MUNICIPALITY OF NORTH MIDDLESEX

Infrastructure Design Guidelines and Construction Standards

North Middlesex

Revision #	Revision Date	Notes
0	Feb.2013	Initial issue of Document
1	March 2025	Full Review and Update of Document
2	July 2025	Revised Design Storms

INTRODUCTION

The following Infrastructure Design Guidelines and Construction Standards provide a means of standardization for the design and construction of sanitary and storm sewers, watermains and roads in the Municipality of North Middlesex.

These standards have been developed with the intention of identifying which items should be considered in the design and construction of the various services to be provided in the development. However, reference should also be made to existing standard methods of design outlined in the Municipal Engineers Association Design Manual, Ministry of Environment Manuals and Guidelines, Ministry of the Environment Stormwater Management Planning and Design Manual, Ministry of Transportation Geometric Design Standards (roads) and the Ontario Provincial Standard Specification and Drawing Manuals.

The following guidelines and standards should be applied wherever possible in the design and construction of the various services outlined herein. Where deviations in the standards are warranted, the necessary approvals outlining the changes must be obtained from the Municipality of North Middlesex.

Periodic revisions or additions to these guidelines and standards may occur. All users are required to keep their copy of the guidelines and standards current by obtaining all revisions and additions from the municipality as they become available.

All aspects of this document are under the sole control of the Municipality.

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1.0 GENERAL

1.1 Purpose

The purpose of these guidelines and standards is to aid in the standardization of the design and construction of municipal services for residential, commercial, institutional and industrial developments in the Municipality of North Middlesex. This document is also to be used as a general guideline for reconstruction or new development in urban hamlet and community settlement areas and is intended as a guide for developers, builders and the general public in the development process for subdivision, severance and individual site developments. It should be noted that this document is to be used as a reference for municipal rehabilitation projects but shall be required for full reconstruction projects.

1.2 Design Guides

These guidelines and standards should be followed wherever possible. Should special or unique conditions occur, minor deviations from these guidelines and standards may be considered and are subject to the written approval of the Municipality. In addition, the Municipality reserves the right to require compliance with one or more of the standards and processes included herein, to require variations from these standards at the Municipality's discretion and to require additional information, standards, services, etc. further to those included herein. For example, the Municipality may require higher standards to accommodate higher density developments, collector and arterial roads, heavy industry, etc.

These guidelines and standards are to be used in conjunction with standard engineering practices and design tests as well as the standards, regulations, design manuals and guidelines of the Municipal Engineers' Association (MEA), Municipal Electrical Association, Ontario Hydro Distribution Standards, Ministry of Environment (MOE), Ministry of Transportation (MTO), Ontario Provincial Standard Drawings and Specifications (OPSD, OPSS), various other government ministries and other regulatory agencies.

1.3 Development Processes and Approvals

Depending on the location and nature of the development, the developer may be required to obtain approvals from various other regulatory agencies including (but not limited to) one or more of the following and in addition to and/or prior to obtaining approval from the Municipality:

- The Department of Fisheries and Oceans (DFO)
- The Ministry of Environment (MOE)
- The Ministry of Natural Resources (MNR)
- The Ministry of Transportation (MTO)
- The Ministry of Municipal Affairs and Housing (MMAH)
- The Ministry of Tourism, Culture and Sport (MTC)
- The County of Middlesex
- Middlesex-London Health Unit
- The Ausable Bayfield Conservation Authority (ABCA)
- The Municipality of North Middlesex
- The Municipality of North Middlesex Chief Building Official (CBO)
- The Municipality of North Middlesex Drainage Superintendent
- The Municipality of North Middlesex Fire Chief.

It is the responsibility of the developer to provide the Municipality with suitable written documentation of the approval from the regulatory agencies.

The development will be subject to the requirements of one or more municipal by-laws such as:

- The Official Plan (Middlesex County and Municipality of North Middlesex)
- Policies and By-laws
- North Middlesex Zoning By-law
- The Site Plan Control By-law
- Sewage By-laws
- Grading By-laws
- Occupancy Permit By-law
- North Middlesex Building By-law.

The developer will be required to enter into a site plan, control severance, Development or Subdivision Site Plan Agreement with the Municipality and pay fees to the Municipality such as application fees for zoning and Official Plan amendments, severances and development agreements, cash in lieu of park land, cash in lieu of parking, development charges and such other fees as may be required.

1.4 Engineering and Geotechnical Reports

The developer shall retain a Professional Engineer licensed in the province of Ontario for the design of all services, the preparation of plans and specifications. The Professional Engineer, or designate, would also be responsible for the full-time supervision and inspection of all construction of the works.

The developer may be required to submit a hydrogeological study and/or geotechnical report prepared by a geotechnical Engineer. Elevations of ground surface at bore holes and test pits shall relate to a geodetic datum. The geotechnical report may be required to address the suitability of the soils at the site and shall make recommendations pertaining to the use of native soils for trench backfill, roadway pavement design, earthworks for site grading, and comments on foundation design.

Where such reports are required, a digital PDF shall be provided, plus one (1) digital copy on a USB Drive, shall be submitted to the Municipality.

The developer's Engineer and planner must consider the overall servicing and development of adjacent lands in the watershed which may be affected by the development, when submitting the development proposal. Where applicable, such considerations and recommendations concerning existing sanitary sewage treatment plants, sewage collection systems, storm water management, water supply/storage and distribution facilities, pumping stations, and oversizing of mains, as well as traffic studies may be required to be submitted by the developer. The layout of internal roads should also consider the future development of abutting lands. The developer may be required to enter into agreements with the Municipality concerning such items as (but not limited to) development charges, cost sharing for oversizing and front-end financing to allow for proper and orderly future development of the neighboring lands as well as the proposed site.

For all developments, the developer's Engineer shall submit sufficient copies of the preliminary design brief, outlining the proposed design criteria as well as commenting on and making recommendations on any previous reports or studies completed for the area of proposed development. In addition, the pre-design brief should address all necessary preliminary investigations and explorations, include an analysis of existing conditions and of all possible alternatives, including financial considerations and of all preliminary estimates of cost, as a basis for conclusions and recommendations to be included in the report to the Municipality, for review. The minimum requirements of the applicable statutes, by-laws, ministries and regulatory agencies must be satisfied.

The developer's Engineer shall provide evidence of professional liability insurance from their Engineer's professional liability insurance insurer, in the amount of $5,000,000 (minimum), prior to the review of any reports/briefs by the Municipality of North Middlesex.

1.5 Utilities

The developer shall coordinate the installation of utilities including (but not limited to) Execulink, Hay Communication, Hydro One, Entegrus Inc., Bell Canada, Enbridge and Union Gas. This list is not necessarily complete for all developments. It is the developer's responsibility to meet all requirements of utility organizations and provide all necessary documents of such organizations to the municipality prior to final approval of development drawings. These utilities shall be installed in accordance with the "Typical Cross-Sections", as noted in **Appendix B**.

2.0 SUBMISSION OF PLANS, REPORTS AND STUDIES

2.1 Submission Procedure

All submissions of plans, specifications, documents, reports, studies, preliminary design criteria proposals, etc. shall be made to the clerk of the Municipality in sufficient quantities as may be required for distribution, to persons such as the Public Works Superintendent, Building Official, Planner, Municipality's consulting engineer, Fire Department, Hydro etc. A detailed flow chart 'General Procedural Guidelines for Subdivision and Condominium Developments' is included in **Appendix A**. The document 'Site Plan Development Control – Proponent's Mandatory Requirements during Construction' is also included in **Appendix A**.

2.2 General Plan Requirements

All drawings shall be standard ANSI D (22" x 34") drawing size. All drawings are to be signed and sealed by a Professional Engineer. General plan layout shall be in accordance with standard engineering practice. All elevations on grading plans, site plans, servicing plans, and profiles, etc. shall relate to Geodetic Survey of Canada Datum with NAD83 co-ordinates and three monuments per site.

2.3 Drawings to be Submitted

In general, the following drawings may be required for subdivision developments. Some of the following may also be required for individual site plan developments:

- A key plan, to scale of not less than 1:10,000 showing the general location of the development to be serviced
- One or more general servicing plans, to a scale of not less than 1:2,000 showing all services to be constructed, including storm sewers, sanitary sewers, the water distribution system, roads, street lighting systems and sidewalk
- A lot grading plan, to a scale of not less than 1:1,000 and including sufficient areas of adjacent land with contours where applicable to illustrate total drainage patterns
- Plan and profile drawings for each street to be constructed, reconstructed, widened, etc. and for each service easement to a scale of 1:250 horizontally and 1:50 vertically
- A storm drainage area plan to a scale of not less than 1:2,000 and including all interior and exterior tributary areas which contribute to the storm sewer and/or storm

water management plan. Storm sewer design charts shall be included on the storm drainage plan. The design charts should include criteria used for design

- A sanitary drainage area plan, to a scale of not less than 1:2,000 and including all interior and exterior tributary areas. Sanitary sewer design charts shall be included on the sanitary drainage plan. The design charts should include criteria used for design
- Such other drawings showing notes, details, typical sections, etc. as may be necessary for the proper construction of the works, such as (but not limited to):
  - Typical road cross-section
  - Typical lot grading plan
  - Typical swale details
  - Geotechnical report information
  - Legend
  - Storm sewer outfall structures, erosion protection and sedimentation controls
  - Materials
  - Trench details
  - Sanitary sewage pumping facilities, forcemain details and related appurtenances
  - Storm water management systems and facilities
  - Water pumping facilities; pressure, metering, and back flow facilities including related appurtenances; design data including domestic and fire design flows used
  - Details of other items not covered by the OPSD, etc.
  - Connection details
  - Privacy and sound attenuation barrier details.

The above drawings shall include sufficient legal survey monumentation, dimensions, etc. to enable the contractor and/or Engineer to locate and/or layout the road rights-of-way, easements, and/or lot corners, as may be required. All elevations on plans shall relate to Geodetic Survey of Canada Datum with NAD83 UTM co-ordinates and three monuments per site.

Appendix A lists items in the form of a checklist which may be required on subdivision and/or individual site development plans.

2.4 Municipal Review

All submissions shall be provided in electronic format, provided both via email and at least one (1) USB drive delivered in-person to the Municipality.

2.5 Final Approval/Submission

After final approval has been given by the Municipality and all other regulatory agencies, and after all plan/documentation revisions have been made by the developer's Engineer, a final (full and complete) submission of plans and documentation shall be made to the Municipality in electronic format as the Municipality may require for distribution as noted in **Section 2.1**. No construction shall proceed until such submission is made by the developer and has been accepted as satisfactory by the Municipality.

Such final submission shall include the latest revision of all plans, storm sewer design charts, sanitary sewer design charts, water distribution system analysis, copies of Environmental Compliance Approvals (e.g., for sewage and water works) from the Ontario Ministry of the Environment, structural approval from the Ministry of Transportation where required, Conservation Authority approvals, etc.

The plans shall contain the details such that the Municipality does not have to refer to the developer's/contractor's contract documents. For purposes of approval by the Municipality, information shown on the plans shall be deemed to take precedent over conflicting or alternate information listed in the developer's/contractor's contract documents.

Any changes to approved plans, which are proposed by the developer or his agents, must be resubmitted to the Municipality for review and approval prior to such changes being made in the field.

2.6 "As-Constructed Record" Drawings

"As-constructed record" drawings are to be submitted to the Municipality to show the services and works as they were actually constructed. The developer shall provide the Municipality with three complete sets of full size and one set of half size "as-constructed record" white prints of all drawings applicable to the project. "As-constructed record"

drawings shall include water service locations with ties, and chainages of private drain connections measured from the nearest downstream manhole.

As well as the submission of "as-constructed record" white print drawings, the Municipality requires "as-constructed record" drawings to be submitted in a satisfactory digitized form (AutoCAD and pdf) on a USB drive Shapefiles shall also be provided such that the Municipality's GIS can be updated.

2.7 Lot Servicing

Services for individual residential lots shall be as follows:

- Water services shall be installed on the centreline of single lots and 1.0 m (3.0') to the right and left of centreline for semi-detached lots.
- Sanitary private drain connections (PDC) shall be installed 2.5 m (8.0') right of centreline for single lots and 3.5 m (11.5') right and left of centreline for semi-detached lots complete with clean-out.
- Telephone, Cable TV and electric services are to be installed in a common trench as noted in **Appendix B.**
- Driveways shall be located on the opposite side of the lot to that of a pad mounted transformer, hydrant, cable utility pedestal or street light pole where possible and shall be perpendicular to the road.
- Each property shall be provided with a sanitary PDC of a minimum diameter of 125 mm (5") having a minimum slope of 2% with a minimum 125 mm clean-out at property line.
- Roof water leaders and foundation weeping tile shall **NOT** be connected to the sanitary sewer.
- Roof water leaders shall not be connected to the storm sewers. Foundation weeping tile shall not be connected to the storm sewers. All houses shall have a sump pump installed, discharging to a drainage swale which preferably drains to the rear of the lots.
- No part of the driveway shall encroach upon the property boundaries when extended from the edge of the right-of-way to the roadway.
- If a concrete driveway is installed, expansion joints are to be installed at both sides of the sidewalk and at the curb. A construction joint is also required at the property line.

- Trees shall be installed 1.5 m behind the property line, a minimum of 4 m from all other services.

3.0 STORMWATER MANAGEMENT

Land development increases both peak flows and the volume of stormwater runoff, and can cause flooding, degradation of water quality, damage to ecosystems, erosion, and property damage. The purpose of stormwater management (SWM) is to mitigate these impacts. The following guidance provides a consistent and concise approach to both private and municipal stormwater management design within the Municipality.

3.1 Design References

Stormwater management systems within the Municipality shall be designed in general conformance with the guidance presented in the following references.

- Stormwater Management Planning and Design Manual (SMPDM) (MOE, 2003).
- Drainage Management Manual (MTO, 1995).
- Low Impact Development Stormwater Management Planning and Design Guide Sustainable Technologies Evaluation Program website.

3.2 Agency Approvals

In accordance with the Ontario Water Resources Act, stormwater management works are considered Sewage Works and require an Environmental Compliance Approval (ECA). For municipal infrastructure, all stormwater works shall be designed in accordance with the provisions of the Municipality's Consolidated Linear Infrastructure ECA (CLI ECA).

3.3 Design Criteria

Stormwater management systems located within the Municipality will achieve the design criteria presented below.

3.3.1 Pre-Consultation

All stormwater management design criteria shall be confirmed by the design Engineer through a pre-consultation discussion with the Municipality. All submissions are subject to the requirements of the Ausable Bayfield Conservation Authority and the MECP. In addition to requirements outlined through consultation, any design submission shall include detailed storm water management plans.

3.3.2 Water Quality

Stormwater from all developments shall receive water quality treatment in accordance with the requirements identified in the SMPDM (MOE, 2003). The level of treatment shall be established based on the sensitivity of the downstream receiver. Water quality control targets may be identified in previous studies and reports for the project area.

At a minimum, Normal Protection Level water quality treatment shall be provided to achieve 70% total suspended solids (TSS) removal. However, greater quality control requirements may be identified through pre-consultation with the Municipality.

A 25mm, 4-hour design storm shall be used to calculate the peak design flows and runoff volumes conveyed to water quality treatment measures. Infiltration or filtration measures with sufficient capacity to capture the runoff volume from 25 mm design storm will be accepted as meeting Enhanced Protection Level water quality treatment, as described in in the SMPDM (MOE, 2003).

3.3.3 Water Quantity

Stormwater management systems shall be designed to control the runoff from all design storms up to and including the 100-year design event. Maximum allowable peak discharges will be established in consultation with the Municipality based on the available capacity of the downstream receiver. At a minimum, post-development peak discharges shall be attenuated to pre-development values for all evaluated design storms.

3.3.4 Erosion Control

Where there is a risk of channel and/or bank erosion in the downstream receiver, erosion control storage will be provided. Erosion control storage requirements will be identified through pre-consultation with the Municipality.

3.3.5 Climate Change

Stormwater quantity controls must include an additional 20% storage volume to accommodate runoff under changing climate conditions.

3.3.6 Water Balance

In accordance with the guidance presented in Interpretation Bulletin: Ontario Ministry of Environment and Climate Change Expectations Re: Stormwater Management (MOECC, 2015), stormwater management designs shall incorporate best efforts to mimic the local pre-development hydrology.

3.4 Stormwater Conveyance System

The stormwater conveyance system shall be designed in accordance with the following requirements.

3.4.1 Catchment Delineation

Both pre-development and post-development drainage area plans shall be provided in all stormwater management reports. Drainage area plans shall clearly label all catchment areas and shall include external areas that contribute runoff to the subject site.

3.4.2 Minor System

The Municipality requires the minor system to be designed to convey, at minimum, the peak flows from the 5-year storm event, using the standards described in **Section 4**. The minor system incorporates storm sewer pipes, catch basins, roadway gutters and swales, and private storm drain connections for all land uses. The minor stormwater system is designed to convey the minor flows to prevent frequent flooding within developed areas.

No surface ponding shall be permitted for design storms up to and including the 5-year design event.

3.4.3 Major System

Major flows must be safely conveyed via a defined Overland Flow Routes (OLFR) to an appropriate outlet without causing damage to private property or municipal infrastructure,

and with minimum risk to the public. The major system shall be designed to accommodate the runoff from the 100-year design storm event. The maximum allowable 100-year flow depth is 300 mm. Ground elevations at all buildings adjacent to major flow routes shall be at least 300 mm above the 100-year water surface elevation.

A major system drainage area plan and supporting calculations must be submitted as part of the design package during the development approvals process to demonstrate safe conveyance of the major flows. Hydraulic capacity calculations shall be provided for all OLFRs and Municipal ROWs.

3.5 Hydrologic Analysis Requirements

The following guidance shall be used for completing hydrologic calculations in the Municipality.

3.5.1 Calculation Methods

The Rational Method may be used to evaluate the runoff from sites up to 2.0 ha. Larger sites shall be evaluated using an industry standard hydrologic model. A qualified professional is responsible for selecting all hydrologic parameters. All reference materials used in parameter selection shall be properly cited in the SWM Report and included in the document appendices.

3.5.2 Imperviousness

TIMP represents the ratio of area covered by an impervious surface (e.g., asphalt, concrete) to the entire area. XIMP represents the ratio of impervious areas directly connected to the conveyance system. An example of a directly connected impervious area would be a parking lot, rooftops with downspouts discharging to paved surfaces, driveways, or roads that contain catchbasins draining to the storm sewer.

The design Engineer shall provide calculations to support the impervious values used for SWM design. Impervious values shall include future yard improvements such as sheds, patios, and pools. The TIMP and XIMP values summarized in the following table may be used for preliminary design.

Table 1: Minimum Impervious Values

Land Use	TIMP	XIMP
Single Family Residential	55%	45%
Medium Density Residential	70%	55%
High Density Residential	90%	80%
Commercial/Industrial	90%	80%

3.5.3 Surface Losses

Surface losses represent the wetting, interception, and surface depression storage of rainfall at the beginning of storm events. The values summarized in the following table shall be used for projects located in the Municipality.

Table 2: Surface Losses

Land Cover	Typical Values (mm)
Impervious	2
Pervious – lawns	5
Pervious – meadows	8
Pervious – woods	10

3.5.4 Infiltration Losses

The design Engineer shall select an industry standard method for calculating infiltration losses that accounts for both the local soil conditions and surface cover.

3.5.5 Design Storms

All stormwater management systems shall be assessed for all design storm distributions, including the Chicago, AES and SCS Type II, with durations ranging from 3-hour up to 24-hour. The practitioner shall select the most conservative storm distribution and duration. The most conservative storm distribution and duration is the one that results in the lowest peak flow for pre-development conditions, and the highest volumetric storage requirement under post development conditions for the 100-year return period.

Rainfall intensity to be used in design storms is provided in Section 4.2.3

Quantity control facilities shall incorporate the climate change requirements as per section 3.3.5

3.6 Hydraulic Analysis Requirements

Where high tailwater conditions may occur at the site outlet, a hydraulic analysis shall be completed to evaluate the impacts of the downstream tailwater elevations on the required stormwater storage volumes.

3.7 Stormwater Practices

This section aims to guide the planning and design of stormwater quality and quantity controls that include Low Impact Development (LID) or source control concepts as well as traditional stormwater control measures. Each site or project will present unique options and challenges. The Municipality encourages innovation as part of any stormwater project.

3.7.1 Best Management Practices

The Municipality will accept Best Management Practices (BMPs) that are designed by a Professional Engineer and demonstrate at-source runoff control. These practices may be eligible towards achieving water balance, quality, quantity or erosion control for the project. These objectives may be achieved by:

1 **Decreasing Impervious Areas**: The Municipality supports reductions in impervious area as part of the runoff reduction strategy. This can be presented by demonstrating a decrease in the standard TIMP or XIMP values.
2 **Intercepting Runoff**: Runoff from hard surfaces may be conveyed to landscaped gardens or grassed areas to promote onsite filtration and infiltration and reduce the volume of water collected by the municipal storm sewer.
3 **Increasing Topsoil Depth**: Will not formally meet stormwater management criteria but, to a reasonable extent, may partially mitigate water balance deficits.

3.7.2 Low Impact Development

All low impact development (LID) measures shall be designed in accordance with the current guidance from the Sustainable Technologies Evaluation Program. LID designs shall be supported by a site-specific hydrogeology report to document local soil condiitons, measured in-situ infiltration rates, and local groundwater elevations.

A minimum setback of 4 m shall be provided from LIDs to all building foundations. The total

design storage volume shall include 20% contingency to mitigate the risk of future decline in performance. All infiltration/filtration LIDs shall include pre-treatment measures to reduce sediment loading.

SWM strategies that include municipal LIDs must be discussed with the Municipality prior to submission.

3.7.3 SWM Ponds

The following design guidance applies to end-of-pipe SWM facilities including wet ponds, wetlands, and dry ponds.

Dimensions and Elevations

All SWM facilities shall meet the design criteria summarized in the following table and shown on Drawing 3.1 in **Appendix B**.

Table 3: Stormwater Management Design Criteria

Design Criteria	Requirements
Maximum Side Slopes	5:1 – Wet Ponds 4:1 – Dry Ponds
Maximum Active Storage Depth	2 m – Wet Ponds 3 m – Dry Ponds
Maximum Permanent Pool Depth	1.5 m
Freeboard Depth	0.3 m above high water level (HWL)
Minimum Setbacks	5 m from top of pond to property limit

Inlets

The inverts of all inlet pipes shall be at least 300 mm above the design permanent pool elevation. Erosion protection shall be provided downstream of all pipe inlets and shall extend the facility invert. The design submission shall include supporting calculations to demonstrate that the proposed erosion protection will remain stable under the maximum anticipated design flows.

Outlets

Outlet structures shall incorporate measures to mitigate the risk of clogging caused by debris. The minimum outlet diameter shall be in accordance with the guidance presented in the SMPDM (MOE, 2003). Erosion protection shall be provided downstream of all pipe outfalls. The design submission shall include supporting calculations to demonstrate that

the proposed erosion protection will remain stable under the anticipated design flows.

Forebays

All wet ponds shall be equipped with a sediment forebay designed in accordance with the guidance presented in the SMPDM (MOE, 2003). The forebay shall be designed with sufficient volume to accommodate a minimum of 10 years of accumulated sediment. The forebay bottom shall be lined with articulated concrete blocks or other material approved by the Municipality. An access route shall be provided to the bottom of the forebay. The maximum allowable longitudinal slope of the access route shall be 10%.

Emergency Overflow

All SWM facilities shall include an emergency overflow outlet to convey flows in the event of a pond failure and shall be sized to convey the greater of an uncontrolled 100-year storm or Hurricane Hazel. A piped emergency system may be considered in consultation with the Municipality in rare instances where an overland emergency system is not feasible. The invert elevation of the emergency overflow shall be equal to the climate change storage volume plus 0.30m of freeboard. The emergency overflow outlet shall include erosion protection to prevent downstream erosion under full flow conditions.

Drawdown Time

The maximum allowable total drawdown time for all SWM facilities is 72 hours.

Sediment Drying Area

All SWM facilities shall include a location within the pond block for temporary stockpiling of accumulated sediment. The footprint of the sediment drying area shall be sufficient to accommodate the calculated 10-year sediment volume.

Landscaping

A landscape plan shall be prepared for all SWM facilities. Plants will be selected to discourage pedestrians approaching the pond slopes and permanent pool, and to deter waterfowl.

Maintenance Access

A maintenance access pathway shall provide access to the pond forebay, inlet and outlet structure.

3.8 Operation and Maintenance

All municipal SWM works shall be operated and maintained by the Developer prior to assumption by the Municipality. Assumption conditions shall be identified in the corresponding Development Agreement. The works shall be operated and maintained in accordance with the conditions of the CLI-ECA. All operation and maintenance activities shall be documented in accordance with the conditions of the CLI-ECA.

4.0 STORM SEWERS

4.1 General

Storm sewers shall be provided to service all of the lands in the Plan of Subdivision or Site Plan and shall be located in the street right-of-way or in an approved easement. The storm sewer outlet must be carried to a sufficient outlet so that no damage is done to lands or roads. All lots and blocks in the plan must be connected to the storm sewer. Storm sewers shall be designed to accept all drainage from the contributing area, including upstream areas which shall be determined by the developer's Engineer and be subject to the approval of the Municipality.

Ontario Provincial Standard Specifications (OPSS), Ontario Provincial Standard Drawings (OPSD) and Municipal Engineer's Association (MEA) guidelines shall govern, where applicable.

4.2 Design Flows

4.2.1 Runoff Computations

The Rational Formula is to be used to determine the quantity of storm runoff. The use of other empirical runoff formulae must be approved by the municipality's engineer. The Rational Formula is:

$$Q = 2.78 C \cdot i \cdot A$$

Where:

Q = Peak flow in L/s
A = Area in hectares
i = Average rainfall intensity in mm per hour for a duration equal to the time of concentration for a particular storm frequency
C = Runoff coefficient (see **Section 3.3.5**)

4.2.2 Drainage Area

The drainage area to be used in the design of a storm sewer system must include all those external areas which will reasonably or naturally drain to the development area.

The area term in the Rational Formula represents the total area tributary to the point on the storm sewer under consideration.

4.2.3 Rainfall Intensity

Rainfall intensity duration frequency (IDF) storm parameters for the City of London and the City of Sarnia are based on the Environment and Climate Canada February 2019 IDF update. The practitioner shall determine the appropriate IDF based on geographic proximity to the assessment area, using the following:

- City of London (Chapter 6: Stormwater Management Requirements, Design Specifications & Requirements Manual, City of London, January 2024):

$$I = \frac{A}{(t+B)^C}$$

Where I = rainfall intensity (mm/hr)
t = duration (minutes)
A,B,S = AES Parameters (see Table 4)

Table 4: AES Parameters for Intensity Duration Frequency Curves

Parameter	25mm[1]	2yr[2]	5yr[3]	10yr	25yr	50yr	100yr
A	538.85	754.36	1183.74	1574.382	2019.372	2270.665	2619.363
B	6.331	6.011	7.641	9.025	9.824	9.984	10.5
C	0.809	0.810	0.838	0.860	0.875	0.876	0.884

- City of Sarnia (Stormwater Management Design Guidelines, City of Sarnia, 2024):

For catchments greater than 2ha, refer to IDF Tables and Curves available in Appendix A of City of Sarnia Stormwater Management Design Guidelines, September 2024. For catchments less than 2ha, the rainfall intensity can be calculated using the following.

$$I\ (mm/hr) = A\ (t + C)^B$$

WhereI = rainfall intensity (mm/hr)

t = duration (hours)

A,B,S = IDF curve fitting parameters (see table 5)

Table 5: IDF Curve Fitting Parameters

Parameters	Return Period, T (Years)						
	1	2	5	10	25	50	100
A	27.0	30.7	41.8	49.3	58.5	65.1	71.4
B	-0.780	-0.798	-0.814	-0.820	-0.823	-0.824	-0.824
C	0.080	0.085	0.090	0.091	0.092	0.092	0.091

4.2.4 Design Storm Frequency

The design storm frequency shall be a 5-year storm for residential lands and a 5-year storm for industrial or commercial lands.

4.2.5 Runoff Coefficients

The value of runoff coefficient C, is to be taken from the following:

Asphalt or Concrete Surfaces	0.9
Roof Areas	0.9
Single Family Residential	0.40 to 0.45
Semi-Detached Residential	0.45 to 0.60
Apartments	0.60 to 0.75
Industrial	0.65 to 0.75
Neighbourhood Commercial	0.75 to 0.85
Playgrounds	0.2
Parks	0.2
Unimproved	0.2

Where the Rational Method is used to calculate flows for return periods of more than 10 years, runoff coefficients shall be increased in accordance with the values presented in

the following table.

Table 6: Runoff Coefficient Adjustments

Design Storm	Runoff Coefficient Increase
25-year	10%
50-year	20%
100-year	25%

4.2.6 Time of Concentration

The time of concentration is the time required for flow to reach a particular point in the sewer system from the most remote part of the drainage area. It includes not only the travel time in the sewers, but also the inlet time, or time required to flow overland into the sewer system. The inlet time shall be based on the table below, unless calculations indicate a shorter or longer time is applicable. Supporting calculations shall be submitted to the municipality's engineer for review.

Table 7: Time of Concentration

Average Runoff Coefficient (C)	Time of Concentration (min)
0.4	23
0.5	17.5
0.6	14.5
0.7	12.5
0.8	11.5
0.9	10.5

4.3 Storm Sewer Design

4.3.1 Flow Formula and Roughness Coefficient

The Manning Formula is to be used for calculating sewer capacity and selecting pipe sizes, and is as follows:

$$Q = 1/n \times A \times R^{2/3} \times S^{1/2}$$

Where:

Q	=	Flow capacity of sewer (m^3/s)
A	=	Cross Sectional Area of Pipe m^2
R	=	Hydraulic radius of pipe
S	=	Sewer Slope m/m
n	=	Manning roughness coefficient

The Manning roughness coefficient (n) shall be as follows:

Smooth walled pipe	0.013
Corrugated metal pipe	0.024
Corrugated metal pipe with 25% paved inverts	0.020

4.3.2 Allowable Flow Velocities

Minimum velocity	0.90 m/s
Maximum velocity	6.0 m/s.

4.3.3 Minimum Pipe Sizes

- Storm sewers 250 mm
- Catch basin leads
  - Single 200 mm
  - Double 250 mm
- Connections 150 mm.

A decrease in pipe size from a large size upstream to a small size downstream will not be allowed regardless of grade increases.

4.3.4 Minimum Grades for Pipes

The minimum grades for storm sewers, flowing fully, based on "n" = 0.013 are as follows:

250 mm	0.56%
300 mm	0.44%
375 mm	0.32%

450 mm	0.26%
525 mm	0.21%
600 mm	0.18%
675 mm	0.15%
750 mm	0.13%
825 mm	0.11%
900 mm and larger	0.10%
150 mm connections	2.0%
200 mm catchbasin leads	1.0%

4.3.5 Depth of Cover

The minimum cover over catch basin leads shall be 1.2 m based on proposed finished grade. Main storm sewers shall be installed with a minimum of 1.5 m of cover. Shallower depths shall be analyzed on an individual project basis. All manhole frame and covers shall not be under wheel tracks.

4.3.6 Manhole Spacing

Manholes shall be placed at all changes in grade, changes in alignment (except for curvilinear sewers) and on straight runs at the following intervals:

- Sewers 375 mm in diameter or less 120 m
- Sewers greater than 450 mm 150 m

4.3.7 Manhole Design

Manholes are to be designed in accordance with Ontario Provincial Standard Drawings and specifications. All sizing of precast manholes is to be based on incoming and outgoing pipe sizes and should be sized based on manufacturer's recommendations. Manhole frames and covers shall conform with OPSD 401.010 – type A.

Drop structures are required when the difference in invert elevations between the upstream and outlet sewers in the manhole is equal to or greater than 1.20 m. Drop structure to be as per OPSD 1003.020.

Manhole safety landings are required at the mid-point depth of the manhole, when the depth of the manhole is between 5.0 m and 10.0 m. Additional safety landings are required at third-point depths, when the manhole is equal to or greater than 10.0 m to 15.0 m deep. Safety landings to be as per OPSD 404.020.

A 150 mm minimum, 300 mm maximum (top of cap to bottom of frame and cover) of pre-cast adjustment units (OPSD 704.010) are to be installed on all manholes and catchbasins. The difference in grade between the manhole lid and the first ladder rung cannot exceed 450 mm. Ladder rungs/steps to be as per OPSD 401.010 or 401.020.

An appropriate "energy drop" is required at all manholes at which a change in direction of the sewer occurs. For bends of 45 degrees and 90 degrees, the minimum allowances for hydraulic losses incurred at a sewer manhole shall be 0.03 m and 0.06 m respectively.

All manholes require benching at the bottom of the manhole as per OPSD 701.021. Benching height to be either to springline or obvert based on headloss calculations to be provided by designer.

Waterproof membrane covering all exterior maintenance hole joints and adjustment unit joints shall be supplied and installed with all maintenance holes. The membrane shall be Mel-Rol, or approved equivalent, and shall be a minimum of 300 mm wide, extending a minimum of 150mm above and below each joint, Contractors are to ensure the surface is clean and that all manufacturer installation instructions are adhered to.

4.3.8 Separation of Sewers from Potable Water Lines

Storm sewers and watermains constructed parallel to each other should be constructed in separate trenches maintaining a minimum clear horizontal distance of 2.5 m. Separation requirements to conform with MOE Procedure ‘F-6-1’.

4.3.9 Catch Basins

Catch basins shall be installed with 600 mm sumps.

Catch basins to be 1.5 m clear of any driveway curb depression.

With a normal 2% road crossfall either side of the centreline, the following maximum catch basin spacings will apply.

Table 8: Catch Basins

Road Gradient	Road Width	Maximum Spacing
0.35% to 0.5 % *	8.5 m 15.0 m	45 m 40 m
0.6% to 3.0 %	8.5 m 15.0 m	90 m 70 m
3.1% to 5 %	8.5 m 15.0 m	75 m 55 m
5.1% to 6 %	8.5 m 15.0 m	60 m 45 m

* 0.50% road gradient is the recommended minimum.

Where changes in gradient occur, the average gradient should determine the maximum spacing.

Double catch basins at all low points and/or curb inlet catch basins with overflow plates (OPSD 400.090). Overflow plates require a modified catch basin precast unit (600 mm x 840 mm). The Engineer shall verify inlet capacity of grate inlet and adjust catch basin spacing accordingly. Adjustment units to conform with OPSD 704.010.

Catch basin types (DICB, TICB, CICB etc.) will be evaluated on an individual basis.

Catch basin frame and grates for 600 mm x 600 mm catch basins to conform with OPSD 400.020.

Curb inlets in drive over curb locations should be recessed into the curb with a curb setback formed as a barrier curb transition section to accommodate the overflow plate.

4.3.10 Storm Sewer Gratings, Manhole Frames and Covers

Inlets and outlets of storm sewers which are accessible to the public shall be provided with protective gratings, for pipe sizes 450 mm or greater.

Metal lift rings to adjust manhole covers to finished grade are not permitted.

Manhole frame and covers are required for all manholes and shall conform with OPSD 401.010. Lockable or watertight manhole covers to be considered on a site-specific basis.

4.3.11 Sewer Separation at Crossings

A minimum 150 mm clearance is required between outside pipe barrels at all pipe crossings. Where storm sewers cross sanitary sewers or watermains, separation requirements as per MOE procedure ‘F-6-1’ shall apply.

4.3.12 Sewer Easements

Standard sewer easements must be a minimum of 6.0 m wide for one sewer, 7.60 m wide for two sewers in the same trench and 9.0 m wide for two sewers in separate trenches.

4.3.13 Storm Sewer Outlets

Storm sewer outlets to existing or proposed trunk sewers, municipal drains or natural watercourses inside or outside the development will be installed by the developer. In no case will an outlet be allowed to discharge to a natural watercourse or municipal drain which does not have sufficient capacity for the proposed discharge. The developer will be required to ensure that development does not cause interference with the riparian rights of properties upstream or downstream from the development.

4.4 Materials for Construction

4.4.1 Storm Sewers

Pipe materials for storm sewers, catch basin leads and sewer connections shall be reinforced concrete or PVC and shall conform with OPSS standards. Alternative materials must be approved by the Municipality. All catch basin leads shall be SDR35 PVC.

4.4.2 Manholes

Manholes are to be precast or cast-in-place concrete structures with cast iron frames and covers and shall be designed in accordance with OPSD and OPSS.

4.4.3 Catch Basins

Catch basins are to be precast or cast-in-place concrete structures with cast iron grates and shall be designed in accordance with OPSD and OPSS and shall have sumps.

4.4.4 Pipe Bedding, Cover Materials and Trench Backfill Materials

These materials shall be designed by the developer's geotechnical Engineer and material type and composition requirements indicated on the plans.

5.0 SANITARY SEWERS

5.1 General

Where sanitary sewer outlets are available to service the development lands, sanitary sewers shall be provided for all of the lands in the development and shall be located in the street right-of-way or in an approved easement. All lots and blocks in the development must be connected to the sanitary sewers.

Ontario Provincial Standard Specifications (OPSS) and Ontario Provincial Standard Drawings (OPSD) and MOE guidelines shall govern where applicable.

5.2 Hydraulic Design

5.2.1 Residential Flow

The following criteria shall be used in determining peak flows for sanitary sewer design for residential areas, including single and multiple housing, etc.

Design Population
For the purposes of estimating future sewage flow rates, reference should be made to the Official Plan. The Official Plan will contain future population densities and land uses.

Unless otherwise stated, a population density of at least 3.5 people per unit is to be used.

Average Daily Domestic Flow
Average daily domestic flow, exclusive of extraneous flows, shall be 400 L/cap.d.

Peak Rate of Flow
Peak domestic sewage flows to be calculated by the following equation:

$$Q(d) = Pq\,M + I$$

Where:

Q (d) = Peak domestic flow L/s
P = Design population
q = Average daily per capita domestic flow in L/cap.d.
M = Peaking factor derived from Harmon Formula

I = Unit peak extraneous flow in L/s/ha
A = Gross tributary area in hectares

Harmon Formula:

$$M = 1 + \frac{14}{4 + P^{1/2}}$$

Where:

M = Ratio of peak flow to average flow
P = Tributary population in thousands

The minimum peaking factor is three.

5.2.2 Commercial and Institutional

Commercial and institutional flows should be based on historical records when available. Where no records are available, the preliminary unit values below should be used, exclusive of extraneous flows. For tourist and commercial establishments, a minimum flow of 28 m^3/ha.d should be used in the absence of reliable flow data. Final unit flows will be negotiated with the Municipality on a project-by-project basis.

Table 9: Commercial and Institutional Flows

Facility	Sewage Flow
Shopping Centres based on total floor area	2500 to 5000 L/1000 m^2 day
Hospitals	900 to 1800 L/bed day
Schools	70 to 140 L/student day
Travel Trailer Park Minimum without water hook-ups Minimum with individual water hook-ups	 340 L/space day 800 L/space day
Campgrounds	225 to 570 L/campsite day
Motels	150 to 200 L/bed space day
Hotels	225 L/bed space day

5.2.3 Industrial Flow

Peak sewage flow rates from industrial areas vary greatly with the extent, the type of industry, the provision of in-plant treatment or regulation of flows, and the presence of cooling waters in the discharge etc. In the absence of accurate flow data, the following preliminary sewage flow allowances may be used. Final unit flows will be negotiated with the Municipality on a project-by-project basis.

- Light industry 35 m^3/ha day
- Heavy industry 55 m^3/ha day.

5.2.4 Infiltration

The infiltration rate for new development into the sewers shall be taken as 0.20 L/sec/hectare for residential, commercial and industrial lands.

5.3 Sanitary Sewer Design

5.3.1 Flow Formula and Roughness Coefficient

The Manning Formula is to be used for calculating sewer capacity and selecting pipe sizes, and the roughness coefficient (n) of not less than 0.013 is to be used for smooth-wall pipe materials.

The Manning formula is as follows:

$$Q = 1/n \times A \times R^{2/3} \times S^{1/2}$$

Where:

Q = Flow capacity of sewer (L/s)
A = Cross Sectional Area of Pipe m^2
R = Hydraulic radius of pipe (D/4) (m)
S = Sewer Slope m/m
n = Manning roughness coefficient (unitless)

5.3.2 Allowable Flow Velocities

- Minimum velocity = 0.6 m/s
- Maximum velocity = 3.0 m/s

5.3.3 Minimum Pipe Sizes

- Sanitary sewers – 200 mm
- Private Drain Connections (PDC) – 125 mm

5.3.4 Minimum Slopes for Pipes

The minimum slopes for sewers, flowing fully, are as follows:

200 mm	0.40 %
250 mm	0.28 %
300 mm	0.22 %
375 mm	0.15 %
450 mm	0.12 %
525 mm	0.10 %
600 mm	0.08 %
675 mm	0.067 %
750 mm	0.058 %
125 mm Connections	2.0 %

*All sewers shall have self-cleansing velocities in accordance with the hydraulic elements graph referenced in the WPCF MOP #9.

5.3.5 Depth of Cover and Alignment

Sanitary sewers are to be located 1.5 m off centreline of street (i.e., 3 m offset from storm sewer) and are to be installed with a minimum depth of cover to the top of the sewer from the road surface of 2.5 m. Shallower depths shall be analyzed on an individual project basis. To allow for gravity drainage from basements, sewer inverts should normally be at least 0.9 m to 1.5 m below basements floor levels. All manhole frame and covers not under wheel tracks.

5.3.6 Manhole Spacing

Manholes shall be placed at all changes in grade, changes in alignment (except for curvilinear sewers) and on straight runs at the following intervals:

- Sewers 375 mm in diameter or less 120 m
- Sewers 525 mm or greater 150 m

5.3.7 Manhole Design

Manholes are to be designed in accordance with Ontario Provincial Standard Drawings and specifications. All sizing of precast manholes is to be based on incoming and outgoing pipe sizes and should be sized based on manufacturer's recommendations. Manhole frames and covers shall conform with OPSD 401.010.

Drop structures are required when the difference in invert elevations between the upstream and outlet sewers in the manhole is equal to or greater than 1.20 m. Drop structure to be as per OPSD 1003.020.

Manhole safety landings are required at the mid-point depth of the manhole, when the depth of the manhole is between 5.0 m and 10.0 m. Additional safety landings are required at third-point depths, when the manhole is equal to or greater than 10.0 m to 15.0 m deep. Safety landings to be as per OPSD 404.020.

A 150 mm minimum, 300 mm maximum (top of cap to bottom of frame and cover) of pre-cast adjustment units are to be installed on all manholes and catchbasins. The difference in grade between the manhole lid and the first ladder rung cannot exceed 450 mm. Ladder rungs/steps to be as per OPSD 401.010 or 401.020.

All manholes require benching as per OPSD 701.021. Benching height to be either to springline or obvert based on headloss calculations to be provided by designer.

The following minimum allowances shall be made for hydraulic losses incurred at sewer manholes:

- Straight run grade of sewer

- 45 deg. turn 0.03 m
- 90 deg. turn 0.06 m

Waterproof membrane covering all exterior maintenance hole joints and adjustment unit joints shall be supplied and installed with all maintenance holes. The membrane shall be Mel-Rol, or approved equivalent, and shall be a minimum of 300mm wide, extending a minimum of 150mm above and below each joint, Contractors are to ensure the surface is clean and that all manufacturer installation instructions are adhered to.

5.3.8 Pumping Station Design

Pumping station design, where required, shall be in accordance with MECP guidelines. Where pumping stations are designed that will be assumed by the Municipality, the design will need to include SCADA that meets the needs of the Municipality's SCADA roadmap and coordination with the Municipality's SCADA vendor should be anticipated. The level of detail required on drawing of a pumping station are shown on the example drawing 4.1, 4.2 and 4.3 within **Appendix B**.

5.3.9 Separation of Sewers from Potable Water Lines

Sanitary sewers and watermains constructed parallel to each other should be constructed in separate trenches maintaining a minimum clear horizontal distance of 2.5 m. Separation requirements to conform with MOE procedure 'F-6-1.'

5.3.10 Sewer Easements

All sewer easements must be a minimum of 6.0 m wide for one sewer, 7.60 m wide for two sewers in the same trench and 9.0 m wide for two sewers in separate trenches.

5.3.11 Sewer Connection Cleanouts

Municipal cleanouts (125 mm dia.) at property line are required on private drain connections (PDC's). Clean outs shall have metal caps 100 mm below finished grade.

5.3.12 Sewer Connection Types

Sewer connections shall be type I, II or III based on depth, see **Appendix B**, **4.4** for detail.

Connection of PDC's directly into manholes is not permitted.

5.4 Materials for Construction

5.4.1 Sanitary Sewers

Pipe materials for sanitary sewers and sewer connections shall be PVC (molded tees preferred) or reinforced concrete (factory installed tees) and shall conform with OPSS standards. Alternative materials must be approved by the Municipality.

5.4.2 Manholes

Manholes are to be precast or cast-in-place concrete structures with cast iron frames and covers and shall be designed in accordance with OPSD and OPSS. Metal lift rings to adjust manhole covers to finished grade are not permitted.

5.4.3 Pipe Bedding, Cover Materials and Trench Backfill Materials

These materials shall be designed by the developer's geotechnical Engineer and material type and composition requirements indicated on the plans.

5.5 Sewer Testing For Leakage

Sanitary sewers shall not exceed the following permissible infiltration and exfiltration rates.

5.5.1 Exfiltration

Up to and including 900 mm diameter pipe
1.4 L per 25 mm of conduit barrel internal diameter, per 30 m of line length, per hour with a 0.6 m head of water above the highest pipe. The above rate is to be increased by 10% for every additional 0.6 m head.

Greater than 900 mm diameter pipe
2.3 L per 25 mm of conduit barrel internal diameter, per 30 m of line length per hour with a 0.6 m head of water above the highest pipe. The above rate is to be increased by 10% for every additional 0.6 m head.

Infiltration

(a) Up to and including 900 mm diameter pipe

1.1 L per 25 mm of conduit barrel internal diameter, per 30 m of line length, per hour.

(b) Greater than 900 mm diameter pipe

2.3 L per 25 mm of conduit barrel internal diameter, per 30 m of line length, per hour.

The above requirements for pipe sizes up to and including 900 mm in diameter conform to the minimum requirements as set by the Ontario MOE. The requirements for pipe sizes larger than 900 mm in diameter conform to the requirements of A.S.T.M. Designation C-443, latest edition.

6.0 WATER DISTRIBUTION SYSTEMS

6.1 General

Where a water supply is available to lands to be developed, the developer shall construct a water distribution system as part of the servicing requirements.

Ontario Provincial Standard Specifications (OPSS), Ontario Provincial Standard Drawings (OPSD), American Water Works Association (AWWA) and MOE shall govern where applicable.

6.2 Hydraulic Design

6.2.1 Design Water Demand

The water requirements in the design of the distribution system shall be based on the following four basic needs:

- Residential water demand
- Commercial and Institutional water demands
- Industrial water demands
- Fire demands.

Water systems shall be designed to satisfy the greater of either of the following demands:

- Maximum day plus fire flow (max day = 3.5 x avg. day)
- Peak rate (maximum hourly demand) (max hour = 7.8 x avg. day).

The maximum day demand is the average usage rate on the maximum day. The fire flow demand will vary with the size of the area and density of development and shall comply with: “Water Supply for Public Fire Protection - A Guide to Recommended Practice (latest edition)” as issued by Fire Underwriters Survey and Insurance Bureau of Canada (c/o Insurers’ Advisory Organization - Toronto). The peak rate demand is the short-term demand placed upon the system by usage other than firefighting. The peak rate demand is usually taken as the average water usage over the maximum hour.

6.2.2 Unit Consumption Rates

Residential Water Demands

For the purposes of design, the average daily per capita water demand shall be 400 L/cap.d. Peak usage rates for residential purposes will vary in accordance with the guidelines published by the MOE.

Commercial and Institutional Water Demands

Commercial and institutional flows shall be based on historical records when available. Where no records are available, the preliminary unit values below shall be used. For tourist and commercial establishments, a minimum flow of 28 m^3/ha.d. shall be used in the absence of reliable flow data. Final unit values will be negotiated with the municipality on a project-by-project basis.

Table 10: Commercial and Institutional Water Demands

Facility	Water Usage (avg. daily)
Shopping Centres based on total floor area	2000 to 4500 L/1000 m^2 day
Hospitals	800 to 1600 L/bed day
Schools	60 to 130 L/student day
Travel Trailer Parks Minimum without water hookups Minimum with individual water hook-ups	 320 L/space day 750 L/space day
Campgrounds	220 to 565 L/space day
Motels	125 to 175 L/bed space day
Hotels	200 L/bed space day

For estimation of peak demand rates, an assessment of the water using fixtures is generally necessary and a fixture-unit approach is required. A peak rate factor of four will apply to campground areas.

Industrial Water Demands

Peak water demand, from industrial areas, varies generally with the extent and type of industry. In the absence of accurate flow data, the following preliminary flow allowances

shall be used. Peak usage rates will generally be two to seven times the average usage rate. Final unit rates will be negotiated with the municipality on a project-by-project basis.

- Light industry 35 m^3/ha. day
- Heavy industry 55 m^3/ha.day.

Fire Demands

The minimum fire flow shall be determined on a project-by-project basis. The system must be simultaneously capable of satisfying the maximum day demand. At this time, fire demands are only considered within the applicable urban areas within the Municipality.

6.3 System Pressure

6.3.1 Minimum Operating Pressures

The distribution system shall be sized so that under maximum hourly demand, the pressures are not less than 275 kPa. Under conditions of simultaneous maximum day and fire flow demands, the pressure shall not be less than 140 kPa.

6.3.2 Transient Pressures

The distribution piping system shall be designed to withstand the maximum operating pressure plus the transient pressures to which it will be subjected. Transient pressures are caused by rapid valve operation, pump start-up and shut-down, power failures, etc.

As a minimum allowance in the distribution system, the pipe and joint strength shall be such that it can withstand the maximum operating pressure plus the pressure surge that would be created by instantaneous stoppage of a water column moving at 0.6 m/s.

6.4 Friction Factors

The Hazen-Williams Formula shall be used in the design of water distribution systems. The following Hazen-Williams "C" values shall be used for the design of water distribution systems, regardless of materials.

Table 11: Friction Factors

Diameter	C-Factor
150 mm	100
200 mm/250 mm	110
300 mm/600 mm	120
Over 600 mm	130

6.5 Minimum Pipe Sizes

6.5.1 Watermains

The minimum size of watermain shall be 150 mm except for the following cases:

- Beyond the last hydrant on cul-de-sacs (50 mm min)
- Extension of dead-ends in rural areas (50mm min).

6.5.2 Water Services

The minimum pipe size for residential water service connections is 20 mm.

6.6 System Layout

6.6.1 Grid Design

The water distribution system shall be designed to eliminate dead-end sections. Where dead-end mains cannot be avoided, the section shall be provided with a fire hydrant or blow-off.

6.6.2 Valve Placement

In residential developments, valves shall be located so that any section of watermain serving up to a maximum of sixty residential water services can be isolated by operating not more than four valves. Phasing of developments should be considered and valving should

be logical (i.e., at intersections). In residential areas, valves shall be spaced no more than 250 m apart.

All valves are to open counter clockwise.

6.6.3 Hydrant Requirements

In residential areas, the line spacing for hydrants shall be not greater than 150 m. For areas other than residential, spacing will be determined on a project-by-project basis.

Fire hydrants must be installed only on watermains capable of supplying fire flow requirements. The hydrant leads shall be 150 mm diameter pipe. Location and number of hydrants is subject to the approval of the engineer/water manager.

6.6.4 Depth of Cover

The minimum depth of cover over watermains and service connections shall be 1.7 m.

6.6.5 Cross-Connection Control

No connection shall be made between a municipal water system and any well or private water system.

All water services shall have a backflow preventor, a pressure-reducing valve (PRV), water service and meter installed by a licensed plumber. These materials are to be provided by the Municipality as part of municipal requirements at the cost of the owner.

6.7 Pipe Design

6.7.1 Pipe Materials

The following is acceptable material for new watermains:

- Polyvinyl Chloride AWWA C900
- High Density Polyethylene in some instances i.e., rural areas, river crossings.

Additional pipe materials may be submitted by the developer for review by the Municipality.

Pipe class and type of material shall be submitted to the Municipality for approval. A solid 12-gauge twu copper tracer wire must accompany the full length of the watermain for locating purposes. Cathodic protection shall be provided.

6.7.2 Restraints

Adequate restraint shall be provided to prevent pipe movement and to prevent joint failure by jointing methods or thrust blocking capable of resisting the forces involved. Restrain lengths for watermains 100 mm to 300 mm shall be in accordance with the requirements outlined below. Restrained length calculations for watermains 400 mm and greater shall be supplied by the pipe manufacturer.

Table 12: Restraints

Diameter of Main (mm)	Minimum No. of Steel Rods	Minimum Length to be Restrained on Each Side of Fittings (m)				
		$11^{1/4°}$	$22^{1/2°}$	45°	90°	Dead End
100	2	4.0	4.0	4.0	4.0	20
150	2	4.0	4.0	4.0	5.5	20
200	2	4.0	4.0	4.0	7.0	20
250	4	4.0	4.0	4.0	8.5	30
300	4	4.0	4.0	4.0	10.0	30

6.7.3 Bedding and Backfill

Bedding and backfill requirements shall be consistent with the pipe material, class and soil conditions in the installation location.

6.8 Appurtenances

6.8.1 Hydrants

All hydrants shall be the dry barrel type manufactured in accordance with the latest requirements of AWWA C502. Hydrant directional operation will be to open counter clockwise and be three-way with steamer port STORZ connection.

The following is acceptable for new hydrants:

- Canada valve – century or approved equivalent.

6.8.2 Valves and Valve Chambers

All valves to be used on the water distribution system and secondary valve on fire hydrants shall be as follows:

- Gate valves shall be manufactured in accordance with the latest provisions of AWWA C509, suitable for direct burial with resilient seats and stainless-steel nuts and bolts
- Gate valves 300 mm in diameter or larger shall be installed in precast valve chambers with features as directed by the municipality. All smaller valves shall have suitable valve boxes
- Valve directional operation will be to open counter clockwise.

6.8.3 Water Services

Water services shall be a minimum of 20 mm (3/4”) internal diameter and shall be equipped with approved corporation stop and curb stop with stainless steel rod and pin and 20 mm hexagonal brass cap plug (See Detail Drawing 6.1 in **Appendix B**). If a residential house with a 20mm service cannot be seen from the right-of-way or if it’s setback more than 30.5m from the property line, the Municipality will require the service to be installed in a meter pit (Ford Meter Pit Setter or approved equivalent) at the property line. The installation and costs associated with the meter pit would be the responsibility of the Owner. For 1.5” and 2” services, the meter shall be installed in a meter pit as per Detail Drawing 6.2 in **Appendix B**. The installation and costs associated with the meter pit would be the responsibility of the Owner. Service pipe shall be Cross-Linked Polyethylene (PEX) potable water service tubing in accordance with AWWA C904, ASTM F876-05, ASTM877-05, CSA-B137.5 and NSF 61. with 12-gauge tracer wire. All services shall be connected to PVC watermains using stainless steel broad band saddles. Hydro services shall not be grounded

to water services. For bulk or large diameter service metering, bulk meters are to be installed as per Detail Drawings 6.3 and 6.4 in **Appendix B**.

6.9 Water Sampling Stations

Required location of water sampling stations will be determined by the Municipality. Water sampling stations shall be 'Test Tap Sampling Station by DR Innovations Inc.' or approved equivalent be installed according to detail 6.5 located in **Appendix B**.

6.10 Acceptance of Work

6.10.1 Pressure and Leakage Test

The distribution system and services shall be back-flow protected and pressure-tested to 1050 kPa for a period not less than two hours. All leaking joints, fittings or appurtenances shall be tightened and all defective materials shall be removed and replaced. The maximum allowable leakage is 1.85 L per day per mm of diameter, per km of length and all necessary steps to reduce the leakage to the allowable amount shall be taken.

When the installation is completed and the leakage test and pressure test results are satisfactory, the system shall be thoroughly swabbed and flushed to remove all debris and unwanted material. The system shall be disinfected using a chlorine solution maintained at a minimum concentration of 50 mg/1 throughout the length of the pipeline. The residual concentration at the end of 24 hours shall be at least 25 mg/1. If tests of the solution are satisfactory, the contents of the pipeline shall be flushed out completely and recharged by municipal water. Samples of the recharge water in the system shall be analyzed for contamination and the system shall not be put into operation until test results indicate no contamination. Disinfection procedures shall be repeated as necessary.

All testing and disinfection shall be carried out by the developer in the presence of the Municipality's representative and in accordance with current provincial regulations.

6.10.2 Valve Boxes and Curb Boxes

The top of all valve boxes and curb boxes must be set to finished grade. Curb boxes must be set plumb and be 150 mm to 300 mm from the street line toward the centreline of the

road.

6.10.3 Hydrants

Hydrants are to be set plumb, with nozzles parallel to edge of pavement or curb line, and pump connection facing pavement.

Flange at base of hydrant is to be set 50 mm to 100 mm above finished grade.

7.0 ROADS

7.1 General

Paved roads and concrete curbs and gutters shall be provided in the development. Existing street allowances, which provide access to the development shall be constructed or improved as determined by the municipality's engineer.

Ontario Provincial Standard Specifications (OPSS), Ontario Provincial Standard Drawings (OPSD), Municipal Engineer's Association (MEA) guidelines, Transportation Association of Canada and Ministry of Transportation guidelines shall govern where applicable.

7.2 Design

In general, the following design criteria shall be used unless otherwise approved by the Municipality.

7.2.1 Pavement Widths and Right-of-Way Widths

The following outlines right-of-way widths, pavement widths (edge of pavement to edge of pavement) for the various street classifications.

Table 13: Pavement Widths and Right-of-Way Widths

Lane Type	Driving Lane	Parking Width	Min. Total Width	Right-Of-Way
Local Residential	3.0 m	2.5 m	8.0 m	20 m
Industrial Commercial	3.5 m	2.5 m	9.5 m	20 m to 26 m

The street classification will be determined by the Municipality. Standard road cross sections for local urban (residential), local semi-urban and local rural are shown on drawings 7.1, 7.2 and 7.3 respectively with **Appendix B**.

7.2.2 Minimum Road Gradients

The minimum allowable road gradient is 0.5% and maximum is 5% (8% absolute). In the case of curves, the minimum gradient applies to the longest gutter (minimum grade at intersection curb radii 0.8%). Vertical curves are required where the algebraic difference in grades is greater than 1.0%. Minimum length of vertical curve shall not be less than 45 m.

7.2.3 Standard Geometrics

Table 14: Standard Geometrics

	Local
No. of Units Traffic Volume (AADT)	<100 <1000
Minimum Boulevard Width	3.15 m
Minimum Cul-de-Sac Pavement Radius (residential)	15.0 m
Minimum Cul-de-Sac Radius at property line (residential)	19.0 m
Minimum Stopping Sight Distance	60.0 m
Pavement Crossfall	2.0 %
Subgrade Crossfall	3.0%

The Municipality's standard for turning basins or cul-de-sacs on terminated streets is shown on drawing 7.4 within **Appendix B**. The Municipality's standard for community mailboxes complete with a parking bay is shown on drawing 7.5 within **Appendix B**.

7.2.4 Standard Road Structure

Table 15: Standard Road Structure

	Local
Pavement Thickness*	
Hot Mix Asphalt	90 mm
Granular "A"	150 mm
Granular "B"	300 mm
Maximum allowable beam deflection (Benkleman)	1.8 mm

* Minimum requirements in the absence of a Geotechnical Engineer's report.

Off–site road improvements (existing street widenings, turning lanes, tapers, traffic island, signals, sidewalks etc. including traffic studies etc.) will be determined on a project-by-project basis.

7.2.5 Intersection Radii

The minimum radii at edge of pavement required at intersections are:

Table 16: Intersection Radii

Street Classification	R.O.W. Widths	Minimum Radius
Local to Local	20 m 20 m	9.0 m residential 11.0 m industrial
Local to collector Collector to local	20 m 20 m	9.0 m residential 11.0 m industrial

7.2.6 Street Patterns

Where possible:

- Intersecting streets at right angles.
- No jogged intersections.
- Intersections not closer than 60 m (200 ft).
- Avoid long cul-de-sacs and ensure OBC requirements are met regarding emergency services and firefighting purposes.
- Minimize through traffic.

7.2.7 Curb and Gutter

Barrier concrete curb and gutter on major streets (OPSD 600.010), mountable on minor streets (OPSD 600.100). Alternative curb types will be considered by the Municipality. All curbs shall be in accordance with OPSS and OPSD Specifications. All curb cuts shall be installed at the time of construction and locations shall be in accordance with driveway location standards.

7.3 Materials for Construction

7.3.1 Concrete

Concrete curb and gutter is to be placed on a Granular "A" base of not less than 50 mm thick. Concrete is to be 25 MPa at 28 days and air entrainment capabilities of 6%+/-1%. Contraction joints are to be provided every 3 m. Expansion joints every 9 m, on both sides of catch basins and at the beginning and end of circular curves. The use of asphaltic concrete curb will not be permitted.

General specifications for concrete shall be according to OPSS. A mix design shall be submitted to the Municipality for approval.

7.3.2 Asphalt

General specifications for asphalt shall be to OPSS 310 and 1150. Granulars used in asphalt shall conform to OPSS. Tack coat required between base and surface courses to OPSS and OPSD.

7.3.3 Granular "A"

Granular "A" shall conform to OPSS 314 and 1010. Granular "A" shall be compacted in roadways to 100% standard proctor maximum dry density. Sieve analysis shall be performed on the proposed material to ensure conformance with the specification before the material is placed on the roadway.

7.3.4 Granular "B"

Granular "B" shall conform to OPSS 314 and 1010. Granular "B" shall be compacted in roadways to 100% standard proctor dry density. Sieve analysis shall be performed on the proposed material to ensure conformance with the specification before the material is placed on the roadway.

7.4 Construction

7.4.1 Trench Compaction and Subgrade Compaction

All sewer water and utility trenches within the roadway shall be compacted to at least 95% standard proctor dry density up to 1 m below finished road grade and 98% up to subgrade level.

The subgrade shall be proof rolled and compacted to at least 98% standard proctor dry density. Imported materials for subgrade shall be compacted to at least 98% standard proctor dry density.

All topsoil shall be removed under roadways and curb and gutters. All subgrade to be approved by a geotechnical Engineer.

Provide sub-grade drainage (sub-drains) at all catch basins (3 m both side at sumps and 3 m upstream side all others).

7.4.2 Boulevard Grading

All boulevards between the curb and street line shall be fine graded. The slopes on boulevards shall be not less than 3% and not greater than 8%. All debris, rubbish and junk shall be removed from the street right-of-way before final acceptance of the subdivision.

7.5 Street Name Signs

Street name signs are to be located on the southwest corner of all street intersections unless otherwise specified. Street signs shall be mounted on separate poles from regulatory signs. The street sign poles shall generally be on the opposite side of the street from regulatory signs. At “tee” intersections, where it is not possible to locate a street sign on the southwest corner, the street sign poles shall generally be located across the intersection opposite the centreline of the intersecting street.

Regulatory sign posts shall be hot dipped galvanized steel or 100 mm x 100 mm pressure treated sign posts. Street sign posts shall be 60 mm (2 3/8”) diameter minimum, galvanized steel posts approximately 3.4 m (11’) long or longer if required. Posts shall be embedded

in concrete (wood) or driven into the ground (steel) to a depth of at least 1.0 m (3.3'). Regulatory signs, post locations and sign mounting heights shall be in accordance with the Highway Traffic Act and Regulations (latest version). Metal posts, regulatory traffic signs and street signs shall be as supplied by Owl Light Trillium, Clemmer Industries Ltd., Fortran Traffic Systems Limited or approved equal. In general, street signs shall be centre-mounted on top of posts. However, at major intersections the Municipality shall require street signs to be mounted on street light poles (see below). In general, the mounting height of street signs (from ground to bottom of sign) shall be 2.3 m to 3.3 m (7.5' to 10.8').

Except as noted below, street name plates shall be extruded aluminum blades with heat activated application of "engineering grade" reflective vinyl to the blank. Lettering shall be reflective white on a reflective blue background with lettering on both sides of the sign.

At intersections with traffic islands and/or signalized intersections, the municipality may require street signs to be installed at more than one corner of the intersection and/or at traffic islands/medians. In these situations, the Municipality may require street signs to be mounted on street light poles. These signs shall be fabricated from flat, heavy gauge (0.8") aluminum sign blanks with reflective white lettering on a reflective green background on one side of the sign, and shall be mounted to light poles with two centre hole brackets and 3/4" x 0.02" thick stainless steel strapping.

Lettering shall be done by the heat application of die cut letters or by the heat-fixed screening process where the quantity of signs having the same name exceeds five, subject to the approval of the municipality. Lettering shall be upper case standard block condensed style. Lettering size and sign blank height shall be as follows:

- Local/collector streets
- 150 mm (6") high sign blank
- 75 mm (3") high street name
- 50 mm (2") high ST., AVE., etc.

Street name signs and traffic signs satisfying the requirements of the Municipality, County and MTO shall be located in accordance with MTO criteria.

In most cases, all new signage is to be provided by the Municipality at the developer's expense.

7.6 Sidewalks

The Municipality will determine where sidewalks are required to be installed at the developer's expense.

Sidewalk shall be:

- On both sides of all collector streets
- On both sides of any street on which a school property fronts
- On one side of local residential streets, except culs-de-sac and crescents which contain less than twenty residential units
- On both sides of streets abutting parkland (each situation to be considered on a case-by-case basis)
- Have a thickness of 100 mm, 125 mm in driveways, 150 mm with reinforcing in industrial entrances
- 30 MPA concrete
- Such that the profile carries through driveways.

Sidewalks and curbs shall be depressed at street intersections to meet barrier free requirements. Sidewalks shall be installed in conjunction with curb installation and prior to driveway construction, final lot grading and boulevard restoration.

7.7 Acceptance of Work

7.7.1 Concrete

The developer shall provide compressive cylinder test results from a geotechnical engineer for concrete used in the work. Such testing shall be performed by a recognized testing company. Visual inspection and impact hammer tests may be made on the concrete by the geotechnical engineer.

The Municipality may also require tests by coring and taking compressive, petrographic and entrained air tests on the cores obtained. Provided that no defective work is indicated by such inspections, the whole cost of coring and testing shall be borne by the developer.

7.7.2 Pavements - Evaluation of Pavements

Specifications for asphalt shall adhere to the following:

The developer shall provide test results from a geotechnical engineer for asphalt used in the works. The testing shall be performed by a recognized CSA certified testing company. The testing required should include compaction testing and sampling and testing to ensure the marshall mix design conforms to the limits specified in the approved mix design.

Mix designs are the responsibility of the developer and must be approved by the Municipality and conform to OPSS.

The applicable OPS Specifications are 310 and 1150.

Indicate the intended year for placing base and surface asphalt for the project.

Proposed mix designs submitted for review by the contractor/supplier should include the relevant backup information including recent quality control test data confirming that this production mixture is conforming to the mix design.

Sampling during paving should be carried out by or under the direction of the Municipality. Testing for asphalt cement content and aggregate gradation would then be carried out by a recognized designated laboratory which should be certified by the Canadian Council of Independent Laboratories for bituminous testing, Type B category. All costs associated with initial testing, and successful testing on the second representative sample is borne by the owner. All costs associated with the failed second sample re-testing, further investigation (testing and subsequent testing), and remedial measures to correct outstanding deficiencies, will be charged to the contractor.

Asphalt Cement Payment Adjustment

The contract administrator shall make an Asphalt Cement Payment Adjustment to reflect OHMPA formula which states:

The payment adjustment per tonne will apply to the quantity of asphalt cement in the hot mix accepted into the work during the month for which it is established. The payment adjustment for the month will be calculated by the following:

- **When asphalt cement prices are rising** by more than a $15.00/tonne difference: The payment adjustment to be paid to the contractor is the result of subtracting the price index when the tender closed from the price index when paving took place, minus the $15.00 float, multiplied by the number of tones of PGAC incorporated in the mix(s) as determined by the job mix formula. If the answer is negative, no adjustment is made
- **When asphalt cement prices are falling** by more than a $15.00/tonne difference: the payment adjustment made in favour of the owner is the result of subtracting the price index when paving took place, plus $15.00 from the price index when the tender closed, multiplied by the number of tonnes PGAC incorporated in the mix(s) as determined by the job mix formula.

Link to MTO asphalt cement price index:
http://www.ohmpa.org/acpi/acpiView.asp

A mark-up on the payment adjustment will not apply to the asphalt Cement Payment Adjustment.

The Municipality may, at their cost, require the contractor to obtain nominal 100 mm dia. cores of the compacted hot mix to verify the thickness of the layer(s). Holes made by the removal of such samples shall be filled with the specified hot mix and compacted.

8.0 DEVELOPMENT GRADING

8.1 General

All development shall be graded in accordance with the following specifications. General and individual lot grading plans shall be prepared by the developer's Engineer and approved by the Municipality along with the subdivision servicing drawings.

8.2 Lot Grading Details

- Yard surfaces shall have a minimum of 2%
- Drainage flows shall be directed away from houses
- Drainage flows which are carried around houses are to be confined in defined swales located as far from the house as possible
- Desirable swale depth to be 300 mm. Minimum swale depth to be 200 mm. Maximum swale depth to be variable, but dependent on location and safety considerations
- Swale width: 1.8 m (2.0 m from property line)
- Grades:
  - Minor swales (providing drainage for up to four lots) minimum grade shall be 2% (in special cases, 1%) with underdrainage.
  - Major swales (providing drainage for more than four lots) minimum grade shall be 1.5%.
- The maximum flow allowable in a side yard swale shall be that from four backyards
- The maximum flow in rear yard swales shall be that from ten to fifteen backyards depending on lot size and grade. The maximum length of a rear yard swale without outlet shall be 90 m. The maximum area contributing to the rear yard swale shall be 0.5 hectare. No rear yard swales may be discharged onto the road allowance
- No front yard catch basins shall be allowed
- Driveways: Optimum grade: 3% to 4%
  Maximum grade: 10% (optimum max. 8%)
  Walks: Optimum cross slope: 2%
- Maximum slope ratio for all terraces and banks shall be 3:1 (3 horizontally to 1 vertically)
  All other site areas: Optimum gradient: 4%
  Minimum gradient: 1%

- Where retaining walls are required, they shall be placed on private property unless otherwise approved by the municipality
- The minimum height of basement openings (i.e., basement window sills) shall be 300 mm minimum above finished road centreline elevation unless otherwise approved by the municipality (such as with rear yard “walk-out” basements).

8.3 Area Grading

The development area grading shall have a self-contained grading design and a major:minor overland flow direction to a maximum depth of 300 mm on the road and 450 mm off the roadway, and acceptable public outlet.

As a condition of obtaining building permits, builders shall be required to submit site plans with sufficient detail and elevations in accordance with the requirements of “Subdivision Requirements Checklist” (**Appendix A)** and in accordance with the approved development grading plan. Further, builders will be required to submit to the municipality lot grading certificates, signed and sealed by a Professional Engineer/Ontario Land Surveyor at two stages of construction:

- Top of footing or top of foundation
- Finished grading.

Each certificate shall provide certification that the appropriate stage has been constructed in accordance with the approved plans, prior to construction proceeding to the next stage.

Lot grading plans on infill lots may be prepared by a Professional Engineer or an Ontario land surveyor.

See “Typical Lot Layout Data’, site grading plan and lot grading certificate are show on drawings 8.1, 8.2 and 8.3 within **Appendix B.** There is also a detailed checklist in **Appendix A**. Lot Grading Plans must be certified by an Ontario Land Surveyor (OLS) or Engineer and submitted to Municipality prior to occupancy.

9.0 PARKLAND/LANDSCAPING

9.1 General

When open space or parkland dedication is required pursuant to the Planning Act or the Development Agreement, the areas so designated shall be identified on the development plans with sufficient details, notes and typical sections as may be required to identify lot grading, drainage, landscaping, access and other details as may be required. The developer shall grade, topsoil, seed, landscape and otherwise prepare the parkland and open space areas to a condition which is acceptable to the Municipality for assumption. Access for maintenance must be incorporated into the layout.

9.2 Passive and Active Recreational Uses

The design and site preparation of the parkland and open space shall take into account the intended and future passive and/or active recreational uses in accordance with the Municipality's requirements. Where possible, natural features including topography, vegetation, trees, soil conditions, watercourses, drainage and orientation to sun and wind, should be carefully considered in the design/layout of the parkland areas. The shape of the site must be suitable for the future layout of official sized sports fields if active usage is required. Narrow strips and triangular pieces of land are generally not acceptable. Natural wooded areas, stream and creeks may be considered on an individual basis and may be desirable where organized recreation uses are not suitable. Boggy lands are generally not acceptable for park purposes except where the area can be defined as a conservation type park area subject to the approval of the municipality. Open water courses are generally not acceptable for proposed active playground areas.

9.3 Site Clearing and Security

No topsoil shall be removed from the site. The parkland and open space areas shall be fenced or otherwise made secure during land development and house construction activities to prohibit the removal of topsoil and the dumping of debris and unauthorized fill.

All rubbish, rocks, boulders, tree stumps and other debris shall be removed from the site. The burning or burying of such materials on the site shall be permitted only if approved by

the Municipality. Dead trees shall be cut and stumps removed. Trees which are to remain shall be adequately protected during land development.

9.4 Site Grading/Drainage

Park drainage and grading plans shall be submitted to the Municipality at the same time as the servicing drawings and shall meet the following minimum standards.

9.4.1 Drainage

- Drainage of parkland dedications shall be self-contained such that areas drain to channels or swales which outlet to catch basins and storm sewers or other suitable outlet, so that park drainage does not adversely affect other properties
- Swales should have gently sloping sides and should be used wherever possible rather than steep sided ditches. The minimum slope of channel and swale inverts shall be 1%. Maximum side slope permitted is 4:1
- Maximum depth to bottom of channel shall be 1 m. Minimum depth of swale shall be 200 mm
- Except for natural watercourses, in general, catch basins shall be provided in open channels and swales at maximum intervals of 100 m
- Swales or open ditching shall not cross the entrance way into the park area
- Natural wetland areas may require special attention and preservation.

9.4.2 Grading

- In general, the minimum grade for grassed areas shall be 1%. However, areas to be developed for future soccer or baseball facilities may have grades less than 1%. Subsurface drainage may be required
- Grassed slopes shall not have gradients steeper than 4:1 so as to allow safe use of moving equipment
- All lands must be satisfactorily graded before the lands will be accepted by the municipality for park purposes
- Grading or natural contours which result in undrained areas are not acceptable. If overland drainage cannot be modified, catch basins and pipe will be required
- The developer shall do all rough grading and filling where required, under all landscaped areas, to establish the sub-grade parallel to the finished grades

indicated on the grading plans, to allow sufficient topsoil depth. All soft and unstable areas below sub-grade, shall be excavated and filled with compacted select fill material

- All areas shall have uniform slopes between points for which finished grades are indicated on the plans or between such points and existing grades. Grades shall be smoothly rounded at top and toe of slopes
- Sub-grade shall be scarified to minimum depth of 75 mm to produce an even, loose textured surface free of all stones, roots, branches, etc. larger than 50 mm in diameter
- Topsoil shall be loose textured and free of all stones, roots, branches, etc. larger than 50 mm in diameter
- The minimum depth of topsoil under seeded areas shall be 150 mm. When additional topsoil exists on site, it shall not be removed from site, but shall be used to increase overall finished topsoil depth, or to construct other landscaping features proposed.

9.5 Seeding

Prior to seeding, an approved formulation of appropriate fertilizer shall be applied at the approved manufacturer's recommended rate to initiate leaf growth and root development. Grass seed shall be a certified seed, meeting the requirements of The Seeds Act for Canada No. 1 Seed. It shall be a mixture which is suitable for the soil conditions, etc. of the site. The seeding periods, in order of preference are:

- August 15 to September 15
- Early spring to May 30.

At the time of inspection for acceptance, grass shall be well established and in vigorous growing condition. Unacceptable areas shall be reseeded by the developer. The developer shall regularly mow the grass after good growth has been established and shall control weeds as required, prior to assumption of the site by the municipality.

9.6 Walkways

Where walkways are required through parklands, they shall be 1.5 m wide and constructed of a 150 mm depth of well-compacted chip and dust over geotextile fabric.

9.7 Fencing

Where permanent fencing is required within or along parkland boundaries, it shall be 1.8 m high and shall meet material specifications as approved by the Municipality on a project-by-project basis.

9.8 Tree Planting

Where possible, mature healthy trees should be preserved. The subdivision plans and park land plans should clearly indicate existing wooded areas and/or single trees where appropriate, and shall indicate those trees/areas to be preserved.

If required by the development agreement, the developer shall plant trees at the standard location 1.5 m behind property line, on private property, at an approximate spacing of 20 m (one tree per residential lot). Species of trees are subject to the approval of the municipality.

If required by the development agreement, the developer shall establish a buffer zone of trees to abut a road allowance to separate and screen non-compatible land uses. Such buffer zones in road allowances shall consist of a continuous row of trees in a location specified by the Municipality.

In all cases where tree planting is required, the development plans shall clearly indicate on the park land plans or separate landscaping plans, the tree type, size, spacing, location, etc.

Planting, staking, watering, pruning and maintenance of new plant stock shall be the responsibility of the developer until such time as the development is assumed by the Municipality.

New plant stock shall satisfy the following minimum standards:

- Deciduous trees:
  - 2.5 to 3.0 m (8 ft to 10 ft) in height
  - 50 mm in caliper (measured at 300 mm above the ground)

  - Well branched.
- Coniferous trees:
  - 1.0 to 1.5 m (3 ft to 5 ft) in height.
- Shrubs:
  - 1.0 m at time of planting
  - Closely spaced (when used for screening).

Plant stock shall be carefully planted in accordance with standard nursery practice and the detail and drawings included with the approved development plans. Plantings shall be done during periods suitable with respect to local weather conditions and established horticultural practice.

10.0 STREET LIGHTING

10.1 General

This document serves as a comprehensive guide for Design Engineers engaged in streetlighting systems within the Municipality. It delineates the criteria for selecting streetlighting design parameters, specifications, and installation procedures, inspection, and the application of best engineering principles and practices. These guidelines aim to ensure the development of optimal streetlighting systems tailored to specific applications. The recommendations are based on the established practices for Roadway Lighting as published by the Illuminating Engineering Society of North America (IESNA). All subdivisions shall be equipped with streetlights as mandated by this section. Lighting systems shall be designed in accordance with the "ANSI IES RP-8 – Lighting Roadway and Parking Facilities," as well as the Ontario Electrical Safety Code (Latest Edition), including amendments and by-laws.

10.1.1 Lighting Definitions

AVERAGE ILLUMINANCE	Average Illuminance, generally referred to as "E_{avg}" and measured in "Lux", is the arithmetical average of individual illuminance values calculated at predetermined points within an area, in accordance with the IES recommended practices.
ESA	The Electrical Safety Authority. The inspection authority for the Province of Ontario responsible for the issuance of electrical codes and inspections of all non-hydro authority owned electrical systems.
FOOTCANDLE	The English unit of illuminance; illuminance on a surface one square foot in area on which there is uniformly distributed a light flux of one lumen. One footcandle equals 10.76 lux.
GLARE	The sensation produced by the luminance within the visual field that is sufficiently greater than the luminance to which the eyes are adapted to cause annoyance, discomfort, or loss in visibility or visual performance.
IESNA	The Illuminating Engineering Society of North America. The recognized technical authority on lighting in North America.
ILLUMINANCE	The luminous flux (light) incident on unit area of a surface. It is

	measured in lux.
INITIAL LAMP LUMENS	Initial lumen output of a light source.
LUMEN	A unit of measure of the quantity of light. One lumen is the amount of light which falls on an area of one square foot every point of which is one foot from the source of one candela. A light source of one candela emits a total of 12.57 lumens.
LUMINAIRE	A complete unit consisting of a lamp or lamps together with the parts designed to distribute the light, to position and protect the lamps, to control the lamp operation to ANSI specifications, and to connect the lamps or the lighting source to the power supply.
LUMINANCE	Luminance of a roadway surface is the intensity of reflected light per unit area of the surface in the direction of the viewer. Luminance indicates the “brightness” of the roadway surface ahead of the observer when viewed from a given location in a given direction. Luminance at any location (point) on the roadway surface varies with the incident angles of light from various light sources on to the surface, the reflectance properties of the pavement and the viewing angle of the stationary observer at the point.
LUX	The SI unit of illuminance; defined as the amount of light on a surface of one square meter all points of which are one meter from a uniform source of one candela. One lux equals 0.0929 footcandle.
MAINTAINED AVERAGE ILLUMINANCE / LUMINANCE	Light output of a roadway lighting system deteriorates over time due to many factors. Though many of these factors are complex in nature to quantify, there are three major factors for HID Luminaires depreciation, lamp lumen output due to its age (referred to as Lamp Lumen Depreciation or “LLD”), accumulation of dirt inside the luminaire as well as on the outside of the optical lens (referred to as Luminaire Dirt Depreciation or “LDD”), and the degree to which the ballast operates the lamp relative to its design wattage (referred to as Ballast Factor or “BF”). The product of these three factors is referred to as Light Loss Factor or “LLF”. Also, the LED Luminaires is conditioned basically of two main factors, as the outside of the optical lens (referred to as Luminaire Dirt Depreciation or “LDD”), and lumen output depreciation for 100k hours (referred to as Lamp Lumen Depreciation or “LLD”

	or “LMF”)
SKY GLOW	The term used to describe the added sky brightness caused by the scattering of extraneous light reflecting from the dust particles in the atmosphere.
SPILL LIGHT or LIGHT TRESPASS	Spill light or Light Trespass can be defined as illumination of an area beyond the primary area (ROW) that the light source is intended to illuminate. Light spillage involves actual contribution of horizontal and vertical illuminance on to a private property.
UNIFORMITY	The variance between the average and minimum illuminance values or the average to minimum and maximum to minimum luminance values on a given section of roadway.
VEILING LUMINANCE	Also known as Disability Glare, it is the direct luminance superimposed on the retina by external light sources, which causes a “veil” of light and reduces contrast of an image. The veiling luminance is produced by roadway luminaires in the field of vision, headlights of an oncoming vehicle, advertising signs along the roadway and stray commercial/residential lighting adjacent to the roadway. The lighting design criteria calculation for the veiling luminance ratio (L_v) includes only the candlepower of the roadway luminaires being used in the lighting calculations and the average pavement luminance.

10.2 General Lighting Requirements

In general, street lighting shall consist of LED luminaires with poles positioned opposite the lot lines perpendicular to the street, where feasible. Poles may be either base-mounted or of the direct burial type. The developer’s engineer is required to provide detailed specifications of the proposed lighting system and materials, including engineering drawings of concrete bases and/or pole embedment. When direct burial poles are approved for use, the municipality may mandate concrete embedment to ensure secure installation. (Refer to OPSD latest issue).

Underground street lighting wiring shall be in buried duct.

The following are recommended general lighting requirements and are to be read in conjunction with the Typical Cross-Sections in **Appendix B** for road width and pole location.

10.3 Design Criteria

The lighting criteria are established based on various roadway classifications and levels of pedestrian activity. The minimum required lighting levels conform to the recommendations of the Illuminating Engineering Society (IES), which address the visual needs of drivers for different roadway classes. These visual requirements vary according to the roadway classification and pedestrian usage levels, necessitating higher lighting levels for higher roadway classifications and/or increased pedestrian activity, and lower lighting levels for lower roadway classifications and/or reduced pedestrian activity.

The following are the recommended standards. Pole spacing, mounting height, and other factors may vary depending on conditions such as staggered pole arrangements, intersections, crosswalks, turning lanes, and median mounting.

The following illumination criteria should also be utilized considered. The developer's engineer may be required to submit photometric data for the lighting system design in accordance with the best lighting practices outlined in the latest edition of RP-8 latest edition.

ANSI/IES RP-8 - Lighting Roadway and Parking Facilities

Lighting Design Criteria for Streets:

Roadway Type	Pedestrian Activity	Average Luminance (cd/m2)	Average Uniformity (Lavg/Lmin)	Maximum Uniformity (Lmax/Lmin)	Maximum Veiling (Lvmax/Lavg)
		(min)	(max)	(max)	(max)
Major	High	1.2	3.0	5.0	0.3
	Medium	0.9	3.0	5.0	0.3
	Low	0.6	3.5	6.0	0.3
Collector	High	0.8	3.0	5.0	0.4
	Medium	0.6	3.5	6.0	0.4
	Low	0.4	4.0	8.0	0.4
Local	High	0.6	6.0	10.0	0.4
	Medium	0.5	6.0	10.0	0.4
	Low	0.3	6.0	10.0	0.4

Issued by ANSI/IES RP-8-22

Lighting Design Criteria for Highways:

Roadway Classification	Average Luminance (cd/m^2)	Average Uniformity (Lavg/Lmin)	Maximum Uniformity (Lmax/Lmin)	Maximum Veiling (Lvmax/Lavg)
	(min)	(max)	(max)	(max)
Freeway Class A	0.6	3.5	6.0	0.3
Freeway Class B	0.4	3.0	6.0	0.3
Expressway	1.0	3.0	5.0	0.3

Issued by ANSI/IES RP-8-22

Pavement Illuminance Criteria for Full Intersection Lighting (lux/fc):

Functional Classification	Pedestrian Classification			Average Uniformity (Eavg/Emin) (max)
	High	Medium	Low	
Major/Major	34.0 / 3.4	26.0 / 2.6	18.0 / 1.8	3.0
Major/Collector	29.0 / 2.9	22.0 / 2.2	15.0 / 1.5	3.0
Major/Local	26.0 / 2.6	20.0 / 2.0	13.0 / 1.3	3.0
Collector / Collector	24.0 / 2.4	18.0 / 1.8	12.0 / 1.2	4.0
Collector / Local	21.0 / 2.1	16.0 / 1.6	10.0 / 1.0	4.0
Local/ Local	18.0 / 1.8	14.0 / 1.4	8.0 / 0.8	6.0

Issued by ANSI/IES RP-8-22

Pavement Illuminance Criteria for Partial (Isolated) Intersection Lighting (lux/fc):

Functional Classification	Pavement Classification			Average Uniformity (Eavg/Emin)
	R1 lux/fc	R2 & R3 lux/fc	R4 lux/fc	
Major	6 / 0.6	9 / 0.8	8 / 0.7	3.0
Collector	4 / 0.4	6 / 0.6	5 / 0.5	4.0
Local	3 / 0.3	4 / 0.4	4 / 0.4	6.0

Issued by ANSI/IES RP-8-22

Design Criteria for Walkways with Road Right of Way:

Condition	Average Iluminance Lux (fc)	Illuminanc e Vertical Lux (fc)	Illuminance avg/min
High Pedestrian Activity	10 (0.9)	5 (0.5)	5.0
Medium Pedestrian Activity	5 (0.5)	2 (0.2)	5.0
Low Pedestrian Activity	2 (0.2)	1 (0.1)	10.0

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10.4 Decorative Street Lighting

10.4.1 Decorative Lantern

- Decorative luminaires shall be LED for local residential streets. Luminaire housings and poles shall be finished black or nostalgia bronze. Mounting height shall be 5.5 m for local residential applications, with 7 PIN receptacle, and individually long-life photocell.

- LED Luminaires shall be Post Top mounted:
  - King Luminaire K601, LED Post Top
  - Signify (Lumec), LED Post Top
  - Or approved equivalent.

- Photometrics: Shall be equal to or exceed ANSI/IESNA RP-8, full cutoff, distribution type I, type II, type III, type IV or type V.

- Colour: Shall be Black or Nostalgia Bronze.

- Poles: Shall be spun concrete tapered and of sufficient size and structural capability to support the type of fixture as required and at the heights required.

Cross Section:	Tapered Round
Finish:	Smooth Concrete
Colour:	Natural Black

10.4.2 Decorative Pendent

Shall be of the LED Marina style type, distribution type I, type II or type III full cutoff, internally shielded with flat lens, with 7 PIN receptacle, and individually long-life photocell.

- LED Luminaires shall be Pendent mounted:
  - King Luminaire K206, LED

- Or approved equivalent.

Photometrics: Shall be equal to or exceed ANSI/IESNA RP-8, full cutoff, distribution type I, type II, type III, type IV.

Colour: Shall be Federal Green.

Bracket/Davit: Shall be 1.8 m (6') in length and shall be compatible in construction with both the luminaire and pole. Brackets shall be bolted directly to the pole (banding is prohibited). The colour of the bracket shall match the luminaire.

Poles: Shall be spun concrete tapered and of sufficient size and structural capability to support the type of fixture as required and at the heights required.

Cross Section:	Tapered Round
Finish:	Smooth Concrete
Colour:	Natural Black

All materials shall be of the best quality and shall be vandal resistant with polycarbonate lens or equivalent.

10.5 Conventional Lighting

10.5.1 Local Residential Street Lighting

For local residential street lighting where nostalgia type streetlights are not used, street lighting shall be conventional LED cobra-head style luminaires, with 7 PIN receptacle, and individually long-life photocell.

- LED Luminaires shall be as follows or approved equal:
  - Acuity Brands (AEL)
  - Signify (Lumec)
  - Cooper Lighting (VERD)
  - CREE (XSP)

- LED Roadway Lighting (NXT)

Photometrics: Shall be equal to or exceed ANSI/IESNA RP-8, full cutoff.

Colour: Shall be Grey.

Pole types shall allow 8 m mounting heights, shall be as follows or approved equal and shall satisfy OPSS/OPSD requirements. Shall be spun concrete tapered/galvanized steel or aluminum and of sufficient size and structural capability to support the type of fixture as required and at the heights required.

Bracket/Davit arm: Shall be tapered elliptical aluminum. Brackets shall be bolted directly to the pole (banding is prohibited). Bracket lengths shall be as required to position the luminaire with 0.6 m (2') + over the near edge of the travelled portion of the road.

10.5.2 Major, Collector, Commercial and Industrial Lighting

All street lighting other than local residential and decorative street lighting, shall be LED cobra-head style luminaries, with 7 PIN receptacle, and individually long-life photocell, mounted on tapered elliptical arms with 1.8 m (6') and 2.4 m (8') reach for major and collector streets.

- LED Luminaires shall be as follows or approved equal:
  - Acuity Brands (AEL)
  - Signify (Lumec)
  - Cooper Lighting (VERD)
  - CREE (XSP)
  - LED Roadway Lighting (NXT)

Photometrics: Shall be equal to or exceed ANSI/IESNA RP-8, full cutoff, Type I, Type II, Type III, or Type IV.

Colour: Shall be Grey.

Pole types shall allow 8 m, 10 m, 12 m mounting heights and shall be as follows or approved equal and satisfy OPSS/OPSD requirements. Shall be spun concrete tapered/galvanized steel or aluminum and of sufficient size and structural capability to support the type of fixture as required and at the heights required.

- Spun concrete (round cross-section with natural smooth concrete finish, direct buried):
  - StressCrete Group: Style 120
  - USI – Hampton Series.
  - Or approved equivalent.

- Aluminum (base mounted):
  - Aluminous Lighting Solutions
  - Or approved equivalent.

Bracket/Davit arm: Shall be tapered elliptical aluminum. Brackets shall be bolted directly to the pole (banding is prohibited). Bracket lengths shall be as required to position the luminaire with 0.6 m (2') + over the near edge of the travelled portion of the road. In no case shall the bracket exceed 10 ft.

10.5.3 Highway Lighting

For Highway luminaires shall be LED "Cobra Head" style, full cut off, with 7 PIN receptacle, individually long-life photocell controlled.

Photometrics: Shall equal or exceed ANSI/IESNA RP-8 Horizontal full cutoff, Type I, Type II, or Type III.

Colour: Shall be Grey.

Bracket/Davit arm: Shall be tapered elliptical aluminum. Brackets shall be bolted directly to the pole (banding is prohibited). Bracket lengths shall be as required to position the luminaire with 0.6 m (2') + over the near edge of the travelled portion of the road. In no case shall the bracket exceed 10 ft.

Poles: The poles shall allow luminaire mounting height of 10.5 m, and 12.9 m, being made of spun concrete or galvanized steel, tapered, and must meet OPSS/OPSD requirements. They should have adequate size and structural strength to support the specified type of fixture at the necessary heights.

Cross Section:	Tapered round
Finish:	Smooth concrete/galvanized steel
Colour:	Natural concrete grey

All materials shall be of the best quality and shall be vandal resistant with polycarbonate or glass lens or equivalent approved by the road's superintendent.

10.6 Photometric Design

The developer's engineer should provide photometric calculations based on accredited lighting software such as AGi32 or approved software and sufficiently show the results in PDF form and submit for approval.

10.7 Source Type

All light sources shall be LED – Light Emitting Diode, having a minimum life of 100,000 hours.

10.8 Pole Locations

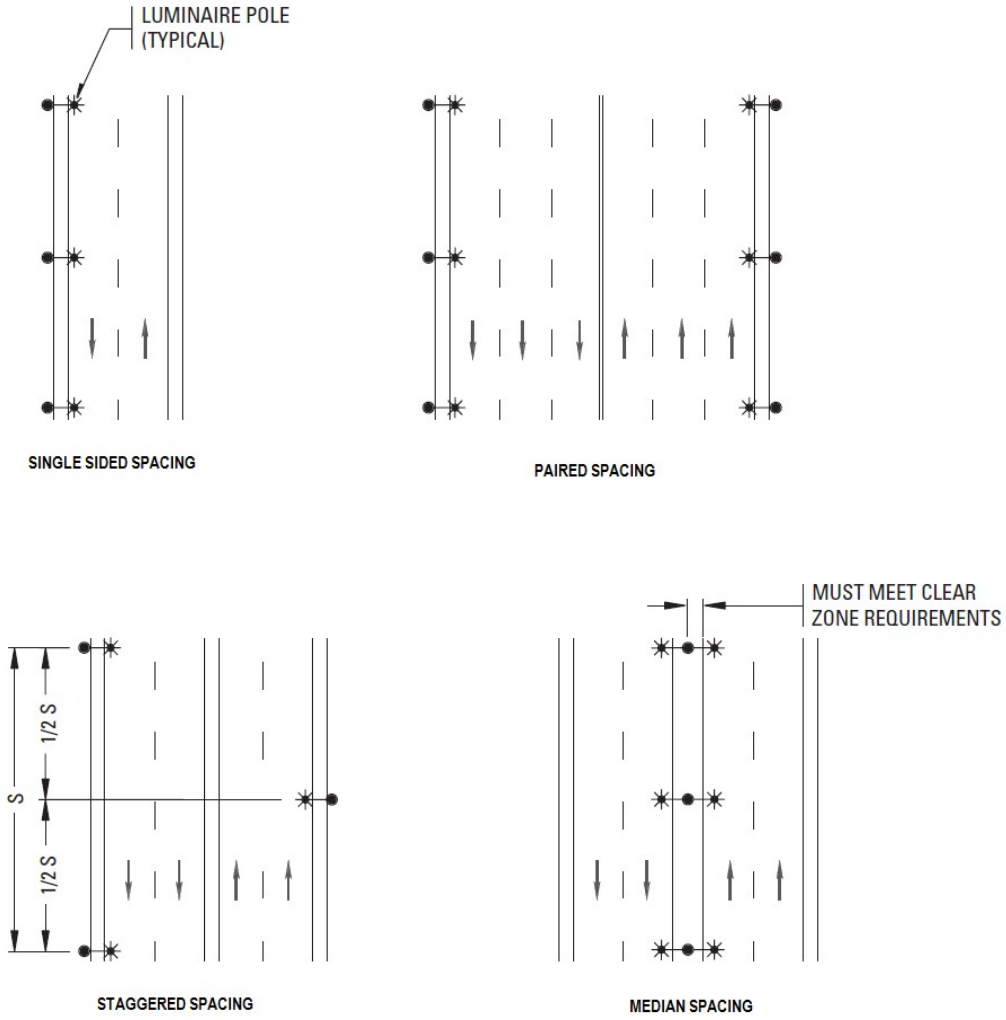
Both one sided and staggered pole arrangements will be permitted.

Poles shall be installed as per the Municipality standards.

There are several options acceptable to the Municipality if the streetlighting design complies with the standards for roadway, sidewalks, and intersection light level requirement. These optional arrangements are:

- Single Sided Spacing
- Staggered Spacing
- Paired Spacing
- Median Spacing

Median lighting is allowed when the median is of sufficient size to allow for the installation of a light standard while meeting the clear zone requirements and / or there are barriers in place.



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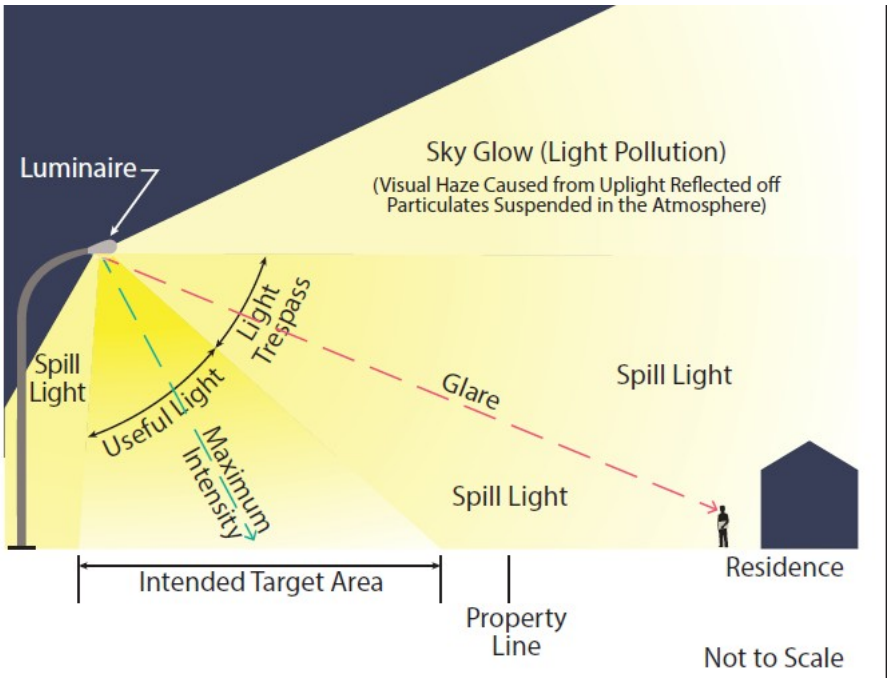
10.9 Obtrusive Lighting

Light trespass or backlighting occurs when an excessive amount of light is directed towards a residence. Homeowners are particularly sensitive to light intrusion from streetlights, which can lead to complaints of sleep disruption and other issues. While the approved luminaires generally control light towards residences effectively, there have been instances of excessive light trespass reported by homeowners. Mitigation measures may include selecting different luminaires, repositioning existing luminaires, or adding light shields to block the unwanted light.

Up-lighting refers to the excessive emission of light upwards from the luminaire, which can impact the visibility of the night sky. The International Dark-Sky Association (IDA) advocates for the use of cobra-head style luminaires with zero up light (i.e., Full Cut-off). Traditional Coach Light Style luminaires (without glass) must comply with the "U" limitations from the luminaire BUG rating as specified in the IES/IDA Model Lighting Ordinance (MLO).



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The Illuminating Engineering Society (IES) and the International Dark-Sky Association (IDA) have collaboratively defined maximum levels of spill light within specified areas of ambient brightness. These classifications, known as Lighting Zones (LZ), are increasingly recognized and utilized by professional organizations and incorporated into lighting ordinances. Detailed descriptions of Lighting Zones (LZ) can be found in the RP-8 guidelines.

- LZ0 - No Ambient Lighting: This zone is characterized by areas where natural darkness is preserved, and artificial lighting is either not present or is extremely minimal. Examples include wilderness areas, parks, and astronomical observatories. The goal in LZ0 is to minimize light pollution and maintain the natural night environment.
- LZ1 - Low Ambient Lighting: This zone includes rural and low-density residential

areas where limited artificial lighting is necessary. The lighting in LZ1 is designed to provide basic visibility and safety while minimizing light trespass and skyglow. Examples include rural roadways and residential neighborhoods with large lots.

- LZ2 - Moderate Ambient Lighting: This zone applies to urban residential areas, light commercial districts, and other areas with moderate levels of nighttime activity. The lighting in LZ2 aims to balance visibility, safety, and energy efficiency. Examples include suburban streets, small town centers, and low-traffic commercial areas.
- LZ3 - Moderately High Ambient Lighting: This zone is intended for urban areas with high levels of nighttime activity, such as commercial districts, industrial zones, and high-density residential areas. The lighting in LZ3 is designed to provide enhanced visibility and safety for both vehicular and pedestrian traffic. Examples include downtown areas, busy commercial streets, and large parking lots.
- LZ4 - High Ambient Lighting: This zone is reserved for areas with very high levels of nighttime activity and where high-intensity lighting is necessary. Examples include major city centers, entertainment districts, and areas with significant pedestrian traffic. The lighting in LZ4 is designed to ensure maximum visibility and safety, often incorporating advanced lighting technologies and controls.

Recommended Maximum Initial Vertical Illuminance Spill Light from Exterior Lighting, Based on Lighting Zone

Lighting Zone	Maximum Initial Vertical Illuminance, lux (fc)
LZ-0	0.5 (0.05)
LZ-1	1.0 (0.1)
LZ-2	3.0 (0.3)
LZ-3	8.0 (0.8)
LZ-4	15.0 (1.5)

IES RP-8-22

10.9.1 Calculating Spill Light

The ANSI/IES RP-8-22 is a standard developed by the American National Standards Institute (ANSI) and the Illuminating Engineering Society (IES) that provides guidelines for roadway lighting. It covers various aspects of roadway lighting design, including the calculation of spill light, which is the light that falls outside the intended area of illumination. To calculate spill light according to the ANSI/IES RP-8-22 standard, you would typically follow these steps:

- Determine the Lighting Layout: Identify the positions of the luminaires and the areas they are intended to illuminate. This includes the height, spacing, and aiming angles of the luminaires.
- Select the Appropriate Lighting Distribution: Choose the appropriate light distribution pattern for the luminaires based on the roadway classification and the surrounding environment.
- Calculate Initial Light Levels: Use photometric data provided by the luminaire manufacturer to calculate the initial light levels on the roadway and surrounding areas. This involves using the luminous intensity distribution of the luminaire.
- Assess Light Trespass: Evaluate the amount of light that spills over into adjacent areas, such as residential properties or natural habitats. This can be done using lighting design software that simulates the light distribution and calculates the illuminance levels at various points around the installation.
- Adjust Design if Necessary: If the calculated spill light levels exceed the recommended limits, adjust the lighting design. This could involve changing the luminaire type, adjusting the mounting height or aiming angle, adding shielding, or using lower wattages.
- Document the Design: Keep detailed records of the lighting design, including calculations, assumptions, and any adjustments made to meet the spill light requirements.

It's important to use appropriate lighting design software and tools to accurately model and calculate spill light.

The E_v measurements is accomplished by orienting the shielded meter’s receptor toward the source of the objectionable light from a height of 1.5 to 1.8 meters above grade and recording the illuminance reading in lux. By comparing the reading to the value for

applicable LZ, the designer is able to confirm whether a light trespass noncompliance issue may exist.

10.10 Wiring

All wiring in new streetlights system to be underground and the lighting completed prior.

- Streetlighting System Supply Cables from transformer to Power Supply Service shall be 3-1/C #2 AWG Copper RWU-90. [NOTE: Jacket colors shall be Black (Line), Red (Line), and White (Neutral)].
- Ground wire shall not be connected between transformer and pedestal disconnect.
- Streetlighting Cables from Power Supply Service to hand hole in pole shall be 3-1/C #6 AWG Copper RWU-90 complete with 1-1/C #6 stranded copper green jacketed ground wire [NOTE: Jacket colors shall be Black (Line), White (Neutral), and Green (Ground)].
- Streetlighting Cables from hand hole in pole to fixture (Bus Riser) shall be 2-1/C #12 AWG Copper RWU-90 complete with 1-1/C #12 AWG stranded copper green jacketed ground wire [NOTE: Jacket colors shall be Black (Line), White (Neutral), and Green (Ground)]

10.11 Power Supply Service Assembly

10.11.1 Power Supply Cabinet

The Contractor shall supply and install a Type 3M 120/240 V, 100 Amp, 1Ø, 3 wire, **supply control cabinet** complete with stainless steel enclosure.

Circuit breakers shall be installed as shown in the Contract and in accordance to the Operating Authority Standard Drawings. The Contractor shall install three, copper stranded RWU 90 conductors (Black, Red & White) from the hydro supply point to the load centre, leaving a sufficient length of cable coiled for connection to the hydro feed. Each conductor must be one continuous piece, with no splices. The contractor shall provide protection guards for all riser conduits on wood poles for a minimum height of 1.0 m.

10.11.2 Power Supply Pedestal

The Contractor shall supply and install a Type SL27 120/240 V, 100 Amp, 1Ø, 3 wire, and **supply control pedestal** complete with concrete base.

Circuit breakers shall be installed as shown in the Contract and in accordance to the Operating Authority Standard Drawings. The Contractor shall install three, copper stranded RWU 90 conductors (Black, Red & White) from the hydro supply point to the load centre, leaving a sufficient length of cable coiled for connection to the hydro feed. Each conductor must be one continuous piece, with no splices.

OR

- Cutler hammer cat # 1SL500PC in pole compact street lighting panel. 120 or 240 volt (CAT. No. as required)
- Cutler hammer cat # 1SL502 rain tight, lockable street lighting panel mounted on pole. 120 or 240 volts (CAT. No. as required)
- Or approved equivalent.

10.12 Inspection

Final installation shall be inspected by and subject to the Municipality and/or E.S.A. inspection/approved.

APPENDIX A

Appendix A – IDF Tables & Curves

Table A1: Total Precipitation Amounts (mm) for the City of Sarnia.

Duration, t (Minutes)	Return Period, T (Years)						
	1	2	5	10	25	50	100
5 min	9.25	10.60	14.51	17.21	20.43	22.77	25.10
10 min	13.41	15.39	21.08	24.98	29.67	33.06	36.38
15 min	16.03	18.37	25.15	29.78	35.37	39.40	43.32
30 min	20.65	23.55	32.11	37.94	45.03	50.14	55.07
1 h	25.43	28.77	38.97	45.90	54.41	60.55	66.46
2 h	30.50	34.16	45.88	53.85	63.73	70.87	77.76
6 h	39.63	43.60	57.63	67.23	79.33	88.12	96.66
12 h	46.40	50.43	65.96	76.63	90.25	100.18	109.88
24 h	54.19	58.17	75.26	87.08	102.35	113.53	124.53

Table A2: Precipitation Intensity Rates (mm/hour) for the City of Sarnia.

Duration, t (Minutes)	Return Period, T (Years)						
	1	2	5	10	25	50	100
5 min	110.96	127.25	174.07	206.50	245.16	273.30	301.16
10 min	80.45	92.32	126.46	149.89	178.02	198.37	218.27
15 min	64.11	73.48	100.59	119.12	141.47	157.60	173.26
30 min	41.29	47.09	64.22	75.88	90.06	100.27	110.13
1 h	25.43	28.77	38.97	45.90	54.41	60.55	66.46
2 h	15.25	17.08	22.94	26.93	31.87	35.44	38.88
6 h	6.61	7.27	9.61	11.20	13.22	14.69	16.11
12 h	3.87	4.20	5.50	6.39	7.52	8.35	9.16
24 h	2.26	2.42	3.14	3.63	4.26	4.73	5.19

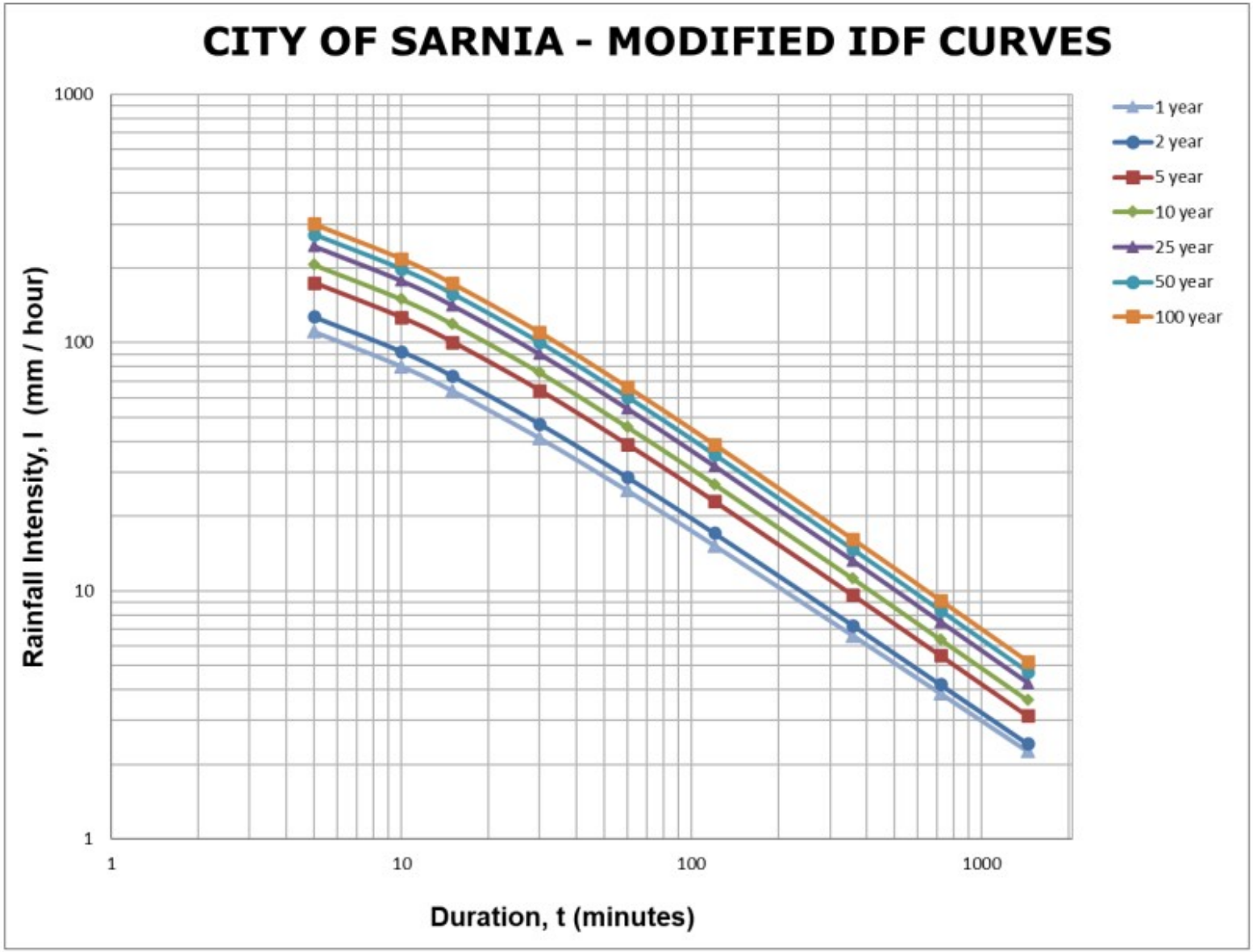

Figure A1: Sarnia IDF Curves –2024.

APPENDIX B

APPENDIX C

GENERAL CONSTRUCTION NOTES

All work shall be done in accordance with the minimum standards and specifications of the Municipality of North Middlesex.

The contractor shall notify the municipality at least 48 hours prior to commencing construction on the road allowance

All existing boulevards and road surfaces disturbed during construction shall be restored to a condition at least as good as original all to the satisfaction of the contract administrator.

Prior to commencement of any construction, ALL sewer outlet information, benchmarks, elevations, and dimensions must be checked and verified, and any discrepancies reported to the engineer.

Prior to commencing any work on the installation of services, an approved set of plans must be available on the site, and remain there while work is being done.

At least 48 hours prior to commencing construction on any existing road allowance maintained by the County of Middlesex, the contractor shall obtain the necessary permits from the County Engineer's Department, after discussion with the staff.

The utility locations shown on these contract drawings have been obtained from drawings and data believed to be accurate but cannot be guaranteed to be complete or correct. The contractor shall contact all applicable authorities for the exact locations prior to construction.

Prior to the commencement of construction, all existing underground utilities that will be affected by construction shall be located and marked. All utilities damaged or disturbed during construction shall be repaired or replaced to the satisfaction of the governing body at the contractor's expense. The contractor is to meet all the requirements of the owners of the utilities on this plan and must make satisfactory arrangements with the utility companies for crossing their installations and for providing adequate protection during construction.

All existing underground plant (hydro, telephone, gas mains, sewers) which will be crossed under during the installation of the services shall be supported by a support beam or by other methods, as may be required by the owners of the plant being crossed under.

Construction and detour signing: minimum construction and detour signs required shall be in accordance with manual of uniform “Traffic Control Devices” Book 7, and the latest revision of the MTO “Traffic control manual for roadway work operations”.

All excavation wholly or partly within proposed or existing roadways, shall be backfilled and compacted in accordance with Ontario Provincial Standard Specifications.

All bedding material shall be compacted to a minimum of 95% of the material’s Standard Proctor Maximum Dry Density (SPMDD). All watermains to have bedding and pipe cover of granular ‘B’ sand bedding a minimum depth of 300 mm over the top of the pipe unless otherwise noted.

All fill material placed within the right-of-way shall be placed in accordance with OPSS206. In areas to be filled, the subgrade shall be proof rolled to obtain 95% Standard Proctor Dry Density. Only acceptable earthen or granular materials shall be used within the road allowances.

Backfill shall be select native excavated material placed in thin layers compacted to at least 95% SPMDD.

Maintenance of flow: all existing surface and underground drainage systems must be maintained during construction.

Existing trees are not to be removed unless approved by the applicable authority having jurisdiction.

All concrete shall be 25 MPa in 28 days unless otherwise stated.

Restrained joints: restrained pipe joints are required at all fittings, valves and deflections exceeding allowable limits. Submit design calculations and restraint details to the engineer prior to construction in accordance with the contract documents.

The contractor shall take all necessary precautions under The Occupational Health and Safety Act while working in the vicinity of the overhead power lines.

EROSION CONTROL NOTES

All erosion control measures to be in place before starting construction and remain in place until restoration complete.

Maintain erosion control measures during construction.

Minimize area disturbed during construction.

The contractor shall construct temporary measures to control silt entering the storm drainage system, all to the specifications of the municipality's engineer.

Protect all exposed surfaces, and control all run-off during construction.

Keep all ditches and sumps clean during construction.

Protect all catch basins, manholes, and pipe ends from sediment intrusion.

Prevent wind-blown dust.

Straw bales to be used in localized areas as shown or as directed by the municipality during construction.

All collected sediment to be disposed of at an approved location.

All dewatering to be disposed of in an approved sedimentation basin.

Provide a granular matt to prevent cohesive soil tracking at all entrances to existing roads.

Sediment control measures to conform to "Guidelines for Urban Construction Sites, Ontario", May 1987.

SHOP DRAWING SUBMISSION PROCEDURE

General

1. When required in a development, during the construction phase, the following specifies general requirements and procedures for developers' submissions of shop drawings, product data and samples to the municipality's engineer for review. Additional specific requirements for the submissions will be assessed on a project by project basis.
2. Do not proceed with work until relevant submissions are reviewed by developer's engineer.
3. Present shop drawings, product data and samples in SI metric units.
4. Where items or information is not produced in SI metric units converted values are acceptable.
5. Developer's responsibility for errors and omissions in submission is not relieved by municipality's engineer's review of submissions.
6. Notify municipality's engineer, in writing at time of submission, identifying deviations from requirements of contract documents stating reasons for deviations.
7. Developer's responsibility for deviations in submission from requirements of contract documents is not relieved by contract administrator's review of submission, unless contract administrator gives written acceptance of specific deviations.
8. Make any changes in submissions which municipality's engineer may require consistent with contract documents and resubmit as directed by municipality's engineer.
9. Notify municipality's engineer, in writing, when re-submitting, of any revisions other than those requested by contract administrator.

Submission Requirements

1. Coordinate each submission with requirements of work and contract documents. Individual submissions will not be reviewed until all related information is available. Review all documents before submission to the municipality's engineer. Submissions must to complete for each system. Partial systems will not be reviewed.
2. Submissions shall include:
    a. Date and revision dates
    b. Project title and number.
3. Name and address of:
    a. Subcontractor
    b. Supplier
    c. Manufacturer.
4. Contractor's stamp, signed by contractor's authorized representative certifying approval of submissions, verification of field measurements and compliance with contract documents.
5. Details of appropriate portions of work as applicable:
    a. Fabrication
    b. Layout, showing dimensions, including identified field dimensions and clearances
    c. Setting or erection details
    d. Capacities
    e. Performance characteristics
    f. Standards

g. Operating weight
h. Wiring diagrams
i. Single line and schematic diagrams
j. Relationship to section number and applicable standards
k. Calculations and reports where specifically noted
l. Completed equipment data sheets as noted in the contract specifications.

6. After municipality's engineer's review, distribute copies.

Shop Drawings/Construction Procedures

1. Shop drawings/construction procedures: original drawings, or modified standard drawings provided by developer, to illustrate details of portions of work, which are specific to project requirements.
2. Maximum sheet sixe: ANSI D (22"x34").
3. Submit two copies of shop drawings/construction procedures and one reproducible original for review by the contract administrator.
   a. Two copies to be reviewed and retained by the contract administrator
   b. One reproducible original to be reviewed and returned to developer
   c. Developer to reproduce and distribute drawings to suppliers and subcontractors
   d. All subcontractor's and manufacturers' drawings shall first be sent directly to the developer, who shall keep a record of the drawings numbers and dates of receipt. The developer shall check thoroughly all such drawings, all other details, to assure himself that they conform to the intent of the developer's engineers drawings and the specifications, and shall promptly return to the subcontractors and/or manufacturers, for correction, such of the drawings as are found inaccurate or otherwise in error. After the developer has checked and approved such drawings, he shall place thereon the date of such approval and the legible signature of the checker and shall then submit them to the developer's engineer for review. The developer's engineer reserves the right to refuse to check or review drawings of a subcontractor or manufacturer which are not submitted in compliance with the foregoing requirements.
   e. Shop drawings/construction procedures shall be complete in all respects and shall show clear compliance with the specifications. Where applicable, performance figures of equipment, finishes and reference to other relevant drawings must be noted on the shop drawings. Details of ancillary items being supplied with the particular equipment must be submitted. Piecemeal submissions will not be considered. Wiring and elementary control diagrams shall be submitted for electrical equipment. Descriptive brochures where applicable shall be included for information. Any notation on the draft drawings which is on the prints and not on the original from which the prints were made shall be in green ink.

Product Data

1. Product data: manufacturers' catalogue sheets, brochures, literature, performance charts and diagrams, used to illustrate standard manufactures products, may be accepted in lieu of shop drawings.
2. Above will only be accepted if they conform to the following:
   a. Delete information which is not applicable to the project

b. Supplement standard information to provide additional information to project
c. Show dimensions and clearances required
d. Show performance characteristics and capacities
e. Show wiring diagrams, when requested, and controls.

Samples

1. Submit for review, samples in duplicate as requested in respective specification sections. Label samples as to origin and intended use in the work.
2. Samples: examples of materials, equipment, quality, finishes, workmanship.
3. Where colour, pattern or texture is criterion, submit full range of samples.
4. Reviewed and accepted samples will become standard of workmanship and material against which installed work will be verified.
5. Notify the municipality's engineer in writing at the time of submission of deviations in samples from the requirements of contract documents.