minimize the risk of frost damage to the watermain and services.

The maximum depth of cover allowed on a watermain pipe, unless it occurs at the crossing of a watercourse or a structure, is 2.1 metres.

Open Ditch and Unimproved Roads

The minimum depth of cover over top of a watermain will be 2.1 metres below the existing centre line of the road, or 1.4 metres below the bottom of the ditch, or 1.8 metres below grade. If there is no ditch, use the greater depth of cover.

Watercourse

Where a watermain crosses under a creek, the minimum cover over the watermain below the creek bottom will be 2 metres. The ductile watermain will be concrete encased and the concrete encasement is to extend to the points where the pipe will be above the high water level—100-year storm. Stabilization of the creek bottom may be required to ensure this amount of cover is maintained.

High density polyethylene pipe (HDPE) is permitted when directional drilling will be applied.

Removal and Abandoning

Existing Watermain

Plug ends of all abandoned metallic mains with concrete. Plug all tees and crosses where the abandoned main connects to a main remaining in service. Remove mechanical joint valves in chambers and salvage. Abandon and bury lead joint type valves. Remove hydrants for disposal or salvage for reuse—if model complies with current standard. Remove top one metre of chamber, salvage frame and cover for future reuse. If remaining chamber is in the roadway, backfill with unshrinkable fill as per City standard TS 13.10 or if in the boulevard area, backfill with granular fill.

Existing Water Service

Water services which are being abandoned should be detached at the main. In case of a driven nipple, it should be plugged or a sleeve repair used around the main to cover the nipple’s hole. If it is a tee, it is to be removed and a filler piece installed. If it is a tapping valve and valve is in good condition, the valve can be shut off and the main capped.

If service connection to main is in the roadway, backfill with unshrinkable fill as per City standard TS 13.10 or if in the boulevard area, backfill with granular fill.

Line Valves

Sizing of Valves

Distribution mainline valves will be the same size as the watermain. For transmission mainline valves on 750 mm diameter mains and larger, the valve size will either be the same size or one size smaller than the main.

Number of Valves

At "tee" intersections, a minimum of two valves is required.

At "cross" intersections, a minimum of three valves is required.

If pipe isolation is critical in certain circumstances, the preferred number of valves at "tee" and "cross" intersections will be three and four, respectively.

Location of Valves

The valves will generally be located at the point where the projection of the street line intersects the watermain. However, care should be taken to ensure that the valve does not conflict with the curb and gutter. Valves should also not be located in the travelled portion of the road, if possible.

Spacing of Valves

The maximum spacing of mainline valves will be based on the diameter of the watermain.

Table: Spacing of valves

If diameter of watermain is …	Then maximum valve spacing is …
150 mm	200 m
200 mm	200 m
300 mm	200 m
400 mm	300 m
greater than 400 mm	600 m

Valve Type

Gate valves will be used on watermains up to 400 mm diameter and butterfly valves may be used for watermains greater than 300 mm diameter.

Direction to Open Valves

To determine the direction to open the valve in your district when you order the valve, see Appendix C, *Maps*.

Open Clockwise

In districts Etobicoke/York (former city of York, east of the Humber River), North York, Toronto/East York all valves supplied to these areas of the city will open by operating in a clockwise direction and the operating nut supplied will be painted in red.

Open Counter Clockwise

In districts Etobicoke/York (former city of Etobicoke, west of the Humber River) and Scarborough all valves supplied to these areas of the city will open by operating in a counter clockwise direction and the operating nut supplied will be painted in black.

Valve Box and Chambers

All valves on watermains smaller than 400 mm in diameter will be installed with valve boxes as per City standard T-1101.02-2. The valve box will be shown on the plan and profile drawing.

All valves on watermains equal to or larger than 400 mm in diameter will be set in precast waterproof concrete valve chambers. Chamber size will be shown on both the plan and profile drawings.

The depth of cover at valves will be reviewed on an individual basis to ensure the operation of the valves is not compromised by excessive depth.

Valve chambers will contain a sump and be drained by a 150 mm diameter drain to a storm sewer, where possible. An approved reduced pressure assembly backwater valve will be installed on the storm drain. If there is no storm sewer or the storm sewer is not deep enough to drain the valve chamber, a 600 mm diameter sump will be installed in the bottom of the valve chamber to allow water to infiltrate into the surrounding soils—assuming there is no high water table.

Air Valves and Drain Valves

For watermains 400 mm and larger, provisions for air release and drainage is required at the high and low points, respectively. This may be incorporated within the mainline valve chamber or in separate chamber, respectively.

Significant amounts of air can accumulate at localized high points, long stretches of flat or gently sloping watermains or at changes in grade. In these instances, an automatic air release valve will be installed inside a chamber.

For large diameter mains, drain valves positioned at low points may be required to permit main repairs. Consideration should be given to locating low points adjacent to suitable discharge locations such as near catchbasins. Drain valves at watercourse crossings will not be required. Small diameter watermains can generally be drained through hydrants using compressed air or pumping.

Zone Boundary Valves

Valves which are installed to separate pressure districts should not be opened under any circumstances due to the potential damage this may cause to properties in the low pressure district. Consequently the operating nut on zone boundary valves should be tagged and locked to prevent accidental opening. All boundary valves will be in valve chambers.

Any changes to the pressure district boundary must be approved by the General Manager, Toronto Water.

Fire Hydrants

Hydrant Spacing in Right-of-Way

Hydrants will be installed on 150 mm diameter and larger watermains with the following being the maximum spacing measured along the right of way.

The hydrant spacing information shown in this table can be used as a guideline for watermain replacement projects where fire flow requirements are not known.

Table: Hydrant spacing in right-of-way

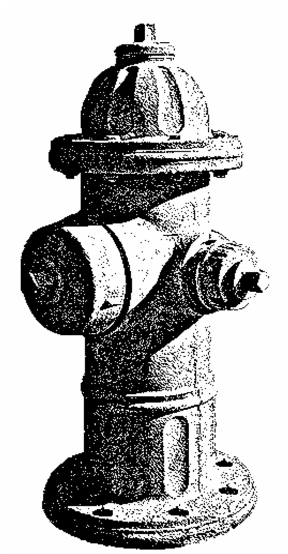
If use is …	Then maximum spacing is …
one and two family dwellings	150 m
other low density residential use and local streets	115 m–120 m
collector streets, high density residential, commercial, industrial, mercantile, educational and institutional	90 m or 45 metres to any opening in a building
cul-de-sacs, townhouses	75 m
arterial roads	150 m

Location of Hydrant from Streetline

The location of the hydrant in relation to the street line will be in accordance with the City's typical standard road cross-section from DIPS.

Table: Hydrant distance from street line

Street type	Right-of-way width	Distance from street line
major local street – option a	20.0 m	2.7 m
major local street – option b	20.0 m	4.5 m
intermediate local street – option a	18.5 m	2.4 m
intermediate local street – option b	18.5 m	3.8 m
minor local street – option a	16.5 m	2.0 m
minor local street – option b	16.5 m	2.0 m



In addition, use the following criteria where applicable:

- On the same side of the road as the watermain.
- Within the City's road allowance at the extension of the lot line between two lots to avoid conflicts with driveways.
- If near a driveway, hydrant will be located a minimum of 1.2 metres clear from the driveway edge —projected garage wall—in residential applications.
- Not located between the intersection "tee" or "cross" and the mainline valve.
- 5 metres away from street intersection valves.
- For watermains up to and including 300 mm diameter, hydrants will be located at high and low points to function as manual air release and drain points.
- Within 60 metres of a cul-de-sac, if one not installed.
- One metre away from an underground utility or open ditch.
- In existing areas, hydrant should be a least 1.2 metres away and not further than 2.1 metres from the back of curb, edge of pavement or roadway shoulder.

Any non-standard location will require individual approval and circulation of the drawings to Toronto Fire for their consent.

When replacing existing hydrants use the same location, if possible. If a hydrant is to be located to a new location, notify the affected homeowners prior to installation.

Isolation Valve and Box

All fire hydrants will have a 150 mm diameter lead, isolation control valve and box. Hydrant control valves will open in the same direction as the mainline watermain valve and be a minimum of one metre away from the fire hydrant.

If the isolation valve is positioned next to the watermain, attach it to the anchor tee.

If the isolation valve is separated from the watermain, restrain the valve, hydrant and all joints in between.

For details and additional design information, see City standard T-1105.01.

Hydrants will not be placed on watermains greater than 400 mm in diameter.

Above Ground Clearances

The minimum clearance from above ground obstructions to a fire hydrant will be as follows:

- behind—1.2 metres
- each side—1.2 metres
- front—clear to the curb line

Protection from Damage

Hydrants located adjacent to parking areas, vehicle traffic areas or in areas without curbing will be protected by bollards or guard posts. The bollards must be located so they are not directly in front of a nozzle cap.

The posts should be of 150 mm diameter steel pipe positioned at least 1.2 metres from the hydrant, cemented in the ground vertically, buried at least 0.6 metre below grade and exposed by at least 0.9 metre above ground. The post will be filled with soil or concrete and capped with concrete. Upon cement curing, the posts will be painted with reflective safety yellow enamel for ease of visibility.

Markings

Hydrants will be colour coded in accordance with NFPA 291 "*Fire Flow Testing and Marking of Fire Hydrants*." Accordingly, barrels are to be chrome yellow. The tops and hose nozzle caps should be painted with the following capacity indicating colour scheme to provide simplicity and consistency with colours used in signal safety, danger and intermediate condition.

- Class AA—rated capacity of 5680 litres/minute or greater—light blue
- Class A—rated capacity of 3785–5675 litres/minute—green
- Class B—rated capacity of 1900–3785 litres/minute—orange
- Class C—rated capacity of less than 1900 litres/minute—red

Rated capacity is measured at 140 kilopascals residual pressure. The capacity colours should be of reflective type paint, for rapid identification at night.

Dead-Ended Watermains

Where the road is not designed to be extended in the future, all dead-ended 150 mm diameter and larger watermains will not use a blow-off but have a hydrant installed at the end for bleeding, charging, and flushing of the watermain.

Municipal Water Service Connections

Water service connections will be sized based on:

- peak water consumption of the building serviced
- length of service to reach the building
- available pressure in the watermain and the relative elevation of the building being served

Unless site conditions dictate otherwise, the size of a water service will be a minimum of 19 mm diameter for single residential connections. The exception is where the length of the connection from the watermain to the building setback exceeds 30 metres, and then the minimum nominal diameter will be 25 mm.

All water service installations will comply with the City's fee schedule for the service diameter installed.

Commercial, industrial, and institutional water service connections will be sized according to the intended use. All service connections will be constructed in accordance to City standard T-1104.01, T-1104.02-1, T-1104.02-2, T-1105.02-1 and T-1105.02-2.

Water services 100 mm in diameter and larger should be installed at the same time as the main line with a new valve at street line. This will allow the service to be pressure tested and disinfected at the same time as the main line watermain.

When the watermain is ductile iron, the service connections will be metallic—that is copper or ductile iron.

All water services must be installed with a minimum of 1.8 metres of cover or no more than 2 metres of cover from the final surface grade.

Electrical Ground

Plastic water services 25 mm in diameter and less are planned to be approved in the future.

When the watermain is PVC, the service connection—25 millimetres and less—will be plastic or copper. If the water service is plastic, a grounding electrode must be installed as per the Ontario Electrical Safety Code.

The use of water services as an electrical ground will comply with the Ontario Electrical Safety Code.

Fire Line and Domestic Service Connections

Domestic connections off a fire line can be made. The size of a domestic service is to be one size smaller than the fire service line.

Table: Fire line and domestic service connection sizes

Fire service size (mm)	Maximum domestic size (mm)
200	150
150	100
100	50

Restraints

All 100 mm diameter and larger water service connections, including the valves, bends and fittings will be fully restrained from the watermain pipe to the property line. If there are more than two consecutive joints, the necessity of installing restraints will be reviewed on an individual case-by-case basis.

Water Service Valving

For services 50 mm and smaller, all services will have two isolation valves. One valve will be installed adjacent to the watermain; main stop and buried, and another valve will be installed at the property line, complete with curb stop and a service box provided to finished grade.

For details and additional design information see City standard T-1104.01 and T-1104.02-1.

For services larger than 50 mm, the designer will contact the City regarding the number and location of valves and boxes.

Service Connections to Transmission Mains

No service connections will be allowed to connect to a transmission watermain under the jurisdiction of the water supply unit. Generally transmission watermains are 600 mm in diameter and larger.

Service Connections inside Easements

Water service connections to distribution watermains within easements will not be allowed unless an exemption is provided by the General Manager, Toronto Water. An easement encroachment agreement stipulating the conditions of the encroachment will be required for all water service connections.

Backflow Prevention

Where there is a risk of contamination at a property, such as non-potable water, wastewater, or any other liquid, chemical or substance entering the waterworks that may affect the quality of the water supply, the owner of the property will install a backflow prevention device.

Backflow prevention devices will be selected, supplied, installed and tested at the owner's expense in accordance with Water Supply Bylaw, Chapter 851 of the Toronto Municipal Code, Ontario Building Code, CSA B64 and NFPA 13/14 standards and specifications.

Temporary Connections to Existing Watermains

A reduced pressure zone assembly backflow preventer is required to isolate the proposed watermain from the existing watermain during construction prior to disinfection and making the permanent connection.

Fire Protection Systems

Where the water distribution system services a fire protection system such as a building sprinkler system, the fire protection system will be isolated by:

- A double check valve assembly for non-health hazards where no water treatment chemicals or anti-freeze are added to the fire protection system.
- A reduced pressure principal backflow preventer for health hazards where water treatment chemicals or anti-freeze solutions are added to the fire protection system.

Corrosion Protection

All metallic components of the water distribution system will be protected from corrosion directly, by using approved protective coatings or indirectly, by means of sacrificial anodes or distributed impressed current systems. The pipe-to-soil potential should be less than -850 millivolts for the pipe to be adequately protected.

Cathodic Protection

All plastic mains with directly buried metallic fittings including bends, tees, crosses, valves, and hydrants and each copper service pipe will be cathodically protected by the installation of a sacrificial anode of the specified size and type. For details and additional design information see City standard T-1106.04 and TS 7.22.

Electrical Continuity

Ductile iron watermains will be connected with copper bond cables at each joint to ensure continuous electrical continuity throughout the watermain system.

Soil Resistivity and Corrosiveness

As part of the geotechnical report, the resistivity and corrosiveness of the soil must be determined.

Where metallic watermains are to be installed, an appraisal must be done to determine if corrosion protection is required. This appraisal will be performed using a 10–point soil evaluation procedure as described in AWWA C105. If the appraisal establishes a need for corrosion protection, the anode spacing will be clearly shown on the construction drawings.

Tracer Wires

Tracer wires will be installed on all non-metallic watermains along the full length of the pipe to provide a means of locating the main.

Tracer wire on non-metallic systems will not be connected to new or existing metallic watermain piping or associated fittings connected to the metallic watermain. This is to ensure there will be no interconnection between corrosion protection systems. For details and additional design information, see City standard TS 7.40.

Electrical Grounding

On reconstruction projects or local improvement projects where existing structures will be serviced by a replacement or new water distribution system, the engineer will determine if the electrical grounding systems are connected to the water service. If so, appropriate measures must be taken to ensure that electrical grounding systems are not compromised. Possible solutions include using copper services or installing new grounding rods or plates.

Watermains and water services will not be used as an electrical ground in new buildings without verifying the electrical continuity.

PVC Pipe in Contaminated Soil

When choosing a watermain material for installation in contaminated soils containing volatile organic compounds (VOC), the following should be considered.

Subject to proper identification of contaminants and in consultation with the pipe manufacturer as per AWWA and CSA B137, thermoplastic pipes with nitrile gaskets will be used if the volatile organic compound—organic solvents and petroleum products—is low in concentration and if, based on proposed land use, no further contamination is likely to occur in the subject area.

Thermoplastic pipe shall not be used in soil with high volatile organic contamination—organic solvents and petroleum products—or in areas with a high risk of contamination such as near buried petroleum fuel tanks, gas stations and petro storage areas. As an alternative, metal pipes with nitrile gaskets will be used.

Toronto Transit Commission

Ductile Iron near TTC Street Car Tracks

This paragraph will only apply until a full plastic system is approved in the near future.

New or replacement watermains which are parallel and within the same road allowance as Toronto Transit Commission (TTC) street car tracks will be ductile iron pipe and adequately cathodically protected.

Stray Current Prevention

The primary source of stray current is the TTC electrified rail system. Drainage bonds and blocking diodes are used to provide a unidirectional return path for any stray direct current (DC) picked up by a watermain by connecting the watermain to the negative pole of the DC source. This metallic connection will have a lower resistance than the alternative earth return path. This method of "drainage" is one of the techniques used in stray current corrosion protection.

When working near one of the 55 TTC substations make sure the drainage cable is not accidentally disconnected.

Suspended Watermains

Suspended watermains from bridges will be properly insulated. The thickness of the insulation will be a minimum of 50 mm or as approved by the consulting engineer.

Pre-insulated high density polyethylene pipe (HDPE) may be used for external bridge crossings.

Water Meters

The terms and conditions under which water meters will be installed are set out in the City's Water Supply Bylaw, Chapter 851 of the Toronto Municipal Code. The City is responsible for installing a water meter on all new or replacement residential water services unless other arrangements with the builder have been agreed to by Toronto Water.

Generally, residential water meters will be sized one size smaller than the diameter of the service pipe installed, unless supported by calculations.

- 38 mm service receives a 25 mm x 38 mm water meter
- 25 mm service receives a 20 mm x 25 mm water meter
- 19 mm service receives a 16 mm x 19 mm water meter

For 50 mm and larger water services, provisions should be made in the piping system for the installation of a water meter of the same diameter as the private system. The sizing of the water meter will be such that the accuracy of the low flow measurement is optimized while ensuring that the rated supply to the property is not adversely affected.

Watermain Replacement

There are two basic approaches that can be taken when replacing watermains.

Design Approach One

Install a new watermain system in a parallel location. The new system also includes the installation of new fire hydrants, valve boxes or chambers, valves, and water services. This method allows the existing system to remain in service until the new watermain is disinfected and the new services are transferred to the appropriate homes or businesses. The old system is taken out of service and decommissioned by capping the ends, removing the valves; breaking down the valve chambers approximately one metre below grade and filling the remaining valve chamber with unshrinkable fill. If the new system is to be installed in the boulevard and mature trees are in the direct path of the proposed watermain, the watermain should be installed by a trenchless method to minimize the impact on the trees.

Design Approach Two

Remove the existing watermain and replace it with a new system in the same location. The new system also includes the installation of new fire hydrants, valves and water services. Valve chambers must be inspected to determine their condition and if found to be satisfactory, may remain in place. This method requires the installation and disinfection of a temporary by-pass watermain and temporary services. The new system is disinfected and new water services are connected to the appropriate homes or businesses.

The approach in order of preference from most desirable to least desirable is as follows:

1 New watermain system in a parallel location. Location of the new watermain is in the boulevard area on the same side as the existing fire hydrants.

2 New watermain system in a parallel location. Location of the new watermain is in the pavement area on the side closest to the existing fire hydrants.

3 Remove the existing watermain and replace it with a new system using a temporary by-pass system. The new system is installed in the same location as the old system.

4 New watermain system in parallel location. Location of the new watermain is in the boulevard area on the opposite side of the existing fire hydrants.

5 New watermain system in parallel location. Location of the new watermain is in the pavement area on the side farthest from the existing fire hydrants.

Chapter 5 – Lot Grading

When a lot grading plan is required as part of a plan of subdivision, the drawing will be titled "*Subdivision Grading and Building Siting Control Plan*" as per Section 12 of the subdivision agreement at the time of the engineering drawing submission. The plan will indicate the lot grading information based on the lot grading criteria and it will indicate the siting of the proposed houses and the driveway locations. The driveways should be located to meet the objectives of the residential vehicle parking bylaw, have adequate clearance from utilities and existing trees, and permit safe vehicular access.

The lot grading criteria outlined in this chapter also applies to site plan applications.

The grading plan will be reviewed by the development engineering section of Technical Services to verify that it agrees with the engineering plan submissions and appropriate specifications. This plan must be reviewed and accepted at the same time as the other engineering drawings.

Information to Show

The following information will be shown on the lot drainage and house siting control plan:

Location Information

- Indicate the north arrow on the plan.
- Key plan showing the site or proposed development. For larger subdivisions, show the location of the lots on the street in relation to the overall development.
- Description of the nearest geodetic bench mark and site bench marks. Refer all elevations to a geodetic city benchmark.
- Show all existing and proposed lot numbers and blocks.
- All existing and proposed easements within the site plan or subdivision.
- Standard lot grading notes. For details, see Appendix B, *General Notes*.

- Indicate type of lot drainage on the plan. For example:
  - FS – front split
  - F – front drainage
  - BS – back split drainage or WO – walkout
  - R – rear
- Indicate finished floor elevations for each dwelling on site development plans.
- Plans should be on a standard metric A 1 sheet (594 mm x 841 mm) with a scale of 1:250.
- Show a table for a list of revisions above the title block.

Existing Information

- Existing ground contours at half metre intervals over the entire subdivision and sufficient area of adjacent lands to establish the overall drainage pattern.
- Show direction of existing flow outside boundary perimeter.
- Along the perimeter of the development lands, existing ground elevations obtained by an actual field survey, will be shown at the lot corners of all existing abutting properties and along two additional lines parallel to the subdivision perimeter lot line—at approximately 3 metres and 6 metres from the perimeter lot line—into the adjoining property.
- If the adjoining property is large, then existing ground elevations along the common property line and along three parallel lines—distant 5 metres, 10 metres, and 15 metres from the common property line—within the adjoining property, taken at a minimum spacing of 15 metres will be shown, as well as at all locations where the ground topography changes abruptly.
- Show location of all road catchbasins, maintenance holes, hydrants, street lights and hydro vaults, utility poles, telephone boxes and cable boxes.
- Show all sidewalks and curbs.
- Show existing trees to be preserved and above ground utility structures and other structures as necessary.

Proposed Information

- Show proposed ground elevations at all lot corners and at intermediate points for change in grade. On large blocks, proposed ground elevations at 15 metres spacing along the frontage of the block and at reasonable spacing along the sides and rear of the block will be shown.

- Show proposed ground elevations at the front of all dwellings on the proposed lots. For split type drainage patterns where the elevation at the rear or side of dwelling will vary by more than 0.4 metre from the elevation at the front of the dwelling, the proposed ground elevation at the rear or side of the dwelling will also be specified.

- Show minimum basement floor elevations of the proposed dwellings. Minimum basement floor elevations will be calculated based on the elevation of the sanitary or the storm connections. For all practical purposes such as when the hydraulic grade line is not known and unless the design of the services indicates special consideration for the service connections, the generally accepted practice is that the minimum basement floor elevation is 1.7 metres lower than the centerline of the road at the location of the service connection.

- Proposed road centre line elevations at all changes in grade, at all intersections, and opposite each proposed lot and block corner. If the frontage of the blocks is greater than 45 metres, proposed centerline road elevations at 15 metres spacing will be provided.

- Show proposed road grades, lengths, and elevations on all streets with symbols at grade changes, indicating direction of slope.

- Show a driveway envelope from the street line to the proposed curbs or edge of the traveled surface of the road.

- Location of any proposed private rear yard catchbasins, leads and the top of grate elevations and inverts.

- Typical sections for all proposed drainage courses and swales.

- Typical details of proposed drainage types of the lots.

Spot Elevations

Proposed spot elevations will be shown at the following locations on the development site plan.

- the four corners of each row of parking spaces
- change in pavement materials
- change in slopes
- centre of driveways
- top of catchbasins and maintenance holes
- building entrances
- top and bottom of curb in front of a building entrance
- beginning and ending of any radius, crest or drainage divides
- a minimum of three spot elevations along each property line or lot line greater than 10 metres in length

Driveways

For residential site plans where a driveway is reconstructed, expanded, or proposed, spot elevations must be shown along both sides of the driveway, at the centre of the driveway three metres from the property line, at the property line, at the sidewalk closest to the road and at the existing gutter of the curb.

Landscape Features

- show limits of landscape features
- top and bottom of slopes
- minimum of four spot elevations around base of a landscape feature, such as a berm
- beginning and ending of a ridge or depression of a feature and any intermediate points
- show grading contours

Other Information

- The consulting engineer will determine if there is an approved development application on adjacent vacant lands and shall co-ordinate the grading with the consulting engineer of the adjacent development, so as to match proposed and existing grades.

- Show any additional plans, sections and details for drainage courses and erosion protection, steep topography, screening, and noise abatement features as may be required.

- All existing and proposed slopes and embankments showing top and bottom of the slope or embankment elevations and degree of slope, for example 3:1.
- Drainage arrows showing the direction of surface drainage on all lots and blocks.
- Drainage arrows indicating the route of the major storm overflow.
- Location, details and x-sections of any retaining walls.
- Percent grades shown to one decimal place.

Lot Grading Requirements

Grading plan will show the existing and proposed grading of lands within the plan of subdivision or site plan to ensure that proper drainage within both the lands being developed and adjacent lands, are not adversely affected.

All areas shall be graded in such a way as to provide proper drainage and maximum use of land. Drainage flows shall be directed away from houses.

Storm drainage is to be self-contained within the subdivision or development site limits. There may be pre-existing conditions where drainage may need to be accepted from surrounding lots.

Basic Requirements of Lot Grading

- minimum acceptable gradient allowable is 2 percent
- maximum allowable gradient is 5 percent
- maximum acceptable slope is 3:1
- slopes greater than 5 percent or 2:1 slopes will not be used in order to maximize the usable areas in the backyard

Rear Yard Gradients

The average gradient of rear yard surfaces will not exceed 10 percent and will be measured by dividing the elevation difference by the measured distance using one of the following three methods:

1 From the rear of the house to the rear lot line, or

2 From the rear of the house to the lowest invert elevation of the rear swale, and

3 From side lot line to side lot line over the full width of the lot.

Should the average gradient exceed 10 percent, the City will require construction of a retaining wall to reduce the average gradient to an acceptable amount.

No alterations to existing boundary elevations or adjacent lands will be undertaken unless a written agreement with the adjacent property owner is obtained and submitted in a format acceptable to the City.

In most cases, each lot will be designed to drain independently. Drainage to a nearby street through the rear of an adjacent lot is not permitted, unless the adjacent lot is part of the same development. However, for lots where "zero lot line" zoning is permitted, drainage to a nearby street through the rear of an adjacent lot is not permitted.

Rear Yard Drainage

Through draining lots will only be considered where lots backing onto each other have common rear lot corners and there is no change in direction of the matching side lot lines. The drainage rights should be registered on title for any affected properties.

Swales

Swales will have a minimum gradient of 2 percent. Desirable swale depth will be 150 mm. Swale depths will conform to the following:

- minimum depth of 150 mm
- maximum side yard depth of 300 mm
- maximum rear yard depth of 400 mm
- maximum side slopes are 3:1

Sod cannot be maintained on slopes greater than 3:1, therefore slopes steeper than 3:1 will not be permitted.

The maximum slope between houses in any direction will be 3:1. If these objectives cannot be met, steps or retaining walls will be required.

All swales having a velocity in excess of 1.5 metres/second will be designed to incorporate erosion protection.

Drainage flows which are carried around houses are to be confined in defined swales located as far from the house as possible. The depth of these swales should be held as close to the minimum of 150 mm.

The alignment of swales will not change more than 45 degrees. If this occurs, additional catch basins will be installed.

Maximum Swale Flows

For lots less than 15 metres in width, rear yard swales will not exceed 50 metres in length.

The maximum flow allowable in a side yard swale will be that volume contributing from a drainage area of half hectare or three backyards—where lot widths are 15 metres or greater, whichever is less.

The maximum flow allowable in a rear yard swale will be that volume contributing from a drainage area of half hectare.

The maximum flow in any swale, which may discharge directly onto any road allowance, will be that from a maximum area of half hectare of contributory area. Areas in excess of half hectare necessitate installation of an inlet structure to intercept run-off prior to its entering the road allowance.

For infill developments where lot widths are small, no rear yard swale will exceed 50 metres in length.

The maximum distance from any rear lot line to the centre of any rear lot swale will be one metre.

Residential Driveways

The minimum gradient on any driveway will be 2 percent. The recommended maximum gradient on any driveway will be 5 percent.

The maximum gradient on any driveway will be 8 percent. Proposed driveway gradients in excess of 5 percent will only be considered upon the receipt of written justification for the owner’s consulting engineer.

Driveway gradients will be calculated based upon the back edge of a sidewalk constructed at the City’s standard location and elevation, regardless of whether or not the sidewalk actually exists.

Transition Slopes

Transition slopes located adjacent to property lines will be constructed such that the top of slope is adjacent to the property line.

Transition slopes between 5 percent and 33 percent or 3:1 will not be used to maximize usable land.

Transition slopes will not be located within the side yard area between dwellings, except for walkouts. Within the rear yard area, transition slopes will be offset 0.6 metre from the property line to maintain common side yard or rear yard swales.

The maximum vertical grade transition across a front or rear yard will be 1.2 metres. For walkout lots, the maximum vertical grade transition within the side yard between dwellings will be 2.5 metres.

Three to one slopes will not exceed a maximum height of 0.6 metre within the rear yard area. Two transition slopes may be used, one offset from each property line to accommodate grade transitions exceeding 0.6 metre within the rear yard area.

Retaining Walls

Retaining walls will be constructed entirely on the upper property so that tie backs, if required, do not encroach onto adjacent properties.

If a retaining wall is required, a detailed drawing showing location and cross section of the design will be submitted for approval. If the retaining wall exceeds one metre in exposed height and is adjacent to space used by the public, adjacent to access points to a building or private property to which the public is admitted, a building permit will be required. You will have to contact Toronto Building to determine the review, certification, permit issuance and inspection process.

The proposed retaining wall detail will show off-sets to lot lines, length, height, sufficient top of wall and footing elevations, wall material type, drainage ports, bedding and backfilling requirements

Retaining Walls in the Road Allowance

No retaining walls are allowed in the road allowance. If an encroachment is granted, the City does not accept wood retaining walls.

Catchbasins

Front yard catchbasins are not permitted and will not be specified. Catchbasins in reverse driveways are acceptable. However, reverse slope and below grade driveways are susceptible to surface flooding in low lying areas and should be discouraged. For report submission guidelines for reverse slope driveways, see Appendix F, *Reverse Slope Driveway Guidelines*.

All rear lot catchbasin leads will be concrete encased.

For a single property that drains to the front road allowance, the rear lot catchbasin and lead will be constructed entirely within the property.

The maximum offset from the centre line of any catchbasin to any rear lot line will be 1.5 metres. The minimum offset will be 0.9 metre.

The offset from the centre line of any catchbasin lead to any side lot line will be 0.60 metre.

The catchbasin frame will be set at the elevation of the invert of the lowest swale.

Catchbasin leads crossing multiple properties should be discouraged during the review phase. Use only if no alternative is available.

In cases where a catchbasin is constructed on one property and its lead is constructed passing through another or other properties, a 3 metres wide maintenance access easement from the municipal road allowance to the catchbasin is required over the properties. This easement will be a private easement and not a municipal easement.

Catchbasins in Parking Lots

Catchbasins in parking lots will not be located within parking spaces but within the drive lanes. Consideration should be given to increasing the inlet capacity for low points where there is an increased possibility of debris accumulating.

The maximum water ponding depth in parking lots will be 0.3 metre.

Fencing

Any house or lot fronting or abutting on any street may make an application for a permit to construct and maintain in any portion of the boulevard abutting a house or lot, a fence which complies with the following criteria:

A fence is to be no more than 1.9 metres in height where it is not located beyond the front wall of a building and one metre in height in front of a building and does not present a hazard to the public or interfere with any public utility use or proposed use.

The fence will be set back a minimum of 0.46 metre from the rear edge of the sidewalk or a minimum of 2.1 metres from the curb where no sidewalk is present. The footings for the fence which are located within the street allowance will not exceed a depth of 0.61 metre.

For more information on fences and ornamental walls, see Toronto Municipal Code, Chapter 313-33.

Fencing on Private Property

For more information on fences on private property, see Chapter 447, Fences of the Toronto Municipal Code and any conditions set out in Section 21–Fencing and Barriers in the subdivision agreement.

Grading Constraints

Provide a 0.6 metre wide flat access strip at a 2 percent slope along at least one side of the building where side yard setbacks permit—usually along the garage side or side door entrance. This stipulation is in addition to the 150 mm apron required around buildings and is needed to permit the construction of a walkway to the rear of the house.

An undisturbed flat area having a width of half metre will be provided at the boundary limits adjacent to other properties in order that the existing boundary elevation will be maintained. No filling or regrading on adjacent lands will be permitted unless written permission is obtained from the affected owner.

Clear stone rather than topsoil and sod is required for combined side yards between two buildings which are less than 1.2 metres apart. For side yards greater than 1.2 metres, clear stone may be required at the discretion of the Executive Director, Technical Services.

Standard Notes for All Lot Drainage Plans

The standard note for all lot drainage plans excluding subdivisions consisting solely of single family and semi-detached residential use will be as indicated in Appendix B, *General Notes*.

Chapter 6 – Material Specifications

Materials incorporated in the finished work and used during construction shall be according to the standards and specifications specified in this chapter. Alternate materials will not be permitted without written consent of the General Manager, Toronto Water.

Watermain Pipe

Ductile Iron

Ductile iron (DI) pipe shall be manufactured according to AWWA/ANSI standard C151/A21.51–09. Special thickness class 'Class 52' in sizes 150 mm up to and including 300 mm diameter, with standard cement lining thickness according to AWWA/ANSI C104/A21.4–08. Ductile iron pipe will be supplied with push-on joints complete with copper bonding cables from pipe to pipe for maintaining electrical continuity. Ductile iron in sizes of 400 mm and 600 mm diameter will use special thickness class 'Class 53' pipe.

Polyvinyl Chloride

All polyvinyl chloride (PVC) pipes ranging in size from 100 mm through 300 mm in diameter, will be Pressure Class 235, DR 18 and manufactured according to AWWA C900-07, certified to CSA B137.3-05 and have the same outside diameter dimensions as cast iron. All PVC pipe ranging in size from 350 mm through 600 mm in diameter, will have a minimum pressure rating 235, DR 18, manufactured according to AWWA C905–10, certified to CSA B137.3-05 and have the same outside diameter dimensions as cast iron.

Molecularly Oriented Polyvinyl Chloride

Molecularly oriented polyvinyl chloride (PVCO) pipes, ranging in size from 100 mm through 300 mm in diameter and manufactured according to AWWA C909-09, certified to CSA B137.3.1 and certified as compliant with NSF/ANSI standard 61. Piping shall be pressure class 235, have cast iron outside dimensions, colour coded blue and be biaxially oriented, that is to say molecular orientation in two directions.

High Density Polyethylene

Where high density polyethylene (HDPE) pressure pipe is specified and approved by the engineer for situations of specialized installations, it will have ductile iron pipe outside diameter, co-extruded blue or blue stripe in colour and meet the requirements of OPSS 441.

The HDPE pipe fittings will meet the requirements of OPSS 441. Joints will be restrained in accordance with OPSS 441.

Concrete Pressure Pipe

Concrete pressure pipe shall be manufactured according to AWWA C301–07 for pipe diameters up to 500 mm. Use AWWA C303–09 for pipe diameters 600 mm and larger.

Fittings shall be manufactured according to AWWA C301–07 and AWWA C303–08. Concrete pressure pipe and fittings will be joined using rubber gaskets and approved joints as outlined in the manufacturer’s installation guide and AWWA C301–07 and AWWA C303–08. All joints shall be protected on the exterior using diapers and grout.

Thrust restraint will be provided through the use of restraining joints approved and supplied by the manufacturer.

Appurtenances

Special Fittings

Metallic

Ductile iron compact fittings shall be according to AWWA/ANSI C153/A21.53–11. Rubber gasket joints, fittings will be supplied with mechanical joint or push-on joint type ends according to AWWA/ANSI C111/A21.11–07. All special fittings will be cement lined according to AWWA/ANSI C104/A21.4–08.

Non-Metallic

PVC fittings shall be according to AWWA C907–12. PVC fittings shall be used with PVC pipe only, having cast iron outside diameter dimensions, DR 18, Pressure Class 235, certified to CSA B137.2-05. PVC fittings will be supplied with push-on rubber gasketed joints in nominal sizes 100 mm through 300 mm.

Transition Couplings

Transition couplings—100 mm and over—shall be according to AWWA C219–11.

All couplings must be coated with fusion bonded epoxy according to AWWA C213–07 and supplied with stainless steel nuts, bolts, and non-corrosive washers. Transition couplings will be supplied with rubber gaskets shall be according to AWWA/ANSI C111/A21.11–07.

Flanged Transition Coupling Adapters

Flanged transition—100 mm and over—coupling adapters shall be according to AWWA C219–11.

All flanged coupling adapters must be coated with fusion bonded epoxy in accordance with AWWA C213–07 and supplied with stainless steel nuts, bolts, and non-corrosive washers. Flanged coupling adapters will be supplied with rubber gaskets manufactured according to AWWA/ANSI C111/A21.11–07.

Joint Restraint Devices

Joint restraints used on PVC pressure pipe, shall be according to AWWA C900–07 or C905–10 and must adhere to ASTM F1674-05 and ULC standard testing procedures. Approved manufacturers are:

- Uni-Flange series 1300–C, 1350–C, 1390–C
- Ebba Iron series 1600, 2000PV, 2500
- Romac Grip Ring
- Clow Tyler Union PVC TUFGrip
- Star PVC StarGrip 4000P, 4100P, Series 1000CP, 1100C, 1200C
- Sigma One-LOK Series SLCEP, PV-LOK Series PWP, PVPF, PWPF

Joint restraints used on ductile iron Class 52 pressure pipe, shall be according to AWWA/ANSI C151/A21.51–09 and must adhere to ULC standard testing procedures. Approved manufacturers are:

- Uni-Flange series 1300, 1390, 1400
- Ebba Iron MegaLug series 1100, 1700
- Romac Grip Ring
- Clow Tyler Union Ductile TUFGrip

- Star StarGrip Series 3000P, 3100P, 3100S
- Sigma One-LOK Series SLDEH, SSLDP

Joint restraints used on PVCO pressure pipe, shall be compatible with both C900–07 and Bionax. Recommened products are:

PVCO Pipe to PVC Fitting 100 mm to 300 mm

- Clow 360c
- Ebba Iron series 2600
- Sigma PV-Lok PWPF
- Star PVC 3500PF with 1200 Series
- Uni-Flange series UFR 1369

PVCO Pipe Standard Bell and Spigot Push-On Joints 100 mm to 300 mm

- Clow 390c
- Ebba Iron series 1900
- Sigma PV-Lok PWP
- Star PVC 3500C Series
- Uni-Flange series UFR 1399

PVCO Pipe to Mechanical Joint Fitting 100 mm to 300 mm

- Clow 300c
- Clow TUFGrip
- Ebba Iron 19MJ00
- Sigma PWM
- Sigma One-Lok SLC
- Star PVC 3500 Series
- Star PVC 4000 Series
- Uni-Flange 1500

Adapter flanges used on PVC pressure pipe, shall be according to AWWA C900–07 or C905–10 and must adhere to ASTM F1674-05 and ULC standard testing procedures. Approved manufacturers are:

- Uni-flange series 900–C
- Ebba Iron series 2100

Adapter flanges used on ductile iron Class 52 pressure pipe, shall be according to AWWA/ANSI C151/A21.51–09 and must adhere to ULC standard testing procedures. Approved manufacturers are:

- Uni-Flange series 800, 1400
- Ebba Iron series 1000, 2100
- Robar 7404/7506
- Romac FCA 501
- Smith Blair 912

Gate Valves – 100 mm to 400 mm

All valves shall be according to AWWA C509–09 or C515-09. Approved manufacturers for valves in sizes 100 mm to 400 mm inclusive, shall be:

- Mueller resilient seat gate valve A2360
- Clow resilient seat gate valve F-6100
- AVK resilient seat gate valve Series 65
- Clow McAvity II–figure 20075

All valves will have inside screw non-rising spindle, complete with mechanical joint ends. Valves specified to open right must be supplied with *'Toronto Operating Nut'* and valves specified to open left must be supplied with 50 mm square operating nut. To determine the direction to open the valve in your district, see Appendix C, *Maps*.

All valves must be coated with fusion bonded epoxy in according to AWWA C550–13. All unprotected nuts and bolts used in the bonnet and valve stem assembly will be made of stainless steel. All 100 mm diameter valves must be supplied with a stainless steel stem.

Valve tie downs to be pre-fabricated as manufactured to City specifications, as approved by the engineer.

Valve tie downs to be galvanized and supplied with stainless steel nuts and bolts.

Tapping Sleeves and Valves

All valves will be manufactured according to AWWA C509–09 or C515-09. All valves are to have inside screw non-rising spindle, 50 mm square operating nut, complete with a flanged end with a male spigot and a mechanical joint at the other end. Direction to open valve clockwise or counter clockwise is district specific. To determine your requirements, see Appendix C, *Maps*. All valves must be interior coated with fusion bonded epoxy according to AWWA C550–13. All unprotected nuts and bolts, used in the bonnet and valve stem assembly will be made of stainless steel. All 100 mm diameter valves must be supplied with stainless steel stem.

Approved manufacturers for tapping valves will be:

- Mueller resilient seat gate valve T-2360
- Clow resilient seat gate valve F-6114
- AVK resilient seat gate valve Series 65
- Clow McAvity II–20695

Tapping sleeves for ductile iron, cast iron, polyvinyl chloride, and asbestos cement pipe will be:

- Robar 6606
- Ford all stainless steel (FAST)
- Romac SST 304
- Mueller H615 s/b H-304

All tapping sleeves will be stainless steel and supplied with stainless steel nuts and bolts and non corrosive washers. Size of tapping sleeves must provide a full seal around the outside circumference of the pipe. Size of tapping sleeves must have a longer body as specified by the engineer.

Air Valves

Air valves are to be 25 mm, 50 mm, and 100 mm and shall be:

Valmatic 15 A.3
Golden Anderson
Empire

Note: Mueller A206 main stop must be used

All air valves must be coated with fusion bonded epoxy according to AWWA C550–05 on both interior and exterior surfaces and supplied with a ring check valve T480Y–13 mm pressure tested to 1725 kilopascals.

Valve Boxes

Valve box on watermains less than 400 mm in diameter will be 130 mm, regular style, slide type with guide plate and with 184 mm diameter cover. Approved manufacturers are:

- Bibby-Ste-Croix VB2200
- Mueller Canada MVB—bottom section only

Valve box for service valves on watermains smaller or equal to 300 mm diameter shall be 105 mm, regular style, slide type with guide plate and with 149 mm diameter cover. Approved manufacturers are:

- Bibby-Ste-Croix VB1200
- Mueller Canada MVB—bottom section only

Repair Clamps

Repair clamps will be:

- Clow Concord D–76R all stainless
- Mueller full seal series 520
- Smith Blair 261/256 full circle
- Robar style 5636–style 1
- Romac SS1
- Ford FS1 style
- EZ–Max 4000

All repair clamps to be all stainless steel and be supplied with stainless steel nuts with passified bolts. Body length to suit repair as per manufacturers installation instructions.

All repair clamps will provide a full rubber seal around entire outside diameter of the pipe to be repaired.

Service Saddles

All service saddles shall be made of a stainless steel band fastened with a minimum double bolt mechanism, tapered rubber gaskets and supplied with stainless steel nuts, bolts, and non-corrosive washers.

For existing cast iron, ductile iron, and asbestos cement pipe, service saddles are required for 19 mm, 25 mm, 32 mm, 38 mm, and 50 mm diameter main stops —all AWWA tapered threads.

On PVC pipe, service saddles must be used for 19 mm, 25 mm, 32 mm, 38 mm, and 50 mm diameter main stops —all AWWA tapered threads.

For new ductile iron only, small water services greater than 25 mm in diameter require saddles.

Approved manufacturers are:

- Romac 306
- Smith Blair 372
- Mueller Servi–Seal 521 to 529 series
- Ford FS 303
- Cambridge Brass Teck series 403
- Robar 2616DB
- Robar 2706

Water Services

The standard water service diameters are 19 mm, 25 mm, 32 mm, 38 mm, and 50 mm. Copper pipe will be ASTM B88-03 (ASTM B88M-05 for metric sizes) type 'K' soft copper.

[Plastic water services] is planned to be approved in the future.

[Plastic water services—reserved for future]

All main stops will have a compression joint and approved manufacturers are:

- Cambridge Brass series 102
- A.Y. McDonald 4701T
- Ford F–1000 and F–600
- Mueller H15008

All curb stops will have a compression joint. Approved manufacturers are:

- Cambridge Brass century ball valve
- Ford ball valve B–44 series
- Mueller H15209
- A. Y. McDonald 6100 T ball valve

All couplings shall have a compression joint. Approved manufacturers are:

- Cambridge Brass series 118
- Ford C–44
- Mueller H15403
- A.Y. McDonald 4758T

Service boxes will be made of cast iron and will suit the respective curb stop. The boxes will be adjustable from 1800 mm to 2100 mm bury.

The rods will be 1125 mm long, made of passivated #304 stainless steel with M5 x 70 mm brass cotter pins.

The plug must be brass and screw type.

Where further extension is required for the box because of extra depth, the extension and the coupling must be of threaded type. If the final grade is more than 1000 mm above the top of the rod, then the rod must be replaced with one which is made of continuous passivated #304 stainless steel.

Box top to be stamped "water".

Self draining stop and drain. Approved manufacturers are:

- Emco series–15790
- Mueller H15219

Hydrants

Hydrants shall be:

- AVK Model 2780
- Canada Valve Century
- Clow–McAvity Brigadier M67
- Mueller Modern Centurion

All hydrants shall be according to AWWA C502-05 and NSF/ANSI 61 for dry barrel hydrants and open counter clockwise. Hydrants will have tapped drain ports, 150 mm mechanical joint inlet with brass to brass fittings on the main valve seat, two 63.5 mm hose nozzles spread 180 degrees apart and a 114.3 mm pumper nozzle with a 100 mm ULC S543 approved Storz connection. Hydrants will be connected to the watermain using a 150 mm lead, 150 mm gate valve and anchor tee. Hydrants will be supplied for a minimum bury depth of 1.8 metres.

Hydrant extensions required to adjust the length of the hydrant barrel are to be obtained from the hydrant manufacturer or approved supplier.

Hydrant anti-tamper devices shall be manufactured according to City specifications, as approved by the engineer.

Hydrant paint will be high gloss exterior chrome yellow and shall be applied over a quality dry red oxide primer. Storz nozzles shall be painted black.

Metal Items

Bolts, Nuts, and Washers

Zinc Coated

Zinc coated bolts, nuts, and washers will conform to the latest issue of ASTM. Use Grade 2, designated A 305 bolts for flanges up to and including 300 mm diameter, and Grade 5, designated A 307 for flanges larger than 300 mm diameter.

Cadmium Coated

Cadmium coated bolts, nuts, and washers will conform to the latest issue of ASTM. Use Grade 2, designated A 305 bolts for flanges up to and including 300 mm diameter, and Grade 5, designated A 307 for flanges larger than 300 mm diameter.

Stainless Steel

Stainless steel bolts, nuts, and washers will be stainless steel type 304 manufactured according to ASTM F593-02e2 and ASTM F594-02.

Cast Iron

Cast iron will conform to ASTM A48, Class 30B, standard specification for gray iron castings. Cast iron products will be asphalt coated.

Galvanizing

Galvanizing will conform to ASTM A123—zinc coatings on iron and steel products. Metal products specified as galvanized will be galvanized after fabrication.

Petrolatum Tape Systems

Anti-corrosion wrap shall be as supplied by Denso North America Inc. or Trenton Tape. Only material from one supplier exclusively shall be used on an installation. At no time will materials from either system be utilized with the other.

Denso coatings material will consist of Denso paste or Denso priming solution for cold temperature application, Denso profiling mastic or Denso Mastic Blanket and Denso LT Tape.

Trenton Tape coating material will consist of TecTape Primer, Fill Putty, and TecTape petrolatum tape.

Anodes

Packaged anodes will be zinc Z–24–48 manufactured using a high purity zinc—99.99 percent pure zinc—conforming to ASTM B–418-06 Type II. The anode shall have an average current efficiency of 90 percent and provide an open circuit potential with a minimum 1.10 volt direct current (DC) as measured with respect to the copper or copper sulphate reference electrode. The zinc casting shall have a 6 mm diameter electro-galvanized steel core wire extending 100 percent of the length of the casting and shall be packaged in a cardboard container approximately 100 mm in diameter. The depolarizing material surrounding the zinc casting shall be composed of a gypsum or bentonite base material having an electrical resistivity less than 45 ohm–cm when saturated with distilled water. An insulated copper wire—AWG #10/7 strand, 3 metres in length will be brazed to the end of the core wire. For details and additional design information, see TS 7.22

Tracer Wire

Tracer wire will be #10 gauge AWG single or seven strand, insulated copper wire. For details and additional design information, see TS 7.40.

Insulation Type

Any non-buried watermain will be insulated with polyisocyanurate foam or polyurethane foam and wrapped in an aluminium jacket. The thickness of the insulation will be determined by the engineer. In most cases the thickness will be 50 mm.

Gasket Type

Standard gasket meeting ASTM D3139 requirements for plastic pressure pipe using flexible elastometric seals will be used for typical watermain applications where PVC pipe is being used. Nitrile gaskets will be used for watermain applications when the pipe must be buried in soil with hydrocarbons.

Sewer Pipe

Both rigid and flexible pipe are permitted in the construction of sanitary and storm sewer systems including service connections. These materials include concrete and polyvinyl chloride. However, the bedding design must be compatible with the type of pipe material used. To determine the preferred pipe material based on the diameter of the pipe, go to Chapter 2, *Sanitary Sewer*, Table: *Sanitary sewer preferred materials* or Chapter 3, *Storm Sewers*, Table: *Storm sewer preferred material.*

Pipe materials for storm and sanitary sewer mainline, fittings, and service laterals will be CSA certified and according to the following:

Concrete Sewer Pipe and Fittings

Circular concrete pipe and fittings will conform to OPSS 1820 and will be manufactured at a plant certified under the Ontario concrete plant prequalification program. Non reinforced concrete pipe will be according to CSA A257.1-03. Reinforced concrete pipe will be according to CSA A257.2-03. Joints and gaskets will be according to CSA A257.3-03.

PVC Sewer Pipe and Fittings

Circular PVC pipe and fittings complete with bell and spigot joints, rubber gasket, lubricant and all other necessary appurtenances will be manufactured according to OPSS 1841 and certified to CSA B182.2-06 for PVC sewer pipe and fittings. PVC pipe will have a minimum pipe stiffness of 320 kilopascals.

HDPE Sewer Pipe and Fittings

Circular PE pipe and fittings complete with bell and spigot joints, rubber gasket, lubricant and all other necessary appurtenances will be manufactured according to OPSS 1840 using virgin resin and will be certified to CSA B182.6-06 for polyethylene sewer pipe and fittings for non-pressure applications. Circular PE pipe and fittings will have a minimum pipe stiffness of 320 kilopascals and 100 kilopascals gasketed joints.

Table: Sanitary sewer pipe materials

Type of pipe	Specification	Diameter	Approved use
non-reinforced concrete	CSA A257.1 extra strength	200 mm to 250 mm	service laterals
reinforced concrete	CSA A257.2	300 mm and larger	mainline
DR 35 PVC	CSA B182.2 320 kPa stiffness	200 mm and larger	mainline
DR 28 PVC	CSA B182.2 625 kPa stiffness	100 mm and 150 mm	service laterals
vitrified clay	CSA A60.1 and CSA A60.3	200 mm and larger	mainline and laterals

Sanitary Forcemain Material

Sanitary forcemain material will be selected to suit the installation and system requirements and be pre-approved by the City. Under no circumstances will the material selected for the forcemain be colour coded blue.

Table: Storm sewer pipe materials

Type of pipe	Specification	Diameter	Approved use
non-reinforced concrete	CSA A257.1 extra strength	200 mm to 250 mm	service laterals
reinforced concrete	CSA A257.2	300 mm and larger	mainline
DR 35 PVC	CSA B182.2 320kPa stiffness	200 mm and larger	mainline
DR 28 PVC	CSA B182.2 625kPa stiffness	150 mm	service laterals

Sewer Related Appurtenances

Maintenance Hole and Catchbasin Adjustment Units

Concrete adjustment units shall be manufactured according to material specification OPSS 1351. Precast adjustment units will be laid in a full bed of mortar with successive units being joined using sealant as recommended by the manufacturer. A minimum of one adjustment unit will be installed with a minimum height of 75 mm. A maximum of four adjustment units be installed to a height not in excess of 0.3 metre.

Rubber adjustment units shall be manufactured according to material specification OPSS 1853 and installed according to City standard T-704.01.

Precast Maintenance Holes and Catchbasins

Precast maintenance holes and catchbasin shall be as manufactured in according to material specification OPSS 1351.

Maintenance Holes and Catchbasins Frame and Covers

Maintenance holes and catchbasin frame and covers will be manufactured in accordance with material specification OPSS 1850.

Flexible Rubber Connectors

Flexible rubber connectors for connecting pipe to maintenance holes can be either cast-in-place during the manufacture of the precast product, or installed into a cored or preformed hole in the finished maintenance hole. Both types shall be according to CSA A.257.3 and ASTM C923M-07.

Concrete Pipe Gaskets

The standard gaskets supplied with any concrete product are generally formulated for maximum sealing performance in a standard sewer installation carrying storm water or sanitary sewage. Other types of gaskets would be required where resistance against hydrocarbons, acids, ultraviolet rays, ozone, and extreme heat is needed. Nitrile gaskets should be specified where hydrocarbon oil and petroleum resistance is required.

Approved Manufacturers' Product List

If the City receives product approval requests from suppliers interested in having the products evaluated for purchase by the City, the supplier should contact The Road Authority.

The City supports the efforts of the Ontario Good Roads Association (OGRA) and the Ontario Provincial Standards (OPS) organization. As part of these relationships, the City is considering to use The Road Authority (TRA) to post it's approved manufacturer's product list for watermain and sewer related products on the Internet. The Road Authority is a service provided by the OGRA and is "an Internet-based information resource that provides a mechanism for infrastructure owners, consultants, contractors and product suppliers to collaborate and share information. TRA provides users with information on products, services and technical solutions available for use in the public works sector."

If a product is listed on the TRA approved supplier list, it means the product is approved for use but it is at the City's discretion whether to use the product.

For more information on The Road Authority, go to web site: www.roadauthority.com .

Appendix A – As-built Drawings

As-built Drawing Requirements

This section describes the minimum format and content requirements for the production of construction as-built drawings. These requirements apply to capital improvement and developer projects.

General Requirements

- Use the approved CADD plans as the base for the as-built drawing—do not redraw the plans.
- Each sheet is to be labelled as “As-built Drawing”.
- Indicate in the revision box, the year the underground infrastructure was constructed, not the year the as-built plan was prepared.
- Place “As-built” with date when as-built submitted in revision box.
- As-built drawings completed by the City must be initialled by a City designated person.
- As-built drawings completed by a consulting engineer must be initialled by the consulting engineer.
- All changes will be made in a manner that is clear, legible, and neat.
- The as-built drawing will identify all existing or abandoned utilities that were constructed or exposed during construction which was not shown on the approved construction drawing. If a utility line was moved, show the new location on the drawing.
- If the word “Proposed” is shown, then remove text or drawing information to indicate changes.
- Electronic versions of the as-built drawings will be provided on CD in Microstation (.DGN) format and Tag Image File Format (.TIFF) format.
- All elevations will be referenced to the same datum as the original design plans.

Water Distribution Systems

- Show any changes to the watermain diameter, material type, class of pipe, depth, and bedding type.
- When there is a change in alignment of the proposed watermain, location of valves, tees and so on, the as-built drawing must reflect this change accurately.
- Show offset distance of watermain as originally indicated on the plan, only if the source as-built data is not from an electronically co-ordinated file.
- Indicate cut and plug locations.
- Indicate any abandonment of valve chambers and so on.
- Cover provided over piping is to be noted at intervals along the main, especially in areas of minimum cover or where cover is less than the City standard of 1.8 metres. Show locations where insulation is used.
- Fire hydrants and water valves will be labelled and shown.
- Vertical and horizontal bends will be indicated in plan view and labelled by type, station, and bend direction in profile view.

Example: 22.5 degree horizontal bend, Sta.1+78.4

- Indicate locations of all newly replaced water services and water curb stops—as per plan chainage.
- Show location of cathodic protection test stations.
- Show location of any drain cables connected to the Toronto Transit Commission (TTC) electrified rail system.
- Label bores and tunnels to show steel casings or tunnel liner type, size, length, and thickness. Show stations at end points.
- Show type of shoring used if it was left in place. Also indicate type and quantity of grout used.
- Pertinent easement information including width of easement, instrument number, reference plan number, and distance from watermain centreline to sides of easement.

- The watermain should be redrawn in plan view if the horizontal alignment has changed.
- The watermain should be redrawn in profile view if the vertical elevation has changed.
- Do not strike through text or drawing information to indicate changes. Remove and replace information on drawing with as-built information.

Sewage and Storm Collection Systems

- Show any changes to sewer lengths, size, slopes, class of pipe, depth, and bedding type.
- When there is a change in alignment of the proposed sewer pipe or location of manholes, the as-built drawing must reflect this change accurately.
- Recalculate pipe slopes on invert-to-invert elevations along the linear distance between maintenance holes.
- Sewer pipe slopes are to be labelled in percents to the nearest hundredths.
- Replace proposed maintenance hole rim elevation and inverts and write in the as-built elevations.
- Maintenance holes are to be designated by stationing from a known and easily located starting point or their coordinates shown in a table on the drawing.
- Show horizontal and vertical location of lift stations/wet wells with inverts of all connections, piping, and pump descriptions indicating size and type of pumps.
- Provide summary of type of lift station, depth, and size of pumps.
- Show location of force mains and gravity mains from property lines as originally indicated on the plan only if source as-built data is not an electronically co-ordinated file.
- Pertinent easement information including width of easement, instrument number, reference plan number, and distance from sewer centreline to sides of easements.

- Indicate locations of all newly replaced sewer services and sewer clean outs—as per plan chainage.
- For sewer laterals, indicate stationing of wyes from maintenance hole, if lateral is not perpendicular to the sewer main.
- Label bores and tunnels to show steel casings or tunnel liner type, size, and thickness. Show stations at end points.
- Show type of shoring used and indicate whether or not if it was left in place. Also indicate type and quantity of grout used.
- The sewer should be redrawn in plan view if the horizontal alignment has changed.
- The sewer should be redrawn in profile view if the vertical elevation has changed.
- When there is a change in the proposed slope of the sewer pipe, the profile view must reflect this change accurately: That is to say, the invert elevation, stations, slope percent, and pipe lengths should be revised as needed.
- Increase the text size of invert elevations to show as-built elevations.
- Do not strike through text or drawing information to indicated changes. Remove and replace information with as-built information.

Stormwater Management Facilities

- A topographical survey of the storm water management facility will be prepared. The plans will contain sufficient spot elevations and grading contour lines to show whether the storm water management facility has been constructed in compliance with the approved design plans.
- Submit certified calculations of the as-built pond volume and verify that it equals or exceeds the required volume. Show stage / storage table showing the volume of the pond on the plan.
- The as-constructed average and peak release rates as compared with the design release rates must be provided in tabular form when major deviations from the approved design have occurred.

- Verify high water elevation, overflow constrictor, and normal water levels.
- Certify installation and size of flow restrictors or outlet system.
- Verify amount of free board around pond.

Grading

- Verify overland flow route.
- Show as-built grading of all outlets, parks, stormwater management facilities, and major drainage ways.
- If a subdivision, grading for individual lots will be submitted when built on.
- If a commercial, industrial or non residential site, show as-built grading of site.

Revision Notes

Revision notes will include a disclaimer depending on the source of the data provided in producing the as-built drawing.

Data Provided by the City

Projects for which the City provided all supporting data will have the following note.

Example: Note when City provides the information

3	Oct/2008	As-built drawing prepared by [name of	RK	
		engineering company] using data provided by		
		the City.		
		Watermain constructed in 2002		
No.	**Date**	**Revisions**	**Initial**	**Signed**

Data Not Provided by the City

Projects for which there was no supporting data available from the City and where the consulting engineer undertook field locates and surveying.

Example: Note when field survey required for completion of as-built drawing

3	May/2008	As-built drawing prepared by [name of	RK	
		engineering company] using data provided by		
		the City. Watermain, chambers and storm and		
		sanitary manholes were field located by		
		[name of engineering company].		
		Watermain, storm and sanitary sewer		
		constructed in 2005		
No.	**Date**	**Revisions**	**Initial**	**Signed**

Year of Construction in Revisions Box

Indicate the year of construction of the watermain, storm or sanitary sewer in the revisions box as this will differ from the date the as-built drawing was completed.

Seal

References to the original sealed drawings should be made on the as-built drawing. In lieu of a seal, the following note will be added on the as-built drawing.

Note:
Original sealed by……..
Dated ……….

The above note will be applicable only when the original sealed construction drawing is available.

General Notes Usage

Development Engineering Projects

Coordinate with your case manager for the latest version of the General Notes. In addition, if the consultant engineer deems to add additional notes, include them in a separate section on the "General Notes Drawing" as an "additional notes" section.

Capital Improvement Projects

Coordinate with your project engineer, project manager or program manager for the latest version of the General Notes. In addition, if the consultant engineer deems to add additional notes, include them at the end of each section of the "General Notes Drawing".

PDF version and Microstation version of General Notes can be found on ECS's Internet Sewer and Watermain Design Criteria webpage.

Other Notes

This note is to appear on the grading and servicing plan within a box, as shown.

Prior to commencing any work within the municipal right of way the contractor, developer or consultant will obtain all necessary road occupancy permits from the city’s right-of-way management unit contact 416-xxx-xxxx. [1]

[1] Contact should reflect district where application is made.

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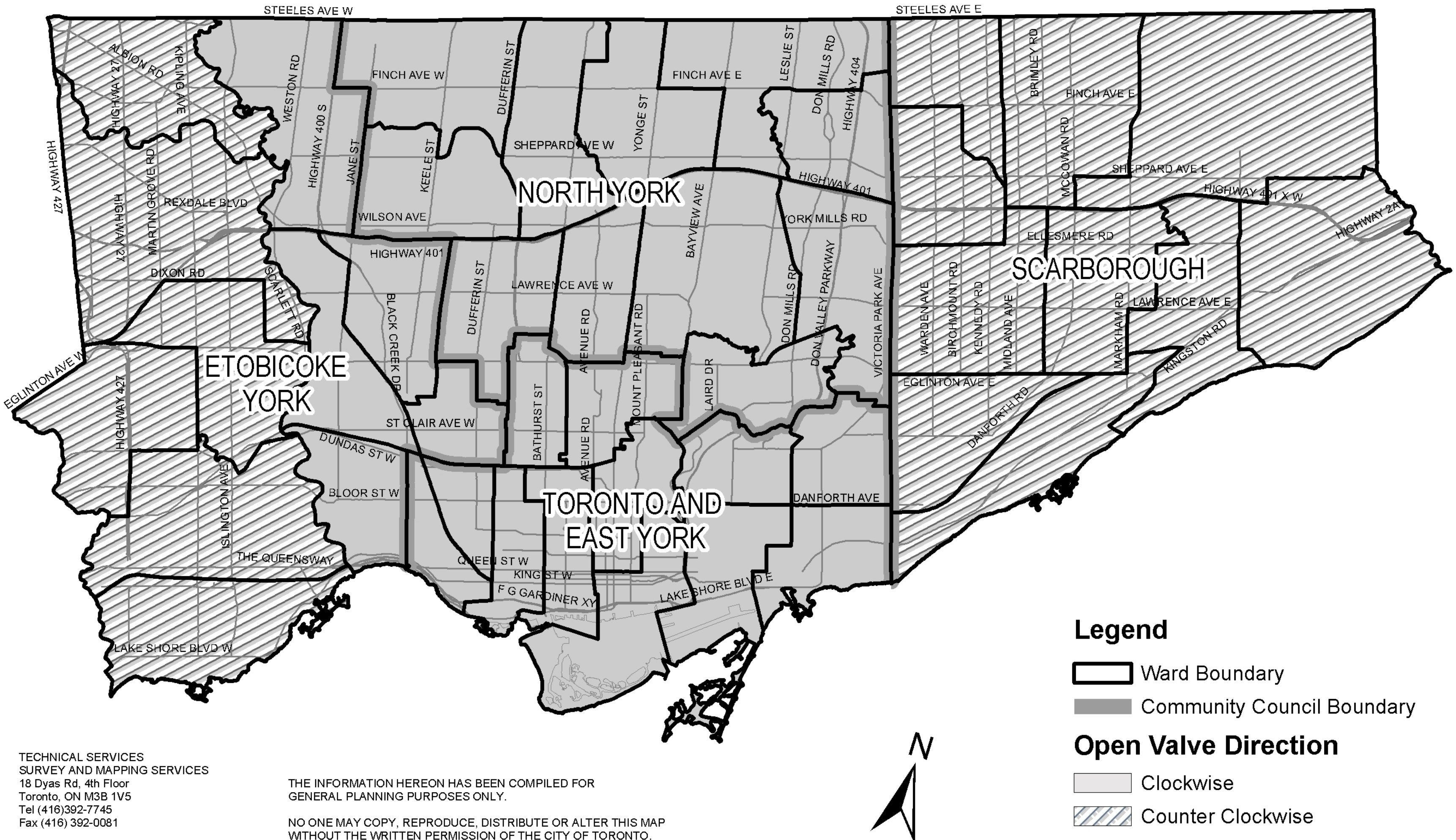
TORONTO

Direction to Open Valves



Legend

Ward Boundary

Community Council Boundary

Open Valve Direction

Clockwise

Counter Clockwise

DATA SOURCE: BASE MAP - TORONTO STREET CENTRELINE, SURVEY & MAPPING SERVICES, 01/2008

TECHNICAL SERVICES
SURVEY AND MAPPING SERVICES
18 Dyas Rd, 4th Floor
Toronto, ON M3B 1V5
Tel (416)392-7745
Fax (416) 392-0081

Produced by: Angela Lim Karellas
Printed :01/2008
File: \\Valve_Direction_Map.mxd

THE INFORMATION HEREON HAS BEEN COMPILED FOR GENERAL PLANNING PURPOSES ONLY.

THIS MAP WAS PREPARED UNDER THE DIRECT SUPERVISION OF KEVIN TIERNEY O.L.S., O.L.I.P. SUPERVISOR GEOSPATIAL SERVICE & INNOVATION

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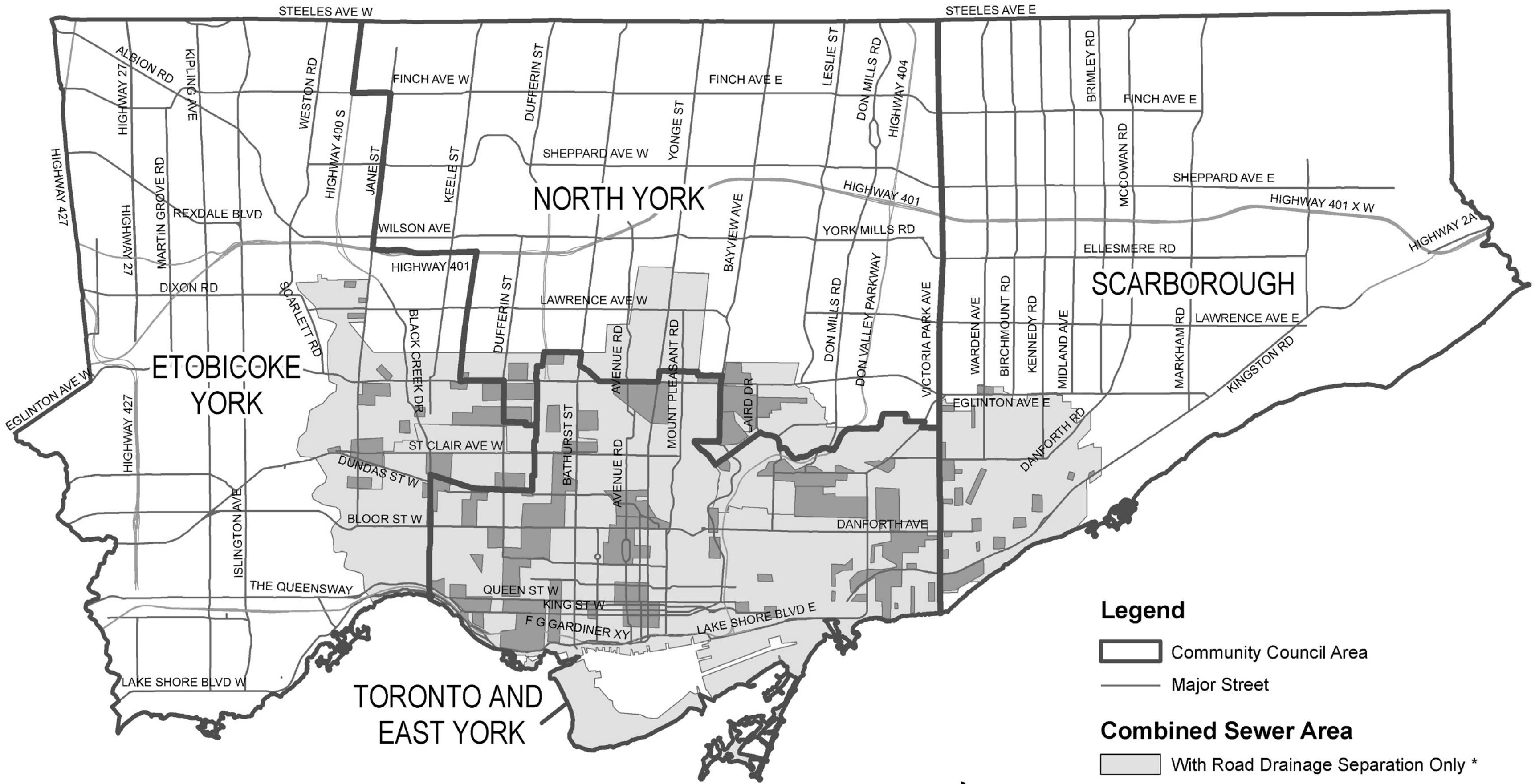
Combined Sewer Areas



Legend

- Community Council Area
- Major Street

Combined Sewer Area

- With Road Drainage Separation Only *
- With No Road Drainage Separation

* *Roof leaders and foundation drains remain connected to the combined sewer*

TECHNICAL SERVICES
SURVEY AND MAPPING SERVICES
18 Dyas Rd, 4th Floor
Toronto, ON M3B 1V5
Tel (416) 392-7745
Fax (416) 392-0081

Produced by: Angela Lim Karellas
Printed :02/2008
File: \\Sewer Separation_Map.mxd

THIS MAP WAS PREPARED UNDER THE DIRECT SUPERVISION OF KEVIN TIERNEY O.L.S., O.L.I.P. SUPERVISOR GEOSPATIAL SERVICE & INNOVATION

DATA SOURCE: BASE MAP - TORONTO STREET CENTRELINE, SURVEY & MAPPING SERVICES, 01/2008

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Appendix D – Utility Separations

Table: Utility separations for buried plant

Utility	Minimum vertical separation (mm)	Minimum horizontal separation (mm)
MTS Allstream Inc. (formerly MetroNet, UniTel, AT&T, CNCP)	300	600
Videotron Telecom (formerly Stream Networks Inc.)	300	600
Telus Communications Inc.	300	600
Rogers Cable Communications Inc.	300	600
Toronto Hydro Telecom Inc.	300	600
Bell Canada		
• maintenance holes	1000 from floor of maintenance hole	1000 from outside edge of walls
• conduit	600 from bottom edge of conduit – concrete encased	600 from outside edge of conduit
• direct buried or non-concrete encased conduit	300	600
• above ground infrastructure	[a]	600
Group Telecom (formerly 360 Networks)	300	600

Table: Utility separations for buried plant (continued)

Utility	**Minimum vertical separation (mm)**	**Minimum horizontal separation (mm)**
Enbridge Gas Distribution Inc. (formerly Consumers Gas)		
• gas main < 300 mm diameter – open trench method	300	600
• gas main ≥ 300 mm diameter – open trench method	600	600
• NEB regulated pipelines and vital mains – open trench method	600	1000
• all pipelines – directional drilling/boring machine	1000	1000
• regulator stations	[a]	1000
Enwave Energy Corporation (formerly Toronto District Heating Corporation)		
• chilled water pipes	300	300
• steam lines	600	600
Toronto Water		
• inside diameter < 100 mm	150	600
• 100 mm ≤ inside diameter < 400 mm	300	750
• inside diameter ≥ 400 mm	500	900
• valve chamber	[a]	600
Toronto Water – fire hydrants		
• above-ground plant clearance from fire hydrant		1200
• buried plant clearance from fire hydrant including lead and valve	400	1500
Toronto Water – storm sewers including catchbasins and sub-drains		
• inside diameter < 150 mm	150	600
• 150 mm ≤ inside diameter < 750 mm	300	750
• inside diameter ≥ 750 mm	500	900

• maintenance hole	[a]	600

Table: Utility separations for buried plant (continued)

Utility	Minimum vertical separation (mm)	Minimum horizontal separation (mm)
Toronto Water – sanitary / combined sewers		
• inside diameter < 100 mm	150	600
• 100 mm ≤ inside diameter < 375 mm	300	750
• inside diameter ≥ 375 mm	500	900
• maintenance hole	[a]	600
Transportation Services – general		
• clearance from road, curb and sidewalks	1000	500
• clearance from catch basins	[a]	500
Transportation Services – traffic signals		
• traffic signal duct	300	600
• above-ground plant clearance from controller boxes	[a]	front 1500 side/back 500
• above-ground plant clearance from traffic signal poles	see MCR	500
Road Emergency Service Communications Unit (RESCU)		
• all insfrastructure	300	600
• RESCU CCTV cameras	1000	2000
Hydro One Networks Inc. (formerly Ontario Hydro)	1000	1000
Toronto Hydro Electric System Limited		
• conduits	300	600
• roof of hydro chambers	600	600
• poles	[a]	1000
Toronto Hydro Street Lighting Inc.		
• street lighting duct	300	600
Toronto Transit Commission		
• streetcar track allowance	600	500

[a] Clearance above and below to be determined on a case-by-case basis.

Appendix F – Reverse Slope Driveway Guidelines

Reverse slope driveways cannot be drained naturally since they create a low lying area that water cannot outlet from but only accumulate in. If the mechanical drainage appurtenances such as catch basins, sumps or sump pumps fail or are overwhelmed by a large storm, then storm water can enter the home resulting in expensive flood damage for the property owner. In addition, it can surcharge the local sanitary sewer system by way of the homeowners' floor drain which could cause sewer backups of neighbouring properties.

Submission Guidelines for Reverse Slope Driveways

Toronto City Council has instructed staff to amend the zoning bylaw to ban the construction of new reverse slope driveways on residential properties. In the interim, where reverse slope driveways are not prohibited, the Toronto Water division requires that a report be prepared by a licensed professional engineer and be submitted for approval prior to the construction of a reverse slope driveway. Applicants are asked to demonstrate in the report that the drainage from the area will not lead to flooding of the reverse slope driveway. The minimum submission requirements that applicants should use when preparing this report are listed below.

Report Submission Requirements

1 Provide design calculations demonstrating that a reverse driveway, where allowed, will not adversely be affected by any storm events up to and including the 100-year storm event. The high water level of adjacent overland flow routes shall be 100 millimetres below the high point of the driveway entrance.

2 No reverse slope driveway will be constructed adjacent to the low point on a street subject to ponding or accumulation of storm water under any storm event.

3 No reverse slope driveway will be constructed if the low point is below the local water table.

4 Within the street allowance, provide a positive 2–4 percent slope from the property line, down to the top of curb, or 150 millimetres above the gutter, whichever is higher. If there is no curb, then to the edge of pavement.

5 A review and analysis of the overland storm run-off adjacent to the reverse driveway or ramp must be conducted by the applicant's engineer. No surface drainage from the site will be allowed to discharge onto the driveway. The property should be graded to prevent recurrent ponding. In addition, the overland storm runoff should be diverted away from the driveway and restricted from entering onto the driveway or ramp so as to eliminate flood damage to the site or adjacent property.

6 No direct or indirect connection of storm area drain to the sanitary sewer system is allowed—no exceptions.

7 The area drain inlet, piping, sump, and sump pump will be sized to accommodate flow from a 100-year storm without storm water entering into the building. Discharge from a sump must be pumped to either one of the following on the property:

- ground surface
- dry well
- storm water storage facility for future use

Storm water from the sump must not cause ponding, erosion or runoff onto neighbouring properties.

8 If a sump pump is used it shall be equipped with a self-resetting thermal overload protection switch. The pump should be rated to run for a continuous amount of time to pump all water from the sump pit. It is recommended that a secondary pump be installed and that both primary and secondary pumps be supplied with backup electrical power to provide up to six hours of continuous pump age in the event of a temporary electrical failure or black out.

9 Provide a 1:100 scale base plan showing the property lines, ground floor plan, and adjacent roads, sidewalks, retaining walls, and neighbouring buildings.

10 Provide a plan and profile of the reverse driveway, driveway grading plans, storm grading plans, spot elevations on the driveway and adjacent land and supporting calculations. Show pre-development and post-development drainage areas when a change in the drainage area has been made.

11 Applicants are asked to include spot elevations on the plan and profile drawing. The drawings shall follow the *DES – CADD Specification Manual* drafting standards. Vertical elevations and horizontal coordinates shall be referenced to the City geodetic benchmarks. A total of nine spot elevations must be included between the street curb and the top of the driveway adjacent to the front of the house. If there is a sidewalk, a total of 27 spot elevations will be shown on the upper and lower driveway and sidewalk, as shown in the figure below.

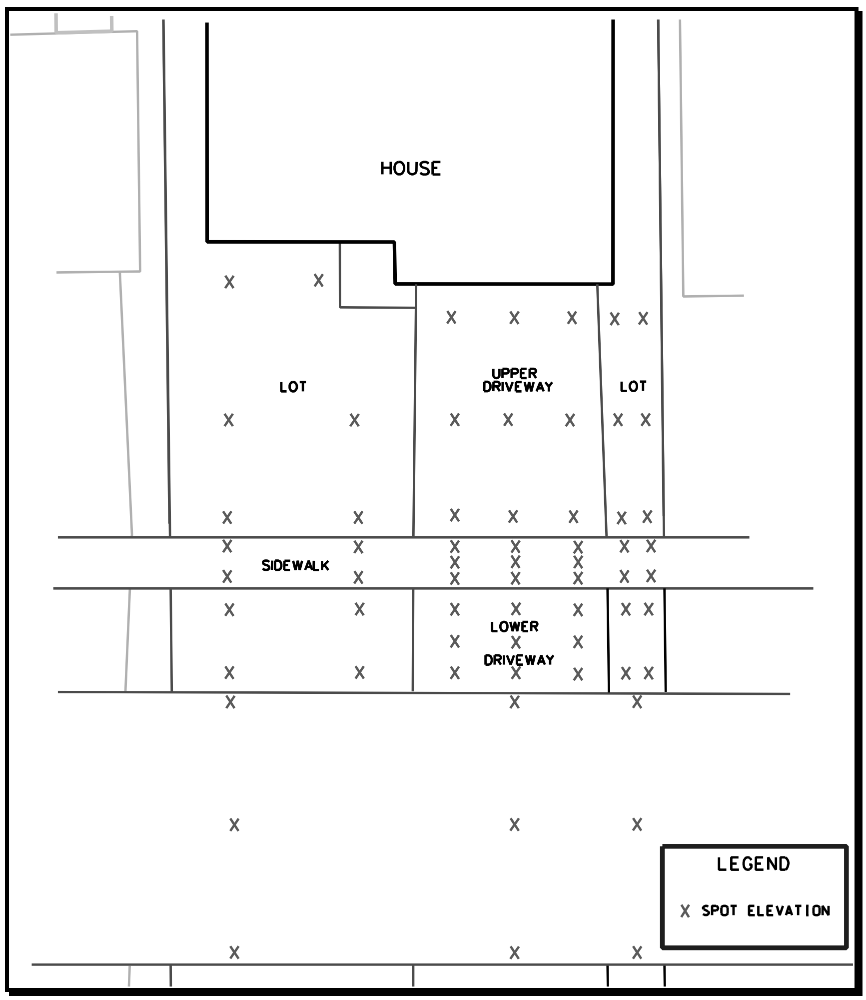

Figure: Spot elevation locations

12 Show on the drawing the applicable storm and surface water drainage directions for both the major and minor systems.

13 Use appropriate runoff coefficient and additional hydrologic parameters when performing calculations.

14 The report should include the following information:

- key map showing location of the subject property
- property address
- present owner contact
- an external drainage plan showing flood and fill lines along with overland flow routes
- schematic layout of existing and proposed sanitary and storm sewer system around the perimeter of the site, including sewer lateral connections to the subject property
- schematic layout of the sub watershed, if any of the existing flow is within 100 metres of the site, for example, a watercourse or trunk sewers
- any supporting calculations, reports, and drawings, such as calculation of surface run-off, ponding elevations, elevations corresponding to the required level of controls, calculation of existing run-off coefficient, if different and release rates.

The report must be prepared, by a professional engineer, licensed to practice in the province of Ontario, with experience in storm drainage analysis and design.

Appendix G – Bibliography

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Design Criteria (Provincial)

Ministry of the Environment – Guidelines for the Design of Sanitary Sewage Systems, Storm Systems and Water Distribution Systems
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City of Toronto – Corporate Writing and Style Guide
By Strategic Communications, City Manager's Office. Published by City of Toronto, 55 John Street, Toronto, Ontario, M5V 3C6, 2006.

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Glossary

AADT – Annual average daily traffic is a calculated annual estimate of the average number of vehicles travelling through a traffic monitoring site during a midnight to midnight period on any day of the year.

ASTM – American Society for Testing Materials

AWG – American Wire Gauge

AWWA – American Water Works Association

Catchbasin – Box like underground concrete structure with openings in the curb and gutter designed to collect runoff from the streets and the pavement.

City – The City of Toronto—the corporation—and will be referred to as the City for the purposes of this document.

Combined Sewer – A combined sewer system is a system that conveys both surface runoff and sanitary sewage. These types of systems are generally located in older parts of the city, specifically the downtown core. The construction of new combined sewer systems is no longer permitted other than for the replacement of existing combined sewers.

Consulting Engineer – A professional engineer or firm of engineers retained by the City or a developer and skilled and experienced in municipal work and land development projects and registered with the Professional Engineers of Ontario.

Contract Administrator – The individual or firm responsible for overseeing the construction and administration of the works and representing the City's interest.

Canadian Standards Association (CSA) – is a non-profit organization that oversees the development of voluntary consensus standards for products, services, processes, systems and personnel in Canada.

Developer – The owner of land upon which municipal services will be located and ultimately owned by the City.

DIPS – Development Infrastructure Policy and Standards apply to public local streets and private streets or mews that are created to serve grade related residential developments.

Dry Weather Flow – Sewage from wastewater flows such as the combined input of industrial, domestic and commercial flows, and infiltration and inflows from foundation drains or other drains during periods when rainfall or snowmelt is not occurring.

Dual Drainage – The accepted best practice for the collection of urban storm drainage systems consist of two separate and distinct systems—the minor system and engineering system.

Engineer – The licensed individual or firm responsible for the design of the works or their designate and registered with the Professional Engineers of Ontario. May also be referred to as the design engineer.

Executive Director – The person appointed by the City from time to time as the Executive Director of Technical Services and his or her successors or his or her duly authorized representative.

Fillets – A curve that is a fillet is a smooth blending arc between two curves.

General Manager – The person appointed by the City from time to time as the General Manager of Toronto Water and his or her successors or his or her duly authorized representative.

GFA – Gross Floor Area

Greenfield Development – Development of land where there has been no previous development.

GSC – Geodetic Survey of Canada

IDF – An intensity duration frequency curve is a statistical description of the expected rainfall intensity for a given duration and storm frequency.

Imperial – British system units

Major Drainage System – That storm drainage system which carries the total runoff of the drainage system less the runoff carried by the minor system—storm sewer. The major system will function whether or not it has been planned and designed and whether or not developments are situated wisely with regard to it. The major drainage system usually includes many features such as streets, gullies and major drainage channels.

Minor Drainage System – That storm drainage system which is frequently used for collecting, transporting and disposing of snowmelt, miscellaneous minor flows and storm runoff up to the capacity of the system. The capacity should be equal to the maximum rate of runoff to be expected from the minor design storm which may have a frequency of occurrence of one in 2 years. The minor system may include many features ranging from curbs and gutters to storm sewer pipes and open drainage ways.

MCR – Municipal Consent Requirements—referred to as "Requirements for the installation of services within the city of Toronto streets".

MOE – Ministry of the Environment

MTM – Modified Transverse Mercator projection

NAD – North American Datum

NFPA – National Fire Protection Association

Non-Industrial Land – Is any land that is not defined as industrial land. Industrial land is defined by Ontario Regulation 525/98 under Section 53 of the Ontario Water Resources Act and includes, for example, gas stations, auto repair shops, warehouses for storage of goods or materials, sites were any waste storage or waste management activities occur.

NSF – National Sanitation Foundation

OCPA – Ontario Concrete Pipe Association

OPSD – Ontario Provincial Standard Drawing

OPSS – Ontario Provincial Standard Specification

Overland Flow Path – Open space floodway channels, road reserves, pavement expanses and other flow paths that convey flows typically in excess of the capacity of the minor drainage system.

Partially Separated Sanitary Sewer – A partially separated sewer system consists of storm sewers that convey surface runoff, primarily from roadways, and sanitary sewers that receiving sanitary sewage as well as foundation drains and some driveway drains. These types of systems are typically found in older subdivisions prior to the introduction of fully separated systems.

R.R.O. – Revised Regulation Ontario

Runoff – That portion of the water precipitated onto a catchment area, which flows as surface discharge from the catchment area past a specified point.

SI – System International units

SDR – Standard dimension ratio or dimension ratio is a dimensionless term that is obtained by dividing the average outside diameter of the pipe by the minimum pipe wall thickness. The lower the DR number, the thicker the pipe wall.

Section 681 – Sewer Use Bylaw

Section 851 – Water Supply Bylaw

Separated Sanitary Sewer – A separated sewer system is a system in which all municipal sewage is conveyed to sanitary sewers and all surface runoff is conveyed to storm sewers. Foundation drains are not connected to either the sanitary or storm sewer systems. This type of system is currently the standard for all new subdivisions.

Sewershed – The drainage area of one or more contributing sewer areas to a sewer system.

STAR process – Streamlining The Application Review. This process establishes criteria for the streaming of most planning applications and sets target timelines for their resolution. The STAR process establishes clear service level expectations, a co-ordinated approach to reviewing applications and clearly defined roles and lines of communication for City staff. The goal of STAR is to provide a faster, more efficient review of applications.

Transfer of Review – The Transfer of Review Program is a program where a designated municipal authority reviews the application and supporting documentation on behalf of the Ontario Ministry of the Environment. The municipal authority then submits the application to the ministry together with their recommendations for approval or comments explaining why an application is not recommended for approval.

Toronto Municipal Code – A municipal code adopted by Toronto city council under Section 248 of the Municipal Act, 2001 or a predecessor of that section, or deemed to be a bylaw adopted by council under the City of Toronto Act, 1997.

The Toronto Municipal Code is updated four times per year. The city of Toronto web site can be checked for “recent amendments” or changes to specific code chapters since the last code update. These bylaws must be consulted along with the code chapters.

TRA – The Road Authority is a service provided by the Ontario Good Roads Association and is an internet based information resource to promote the sharing of information.

TRCA – Toronto Region Conservation Authority

ULC – Underwriters Laboratories of Canada

UNI-B – Uni-Bell PVC Pipe Association

Wet Weather Flow – Stormwater runoff generated by rainfall, snowmelt or flow resulting from sanitary wastewater that enters the combined sewer system. A secondary source is infiltration and inflows from foundation drains or other drains resulting from rainfall or snowmelt.

WWFM Guidelines – Wet weather flow management guidelines prepared to support the wet weather flow management master plan. These guidelines provide the technical and quantitative tools needed to support the WWFM policy and the wet weather flow management master plan and are based on recent performance monitoring data and synthesis and provincial and international wet weather flow technical guidelines, standards and manuals of practice.

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Index

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