
	WSTP Civil Design Guideline	Revision: 002	Page 1 of 38
		Document Code:	




The City of Winnipeg
Winnipeg Sewage Treatment Program

Civil Design Guideline


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Approved By:	 <hr/> Colin Javra, Project Director, WSTP	<hr/> January 12, 2023 Date
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	WSTP Civil Design Guideline	Revision: 002	Page 2 of 38
		Document Code:	

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 Winnipeg	WSTP Civil Design Guideline	Revision: 002	Page 4 of 38
		Document Code:	

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Table of Contents

1	Introduction	7
1.1	Scope of the Standard	7
1.2	Application	7
1.3	Deviations from Standard	7
1.4	Acronyms and Abbreviations	8
2	General.....	9
2.1	Design Codes and Standards	9
2.2	Other City Standards	9
2.3	Units.....	10
2.4	Site Co-ordinates	10
3	General Site Development Requirements	11
3.1	Overall Site Layout	11
3.2	Flood Protection	11
3.3	Buried Services	11
3.4	Sanitary Sewers	11
3.5	Fencing.....	12
3.6	Railway Crossing.....	12
3.7	Landscaping	12
3.8	Spill Contaminant	13
4	Water Main Design Criteria.....	15
4.1	General Requirements	15
4.2	Hydraulic Design	15
4.2.1	Non-Residential Water Demand.....	15
4.2.2	Fire Flow Analysis	15
4.2.3	Hydraulic Model Analysis	15
4.3	Design and Installation Requirements.....	16
4.3.1	Depth of Cover	16
4.3.2	Pipe Structural Design.....	16
4.3.3	Fire Hydrants	16
4.3.4	Valves	16
4.3.5	Water Services	17
4.3.6	Materials	17
4.3.7	Separation Distances between Water and Sewer Mains.....	17
4.3.8	Connections to Buildings.....	17
4.3.9	Dissimilar Materials and Corrosion Protection	17
4.3.10	Thrust Restraint.....	17
4.3.11	Installation of Water Mains	18
4.3.12	Abandonment of Existing Water Mains	18
5	Wastewater Sewer Main Design Criteria	19
5.1	General Requirements	19
5.2	Hydraulic Design	19
5.3	Design and Installation Requirements.....	19
5.3.1	Depth of Cover	19
5.3.2	Major Yard Pipe Structural Design	19
5.3.3	Dissimilar Materials and Corrosion Protection	20

5.3.4	Manholes	20
5.3.5	Valves - Forcemain.....	20
5.3.6	Connections to Buildings - Forcemain.....	20
5.3.7	Thrust Restraint – Forcemains	20
5.3.8	Wastewater Sewer Size	21
5.3.9	Materials	21
5.3.10	Installation of Wastewater Mains.....	21
5.3.11	Deflection Testing of Flexible Sewers	21
5.3.12	Abandonment of Existing Waste Water Mains	21
5.3.13	CCTV Inspection	21
6	Road Design Criteria.....	22
6.1	General Requirements	22
6.2	General Road Design	22
6.2.1	Road Type and Design Life	22
6.2.2	Pavement Structure	23
6.2.3	General Roadway Grading Requirements	24
6.2.4	Roadway Signage Requirements.....	25
6.2.5	Roadway Clearance Requirements.....	25
6.2.6	Sidewalks	25
6.2.7	Parking Lots.....	25
6.2.8	Road Removals/Restorations.....	26
7	Site Drainage Criteria.....	29
7.1	General Requirements	29
7.2	Design Criteria.....	29
7.3	Site Design	30
7.4	Ditches.....	31
7.5	Culverts.....	31
7.6	Land Drainage Sewer.....	31
7.7	Manholes and Catch Basins.....	31
7.8	Retention and Detention Storage	32
7.9	Oil and Sediment Interceptors	32
8	Civil Design Team Responsibilities	33
8.1	General	33
8.2	Drawings.....	34
8.2.1	General Requirements	34
8.2.2	Legend.....	34
8.2.3	General Notes Drawing	34
8.2.4	Existing Site Plan.....	34
8.2.5	Site Plan	35
8.2.6	Site Servicing Plan	36
8.2.7	Lot Grading Plan.....	36
8.2.8	Plan and Profile Drawings	37
8.3	Other Documents	37
8.3.1	Traffic Management Plan	37
8.4	Design Calculations.....	38
8.5	Civil Servicing Report	38

	WSTP Civil Design Guideline	Revision: 002	Page 7 of 38
		Document Code:	

1 INTRODUCTION

This document identifies the standard design requirements that are applicable to any civil work within the City of Winnipeg wastewater treatment facilities.

1.1 Scope of the Standard

These design requirements will apply to the following facilities:

- Wastewater treatment plants

1.2 Application

The scope and intent of this document is to convey general design guidance and expectations regarding civil infrastructure systems. This document does address specifics related to design type, selection, and configuration; however the indicated requirements are presented without knowledge of the specific site civil infrastructure implementation. It is not within the scope of this document to provide detailed design direction, and it will be the responsibility of the respective civil designers to fully develop the civil details with general conformance to the concepts presented herein. This standard shall not be construed as comprehensive engineering design requirements or negate the requirement for professional engineering involvement. Any design must be executed under the responsibility and seal of the respective engineer in each instance, and must be performed in conformance with all applicable codes and standards, as well as good engineering practice.

Existing facilities do not necessarily comply with this standard. The expectations regarding application of this standard to maintenance and minor upgrades at existing facilities must be assessed on a case-by-case basis; however general guidelines for application are presented as follows:

- All new buildings and sites are expected to comply with this standard.
- All major upgrades to a building or site are expected to comply with this standard; however, in some cases, compromise with the configuration of the existing facility design may be required.
- All minor upgrades should utilize this standard as far as practical for new work; however, in some cases, compromise with the configuration of the existing facility design may be required.

1.3 Deviations from Standard


It is expected that there will be occasional situations where the design engineer will propose a deviation from this design guideline. The rationale for potential deviations from the design guideline may include:

- Evolution of technology,
- Updates to standards and regulations,
- Practical limitations due to existing on-site conditions, or
- Significant cost benefits to the City due to specific project constraints.

For each proposed deviation from this standard, fully complete a *WSTP Standards Deviation Form* and submit to the City project manager for approval. Do not proceed with the proposed deviation unless approval is received from the City project manager.

1.4 Acronyms and Abbreviations

AASHTO	American Association of State Highway and Transportation Officials
ANSI	American National Standard Institute
ASTM	American Society for Testing Materials
AWWA	American Water Works Association
CSA	Canadian Standards Association
NBC	National Building Code
TAC	Transportation Association of Canada
WSTP	Winnipeg Sewage Treatment Program

	WSTP Civil Design Guideline	Revision: 002	Page 9 of 38
		Document Code:	

2 GENERAL

2.1 Design Codes and Standards


The requirements of the latest issue of the following codes, standards and regulations shall apply to civil design:

- National Building Code of Canada with Manitoba Amendments (NBC);
- Geometric Design for Canadian Roads, Transportation Association of Canada (TAC);
- AASHTO Guide for Design of Pavement Structures;
- Manual of Uniform Traffic Control Devices for Canada (MUTCDC);
- Water Supply for Public Fire Protection, Fire Underwriters Survey;
- Canadian Standards Association (CSA);
- American National Standard Institute (ANSI);
- American Water Works Association (AWWA);
- National Fire Protection Association (NFPA);
- Transport Canada's Grade Crossing Standards (TC-E10); and
- Pipe and Wire Crossing CPR Right of Way Approval Guide.

2.2 Other City Standards

While not exclusive, ensure that the following City Standards are adhered to:

- Water Demand Estimation and Design Guidelines;
- Wastewater Flow Estimation and Servicing Guidelines;
- Storm Water Management Criteria;
- City of Winnipeg Transportation Standards Manual;
- 2010 City of Winnipeg Accessibility Design Standard;
- City of Winnipeg Standard Construction Specifications;
- City of Winnipeg Listings of Approved Products ;
- Water and Waste Department Identification Standard;
- Drainage Criteria Manual for the City of Winnipeg;
- Culvert and Drainage Inlet/Outlet Safety Guidelines;
- City of Winnipeg Water and Waste Department WWD CAD/GIS Standards (August 2016); and
- Manual for the production of Construction Drawings for the City of Winnipeg, Works and Operations Division (November 1984).

	WSTP Civil Design Guideline	Revision: 002	Page 10 of 38
		Document Code:	

2.3 Units

All drawings and documentation shall use the International System of Units (SI units). Imperial units will be provided in parenthesis after the metric unit, where requested or appropriate. Specific requirements are as follows:

1. All building dimensions are to be in millimeters; and
2. All elevations are to be in meters, in the format EL. ###.### (example EL. 273.520).

2.4 Site Co-ordinates

All site co-ordinates shall be provided in Universal Transverse Mercator (UTM) Zone 14 North mapping projection. North American Datum 1983 (NAD 83) co-ordinates using Province of Manitoba 1990 realization, consistent with City of Winnipeg co-ordinates

Vertical datum shall be as per metres above sea level (MSL) (example EL.273.500), and co-ordinated with on-site monumentation.

Co-ordinates shall be site calibrated to on-site monumentation, where provided. Site specific Combined Scale Factor shall be provided.

	WSTP Civil Design Guideline	Revision: 002	Page 11 of 38
		Document Code:	

3 GENERAL SITE DEVELOPMENT REQUIREMENTS

3.1 Overall Site Layout

1. Provide an overall site layout design considering all civil and building works, as well as requirements of other disciplines.
 - 1.1 Include all inter-building electrical and control services.
 - 1.2 Include all inter-building mechanical services.
2. Coordinate site layout requirements to include both current and future site development requirements.
3. Coordinate the site arrangement to minimize fill and/or excavation costs while maintaining efficiency of project construction, operation, and maintenance.
4. Ensure oil and chemical storage areas are designed to contain spills.

3.2 Flood Protection

1. Unless otherwise indicated by the City, design flood protection systems to protect all facilities as follows:
 - 1.1 The NEWPCC shall be designed based on 700-year flood protection level of 229.83 m.
 - 1.2 The SEWPCC shall be designed based on 1997 FPL + 0.61m flood protection level (1997 water level + 0.61m + 0.61m) of 232.56 m.
 - 1.3 The WWPCC shall be designed based on 700-year flood protection level of 234.1 m.


Note: The process hydraulic requirements with respect to flood levels may be different.

3.3 Buried Services

1. Ensure that all buried infrastructure is accurately updated in the City's GIS based upon the completed installation.
2. All non-conductive underground piping shall be provided with durable electrical trace wires such that they can be easily traced in the future.

3.4 Sanitary Sewers

1. Design sanitary sewers and drains for the entire facility.
2. Ensure that sanitary sewers are drained into or upstream of the headworks facility.

	WSTP Civil Design Guideline	Revision: 002	Page 12 of 38
		Document Code:	

3.5 Fencing


1. Design a permanent perimeter fence around the entire facility.
2. Except where architectural fencing is required to be architectural, permanent perimeter fencing shall be chain link fencing, in accordance with CW 3550-R3.
 - 2.1 Fencing shall have a height of 3 m (10 feet) plus top guard.
 - 2.2 Fencing shall have a top guard consisting of 600mm tall outrigger at 45 degree angle, facing outward with 3 strands of 13.5 gauge barbed wire.
3. Gates:
 - 3.1 Provide gates on all access roads.
 - 3.2 Gates must provide an opening to the full width of the access road.
 - 3.3 Gates must be able to be secured (locked) in either an open or closed position.
 - 3.4 Gates which are expected to be open and closed more than twenty times per week shall be electric actuated. Include controls including pushbuttons, RFID, or wireless controls as appropriate for the application.
4. Design temporary fencing for construction areas.

3.6 Railway Crossing

1. Proposed utility crossings under Canadian Pacific Railway's (CPR) track and parallelisms within CPR's right of way will require a formal application submission complete with 11x17 drawing containing all information as outlined in CPR's "*Pipe and Wire Crossing CPR Right of Way Approval Guide*".
2. Proposed utility crossings under Canadian National Railway's (CNR) track and parallelisms within CNR's right of way will require a formal application submission as outlined in CNR's "A Guide to the Pipe and Wire Process".
3. Proposed road crossings over Canadian Pacific / National Railway's track will be subject to a crossing safety review by CPR as per the most recent version of Transport Canada's Grade Crossing Standards.


3.7 Landscaping

1. Design landscaping for all new and modified areas of the facility.
2. Provide low maintenance landscaping. Where shrubs are provided, they shall be drought-resistant.
3. Include aesthetic landscaping in publically accessible areas of the facility (i.e. next to Administration Building).
4. Removal of trees and shrubs shall be according to the City of Winnipeg Standard Construction Specifications CW 3010 "Clearing and Grubbing".
5. When designing sodding it shall be in accordance with City of Winnipeg Standard Construction Specifications CW 3510 "Sodding".
- 6.

	WSTP Civil Design Guideline	Revision: 002	Page 13 of 38
		Document Code:	

3.8 Spill Contaminant

1. Design must include grading of pavement to provide containment in the in areas where chemical is being delivered in a liquid state. Appropriate valves must also be included on the land drainage system to isolate land drainage piping during chemical delivery.
2. Provide containment around chemical storage tanks, sized as per codes, or 110% of the largest tank, whichever is greater.
3. Provide containment around chemical delivery areas, sized as per codes, or 110% of the largest delivery vehicle, whichever is greater.

 Winnipeg	WSTP Civil Design Guideline	Revision: 002	Page 14 of 38
		Document Code:	

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	WSTP Civil Design Guideline	Revision: 002	Page 15 of 38
		Document Code:	

4 WATER MAIN DESIGN CRITERIA

4.1 General Requirements

1. These requirements apply to potable water mains from the municipal water supply.
2. Provide new water mains to service new structures (where service is required). Ensure water service to modified structures is suitable for the required service in those structures.
3. Provide location and size of water meters external to building as required.
4. Water mains shall be designed according to the City of Winnipeg "Water Demand and Design Guidelines"
5. Geo-coordinates for all hydrant and valve locations shall be submitted as part of the As-Built / Record Drawings.
6. The water distribution system should be designed to provide full redundancy for critical buildings and facilities.
7. Where possible, provide ring or loop water distribution to ensure continuity of service in the event of a break or maintenance.

4.2 Hydraulic Design

4.2.1 Non-Residential Water Demand

1. Where actual water demand is unknown, use 22,500 L/ha/day for light industrial development and 33,600 L/ha/day for wet industrial development.
2. For design purposes, where specific land uses are known, water demand can be derived from literature values i.e. AWWA Water Distribution System Handbook; references must be included with design assumptions.

4.2.2 Fire Flow Analysis

1. The required minimum required fire flow will be either as determined based NFPA 1142.
2. The fire flow shall be provided at minimum residual pressure of 140 kPa (20 psi) during maximum day demand.

4.2.3 Hydraulic Model Analysis

1. Contact the City of Winnipeg Water and Waste department for pressure and flow curves at requested feed points to facilitate hydraulic modeling analysis.
2. Utilize the following factors for analysis:
 - Hazen-Williams C-value = 120 for water main diameter \leq 200mm;
 - Hazen-Williams C-value = 130 for water main diameter $>$ 200mm;
 - Minimum water main pressure during peak hour demand = 207 kPa; and
 - Minimum feeder main pressure during peak hour demand = 310 kPa.

4.3 Design and Installation Requirements

4.3.1 Depth of Cover

1. Minimum ground cover for water mains shall be 2.5 m.
2. Where it is not possible to achieve 2.5 m of cover, water main and water service shall be insulated according to the City of Winnipeg standard detail SD-018 "Watermain and Water Service Insulation".

4.3.2 Pipe Structural Design

1. All water main piping shall be designed for the following pressures:
 - 1.1 minimum working pressure 700 KPa;
 - 1.2 minimum transient allowance of 40%; and
 - 1.3 minimum test pressure of 1,000 KPa, or as approved by City for systems over 600 mm in diameter.
2. All piping shall be designed for:
 - 2.1 Earth dead loads and surcharge loads;
 - 2.2 Live Loads minimum CSA CL-625 Design Vehicle;
 - 2.3 Construction loads should be considered where appropriate; and
 - 2.4 Combination pressure, live and dead loads as required by the appropriate AWWA and or/CSA Standard.
3. Pipes shall be selected according to CSA, ANSI, ASTM or AWWA standards for the relevant materials.

4.3.3 Fire Hydrants

1. Hydrants shall be AWWA Standard C502 Dry-Barrel Fire Hydrants.
2. Linear spacing of hydrants along streets shall not be greater than 90 m. The maximum spacing of hydrants shall be such that a circle of protection is not more than a 75 m radius.
3. Hydrants shall be installed at water mains dead ends.
4. Hydrants to install standard thread. In Manitoba, the standard thread is 2.5 inch Canadian Thread.

Code	Region	Description	Outer Diameter	Pitch
WCT	Saskatchewan & Manitoba	Western Canada Fire Underwriters Association	3.250"	6

4.3.4 Valves

1. Maximum distance between valves shall be 150 m.
2. Minimum two valves shall be installed at each water main tee.

	WSTP Civil Design Guideline	Revision: 002	Page 17 of 38
		Document Code:	

3. Minimum three valves shall be installed at each water main crossing.

4.3.5 Water Services

1. Minimum size of fire service shall be 150 mm and installed in accordance with City of Winnipeg Standard Construction Specifications CW 2110 "Watermains".
2. .
3. Sizes of domestic water service pipes shall be determined based on the fixture or appliance numbers. And minimum size of domestic water service is 25 mm.
4. Valves for fire and fire-domestic services shall be installed 1 m from the City water main.

4.3.6 Materials

1. Materials for pipes, joints and fittings shall be in accordance with "Approved Products for Underground Use within the City of Winnipeg" where specified.
2. Bedding and backfill materials shall be according to the City of Winnipeg Standard Construction Specification CW 2030 "Excavation Bedding and Backfill" as a minimum, or as required by structural pipe design.

4.3.7 Separation Distances between Water and Sewer Mains

1. Parallel Installation:
 - 1.1 Minimum horizontal distance between water main pipe and any gravity sewer pipe shall be 3.0 m.
2. Crossings:
 - 2.1 Minimum vertical distance between the outside of water main pipe and outside of any gravity sewer pipe shall be 450 mm.

4.3.8 Connections to Buildings


1. Piping connections to buildings and rigid structures shall be designed to prevent shear and settlement using appropriate means including but not limited to:
 - 1.1 flexible ball joints,
 - 1.2 grade beams, and
 - 1.3 non-shrink foundation materials.

4.3.9 Dissimilar Materials and Corrosion Protection

1. All dissimilar metallic components shall be provided with non-metallic electrical isolation components.
2. Galvanic anodes shall be provided where required by City construction specifications.
3. Corrosion systems shall be designed for soil electrical resistivity of 150 ohm-cm.

4.3.10 Thrust Restraint

1. Thrust Restraint for mains less than 600 mm in diameter shall be as per City of Winnipeg Specification CW 2110.

	WSTP Civil Design Guideline	Revision: 002	Page 18 of 38
		Document Code:	

2. Thrust Restraint for mains greater than 600 mm in diameter shall be designed for appropriate thrust forces and allowable soil bearing pressures as recommended by a Geotechnical Engineer.
3. Where suitable soils for reaction blocking are not available or have potential to be disturbed, provide thrust restraint by means of joint restraint devices. Provide design criteria and minimum restraint lengths on construction drawings. Permanent metallic restraint devices shall be protected from corrosion.

4.3.11 Installation of Water Mains

1. The following items shall be specified in accordance with the City of Winnipeg Standard Construction Specifications:
 - bedding and backfill,
 - pressure/leak testing, and
 - disinfection.

4.3.12 Abandonment of Existing Water Mains

1. Abandonment of existing water mains shall be according to the COW Specification CW 2110 "Water mains" within the limits shown on the drawings.
2. Sections of abandoned water mains within excavation limits (including existing water mains and previously abandoned water mains) shall be removed.
3. The ends of remaining water main sections shall be plugged and abandoned according to CW 2110.

	WSTP Civil Design Guideline	Revision: 002	Page 19 of 38
		Document Code:	

5 WASTEWATER SEWER MAIN DESIGN CRITERIA

5.1 General Requirements

1. These requirements apply to collection, interceptor, forcemain and transmission wastewater mains.
2. Provide new sewer mains to service new structures (where service is required). Ensure sewer service to modified structures is suitable for the required service in those structures.
3. Collection wastewater mains shall be designed according to the City of Winnipeg "Wastewater flow estimation and servicing guidelines".
4. Geo-coordinates for all manhole, junction and connection locations shall be submitted as part of the as-built/record drawings.

5.2 Hydraulic Design

1. Gravity wastewater mains shall be designed to attain minimum flushing velocity of 0.6 m/s under full flow conditions using a roughness co-efficient (n) of 0.013.
2. Wastewater design flow rate shall include peak domestic inflows, extraneous inflow and infiltration, processing wastewater flows, and wash down flows.

5.3 Design and Installation Requirements

5.3.1 Depth of Cover

1. The minimum invert depth at the high end of a wastewater pipe shall be 2.6 m below finished street centre line grade.

5.3.2 Major Yard Pipe Structural Design

1. Flexible pipe design shall consider prism load for earth load.
2. Rigid pipe design shall consider construction constraints, adjacent and parallel pipelines and structures. Where trench widths cannot be assured, consider use of embankment loading, as described in ASCE 15 Standard Practice for Direct Design of Buried Precast Pipe Using Standard Installation (SIDD) Type 3 installation and minimum vertical arching factor of 1.40.
3. For reinforced concrete pipe in deep fills, consider use of Direct Design as per latest version of ASCE 15 Standard Practice for Direct Design of Buried Precast Pipe Using Standard Installation (SIDD).
4. Minimum excavation widths to ensure proper embedment compaction and safety shall be selected.
5. As a minimum live loads shall be based on CSA CL625 design vehicle. Construction loads shall also be considered where appropriate, including potential crane staging, earth moving and other temporary and transient loads that may be present.
6. Forcemains shall consider cyclical pressure loading as per appropriate AWWA standard.
7. Pipes shall be selected according to CSA, ANSI, ASTM or AWWA standards for the relevant materials.

	WSTP Civil Design Guideline	Revision: 002	Page 20 of 38
		Document Code:	

8. All force main and pressure piping shall be designed for the following pressures:
 - 8.1 Maximum working pressure as required by force main design;
 - 8.2 Minimum transient allowance of 40% of maximum working pressure; and
 - 8.3 Minimum test pressure of 1.25 times the maximum design operating pressure or as approved by City.

5.3.3 Dissimilar Materials and Corrosion Protection

1. Gravity wastewater sewer pipe material selection and design shall consider:
 - 1.1 Hydrogen sulfide gas corrosion;
 - 1.1.1 When utilizing concrete pipe in area with high hydrogen sulfide level, evaluate the use of HDPE or PVC liner and provide recommendation accordingly; and
 - 1.2 CSA S1 soil sulphate exposure.
2. Forcemain pipe material selection and design shall consider:
 - 2.1 All dissimilar metallic components shall be provided with non-metallic electrical isolation components;
 - 2.2 Galvanic anodes shall be provided where required by City construction specifications; and
 - 2.3 Corrosion systems for metallic mains and components shall be designed for soil electrical resistivity of 150 ohm-cm.

5.3.4 Manholes

1. For collection systems, manholes shall be spaced a maximum of 120 m apart.
2. For interceptor sewers, manholes shall be spaced a maximum of 200 m, or as otherwise approved.

5.3.5 Valves - Forcemain

1. Maximum distance between valves shall consider operational and maintenance requirements. Mains with multiple flow paths should consider isolation for operation and maintenance.

5.3.6 Connections to Buildings - Forcemain

1. Forcemain piping connections to buildings and rigid structures shall be designed to prevent shear and settlement using appropriate means including but not limited to;
 - 1.1 Flexible ball joints,
 - 1.2 Grade beams, and
 - 1.3 Non-shrink foundation materials.

5.3.7 Thrust Restraint – Forcemains

1. Thrust Restraint for mains less than 600 mm in diameter shall be as per City of Winnipeg Specification CW 2110.
2. Thrust Restraint for mains greater than 600 mm in diameter shall be designed for appropriate thrust forces and allowable soil bearing pressures as recommended by a Geotechnical Engineer.

	WSTP Civil Design Guideline	Revision: 002	Page 21 of 38
		Document Code:	

3. Where suitable soils for reaction blocking are not available or have potential to be disturbed, provide thrust restraint by means of joint restraint devices. Provide design criteria and minimum restraint lengths on construction drawings. Permanent metallic restraint devices shall be protected from corrosion.

5.3.8 Wastewater Sewer Size

1. Minimum size of service shall be 150 mm and installed in accordance with City of Winnipeg Standard Construction Specifications CW 2130 "Gravity Sewers".
2. Minimum size of collection main shall be 250 mm.
3. Sizes of wastewater service pipelines shall be determined based on the fixture or appliance number.

5.3.9 Materials

1. Materials for pipes, joints and fittings shall be in accordance with "Approved Products for Underground Use within the City of Winnipeg" where available.
2. Bedding and backfill materials shall be according to the City of Winnipeg Standard Construction Specification CW 2030 "Excavation Bedding and Backfill" as a minimum, or as required by structural pipe design.

5.3.10 Installation of Wastewater Mains

1. The following items shall be specified in accordance with the City of Winnipeg Standard Construction Specifications:
 - bedding and backfill, and
 - pressure/leak testing.

5.3.11 Deflection Testing of Flexible Sewers

1. Deflection testing of flexible sewers shall be completed in accordance to CW 2130.
2. Further to CW 2130, deflection testing of flexible gravity sewers, testing shall not occur until a minimum of 30 days of completion of backfilling.

5.3.12 Abandonment of Existing Waste Water Mains

1. Abandonment of existing water mains shall be according to the COW Specification CW 2130 "Gravity Sewers" within the limits shown on the drawings.

5.3.13 CCTV Inspection

1. Perform video inspection of sewers in accordance with CW 2145.

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6 ROAD DESIGN CRITERIA

6.1 General Requirements

1. Provide a comprehensive design for all roads and parking lots required for the facility.
2. Include in the design:
 - 2.1 all permanent roadways and parking lots; and
 - 2.2 all temporary construction access roads, laydown areas and contractor parking lots.
3. Horizontal and vertical alignments for roads shall be designed according to the more stringent Guideline of either the TAC or City of Winnipeg standards. Design speed shall be 40 km/h for construction access road. Horizontal alignment for temporary construction roads shall be developed.
4. All roadway geometry shall meet the most stringent of TAC, City of Winnipeg Transportation Standards Manual or City of Winnipeg Standard Construction Specifications Surface Works Standard Details.
5. Perform simulations to evaluate truck movements around the facility to verify roadway geometry.
 - 5.1 Standard of acceptance is AutoTURN simulation.
6. Avoid mixing vehicle and pedestrian traffic.
7. Provide a traffic management plan for construction and operation, as per Section 8.3.1.

6.2 General Road Design


6.2.1 Road Type and Design Life

1. Selection of road type shall be as per Table 6-1.

Table 6-1 : Sewage Treatment Plant Road Type Selection

Location	Road Type	Pavement Material	Design Speed	Min. Pavement Width	Design Vehicle
Main Plant Entrance to Administration Building	Primary	Concrete	40 km/h	7.5 m	WB-20
Connection to municipal roads	Primary	Concrete	40 km/h	7.5 m	WB-20
Interior plant roads	Primary	Concrete	40 km/h	7.5 m	WB-20
Interior plant roads	Secondary	Concrete or Asphalt	30 km/h	7.5 m	HSU
Approaches to Buildings	Secondary	Concrete or Asphalt	30 km/h	7.5 m	HSU
Other	Gravel	Gravel	30 km/h	6.0 m	HSU
Construction Roads	Gravel	Gravel	30 km/h	6.0 m	As required

2. Posted speeds for roadways are intended to be 10 km/h less than design speed.

	WSTP Civil Design Guideline	Revision: 002	Page 23 of 38
		Document Code:	

3. Primary roads shall be designed and constructed as concrete pavement with a minimum 30-year design life.
4. Secondary roads shall be designed and constructed as asphalt or concrete pavement with a minimum 20-year design life.
5. There shall be two classifications of roadway type, Urban and Rural. Each shall be designed as follows:
 - 5.1 All urban roadways shall be designed and constructed with a Mountable Curb (COW detail SD-201 for concrete pavement) or Mountable Curb and Gutter (for asphalt pavement). The exception shall be at all containment areas where Barrier Curb shall be constructed. All administration buildings and public areas requiring handicap access shall have ramp curb constructed. Drainage shall be accommodated along gutters and shall be collected in drainage inlets with either catch pits or catch basins. Boulevards shall be graded flush to the top of the curb along the roadway edges.
 - 5.2 All rural roadways shall be constructed with an embankment 0.9 m above surrounding existing ground, side slopes to a ditch, ditch width and ditch back slope. Ditch widths and depths shall be designed to accommodate the specified storm events.

6.2.2 Pavement Structure

1. Concrete or asphalt pavement surface thickness (concrete or asphalt) and pavement structure shall be determined according to the AASHTO Guide for Design of Pavement Structures based on the traffic movement data obtained from the City of Winnipeg.
2. Minimum pavement structure requirements for Primary Roads:
 - 2.1 200 mm reinforced Portland cement concrete pavement;
 - 2.2 75 mm of compacted base course material;
 - 2.3 375 mm of 50 mm compacted crushed sub-base material;
 - 2.4 Non-woven geotextile; and
 - 2.5 Geo-grid as required at weak subgrade locations.
3. Minimum pavement structure requirements for Secondary Roads (Asphalt)
 - 3.1 100 Asphaltic concrete pavement Type 1A;
 - 3.2 75 mm of compacted base course material;
 - 3.3 400 mm of 50 mm compacted crushed subbase material;
 - 3.4 Non-woven geotextile; and
 - 3.5 Geo-grid at weak subgrade locations.
4. Minimum pavement structure requirements for Secondary Roads (Concrete)
 - 4.1 150 mm reinforced Portland cement concrete pavement;
 - 4.2 75 mm compacted base course material;
 - 4.3 375 mm of 50 mm compacted crushed sub-base material;
 - 4.4 Non-woven geotextile; and
 - 4.5 Geo-grid as required at weak subgrade locations.
5. Minimum pavement structure requirements for Gravel Roads
 - 5.1 100 mm compacted base course material;
 - 5.2 300 mm of 50 mm compacted crushed sub-base material;
 - 5.3 Non-woven geotextile; and
 - 5.4 Geo-grid as required at weak subgrade locations.

	WSTP Civil Design Guideline	Revision: 002	Page 24 of 38
		Document Code:	

6. All Portland Cement Concrete pavements shall be constructed with a longitudinal centreline joint and transverse joints as per the COW Standard Construction Specifications. All joints shall have either tie bars (tied joint) or dowels (moving joint) as per COW Standard Construction Specifications for the thickness of pavement in question.
7. All manholes or catch basins within pavement limits shall have isolations constructed, as per the COW Standard Construction Specifications.
8. At an urban site all roadways will be constructed using the Urban Classification with the exception of gravel roadways.
9. At rural sites all roadways will be constructed using both the Urban and Rural Classifications as directed by the City of Winnipeg.
10. Where asphalt or gravel pavement is permitted, provide concrete pavement where handicap parking is provided or where fully loaded transport vehicles are parked for extended periods.
11. Where gravel payment is permitted, consider the use of dust control systems where dust from road traffic may impact operations or adjacent private properties.
12. Non-woven geotextile as per City of Winnipeg Standard Construction Specifications CW 3130 "Supply and Installation of Geotextile Fabrics".
13. Geo-grid as per City of Winnipeg Standard Construction Specifications CW 3130 "Supply and Installation of Geo-grid".

6.2.3 General Roadway Grading Requirements

1. All urban roadways will have a minimum longitudinal gutter gradient of 0.50% with a maximum grade differential at low or high points of 1.50%. Low or high points with a longitudinal grade differential of greater than 1.50% shall have a vertical curve incorporated into the design. The vertical curve K value will be in accordance with the design speed for the road and TAC guidelines.
2. Minimum longitudinal gutter gradient around radii or on Cul-de-Sacs shall be 0.75%.
3. All urban roadways shall have a minimum transverse crossfall of 2.0%.
4. All rural roadways shall be constructed with a 2.0% crossfall for paved roadways and 4.0% for gravel surface roadways.
5. All rural roadways shall have a minimum 0.25 m shoulder rounding allowance, minimum 4:1 side slopes, and 3:1 back slopes.
6. Minimum longitudinal grades for ditches shall be 1.0% or in extreme cases of very long ditches 0.75%.

	WSTP Civil Design Guideline	Revision: 002	Page 25 of 38
		Document Code:	

6.2.4 Roadway Signage Requirements

1. All roadway signage shall be designed in accordance with the Manual of Uniform Traffic Control Devices for Canada (MUTCDC).
2. All roadway signage installation locations shall be designed in accordance with the MUTCDC.
3. Stop/Yield signs shall be provided on the secondary road at intersections with Primary Roads and on the Gravel roads at intersections with Secondary Roads.
4. Speed limit signs shall be provided on all Primary Roads and shall be considered to be 10 km/h less than the applicable design speed.
5. All pavement striping for Primary Roads shall be installed in accordance with MUTCDC.

6.2.5 Roadway Clearance Requirements


1. Lateral clearance requirements from edge of roadway to physical obstructions including but not limited to; poles, trees and buildings, shall be in accordance with the Clear Zone requirements from TAC for the applicable design speed of each type of roadway.

6.2.6 Sidewalks

1. Design sidewalks for all pathways between buildings routinely utilized by Operations personnel.
2. All sidewalks shall be concrete.
3. Concrete sidewalks shall be minimum 1.5 m wide with 100 mm thick slab according to the COW detail SD-228A. Thickness of sub-base course shall be 150 mm.

6.2.7 Parking Lots


1. Parking lot pavement type:
 - 1.1 Administration and Workshop areas (all sizes): concrete.
 - 1.2 Parking lots for greater than ten vehicles: asphalt or concrete.
2. Layout:
 - 2.1 Minimum parking stall width: 2.8 m
 - 2.2 Minimum parking stall length/depth: 6.1 m
 - 2.3 Minimum parking aisle width: 7.0 m
3. Parking lot shall include number of barrier free parking stalls according to the City of Winnipeg Accessibility Design Standard. This is expected to only be applicable for the Administration Buildings and public areas of the wastewater treatment plants.
4. Minimum requirements for concrete parking lot pavement:
 - 4.1 Non-woven geotextile with geo-grid at weak subgrade locations;
 - 4.2 Sub-base course: 350 mm of 50 mm crushed sub-base material;
 - 4.3 Base course: 75 mm of base course material; and
 - 4.4 Pavement surface: 150 mm Reinforced Portland cement Concrete Pavement.

	WSTP Civil Design Guideline	Revision: 002	Page 26 of 38
		Document Code:	

5. 5.6. Minimum requirements for asphalt parking lot pavement:
 - 5.1 Non-woven geotextile with geo-grid at weak subgrade locations;
 - 5.2 Sub-base Course: 375 mm of 50mm crushed sub-base material;
 - 5.3 Base Course: 100 mm of base course material; and
 - 5.4 Pavement Surface: 100 mm of asphalt Type 1A.
 - 5.5 Minimum slope for asphalt pavement 1%.
6. All parking lots shall have yellow parking stall pavement markings and handicap parking stalls shall have markings in accordance with City of Winnipeg codes and by-laws.
7. All concrete parking lot pavements shall have joints constructed as per City of Winnipeg Standard Construction Specifications.
8. All manholes/catch basins in concrete parking lots shall have isolations constructed in accordance with City of Winnipeg Standard Construction Specifications.

6.2.8 Road Removals/Restorations

1. Removal of concrete pavement and concrete curbs shall be performed according to the City of Winnipeg Standard Construction Specifications CW 3110 "Sub-Grade, Sub-Base and Base Course Construction" and CW 3230 "Full-Depth Patching of Existing Pavement Slabs and Joints".
2. Removal of gravel roads shall be performed according to the City of Winnipeg Standard Construction Specifications CW 3110 "Sub-Grade, Sub-Base and Base Course Construction".

	WSTP Civil Design Guideline	Revision: 002	Page 27 of 38
		Document Code:	

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	WSTP Civil Design Guideline	Revision: 002	Page 29 of 38
		Document Code:	

7 SITE DRAINAGE CRITERIA

7.1 General Requirements

1. Provide a comprehensive site drainage design.
 - 1.1 The general site grading will establish a working surface for operating and construction areas, provide positive drainage from buildings and structures, and provide adequate soil coverage for underground utilities.
2. On-site drainage will be accomplished through gravity flow whenever possible. The surface drainage system will consist of gentle, uniform slopes.
3. Land drainage system should include two separate systems: Minor System and Major System. The minor system is usually applied for the urban area drainage design, and the major system is applied for the rural area drainage design.
 - 3.1 The minor system consists of the gravity pipeline network, plus gutters and inlets which provide a conveyance system to rapidly carry away storm runoff from road surface for the City of Winnipeg's 5-Year MacLaren rainfall events.
 - 3.2 The site must be able to store the 25-Year MacLaren rainfall event with criteria not less than that applicable for commercial properties in the City of Winnipeg.
 - 3.3 The major system conveys runoffs from for the City of Winnipeg's 25-Year MacLaren rainfall event which exceed the capacity of the minor system. The major drainage system consists of mainly open ditch, swales, and culverts.
 - 3.4 Retentions / detentions facilities shall be designed to accommodate runoff from the City of Winnipeg 100-Year design rainfall event.
4. The NEWPCC shall meet the urban area drainage design criteria; the SEWPCC and the WWPCC shall meet the rural area drainage design criteria.
5. The site will be graded away from structures with an appropriate slope for drainage. Minimum standard of acceptance is 2% uniform slope.
6. Design temporary facilities for site and excavation drainage during construction.
7. A detailed hydrograph method such as the SWMM modeling must be used for final design of pipe networks, open channels, and storage facilities that incorporate regional retention/detention facilities.

7.2 Design Criteria

1. Peak runoff rate calculation shall use Rational Method for development area smaller than 100 ha, and use Hydrograph Method (SWMM hydraulic modeling) for development area larger than 100 ha.
2. The Rational Method is used to estimate the peak runoff to be conveyed in the piped or open ditch system. Runoff coefficients used in the Rational Method for various land uses are listed in Table 7-1.

Table 7-1 : Runoff Coefficient "C" Values

Surface Type	C Value
Roof	0.9
Concrete / Asphalt pavement	0.9
Gravel Pavement	0.85
Lawn	0.25

3. Rainfall intensity values shall be calculated based on the intensity – duration formula below:

$$i = a / (t_c + b)^c$$

where: i = rainfall intensity in mm/hr

t_c = time of concentration in minutes. Initial time to concentration (t_c) is equal to 10 minutes for paved development.

4. City of Winnipeg design rainfall (IDF) coefficients are listed in Table 7-2.

Table 7-2 : IDF Coefficients

Design Rainfall	a	b	c
5 Year	1199	8	0.828
10 Year	1529	9	0.842
25 Year	1842	9	0.842
50 Year	2068	8	0.854
100 Year	2318	8	0.856

5. For modifications to existing sites that have existing drainage infrastructure, review the existing drainage pipes and ditches and provide the capacity to meet the calculated runoff requirements, as stated above. Should the review determine that the existing infrastructure is based on design criteria with a lower calculated runoff rate and this was not noted within the project scope of work, provide appropriate drainage (or storage) solutions for the new infrastructure, and review the existing deficiencies with the City. That is, the civil designers are required to upgrade existing infrastructure as needed to meet the requirements of the current project, but correction of existing design criteria deficiencies shall be reviewed with the City unless noted in the project scope of work.

7.3 Site Design

1. Site design criteria must be controlled in accordance with the Sewer By-law.
2. Runoff rates to be restricted to the 5-year MacLaren City of Winnipeg design storm using a "c" value coefficient. The "c" value coefficient will be supplied by the Water and Waste Department and must be obtained in advance (Contact 204-986-3484).
3. The pre-development and post-development peak discharge rates for 5-year and 25-year MacLaren City of Winnipeg design rainfalls should be used to estimate the required on-site storage.

	WSTP Civil Design Guideline	Revision: 002	Page 31 of 38
		Document Code:	

4. Maximum depth and extent of ponding shall not exceed 0.3 m of depth on paved surfaces for the 25-year MacLaren City's design rainfall.

7.4 Ditches

1. New ditches will be built and existing ditches shall be regarded or filled according to the City of Winnipeg Standard Construction Specifications CW 3170 "Earthwork and Grading" and CW 3110 "Sub-Grade, Sub-Base and Base Course Construction".
2. Ditches shall be designed with a maximum side slope of 4 to 1, minimum bottom width of 1.0 m and minimum longitudinal slope of 0.1%.
3. Ditch sides and bottom surfaces shall be covered with erosion control blanket to promote establishment of vegetation.

7.5 Culverts


1. Culvert and drainage inlet/outlet structures shall be designed based on the City of Winnipeg's Culvert and Drainage Inlet/Outlet Safety Guidelines.
2. New culverts will be built and existing culverts shall be removed according to the City of Winnipeg Standard Construction Specifications CW 3610 "Installation of Culverts".
3. Culvert sizing shall be determined based on the peak flow calculated with the Rational Method and using time of concentration of 15 minutes using coefficient "C" values provided in Table 7-1.
4. Minimum culvert size shall be 450 mm.
5. Corrugated metal pipe culvert size shall be calculated using Manning roughness coefficient (n) of 0.024.

7.6 Land Drainage Sewer

1. LDS installation shall be accordance with the City of Winnipeg Standard Construction Specifications CW 2130.
2. Land drainage sewer (LDS) pipe size shall be based on the City of Winnipeg 5-year MacLaren design rainfall event.
3. LDS pipes shall be designed with capacity to control the maximum surcharge level at the upper reach of the development's LDS is 0.30 m below gutter elevation.
4. LDS pipes shall be designed with a minimum full flowing velocity of 0.9 m/s using a Manning roughness co-efficient (n) of 0.013.
5. The minimum LDS size shall be 300 mm; minimum catch basin lead size shall be 250 mm.
6. The minimum invert depth at the high end of LDS system shall, where practicable, be 1.52 m below finished street centre line grade.

7.7 Manholes and Catch Basins

1. Manholes and Catch Basins installation shall be accordance with the City of Winnipeg Standard Construction Specifications CW 2130.

	WSTP Civil Design Guideline	Revision: 002	Page 32 of 38
		Document Code:	


2. Manholes for land drainage sewers shall be installed at the junction of LDS, except at catch basin connections, at changes of alignment or grade except in curved LDS, at the upper end of each line and at all street intersections, with a maximum desirable spacing between any two manholes of 107 m, and in no case more than 120 m in cases of LDS pipe 1,350 mm diameter or larger, the manhole spacing may be varied upon approval.
3. For all manholes and catch basins the minimum barrel diameter shall be 910 mm. the minimum bottom section diameter shall be 1,200 mm.

7.8 Retention and Detention Storage

1. All retention and detention facilities shall meet the City of Winnipeg Criteria for Stormwater Management.
 - 1.1 Flood level or high water level (HWL): 100-year design rainfall.
 - 1.2 Maximum design water level rise in 25-year design rainfall is 1.8m for industrial or open space.
 - 1.3 Freeboard elevation from 100-year rainfall is 0.6 m.
 - 1.4 Minimum depth is 2.5 m.
2. Stormwater retention basin shoreline revetment shall accordance with City of Winnipeg Standard Construction Specifications CW 2165 and detail drawing SD-026.

7.9 Oil and Sediment Interceptors

1. Oil and sediment separators shall be provided in accordance with the City of Winnipeg Sewer By-law.
2. Oil and sediment interceptor should be installed underground and integrated into the land drainage sewer system in parking lots and loading areas to capture particulates and hydrocarbons from small, highly impervious surfaces.

	WSTP Civil Design Guideline	Revision: 002	Page 33 of 38
		Document Code:	

8 CIVIL DESIGN TEAM RESPONSIBILITIES

8.1 General

1. Responsibility for deliverables
 - 1.1 All drawings and other deliverables related to a design are the responsibility of the civil designer / engineer.
2. Ensure all civil design deliverables are sealed by a qualified professional civil engineer registered in the Province of Manitoba.
3. Completeness of drawings:
 - 3.1 All drawings shall be comprehensive in nature to allow for effective use in construction.
4. Update of existing drawings:
 - 4.1 If the project is an addition, expansion, upgrade or modification to an existing site or facility, existing drawings may require up-dating. Coordinate with the City to understand the specific requirements. Typical requirements include.
 - Update existing site plans.
5. Design reviews:
 - 5.1 Issue the design documents to the City for review at appropriate intervals in accordance with the City's expectations.
 - 5.2 Detailed drawings and specifications (hard copy and electronic format) at the 33%, 66% and 90% working drawings stages, or other design review milestones approved by the City.
 - 5.3 Incorporate all WSTP comments into the design. Where a WSTP comment is not accepted by the design team, provide a complete response, including rationale, to the City Project Manager.
6. As-Built Drawings:
 - 6.1 All design deliverables shall be updated to "as-built" status at the end of the project. The "As-Built Drawing" documents shall incorporate contractor mark-ups, inspections performed by the design team, change orders, RFIs, and other communication between the Contractor and Design Team.
 - 6.2 Unless otherwise specified by the City and agreed to by the Design Team, as-built drawings are not required to be sealed (Otherwise known as record drawings).
 - 6.3 Record drawings for all underground utilities and services.
7. External, 3rd Party Consultants:
 - 7.1 Expertise and assistance may be required, from external 3rd party specialized consultants, outside of the primary civil design team.
 - 7.2 The design team shall be responsible for monitoring the activities and progress of each 3rd party consultant.
 - 7.3 It is the responsibility of the design engineer to ensure that the deliverables follow all City standards and guidelines.
8. Site Visits:
 - 8.1 The design team is responsible for ensuring that a sufficient number of site visits occur to facilitate the understanding of specific field conditions or status of existing facilities and buildings.

	WSTP Civil Design Guideline	Revision: 002	Page 34 of 38
		Document Code:	

9. Demolition Requirements

- 9.1 It is generally required that the civil designer / engineer is responsible for associated demolition works required to implement the scope of work. Clearly indicate all demolition requirements on the drawings and in the specifications.
- 9.2 Where demolition requirements are significant, create dedicated demolition drawings.

8.2 Drawings

Provide a comprehensive set of drawings to detail the civil construction requirements. The drawings indicated in this section are minimum requirements for new construction, unless otherwise approved by the City. All drawings shall meet or exceed City of Winnipeg Water and Waste Department WWD CAD/GIS Standards (August 2016) and the Manual for the production of Construction Drawings for the City of Winnipeg, Works and Operations Division (November 1984).

8.2.1 General Requirements

1. All civil drawings are to be produced on a standard A1 size drawing.
2. All civil drawings shall be to scale.
3. All dimensions required for construction shall be shown.
4. Indicate north direction on all plan drawings.
5. Provide scale bars on drawings to allow for simplified scale takeoff on the drawings.
6. Differentiate new work from existing work via bold lines.

8.2.2 Legend

1. Provide a legend drawing showing the symbols and abbreviations utilized. Ensure that the legend is consistent with the City's practices and other disciplines.

8.2.3 General Notes Drawing

1. Provide a general notes drawing.
2. Content
 - 2.1 Include general construction notes.
 - 2.2 Provide key design criteria

8.2.4 Existing Site Plan

1. Provide a detailed site plan of the existing facility, prior to construction.
2. Contents shall include:
 - 2.1 All existing surface topography and spot elevations
 - 2.2 All existing underground plant
 - 2.3 All existing legal boundaries
 - 2.4 Label all existing buildings/facilities
 - 2.5 All existing underground utilities

	WSTP Civil Design Guideline	Revision: 002	Page 35 of 38
		Document Code:	

3. Format:
 - 3.1 Scale:
 - 3.1.1 Maximum: 1:500

8.2.5 Site Plan

1. Provide an overall site plan showing all buildings and major services.
2. Contents shall be in accordance with City of Winnipeg Building and Site Design Summary, Section II required for permitting (<http://www.winnipeg.ca/ppd>).
3. Contents shall include:
 - 3.1 All proposed buildings, roadways and sidewalks;
 - 3.2 All proposed surface features including but not limited to landscaping, lighting, poles;
 - 3.3 All proposed access points to existing roadways;
 - 3.4 North Arrow, civic address, street names, and legal description;
 - 3.5 Property lines, lot lines and all adjacent public right-of-way, lot dimensions;
 - 3.6 Total lot area;
 - 3.7 Construction access route(s);
 - 3.8 Indicate site-surfacing material and show all curbs, wheel stops, parking fences and lighting;
 - 3.9 Dimensions of all projections;
 - 3.10 Proposed on-site lighting and signage;
 - 3.11 Existing and proposed approaches, aisles/driveways, vehicle parking areas, loading, storage, etc. including dimensions, location and surface type;
 - 3.12 Accessory structures (e.g. booths, fences, parking lots, planters, retaining walls, curbing, lamp standards, free standing signs, awning, etc.) with dimensions and offsets/setbacks from property lines;
 - 3.13 Indicate total number of parking spaces;
 - 3.14 Indicate total number of loading spaces;
 - 3.15 Indicate all landscaping areas and identify material (grass, trees, shrubs, ornamental paving, etc.);
 - 3.16 Storage compounds with the surfacing indicated and the type and height of fencing around the compound;
 - 3.17 Proposed surface alternations and enhancements or improvements in the public right-of-way including all landscaping, ditch modifications, and proposed hard surfacing; and
 - 3.18 Areas of the public right-of-way that will be encumbered, occupied or obstructed as a result of the proposed construction, including the installation of any hoarding, fencing, covered walkways, piles or shoring, or any portion of a construction crane that occupies or projects into the right-of-way.
4. Format:
 - 4.1 Scale:
 - 4.1.1 Maximum: 1:500


	WSTP Civil Design Guideline	Revision: 002	Page 36 of 38
		Document Code:	

8.2.6 Site Servicing Plan

1. Provide detailed plans showing all piping in the yard.
2. Contents shall be in accordance with City of Winnipeg Building and Site Design Summary, Section II required for permitting (<http://www.winnipeg.ca/ppd>).
3. Contents shall include:
 - 3.1 Show sizes and locations of sewer (wastewater and/or land drainage) and water (domestic, fire or combined fire/domestic) service connections, fire hydrants, and Siamese connections, including percent slope and connection details to the common mains. Wastewater and land drainage connections shall be separate connections to the common sewer mains;
 - 3.2 Indicate size and location of all existing services not planned for re-use which are then to be abandoned in accordance with the City of Winnipeg Standard Construction Specifications;
 - 3.3 Indicate size, location, and material type of common sewer and water mains and other underground utilities in the street or easements;
 - 3.4 Indicate the size, location, and configuration of storm water control devices including overflow locations;
 - 3.5 Indicate 25-year ponding limit on the drawings; and
 - 3.6 The size, location, and configuration of drainage safety features must be constructed in accordance with City of Winnipeg Culvert and Drainage Inlet/Outlet Safety Guidelines.

8.2.7 Lot Grading Plan

1. Provide detailed yard grading plan including all slopes and elevations.
2. Contents shall be in accordance with City of Winnipeg Building and Site Design Summary, (Section II B. Lot Grade Plan) required for permitting (<http://www.winnipeg.ca/ppd>).
3. Contents shall include:
 - 3.1 Indicate civic address and legal description of the property;
 - 3.2 Indicate project location with reference to adjoining streets or dimensions to street corners at mid-block locations;
 - 3.3 Show building locations and distance to other buildings, property lines, driveways, etc.;
 - 3.4 Show existing and proposed geodetic lot grade elevations in metric both on the site and on adjacent property, public right-of-way, easements, including all property corners, along all lot lines, swales and other drainage features, plus entrances to buildings and proposed finished floor elevations;
 - 3.5 Mark drainage patterns indicated by flow arrows and slopes for all swales and other areas within the property;
 - 3.6 Indicate dimensions and locations of all paved or impervious areas such as parking lots, lanes, driveways, sidewalks, curbs and gutters, roof, etc.; and
 - 3.7 Indicate all entrances to building, private approach locations, roof drain downspouts and any sump pump discharge locations
 - 3.8 Indicate catch basin locations with rim and invert elevations including location of land drainage sewer connections.

	WSTP Civil Design Guideline	Revision: 002	Page 37 of 38
		Document Code:	

4. Format:
 - 4.1 Scale:
 - 4.1.1 Maximum: 1:500


8.2.8 Plan and Profile Drawings

1. Provide a comprehensive set of drawings to detail the plan and profile of all buried services and surface grades and roadwork.
2. Format:
 - 2.1 Scale:
 - 2.1.1 Maximum plan view: 1:250
 - 2.1.2 Maximum profile view: 1:10

8.3 Other Documents

8.3.1 Traffic Management Plan

1. Provide a traffic management plan for all facility upgrades where traffic is affected. The traffic management plan shall be developed to maintain the safe and efficient passage of vehicular and pedestrian traffic on existing roadways and sidewalks within and adjacent to the site.
2. Ensure that safe and efficient emergency vehicle access is maintained to the site at all times.
3. Construction and operations traffic shall be considered during the roadway and parking design and the overall approach shall consolidate construction traffic to minimize impacts to existing plant operation. This includes employee traffic and parking, surrounding environments and deliveries and pickups required for normal plant operations.
4. Comply with requirements of Acts, Regulations and By-Laws in force for regulation of traffic or use of roadways upon or over which it is necessary to carry out work or haul materials or equipment. All traffic controls to be in accordance with the latest edition of the City of Winnipeg Manual of Temporary Traffic Control on City Streets (herein after called The Manual).
5. Do not close any lanes of City streets or control areas outside the wastewater treatment facility without approval of the City of Winnipeg Public Works Department.
6. When construction activities disrupt the normal flow of public traffic, provide and maintain flag persons, traffic signals, barricades and flares, lights and lanterns as required to direct the flow of equipment used in performance of the Work and to protect public traffic in accordance with "The Manual".
7. Where applicable ensure that all traffic disruptions and plans are updated to the City of Winnipeg Waze traffic information program managed by the City of Winnipeg's Transportation Management Centre (TMC).
8. If it is necessary to haul materials over roads that are not designated as truck routes, the Contractor shall be responsible for obtaining written acceptance from the AHJ and/or the City of Winnipeg Public Works Department for use of proposed haul routes within their respective jurisdictions.
9. If a new access road is required for construction purposes, the Contractor shall obtain necessary permits and approvals in consultation with the City of Winnipeg Public Works Department or appropriate Government Authority having jurisdiction.

	WSTP Civil Design Guideline	Revision: 002	Page 38 of 38
		Document Code:	

10. Plan for pedestrian and vehicular traffic control to be compatible with construction operations employed in each construction area. If existing parking facilities will be disrupted by the work; provide temporary parking facilities so as not to obstruct the construction zone and the flow of the vehicular and pedestrian traffic.
11. Incorporate construction sequencing and operations within the traffic management plan.
12. Include procedures for pedestrian and vehicular traffic routing and protection in immediate construction area and surrounding area during working and nonworking hours.
13. When deemed necessary due to construction activities, provide well graded detours or temporary roads to facilitate passage of traffic around restricted area. Provide and maintain signs and lights and maintain roadway. Reduce the length of detours to the degree possible.
14. Provide and maintain reasonable road access and egress to all facilities in vicinity of the Work unless other reasonable means of road access exist.
15. Contractor parking will be permitted on-site provided it does not disrupt existing site operations, employee traffic or parking, and the performance of the Work.
16. Provide and maintain dust control in the construction areas and along any approved traffic diversion route or temporary parking area.
17. Keep the travelled way free of mud and debris. Materials spilled on, or dropped along, or across any roadway, both within and outside the contract limits, shall be removed immediately.
18. Do not proceed with construction of any portion of the work until relevant plans for traffic control measures have been presented and the implementation of those measures have been reviewed and approved.

8.4 Design Calculations

1. Provide detailed design calculations in accordance with the relevant codes and authorized local and national bodies taking into account the most unfavorable conditions. Design calculations shall be submitted with the design drawings as part of the review cycle to allow for parallel review. At minimum, the following calculations shall be submitted to the City for review.
2. Submit draft design calculations to the City when the design calculation is performed, such that the calculation can be referenced during the review stage.
3. Provide final calculations, updated to include any modifications during design and construction, as part of the final as-built/record package.

8.5 Civil Servicing Report

1. Provide civil servicing report including design briefs, outline specifications, calculations, design criteria and associated figures and appendix for water distribution system, wastewater collection system and land drainage study.