

TOWN OF AJAX
DESIGN CRITERIA

SECTION C
STORM DRAINAGE

SECTION C - STORM DRAINAGE

C 1.00 WATERSHED AREA

The watershed area shall be determined from contour plans and shall include all lands that naturally drain into the system and any fringe areas not accommodated in adjacent storm drainage systems, as well as other areas which may become tributary by reason of regrading. This information shall be confirmed with the Town prior to the start of the design of the internal servicing of the site.

C 2.00 STORM DRAINAGE PLANS**C 2.01 EXTERNAL AREAS**

A plan shall be prepared to a scale of 1:1000 or 1:2000, depending on the size of the watershed area, to show the nature of the drainage of the lands surrounding the development site and to show all external drainage areas that are contributory to the drainage system for the development. The external drainage areas shall be divided into smaller tributary areas and the area and the location to which the tributary area is considered in the design shall be clearly shown. The plan shall clearly show all existing contours used to justify the limits of the external drainage area.

In lieu of precise information on development on the whole or any part of a watershed area, the latest zoning by-law and Official Plans issued by the Planning Department shall be used for all external areas in the design and to determine the specific areas to which these values apply.

This external drainage area plan shall be prepared and shall be submitted to the Town at the functional report stage and prior to the commencement of the detailed storm sewer design.

C 2.02 INTERNAL DRAINAGE PLAN

All internal storm drainage plans shall be prepared to a scale of 1:1000 and shall include all streets, lots, blocks and other lands within the development. The proposed storm sewer system shall be shown on this plan with all manholes numbered consecutively from the outlet. These manholes shall be the tributary points in the design, and the area contributing to each manhole shall be clearly outlined on this plan. The area, in hectares, of each contributing area (to the nearest tenth) and the runoff co-efficient used shall be shown in a circle located within the contributing area. In cases where areas of different runoff co-efficients may be tributary to the same manhole, the areas and the co-efficients shall be separately indicated on the plan.

In determining the tributary area to each manhole, the proposed grading of the lots must be considered to maintain consistency in the design. In the case of large areas under single ownership or blocks requiring future site plan agreements, the design shall be prepared on the basis of the whole area being contributory to one manhole in the abutting storm sewer unless more than one private storm connection is necessary to serve the property in which case the appropriate area tributary to each connection shall be clearly shown and taken into account in the storm sewer design.

The length, size and grade of each section of storm sewer shall also be shown on the storm drainage plan.

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C 3.00 STORM SEWER DESIGN

C 3.01 DESIGN FLOWS

The design flow, in each length of sewer, shall be computed on the standard Town of Ajax design sheets according to the "rational" formula $Q = 0.002778 AIR$, where

- A = contributing drainage area in hectares
- I = rainfall intensity mm/hr
- R = imperviousness or runoff co-efficient dimensionless
- Q = volume of runoff in cubic metres per second

C 3.02 RAINFALL INTENSITY

For normal residential and industrial developments, the rainfall intensity shall be determined from Yarnell's 5-Year Storm Curve $i=2464 \div (t+16)$ using a 15 minute inlet entry time at the head of the system for residential developments, and a 5 minute inlet entry time for industrial developments.

For high value commercial and existing heavily developed urban areas, the City of Detroit 10-Year Storm Curve $i=3455 \div (t+20)$ shall be used in a 10 minute inlet entry time at the head of the system.

The 25-Year Storm Curve, as contained in the Ministry of Transportation - Ontario Manuals, shall be used for all culvert, watercourse and major trunk sewer design unless a higher year storm-duration curve such as the Regional or 100 Year Storm is required by the Ministry of Natural Resources or the local Conservation Authority or the Ministry of Transportation - Ontario.

C 3.03 OVERLAND FLOW

The depths of flooding permitted on streets while acting as part of the minor drainage system, generally designed for the 1:5 year storm, are as follows:

- (a) there shall be no curb overtopping,
- (b) on local roads, the flow may spread to the crown,
- (c) on collector roads, the flow spread must leave one lane free of water,
- (d) on arterial roads, the flow spread must leave one lane in each direction free of water.

The overland flow for a 100 year or Regional storm curve, whichever is more stringent, shall be accommodated in road cross sections and/or in blocks of land dedicated to the municipality. The extent and top elevation of any potential 100 year ponding are to be shown on the grading plan drawings. Complete design calculations and plans shall be prepared and submitted for approval by the Town Engineer.

C 3.04 RUNOFF OR IMPERVIOUSNESS CO-EFFICIENTS

Runoff co-efficients to be used in storm sewer design shall be as follows:

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● Parks over 4 hectares	0.20
● Parks 4 hectares and under	0.25
● Single Family Residential	0.45
● Single Family Residential (lot size less than 12.2m)	0.60
● Semi-detached Residential	0.60
● Townhouses, Mainsonettes, Row Houses, etc.	0.75
● Apartments	0.75
● Schools and Churches	0.75
● Industrial	0.90
● Commercial	0.90
● Heavily Developed Areas	0.90
● Paved Areas	0.95

C 3.05 PIPE CAPACITIES

Manning's formula shall be used in determining the capacity of all storm sewers. The capacity of the sewer shall be determined on the basis of the pipe flowing full. The Region of Durham's tables for "Capacity and Velocity of Circular Pipes by Mannings Formula" shall be used in conjunction with the design criteria.

The value of the roughness co-efficient 'n' used in the Manning's formula shall be as follows:

(a) Concrete Pipe all sizes	0.013
(b) Concrete Box Culverts	0.013
(c) Corrugated Metal 13 mm corrugations	0.024
(d) Corrugated Metal 25% paved invert	0.020
(e) PVC Pipe	0.009 or 0.013

C 3.06 FLOW VELOCITIES

Minimum acceptable velocity = 0.75 m/sec.
Maximum acceptable velocity = 4.60 m/sec.

C 3.07 MINIMUM SIZES

The minimum size for a main line storm sewer shall be 300mm.

C 3.08 MINIMUM GRADES

Regardless of flow velocities obtained, the minimum design grades for pipe storm sewers shall be as follows:

<u>Sewer Size</u>	<u>Minimum Grade</u>
Up to 375mm	0.50%
450mm to 525mm	0.30%
600 mm to 1200mm	0.20%
1200mm and Over	0.15%

The first leg of any sewer regardless of size shall be 1.00%.

C 3.09 MINIMUM COVER

The depth of the storm sewer shall be sufficient to provide a suitable outlet for the building foundation weeping tiles. The minimum cover to the top outside pipe barrel of a shallow storm sewer system shall in no case be less than 1.3m from the centre line of the roadway.

C 3.10 LOCATION

The storm sewers shall be located as shown on the Standard Town of Ajax Road Cross Section Drawings. This standard location shall be generally 1.5m off the centre line of the roadway. In the case of crescents, looped and curvilinear streets, this standard location may be varied to the extent that the storm sewer remains on the same side of the centre line of the street (i.e. left or right) to avoid crossing the sanitary sewer trenches at the changes in direction of the street.

Any relocation from the standard location must have the approval of the Town before construction.

C 3.11 DEEP AND SHALLOW STORM SEWERS IN RURAL SUBDIVISIONS

For Estate Subdivisions in the rural areas, a shallow storm sewer system shall be permitted provided the lot sizes are equal to or in excess of 0.20 hectares.

For lot sizes less than 0.20 hectares in the rural subdivisions, a deep storm sewer system shall be constructed to provide a suitable outlet for the building foundation weeping tiles.

C 3.12 CURVED SEWERS

Manufactured radial pipe shall be allowed for all storm sewers 1050 mm in diameter and larger, providing that a manhole is located at the beginning or at the end of the radial section. The minimum centre line radius allowable shall be 15 times the pipe diameter.

C 3.13 LIMITS

All sewers shall be terminated at the subdivision limits using manholes when external drainage areas are considered in the overall design of the storm sewer system. These manholes shall be designed to allow for the future extension of the sewer.

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When external areas are not included in the sewer design, the sewer shall extend at least halfway across the frontage and/or flankage of any lot or block in the subdivision.

C 3.14 SEWER ALIGNMENT

All storm sewers shall be laid in a straight line between manholes unless radial pipe has been designed. The maximum change in direction of flow in manholes for sewer sizes 1050 mm diameter and over shall be 45°.

C 3.15 PIPE CROSSINGS

A minimum clearance of 0.15 metres shall be provided between the outside of all pipe barrels at all points of crossing. In cases where the storm sewer crosses a recent utility trench at an elevation higher than the elevation of the utility, a support system shall be designed to prevent settlements of the storm sewer, or alternatively the original trench shall be re-excavated to the top of the utility and backfilled with compacted crushed stone or concrete to adequately support the storm sewer. When the storm sewer passes under an existing utility, adequate support shall be provided for the utility during and after construction to prevent damage to that utility.

C 3.16 CHANGES IN PIPE SIZE

No decrease of pipe size from a larger upstream to a smaller size downstream shall be allowed regardless of the increase in grade.

C 3.17 HEAD LOSSES

Suitable drops shall be provided across all manholes to compensate for the loss in energy due to the change in flow velocity and for the difference in the depth of flow in the sewers.

In order to reduce the amount of drop required, the designer shall, wherever possible, restrict the change in velocity between the inlet and the outlet pipes to 0.6 m per second.

Hydraulic calculations shall be submitted for all junction and transition manholes on sewers where the outlet is 1050 mm or greater. In addition, hydraulic calculations may be required for manholes where the outlet pipe is less than 1050 mm diameter if, in the opinion of the Town Engineer, there is insufficient invert drop provided across any manhole.

Regardless of the invert drop across a manhole as required by calculations, the obvert of the outlet pipe shall not be higher than the obvert of the inlet pipes at any manhole location.

The minimum drop across manholes shall be as follows:

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<u>Change of Direction</u>	<u>Minimum Drop</u>
0°	20 mm
1° to 45°	50mm
46° to 90°	80mm

C 4.00 SEWER PIPE

C 4.01 MATERIALS

Storm sewers shall be constructed of concrete or PVC pipe. The type and classification of all storm sewer pipe, and the sewer bedding type shall be clearly indicated on all profile drawings for each sewer length.

PVC pipe shall be of the solid wall type construction, grade SDR 35 minimum, and may be used for all main line sewer up to 375 mm and for rear lot catchbasin leads. The ribbed style of PVC pipe, grade SDR 35 minimum, may be used with permission of the Town.

Concrete pipe shall conform to the requirements of CSA Specification A-257 for the particular classes as shown below:

- a) Extra strength non-reinforced concrete pipe, CSA Specification A-257-1
- b) Reinforced concrete pipe, CSA Specification A-257-2
- c) Concrete pipe to have a three bearing test completed on the pipe supplied to the site at the rate of 0.5% of the total length per class per size of pipe. There will be a minimum of 2 pipe lengths tested per class per size.

C 4.02 PIPE BEDDING

The class of pipe and the type of bedding shall be selected to suit loading and proposed construction conditions. Details of the types of bedding are illustrated in the Town of Ajax Standard Drawings. The width of trench at the top of the pipe must be carefully controlled to ensure the pipe strength is not exceeded due to going beyond the maximum trench specified. If this were to occur, additional bedding or higher strength pipe would have to be used.

C 5.00 MANHOLES

C 5.01 MAXIMUM SPACING

The maximum spacing between manholes shall be as follows:

<u>Pipe Size</u>	<u>Maximum Manhole Spacing</u>
300 mm	95 metres
375 mm to 750 mm	100 metres
825 mm to 1200 mm	125 metres
1200 mm and over	150 metres

C 5.02 MANHOLE TYPES

Manholes may be constructed of precast or poured concrete. The Town of Ajax Standard Manhole Detail Drawings shall be used for manhole design where applicable. Although these Standard Drawings provide details for manholes up to certain maximum depths and sizes, the Consulting Engineer shall individually analyze each application of the standards related to soil conditions, loading and other pertinent factors to determine structural suitability. In all cases where the Town of Ajax Standard Manhole Detail Drawings are not applicable, the manholes shall be individually designed and detailed by a competent person.

A reference shall be made on all profile drawings to the type and size of all storm manholes. In the case of the standard 1200mm precast manhole, the size of the manhole may be omitted and reference need only be made to the Town of Ajax Standard Detail Drawing number.

Precast manholes shall conform to A.S.T.M. Specification C-478M latest revision.

C 5.03 MANHOLE DESIGN

- (a) All manhole chamber openings shall be located on the side of the manhole parallel to the flow for straight run manholes, or on the upstream side of the manhole at all junctions.
- (b) The direction of flow in any manhole shall not be permitted at acute interior angles.
- (c) Safety gratings shall be provided in all manholes when the depth of the manhole exceeds 5m. The maximum spacing between safety gratings shall not exceed 4.5m.
- (d) The obverts on the upstream side of manholes shall not be lower than the obvert of the outlet pipe.
- (e) The maximum change in direction of flow in manholes, for sewer sizes 1050 mm diameter and over, shall be 45°.
- (f) Where the difference in elevation between the invert of the inlet and outlet pipes exceeds 0.9 m, a drop structure shall be placed on the inlet pipe with the invert of the drop pipe located at the spring line of the outlet pipe as per AS-130.
- (g) All storm sewer manholes shall be benched as per AS-113.
- (h) The minimum width of benching in all manholes shall be 230 mm.
- (i) Manholes in boulevards shall be located, wherever possible, a minimum of 1.5m distant from the face of curb or other service.
- (j) Minimum size of any manhole stack shall be 685 mm x 685 mm.

C 5.04 GRADES FOR MANHOLE FRAME AND COVERS

All manholes located within the travelled portion of roadway shall have the rim elevation set flush with the surface of the base course asphalt. The bricking and setting of the frame and cover shall be completed in accordance with the details provided in the Town of Ajax Standard Drawings.

The manholes are to be raised using concrete adjustment rings prior to placement of top course asphalt.

SECTION C - STORM DRAINAGE

DESIGN CRITERIA

C 6.00 CATCHBASINS

C 6.01 LOCATION AND SPACING

Catchbasins shall be selected, located and spaced in accordance with the conditions of design. The design of the catchbasin's location and type shall take into consideration lot areas, lot grades, pavement widths, road grades and intersection locations. The recommended maximum catchbasin spacings are as follows:

<u>Pavement Width</u>	<u>Road Grade</u>	<u>Recommended Spacing</u>
8.5m	Up to 4%	95 m
8.5m	Over 4%	69 m
10.0m	Up to 4%	84 m
10.0m	Over 4%	61 m
11.0m	Up to 3.5%	76 m
11.0m	Over 3.5%	53 m
14.0m	Up to 3%	61 m
14.0m	Over 3%	46 m

Catchbasins shall be generally located upstream of sidewalk crossings at intersections and upstream of all pedestrian crossings. Catchbasins shall not be located in driveway curb depressions, if at all possible.

Double catchbasins shall be normally required when the catchbasin intercepts flow from more than one direction. Single catchbasins may be used in the case where the total length of drainage to the catchbasin, from both directions, is less than 95 m.

Rear lot catchbasins and connections shall be located as outlined in the Lot Grading Criteria.

C 6.02 CATCHBASIN TYPES

Catchbasins may be precast.

Typical details for the single, double and rear lot type catchbasins are shown in the Town of Ajax Standard Drawings.

Special catchbasins and inlet structures shall be fully designed and detailed by the Consultant.

C 6.03 CATCHBASIN CONNECTIONS

For single catchbasins, the minimum size of connection shall be 250 mm and the minimum grade shall be 1.0%.

For double catchbasins, the minimum size of connection shall be 300mm and the minimum grade shall be 1.0%.

For rear lot catchbasins, the minimum size of the connection shall be 250 mm and the minimum grade shall be 1.0%.

In general, catchbasins located in close proximity to a manhole shall have their leads connected to the manhole. Long catchbasin connections (in excess of 23 m) shall be connected to a manhole or, alternatively, the lead can be connected to the sewer and a 1200mm manhole catchbasin used in lieu of the normal 600 mm square catchbasin. Access must be available to all rear lot catchbasin leads for maintenance.

C 6.04 GRATINGS

The frame and cover for catchbasins shall be as detailed in the Town of Ajax Standard Drawings. In general, the "bike-proof" catchbasin grate shall be required for all catchbasins located in roadway or walkway areas, the pyramidal type shall be used for parks, and the beehive type shall be used for ditch and rear lot catchbasins.

C 6.05 GRADES FOR CASTINGS AND ADJUSTMENTS

In roadways, the grade for the top of concrete shall be established as shown in the Town of Ajax Standard Drawings. The adjustment to the final elevation shall be poured at the time of curb construction as detailed on the Standard Drawings.

C 6.06 CATCHBASINS AT INTERSECTIONS

All catchbasins at street intersections shall be located on the tangent section of the curb, a minimum of 0.6 m distant from the beginning or the end of the radial portion of the curb, and the grading of the intersection shall provide for drainage to the catchbasin's location.

C 7.00 INLETS, OUTFALLS AND SPECIAL STRUCTURES

C 7.01 GENERAL

Inlet and outlet structures shall be fully designed on the engineering drawings. The details provided shall include the existing topography, proposed grading and the work necessary to protect against erosion.

C 7.02 INLETS

For other than minor swales, where catchbasins with pyramidal or beehive tops are used, inlet structures shall be fully designed.

Inlet grates shall generally consist of inclined parallel bars or rods set in a plane at approximately 45°

with the top, away from the direction of flow. Gabions, rip-rap or concrete shall be provided at all inlets to protect against erosion and to channel the flow to the inlet structure.

C 7.03 OUTLETS

The Town of Ajax Standard Headwall Drawing shall be used for all storm sewers up to 1800 mm. For sewers over 1800 mm in diameter, the headwalls shall be individually designed. All headwalls shall be equipped with a grating over the outlet end of the pipe with a safety railing across the top of the headwall for the protection of the public.

All outlets shall blend in the direction of flow of the watercourse with the directional change being taken up in the sewer rather than the channel.

Gabions, rip-rap, concrete or other erosion protection shall be provided at all outlets to prevent erosion of the watercourse and the area adjacent to the headwall. The extent of the erosion protection shall be indicated on the engineering drawings and shall be dependent upon the velocity of the flow in the storm sewer outlet, the soil conditions, the flow in the existing watercourse, and site conditions.

The weep holes placed in the structures shall be left unobstructed to allow drainage from behind the structure.

C 7.04 OPEN CHANNELS

Open channels shall only be considered at the discretion of the Town when the design flow exceeds 14.2 m³/second. All open channels should be designed to convey a 5 years flow flood event, with free board of 0.15 times the depth.

The proposed criteria for an open channel design shall be submitted by the Consulting Engineer to the Town for his approval, prior to the actual design being undertaken. The Consulting Engineer shall also be responsible for obtaining the approval of the design from the Ministry of Natural Resources, the Ministry of the Environment and the local Conservation Authority if the open channel concept is favourably considered.

C 8.00 CONSTRUCTION

Construction of all storm sewers and appurtenances shall be in accordance with the specifications and Standard Drawings of the Town of Ajax at the time of approval of the Design Drawings by the Town. All pipes, regardless of size, including rear lot catchbasin leads shall be televised and video tapes presented to the Town for their review and acceptance before any maintenance dates can be set.