Prepared for:

Arcadis

Block 5 Stormwater Management:

Infiltration Facility Development Memo

Design Brief prepared by:

Aquafor Beech Limited

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1 Introduction

Aquafor Beech was retained by Arcadis on behalf of Rohit Homes to complete the design of an infiltration-based Stormwater Management (SWM) facility in support of the development at Block 5 of the Wateridge Development, located in Ottawa. The facility is to serve as an integral part of the site's ability to achieve the water balance target in accordance with the City of Ottawa Low Impact Development (LID) Technical Guidance Report (February, 2021).

The site is encompassed by Rue Kijigong Street to the North, Rue Oshedinaa Street to the East, Hemlock Road to the South, and future development lands to the west. The site is currently vacant and located on the former CFB Rockcliffe air base site. The surrounding roads and underground services for the site have been constructed. The site has been zoned for a Mid-Rise Mixed Use.

The proposed development block consists of a single four-storey residential building with one level of underground parkade. The site also features a small surface parking lot with access from the laneway connected to Rue Oshedinaa Street.

2 Background Information

A review of both existing site conditions and relevant design standards was completed to support the development of the infiltration facility. The following subsections outline relevant information from both review exercises.

3 Relevant Design Standards

The following design standards were referenced in the design development process for the proposed infiltration facility:

1. City of Ottawa Sewer Design Guidelines (Second Edition, October 2012)
2. Stormwater Management Planning and Design Manual (Ministry of Environment, Conservation, and Parks, March 2003)
3. City of Ottawa Low Impact Development (LID) Technical Guidance Report: Implementation in Areas with Potential Hydrogeological Constraints (February, 2021)
4. Low Impact Development Stormwater Management Guidance Manual – Draft for Consultation (Ministry of Environment, Conservation, and Parks, January 2022)
5. Low Impact Development Stormwater Management Practice Inspection and Maintenance Guide – Version 1.0 (Toronto Region Conservation Authority, 2016)

4 Subsurface Conditions

A geotechnical investigation was completed by Terrapex in October 2023 for the Block 5 development area, involving installation of two boreholes and two subsequent monitoring wells on the Block 5 site. These features were used to classify subsurface soil physical and chemical properties, groundwater depth, and bedrock conditions.

In-situ infiltration testing was also completed by Terrapex at a number of test pits and holes to various depths across the site in the fall of 2023. Testing was completed using a Guelph permeameter. Each test consisted of a 5-15cm head test, based on the level of saturation and subsurface materials encountered

at the test location. Changes in reservoir water levels were monitored and recorded over time until a steady state was reached between three consecutive readings.

The relevant findings from both investigations in regards to design of the infiltration facility are outlined below:

1. Infiltration Facility Setbacks
    a. Infiltration and any other LID practices must be located on site such that a minimum horizontal setback of 4.0m is provided between the LID footprint and edge of building foundations per City of Ottawa Low Impact Development (LID) Technical Guidance Report (February, 2021).
2. Bedrock and Groundwater
    a. Bedrock elevation in the approximate infiltration facility excavation area was observed at 2.16m below existing ground surface per data collected at BH 5-1. No groundwater was observed in either monitoring well (MW-1 and MW-2) during recorded readings by Terrapex, thus groundwater is not expected to restrict design depth of the facility.
3. Infiltration Rate
    a. In-situ infiltration rates were obtained from test pits or cores dug varying depths of 1.5 to 1.0m below ground surface at INF 5-1 and INF 5-2 per the map provided in Appendix A, approximately the depth of the infiltration facility invert. In-situ rates across the three locations averaged to 53mm/hr. The design infiltration rate adopts a safety factor in accordance with the LID Stormwater Management Guidance Manual, producing an average design infiltration rate of 15.1mm/hr.

5 Infiltration Facility Sizing

The following subsections outline the design development process used in sizing the infiltration facility.

6 Stormwater Management Design Targets

To aid in the development of the infiltration facility, several design targets were identified from the various guidance documents outlined in Section 2.2 above. Table 1 below summarizes the design targets applied and source of information.

Table 1: Various Design Targets Applicable to the Infiltration Facility.

Design Target Category	Target Value or Range	Source
Clearance to bedrock or groundwater	Minimum 1.0m	City of Ottawa LID Technical Guidance Report: Implementation in Areas with Potential Hydrogeological Constraints
Erosion Control Storage	4mm rainfall depth across entire site area	Wateridge Phase 2B LID Developer's Checklist
Water Balance Storage	4mm rainfall depth across entire site area	Wateridge Phase 2B LID Developer's Checklist
Water Quality Storage	N/A	N/A
Drawdown Time	48-92 hours	City of Ottawa LID Technical Guidance Report: Implementation in Areas with Potential Hydrogeological Constraints

The Water Quality Control target constraint does not apply to Block 5 as discharge from this Block is conveyed to the existing SWM facility servicing the Wateridge development lands which has been designed to provide quality control through an extended detention storage component.

While the infiltration facility must hold and infiltrate the equivalent volume of 4mm of rainfall depth across the entire site area, the design will be prepared such that only runoff generated from the rooftop contributes to the facility to eliminate the need to pre-treatment that is otherwise required

7 Proposed Hydrologic Conditions

Intensity-duration-frequency (IDF) data was referenced from the City of Ottawa Sewer Design Guidelines, adopting rainfall intensities for the 2-year to 100-year design storm event under a 10-minute time of concentration. Given that the infiltration facility has been design to only accept inflows from rooftop areas, the catchment area was delineated based upon total rooftop area from the four-storey building, with a standard impervious surface runoff coefficient of 0.9 adopted for the hydrological analysis. Table 2 through Table 3 below summarize the peak design storm flows and required runoff storage volumes relevant to the design.

Table 2: Design Storm Peak Flows from Building Rooftops.

Return Period	Rainfall Intensity (mm/hr)	Rooftop Flow (m^3/s)
2-year	77.1	0.03
5-year	104.4	0.045
10-year	122.5	0.05
25-year	145.3	0.07
50-year	162.2	0.08
100-year	179	0.10

All inlet pipes to the infiltration facility shall convey up to the 5-year design storm flows under free-flowing conditions in order to meet the minor system standard per the City of Ottawa Sewer Design Guidelines (Second Edition, October 2012).

Table 3: Runoff Volume Storage Requirements for Site.

SWM Category	Target Value	Required Volume (m^3)
Water Balance Storage	4mm rainfall depth across entire site area	16.7m^3
Erosion Control Storage	4mm rainfall depth across entire site area	16.7m^3

To achieve both stormwater management category targets, the infiltration facility was thus designed to ensure 16.7m^3 of the 26.5m3 total storage was below the invert of the outlet facility by incorporating a vertical standpipe outlet within the outlet catchbasin (CB1) that only allows discharge from the infiltration facility once water levels surpass an elevation of 87.29m.

8 Infiltration Facility Summary

With design targets and site constraints established, a design for the infiltration facility was developed. The facility consists of a plastic chamber system complete with inlet debris settling rows, inspection ports, inlet and outlet connections, and an open bottom stone base for infiltration of stored water below the outlet invert. A summary of key design information for the infiltration facility is provided in Table 4 below.

Table 4: Key Design Parameters of Proposed Infiltration Facility.

Design Parameter	Value
Maximum Storage Volume (m^3)	26.5m^3
Maximum Infiltration Volume (m^3)	16.7 m^3
Excavation Footprint Area (m^2)	53m^2
Total Facility Depth (m)	0.81m
Minimum Cover (m)	0.6m
Minimum Clearance to Bedrock from invert of Aquabox Cubes (m)	1.0m
Drawdown Time (hrs)	26hrs*
Inlet Pipe Diameter(s) (mm)	150mm
Outlet Pipe Diameter (mm)	150mm
Structural Loading Capacity	HS-25 Rated

*Note: drawdown time based off water level reduction from outlet standpipe elevation to bottom of levelling course 19mm stone.

In addition to the design information in the above table, various other design aspects were incorporated to enhance the function of the system and allow for greater ease of operation and maintenance. These additional design aspects are outlined and described below:

1. Overflow bypass system
    a. One standard OPSD 705.010 catchbasin is proposed to be installed along the inlet pipe from the building such that in major storm events when the infiltration facility has reached maximum capacity, overflow can exit the system and drain across the landscaped area adjacent to the parking lot and onto Rue Kijigong Street. Additionally, the catchbasin allows for bypass should the infiltration facility inlet or outlet become blocked.

2. Inlet Debris Row
    a. An inlet debris row is included at the inlet location as part of the Aquabox Cube infiltration chamber design such that sediment and other fine debris has the opportunity to settle in a small forebay area before runoff spills over the internal weir wall and into the main chamber area. The debris row concentrates sediment deposition in the system to a small area for ease of maintenance.
3. Inspection Ports
    a. Two inspection ports are provided in the design featuring 375mm diameter riser pipes. These ports can be used for visual inspection inside the chamber or cleanout of sediments via vac truck.

9 Operation and Maintenance Considerations

A number of operation and maintenance (O&M) practices should be considered by the site owner to ensure the infiltration facility can maintain its as-designed function in future years. The considerations outlined in Table 5 are summarized from previous industry experience of Aquafor Beech and the TRCAs' Low Impact Development Stormwater Management Practice Inspection and Maintenance Guide.

Table 5: Operation and Maintenance Considerations for Underground Infiltration Chambers.

Design Component	O & M Description	Frequency
Contributing Catchment	Inspect Contributing rooftop area for inlet to CB2 to ensure no significant leaf litter, sediment, leaking contaminated substances, or other garbage debris are present that may enter the system and cause partial or full blockage of the inlet.	Biannual visual inspections.
Inlet Conveyance System	Inlet should remain unobstructed to ensure runoff enters infiltration facility unimpeded. Visual inspection of inlet catchbasin CB2 should be completed. CCTV and flushing of pipe segments should occur when pipe segments are or suspected to be clogged. Standing water within CB2 or frequent surcharging are indicative of clogging or capacity issues within the infiltration chamber and outlet system, respectively.	Visual Inspection – biannual Flushing & CCTV – when clogging/damage suspected.
Debris Row/ Pretreatment	For effective debris row function, area should be inspected visually via the inspection port for sediment or other debris accumulation limiting storage capacity or conveyance of inlet flows into the main chamber area. Inlet flushing and vac truck cleanout of the debris row shall be adopted to remove debris and sediment when required.	Biannual visual inspections. Flushing & Vac Truck – when sediment accumulation reaches half the height of the debris row geotextile wall.
Main Filter Bed Area	Visual inspection in dry weather to quantify sediment accumulation and inspections following storm events to monitor draw down time. Should facility draw down exceed 92 hours or sediment accumulation limit inlet/outlet function of facility, flushing and vac truck sediment removal shall be adopted.	Annual visual inspections. Flushing & Vac Truck – when drawdown exceeds 92hrs **OR** sediment accumulation impeding inlet/outlet function.
Outlet Conveyance System	Outlet should remain unobstructed to ensure discharged water leaves the site unimpeded. Visual inspection of outlet catchbasin CB1 for standing water can help identify any conveyance problems in the outlet system. Where clogging is suspected, CCTV and flushing of pipe sediments should occur.	Visual Inspection – biannual Flushing & CCTV – when clogging/damage suspected.
Outlet Stand-Pipe System	Outlet standpipe within CB should remain unobstructed and free of debris or ice such that drain hole at bottom of 90 degree elbow can function.	Biannual visual inspections. Debris removal with hand tools or vac truck as required.
Emergency Overflow Outlets	Grate opening of CB2 along inlet pipe should remain unobstructed and free of debris such that surcharge of excess runoff to the surface in major storm events can occur.	Biannual visual inspections.
Inspection Ports	As a vital component to maintenance access, inspection of the inspection ports to ensure proper function and access is maintained via the surface grates.	Biannual access function inspections.

10 Storm Sewer Outlet Bioswale Restoration

The site's storm sewer outlet connects to an existing trunk sewer on Oshedinaa Street, however must cross the boulevard bioswale along this street in order to achieve connection. The bioswale must be restored to the approved design drawing conditions of the bioswale or better. Design drawings for the appropriate Wateridge development phase can be obtained from Canada Lands Corporation (CLC), or the City of Ottawa.

The following recommendations shall be adopted by the Contractor involved in constructing the Block 5 storm sewer outlet for when crossing the bioswale:

1. Plant material shall be removed and temporarily stored on site in a planter box large enough to ensure plant placement does not exceed the density of the plantings observed within the bioswale prior to removal.
2. Biomedia material must be stored on site separately from all other excavated material to minimize risk of contamination. Use of ESC measures such as sediment logs or sediment fencing shall also be adopted should any risk of surface runoff contamination be present at the storage location.
3. The Contractor shall install a trench box immediately following removal of plant material and excavation of biomedia to ensure excavation walls remain supported and stabilized.
4. To avoid any damaging of the underdrain within the bioswale, the Contractor must provide support for the underdrain during installation of the Block 5 outlet storm sewer.

Figure 1 below shows a typical cross section of the bioswale along Oshedinaa Street.

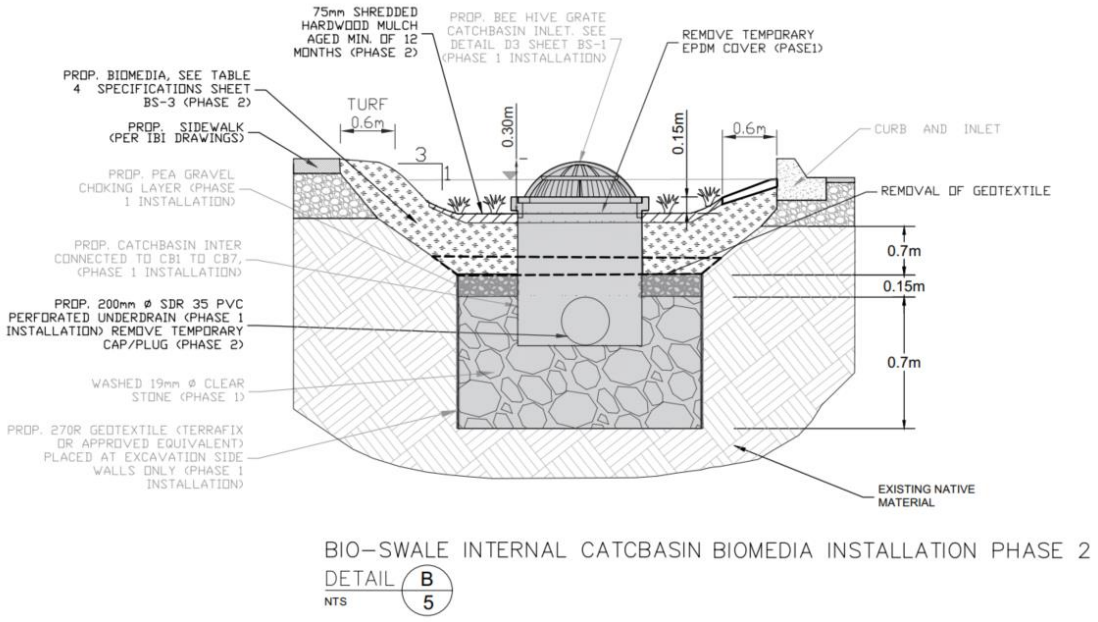
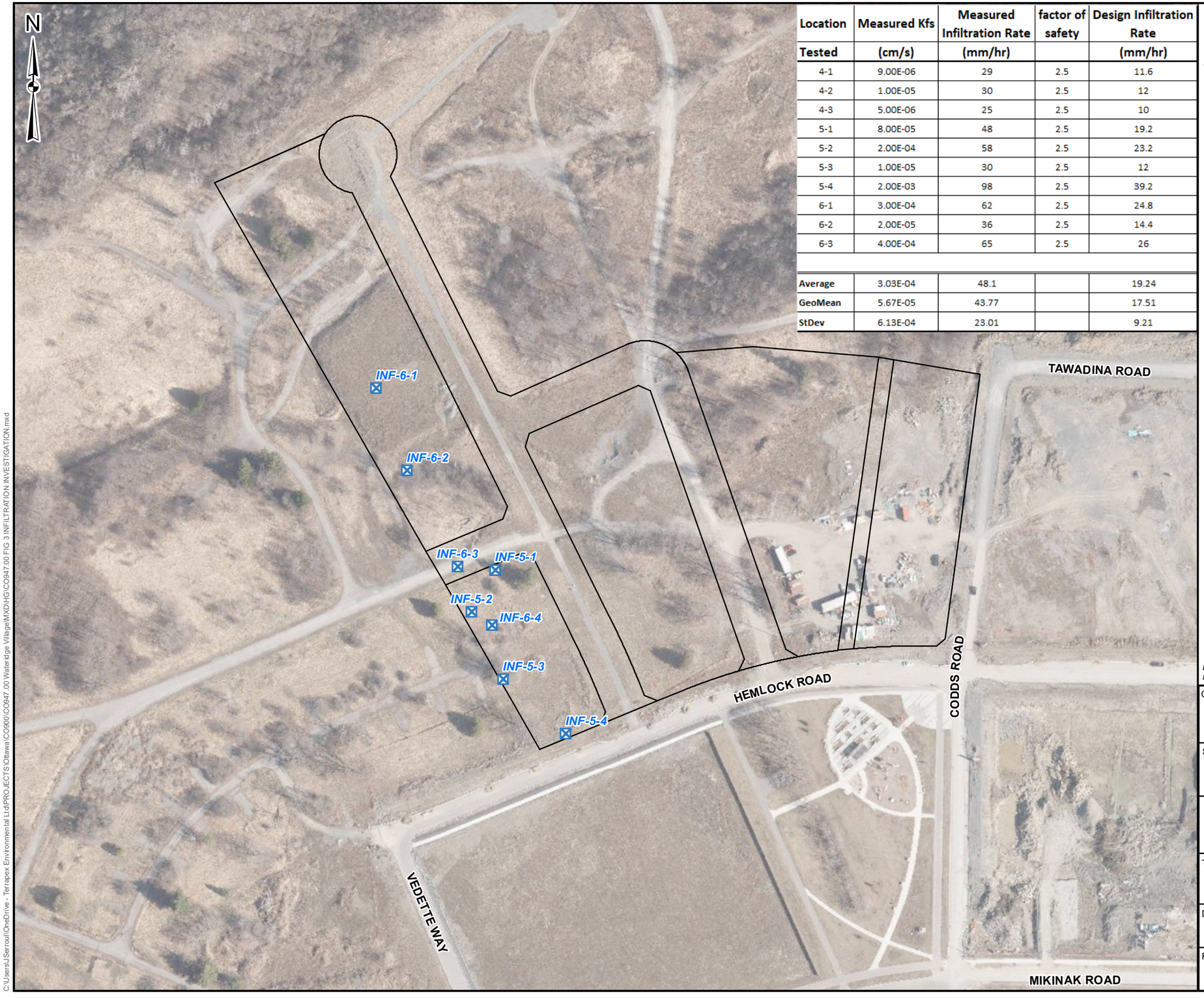


Figure 1: Phase 4 Typical Cross Section Detail for Right of Way Boulevard Bioswale.

Relevant construction tender specifications for the bioswale components are provided under Appendix B as reference for bioswale restoration following storm sewer site outlet installation.

Appendix A: Infiltration Investigation Results

Location Tested	Measured Kfs (cm/s)	Measured Infiltration Rate (mm/hr)	factor of safety	Design Infiltration Rate (mm/hr)
4-1	9.00E-06	29	2.5	11.6
4-2	1.00E-05	30	2.5	12
4-3	5.00E-06	25	2.5	10
5-1	8.00E-05	48	2.5	19.2
5-2	2.00E-04	58	2.5	23.2
5-3	1.00E-05	30	2.5	12
5-4	2.00E-03	98	2.5	39.2
6-1	3.00E-04	62	2.5	24.8
6-2	2.00E-05	36	2.5	14.4
6-3	4.00E-04	65	2.5	26
Average	3.03E-04	48.1		19.24
GeoMean	5.67E-05	43.77		17.51
StDev	6.13E-04	23.01		9.21



LEGEND

- ⊠ INFILTRATION TESTING
- —— PROPOSED PLAN OF SUBDIVISION

0 25 50 75
Metres

DATA SOURCE: CITY OF OTTAWA
MAP PROJECTION: NAD 1983 UTM ZONE 18N

CLIENT:
CLC

SITE LOCATION:
WATERIDGE VILLAGE
OTTAWA, ONTARIO

TERRAPEX

TITLE:
INFILTRATION INVESTIGATION

DRAWN BY:	PROJECT NO.:	CHECKED BY:
JS	CO947.00	CB
REVISION: 00	DATE: NOVEMBER 2023	FIGURE: **3**

C:\Users\JSerroul\OneDrive - Terrapex Environmental Ltd\PROJECTS\Ottawa\CO900\CO947.00 Waterridge Village\MXD\HG\CO947.00 FIG 3 INFILTRATION INVESTIGATION.mxd

Appendix B: Bioswale Construction Specifications

Supply and Install 600mm x 600mm Catchbasin (OPSD 705.010) Including Frame and Beehive Grate

The requirements of **OPSS 407** shall apply to these items, except as otherwise specified herein.

Work under this item shall include all materials, equipment, and labour necessary to supply and install/place the catchbasins as detailed on the contract drawings. This works shall include catchbasins with a 600mm sump and catchbasins without sumps as detailed on the contract drawings. Each catchbasin installation shall include a beehive grate (Product JW-105B) or approved equivalent per contract drawings.

- ***Measurement and Basis for Payment***

Measurement for this item shall be each unit. Payments made to the Contractor under this item shall include all labour, materials, and equipment for the installation of each catchbasin unit regardless of depth, at the applicable unit prices tendered.

Payment at the Contract unit prices shall be full compensation for supplying all materials, for all excavation and for the disposal as directed by the Agency of surplus excavated materials, for the placing and compacting of granular bedding and backfill, for the construction or installation of the precast unit, for catchbasin adjustments required, for the supply and installation of the frame and grate, for benching, and for all other items of Work necessary to complete the structures in accordance with the Contract requirements.

Catchbasin Waterproof Membrane

Work under this item shall include all materials, equipment, and labour necessary to seal inside and outside of joints with mortar and a 600mm wide strip of waterproof membrane.

The waterproof membrane shall be placed to form a continuous barrier centered around the exterior of all buried and exposed joints. The waterproof membrane shall be free of folds, tears, and wrinkles. The waterproof membrane shall be joined so that the material laps a minimum of 500mm and shall be pinned together. The Contractor shall ensure that the catch basin is sealed at all joints. The waterproof membrane shall be “MEL-ROL” by W.R. MEADOWS of MILTON ONTARIO or approved equivalent.

- ***Measurement and Basis for Payment***

Measurement for this item shall be each unit. All materials, labour and equipment required to complete the works shall be included under SP-17 Supply and Install 600mm x 600mm Catchbasin (**OPSD 705.010**) Including Frame and Beehive Grate.

Supply and Install Sewer Connections Including Excavation, Bedding and Cover and Backfill

The requirements of **OPSS 490** and manufactures standards for construction of pipe sewers shall apply, except as modified herein.

- ### *PVC SDR35 Pipe*

As a minimum, all pipes shall be marked to designate the pipe manufacturer, pipe class, and Manufacturer's Quality Assurance Stamp. Each fitting or special shall be marked to indicate its position in the pipeline.

- ### *HDPE Pipe*

As a minimum, all pipes shall be marked to designate the pipe manufacturer, pipe class, and Manufacturer's Quality Assurance Stamp. Each fitting or special shall be marked to indicate its position in the pipeline.

- ### *Bedding and Cover Materials*

Class 'B' bedding and cover material, specifically 20mm Crusher-Run Limestone, shall be used for entire sections of the solid sewer sections and shall conform to the requirements of **OPSS 1010**. The cost of this shall be included in the unit price provided for this item. Bedding and cover heights shall be installed per **OPSD 802.030** and **802.032**.

All subgrade conditions must be inspected and approved by a geotechnical Engineer/ Contract Administrator retained by the Contractor prior to placement of bedding and cover material with reports and records provided to the Contract Administrator and Owner for their review and records.

- ### *Joints*

All pipe joints shall be leak proofed or wrapped with a waterproof membrane as specified by the product manufacturer.

- ### *Backfill Material*

Backfill shall be according to **OPSS 902**.

On-site inorganic soils may be suitable for trench backfill for areas not within the road right-of-way or below surface structures. All specific requirements for native backfill installation shall be provided by the Contractor at no additional cost should native backfill material be approved for use.

Native backfill with a moisture content of 3% or more shall not be installed until properly dried such that adequate compaction can be achieved. Native backfill shall be installed in 200mm lifts and compacted to

98% SPMDD at a water content close to optimum (within 3% of optimum).

Native backfill must not include particles greater than 100mm dimensions, greater than 15% of the material larger than 4.8mm, and greater than 5% organic content by weight, as well as visible roots or topsoil.

Native/excavated fill material used as backfill must be approved for use by a Geotechnical Engineer/ Contract Administrator retained by the Contractor prior to backfilling with reports and records provided to the Contract Administrator and Owner for their review and records. The Contractor shall also provide compaction reports.

Unshrinkable backfill shall be required to backfill pipe section situated within the road right-or- way, the use of such unshrinkable backfill shall be considered included in the tendered item price.

The height of backfilling under roadway and curb sections or under surface structures is to be at the level where the existing or proposed granular road/surface feature subgrade begins, as per **OPSD 802.030** and **802.032.** The height of backfill in all other areas shall be a maximum of 300mm below finish grade.

Where badly weathered or loose soils are encounter, they should be sub-excavated and replaced with bedding material compacted to 95% SPD. Payment for additional excavation and bedding material shall be made based on a time and material basis. Quantities for any soft spotrestoration shall be verified through on-site measurements as agreed upon between the Contract Administrator and Contractor. Approval of all soft spot restoration shall be made by the geotechnical Engineer/ Contract Administrator retained by the Contactor with reports and records provided to the Contract Administrator and Owner for their review and records.

- ***Pipe Support at Catchbasin***

Concrete pipe support at catchbasins and maintenance holes shall be required as shown on standard **OPSD 708.02**.

- ***Removal of Abandoned Utilities***

The Contractor shall include in their unit price bid for this item, the removal of abandoned utilities in order to complete their work.

- ***Curb and Gutter Removal and Restoration***

The unit price bid for this item shall include the sawcutting, removal and disposal of curb and gutter and reinstallation of curb and gutter sections where required for the installation of the storm sewer sections per **OPSS 510** and City of Ottawa Sidewalks, curbs and pathways standard detail drawings.

- ***Sidewalk Removal and Restoration***

The unit price bid for this item shall include the sawcutting, removal and disposal of sidewalk and

reinstallation of sidewalk sections where required for the installation of the storm sewer sections per **OPSS 510** and City of Ottawa Sidewalks, curbs and pathways standard detail drawings.

- ***Road Asphalt and Base Removal and Restoration***

The unit price bid for this item shall include the sawcutting, removal and disposal of asphalt and road base materials and reinstallation of base materials and asphalt sections where required for the installation of the storm sewer sections per **OPSS 510** and IBI standards and detail drawings.

- ***Measurement and Basis for Payment***

Payment shall be made at the price bid per linear metre for supplying all materials, carrying out all excavation, dewatering, sheathing, shoring and disposal of excess material, supplying and installing sewer pipe, supplying placing and compacting bedding, cover and backfill material, supplying and placing concrete bedding, pavement restoration, sidewalk, curb and gutter, and boulevard removal and restoration (as required), and all other work to complete the storm sewer system as specified on the Contract Drawings, and herein.

Supply and Install 200mm PVC SDR35 Perforated & Solid Underdrains

The requirements of **OPSS 401** and **OPSS 410** shall apply and govern except as amended or extended herein.

Works under this item comprise the supply of all equipment, labour, and materials required for the installation of 200mm diameter sections of PVC SDR35 pipe (smooth interior, perforated & solid) required for the bioswales including all connections with structures and manufacturer approved fittings as shown in the Contract Drawings and/or directed by the Engineer/ Contract Administrator. It should be noted that bedding and backfill for the pipe shall consist of the 20mm clear stone aggregate per SP-21. Solid piping shall be used within 1.0m of connections with catch basins/maintenance holes and sidewalls of permeable pavement and bioswale excavations.

The Contractor is to supply and install the PVC pipes as indicated on the drawings. The underdrain material is specified as Heavy walled PVC (polyvinyl chloride) SDR35 pipe. The underdrain shall meet the requirements of **OPSS 1840** and **OPSD 1801,** and **CSA B182.8** for open profile sewer and drainage pipe. All piping shall use manufacturer approved couplings and fittings.

All perforated pipe section must arrive on-site with manufactured perforations. The installation of manual perforations onsite is not acceptable unless approved by the Engineer/ Contract Administrator.

The Contractor shall note that the unit price per linear meter for piping shall include the cost of the following items associated with the piping work:

- Any shoring, if required.
- De-watering of the excavation.
- Excavation and off-site disposal of underdrains requiring trenching.
- Supply, place and connection of underdrain works.

- Manufacturer approvedcouplings and fittings.
- Connections with proposed and existing maintenance hole and catchbasins.
- All underdrains using plastic pipe shall require deflection testing as per **OPSS 410.07.15.05 prior** to placing of surface works.

- ***Measurement and Basis of Payment***

Measurement for this item shall be linear meters. Payments made to the Contractor under this item shall include all labour, materials, and equipment for the installation of these items at the applicable unit prices tendered.

Supply and Install Aggregates (20mm Washed Clear Stone, HPB, & 3- 10mm Washed Pea Gravel)

Work under this item shall include all materials, equipment, and labour necessary to supply and install/place, and grade aggregate material for the bioswales.

For the bioswales stone reservoir layers, material shall consist of a clear, crushed, angular, washed 20mm diameter stone confirming to **ASTM No. 57** and installed as per the thickness and details as shown on Contract Drawings. Choking course layers shall consisted of a 150mm thick layer of 3-10mm washed pea gravel material.

All aggregate material shall be washed and cleaned and shall be free from fines. All aggregates shall have equal to or less than 2% passing the No. 200 (0.075 mm) sieve. Aggregate material shall be supplied, placed and sized as detail on Contract Drawings.

- ***Measurement and Basis of Payment***

Payments made to the Contractor under this item shall include all labour, materials, and equipment for the installation of these items at the applicable unit prices tendered. Measurement for this item shall be tonnes.

Supply and Install Geotextile (Filter Fabric)

Work under this item shall include all materials, equipment, and labour necessary to supply and install/place a needle punched non-woven geotextile between open grade field stone used to line the sidewalls of the permeable pavement and bioswale excavations in addition to lining the bottom and sides of the permeable pavement underdrain trench excavations in order to prevent fine migration from the native soils into the open grade stone and biomedia. This material shall conform to the material specifications in **OPSS 1860** Class II geotextile fabrics (i.e Terrafix 270R or approved equivalent).

Geotextile material shall be placed smooth and free of tension stress, folds, wrinkles and creases. Each successive strip of geotextile shall overlap the previously overlapped by 600 mm. Geotextile used within permeable pavement underdrain trench excavations shall extend 300mm along permeable pavement subgrade on either side of the trench. Geotextile install along sidewalls of the bioswale and permeable pavement excavations shall extend 300mm along bottom of excavation and be pinned down by open

graded, granular backfill.

For the selection of geotextile fabric, the following criteria shall be followed:

- Apparent Opening Size (AOS) OR Percent Open Area (POA):
- For fine grained soils, the AOS ≤ 0.3mm (non-woven fabrics) and POA ≥ 4% (woven fabrics)
- Hydraulic Conductivity (k, in cm/sec)
- k (fabric) > k (soil)
- Permittivity {k (fabric)/ thickness (fabric)}(in sec-1)
- For fine grained soil, the permittivity shall be 0.1 sec-1.

The installed geotextile shall be protected from displacement, damage or deterioration before, during, and after placement of material layers. The Contractor shall replace any damaged or deteriorated geotextile to the approval of the Engineer/ Contract Administrator.

- ***Measurement and Basis of Payment***

Measurement for payment will be in square metres of geotextile placed and will be calculated by multiplying the length by the width of the area where fabric is placed. No allowance will be made for seams and overlaps. Payment at the Contract price shall be full compensation for all labour, equipment and material to do the work. The Contractor must supply receipts which clearly identify the product type prior to issuances of payment.

Supply and Install Clay Seals

Work under this item shall include all equipment, labour, and materials required to install all clay seals including all items as indicated in the contract drawing details. The clay seals shall meet the requirements of **OPSD 802.095**, the associated special provisions and City of Ottawa standards.

- ***Measurement and Basis of Payment***

Measurement of this items shall be per unit installed (i.e. each). Payments made to the Contractor under this item shall be considered as payment in full for these items in the applicable unit prices tendered.

Supply and Install Bioswale Monitoring Wells

Work under this item shall include all materials, equipment, and labour necessary to supply and install monitoring wells as specified on the Contract Drawings. The item shall include the supply of all labour, equipment and materials to install/undertake the following:

Additional excavation and off-site disposal of material required to install well sumps. 150mm

diameter PVC piping and manufacturer fittings required for well assembly.

6 ¼" I.D x 12" height flush mount monitoring well covers (bolt-down) available from Wellmaster Pipe and Supply Inc. (Tel: 1-800-387-9355) or approved equivalent. Models may vary.

20mm diameter, washed clear stone to fill sump. Geotextile to
line sump excavation sidewalls and bottom.

- ***Measurement and Basis of Payment***

Measurement for payment will be per each monitoring well supplied, assembled and installed. Payment at this Contract unit price for this item shall include all labour, materials, and equipment to complete the work.

Catch Basin TemporaryOff-line Measures (EPDM Liner and Plugs)

Work under this item shall include all materials, equipment, and labour necessary to install all EPDM liners in all bioswale internal catchbasins and plug all bioswale underdrain connections upon completion of Phase 1. Works shall also include the removal of all EPDM liners and underdrain plugs upon completion of Phase 2 with approval from the Contract Administrator.

The EPDM liners and underdrain plugs shall be installed per contract drawings.

- ***Measurement and Basis for Payment***

All materials, labour and equipment required to complete the works shall be included in this unit price and measured per each catch basin sealed. Payment at the contract unit price for theabove items shall be compensation in full for supplying all labour, equipment, and materials to complete the work.

Supply and Install Biomedia

Work under this item shall include all materials, equipment, and labour necessary to supply and install Biomedia as per the Contract Drawings including:

- ***Materials***

Biomedia shall be obtained premix from supplier. Contact Greely Sand and Gravel at 613-821- 3003 or 416-791-6700, or approved equivalent. Media shall be comprised of a mix of organic matter and sand in the following proportions:

85-88% sand (grain size 2.0-0.05mm) 8-

12% fines (less than 0.05mm)

3-5% organic matter

Filter media is to remain free from contamination from clay, in-situ soils or other debris throughout the duration of the construction period. For more details on media specification, refer to construction notes on contract drawings. Filter media is to conform to Table 1 Media for bioswale facility as detailed in the contract drawings. On-site mixing of media is not acceptable.

- ***Sampling and Testing***

Contractor to provide testing results prior to installation for the parameters shown on the design drawings or as specified by the Engineer/ Contract Administrator. Deliveredmediashall be tested and approved by the Engineer/ Contract Administrator prior to installation. Media installed without Engineer/ Contract Administrator approval shall be removed at the Contractor's expense if deemed necessary by the Engineer/ Contract Administrator. The Contractor will be solely responsible for all required media testing expenses. Media testing results can be expected approximately 2 - 3 weeks after submission to lab. The Contractor is responsible for any delays suffered as a result of testing. No compensation will be provided for delays due to media analysis. In any areas where the tests do not meet the specifications, rectification and retesting shall be done at the Contractor's expense.

Contractors' equipment and method of materials testing are subject to the approval by the Engineer/ Contract Administrator. The Contractor shall receive and use chain of custodies provided by the Engineer/ Contract Administrator with the approved tests to be performed as part of the media certification. The Agency shall not be responsible for expenses suffered should the Contractor pre-emptively undertaking testing using the incorrect testing parameters.

The Contractor must fulfill the following biomedia testing requirements to ensure that the desired filter media mixes areachieved.

i. The Contractor must provide a hand mixed sample of the proposed filter media to be submitted for analysis. Hand mix samples are intent to roughly gauge the proportions of materials required in order to satisfy the specifications. Depending on the soil manufacturer/Contractor, submission of hand mixed samples may have to be conducted several times to obtain a passing sample. Analytical results must be submitted to and approved by the Engineer/ Contract Administrator prior to beginning mechanical mixing operations.

ii. Media samples from mechanically mixed operations must be submitted for analysis and satisfy the media specifications. To minimize contamination and clean out the mixing system prior to sampling, a minimum of ten (10) cubic meters of filter media must be passed through the system and disposed of. A minimum of three (3) samples shall be collected from the next ten (10) cubic meters of material including one from the bottom of the pile (1-3 m^3 of material), the middle (4-6 m^3 of material), and top (7-10m^3 of material). Approved mechanically mixed samples shall be issued

for installation.

iii. All hand and mechanically mixed samples must be submitted to a certified laboratory. Chain of Custodies which details the required testing to be conducted should be assemble by the Engineer/ Contract Administrator and provided to the Contractor.

iv. Obtaining media samples shall be conducted by the Contractor.

v. The Contractor shall notify the Engineer/ Contract Administrator when the mechanically mixing operations shall be taking place and be provided the opportunity to observe the source material being used for mediadevelopment and mixing operations. The Contractor must ensure that access for sampling is provided to the Engineer/ Contract Administrator if necessary.

vi. Delivered media shall be tested and approved by the Engineer/ Contract Administrator prior to installation and originate from the same location and use the same materials as the approved samples.

vii. Media installed without Engineer/ Contract Administrator clearance shall be removed at the Contractor's expense if deemed necessary by the Engineer/ Contract Administrator.

viii. The Contractor is solely responsible for all required media testing expenses.

ix. The Contractor is responsible for any delays suffered as a result of testing. No compensation will be provided for delays due to media analysis.

- ***Execution***

a) Spread biomedia within excavated limits and fill to required design grades. Placement on biomedia shall be in 150-200mm lift. Each lift shall be properly consolidated by soaking the media with water prior to placing of sequential lifts. Grade as required to achieve proposed ditch profile and cross-section.
b) Soak biomedia with water to achieve natural consolidation and fill areas of settling to required design grades. Ensure positive drainage is provided.
c) Install surface treatments immediately following biomedia placement. Placement of biomedia shall only be permitted if surface treatment placement is to immediately follow.

- ***Other Conditions***

Biomedia shall remain free from contamination from clay, in-situ soils, or other sources of contamination throughout the duration of the construction period. Any potential risk of contamination shall be investigated by the Engineer/ Contract Administrator. The Contractor may not claim for delays suffered as a result of such activities. Shall contamination of the biomedia be confirmed, the Contractor shall be responsible for rectifying the area of contamination, as delineated by the Engineer/ Contract Administrator, through the removal and off-site disposal of contaminated material and replacement thereof usingapproved biomedia, at the Contractor's own expense.

Prior to acceptance, the Contractor shall repair any erosion and areas of settlement which may occur within the bioswale areas.

- ***Measurement and Basis of Payment***

Measurement shall be per tonne of material supplied and installed. Payments made to the Contractor under this item shall be compensation in full for all labour, material, and equipment per the applicable unit prices tendered.

Supply and Install Hardwood Mulch

Work under this item shall include all materials, equipment, and labour necessary to supply and install shredded Natural Hardwood Mulch over all areas specified on the Contract Drawings. Installation shall conform to the requirements of **OPSS 804** and **572**. Obtain the approval of the Contract Administrator of the finished grading surface before proceeding with mulch.

The hardwood mulch shall be aged a minimum 12 month prior to installation. The hardwood mulch shall be laid smooth to a minimum depth of 75mm and reduced to 50 mm around the base of trunks and shrubs as specified in the contract drawings within bioswale areas. The hardwood mulch shall meet the adjoining grass areas and paving and top surface of adjacent hard surfaces unless shown otherwise on the drawings.

It is the Contractor's responsibility to take all necessary precautions as required to protect all newly mulched areas from damage. If broadleaf weeds appear in maintained areas, Contractor shall remove weeds by hand.

- ***Measurement and Basis of Payment***

Measurement for payment shall be made on a per cubic meter basis. Payment at the contract unit price for the above items shall be compensation in full for supplying all labour, equipment, and materials to complete the work.

Supply and Install Aluminum Edging

Work under this item shall include all materials, equipment, and labour necessary to supply and install 3.2mm x 140mm 1.82mm thick Black duraflex aluminum edging at all locations specified on the Contract Drawings. The Contractor shall submit shop drawings or material specifications to the Contract Administrator for approval prior to installation.

- ***Measurement and Basis of Payment***

Measurement for payment shall be made on a per linear meter basis. Payment at the contract unit price for the above items shall be compensation in full for supplying all labour, equipment, and materials to complete the work.

Supply and Install Bioswale Plantings

Work under this item shall include all materials, equipment, and labour necessary to supply and install, of all specified plant material within the bioswale Area 1 as per the drawings and details.

- ***References***

Abbreviations and Acronyms:

- All work shall conform to currentOPSS specifications and OPSD standard details.

- ***Quality Assurance***

Contractor Qualifications: Work specified herein shall be done by experienced, qualified personnel, under the direction or supervision of a foreman with minimum five (5) years of horticultural and planting experience.

- ***Source Quality Control***

- Make arrangements for prior inspection and approval of plant material at source of supply and at a time mutually agreedupon.
- Prior approval will not invalidate rejection of stock at later inspection should it prove defective or damaged.

- ***Submittals***

- Green Material Data Sheet
  - Submit completed GMDS with all supporting documentation for the Engineer/ Contract Administrator's review with shop drawings.
  - If more than one type of material or product is supplied, provide a separate GMDS for each.
- Affidavits
  - Submit affidavits to certify that manufactured or processed materials supplied in bulk meet specified requirements, if requested.

- Maintenance Instructions
    - Submit instructions on maintenance procedures to be followed after end of specified maintenance period.

- ***Delivery, Storage and Handling***

- Label manufactured, processed or otherwise prepared materials that are packaged with full details of contents and source of supply.
- Store and protect products to prevent damage from moisture

Plant Material:

- Transport plants specified "B&B" with solid balls wrapped with 150 gram hessian burlap. Wrap balls under 450mm diameter. with single thickness, between 450mm and 1000mm diameter with double thickness, and 1000mm diameter and over with double thickness and drum laced with 5mm rope at 200mm spacing.
- Transport plants with frozen ball only when they are complete with root systems intact.
- Transport plants with branches tied to prevent damage, and padded to avoid abrasion from equipment.
- Prevent drying out of any part of plants from time of removal at place of origin until they are planted. While temporarily stored at site, protect them with soil, or similar materials, and keep moist.
- Spray plant materials with an anti desiccant immediately before moving them from their original location. Apply a sufficient amount over trunks, branches, and foliage. Plants may be re-sprayed after planting.

Site Conditions

- Environmental Requirements: Install landscaping specified in this Section under weather conditions and in growth season suitable for each specified material, and as approved.

Scheduling Work

- Schedule work to minimize conflict with other trades on work site to minimize repairs of work previously executed.

Warranty

- Plants accepted during the period from January 15 to July 15 shall be warranted until July 15 the following three (3) years.
- Plants accepted during the period from July 15 to December 15 shall be warrantedfor three (3) years from date of acceptance.
- The warranty periods listed above shall apply to all nursery grown plants.
- During the warranty period, replace all plants which are dead, missing, or which are not in healthy, vigorous growing condition immediately upon notification and do all maintenance.
- Notify the Agency and Engineer/ Contract Administrator, in writing, of any corrective or preventive measures necessary to safeguard planting and date measures performed.

- Supply and plant all replacements in strict accordance with Drawings and Specification and warrant replacements as specified.
- During warranty period, remove from site any plant material that has died, or failed to grow satisfactorily as determined by the Engineer/ Contract Administrator.
- Replace plant material immediately upon notification. Extend warranty of replacement plant material for a period equal to the original warranty period.
- Continue such replacement and warranty until plant material is acceptable.

Products

• *Materials*

i. Sustainability Characteristics: It is the responsibility of the Contractor to ensure mandatory credits, measures, targets, etc, are met.

ii. Biomedia: For finished grading biomedia shall be used to finalize surface grading and act as growing media within the proposed Bioswaleareas.

iii. Shredded Hardwood Mulch: Aged (minimum 12 months) shredded hardwood mulch shall be used around trees, perennials and shrubs as required.

iv. Topsoil: Topsoil shall be used to restore areas outside of Bioswale areas as boulevards, excluding areas where biomedia has been installed. Cross-contamination shall not be accepted.

v. Anti-desiccant: Emulsion to form permeable film over plant surfaces, and mixed according to manufacturer's directions.

vi. Accessories:

- Tree Wrapping: Minimum 250 grams/m^2 mass first quality burlap in strips from 150mm to 250mm wide, or heavy waterproof crepe paper 100mm to 150mm wide.

- Stakes: For Cable Anchors: 150mm diameter galvanized steel disc, screw in type.
  For trees: T rail iron stakes primed with 1 brush coat of matte black paint.

- Cable, Wires: Zinc coated steel cable of diameters suitable for anticipated stresses for trees over 150mm caliper; and zinc coated pliable wire of minimum 3mm for trees between 75mm and 150mm caliper and minimum 2.5mm for those under 75 diameter Mm.

- Eye Bolts, Turnbuckles: Zinc coated. Turnbucklesshall have 10mm diameter bolts for trees over 75mm caliper and 5mm diameter bolts under 75mm.

- Hose: 12mm diameter New black rubber, 2 ply reinforced.

vii. Plant Material:

- Quality and Source: Comply with Guide Specification for Nursery Stock 1996 Edition of Canadian Nursery Trades Association referring to size and development of plant material and root ball. Measure plants when branches are in their natural position. Height and

spread dimensions refer to main body of plant and not from branch tip to branch tip. All plants shall be No. 1grade.

- Plant materials obtained from area with milder climatic conditions from those of site are acceptable only when moved to site prior to the breaking of buds in their original location and heeled in in a protected area until conditions are suitable for planting.

- Use trees and shrubs with strong fibrous root system free of disease, insects, defects or injuries and structurally sound. Use trees with straight trunks, well and characteristically branched for species. Plants must have been pruned regularly, but not later than 1 growing season prior to arrival on site.

- Plant material that has come out of dormant stage and is too far advanced will not be accepted unless prior approval is obtained.

- Prepare plants with cleanly cut roots: split roots will not be accepted. Cut roots at edges of ball when combing is not practised. Paint ends of cut roots 25mm diameter and larger with asphalt emulsion.
- Ensure that plants are healthy; in vigorous growth; well branched; densely foliated in leaf; with well developed root systems; and free of disease, damage, insect pests, and eggs or larvae.

- Ensure that woody stems, branches, and trunks are free of sun scalds, frost cracks, rodent damage, abrasions, and cuts; that old wounds are completely calloused over; that pruning wounds have vigorous bark growth on all edges, and that all parts are moist and show live green cambium tissue when cut.

- Container grown stock is acceptable if containers are large enough for root development. Root system must be able to hold soil when removed from container. Plants that have become root bound are not acceptable. Container stock must have been fertilized with slow releasing fertilizer.

- Balled and Burlapped: All coniferous and broad leafed evergreens must be dug with soil ball. Deciduous trees in excess of 300cm height must have been dug with large firm ball. Root balls must include 75 per cent of fibrous and feeder root system. This excludes use of native trees grown in light sandy or rocky soil. Secure root balls with burlap, heavy twine and rope. For large trees, wrap ball in double layer of burlap and drum lace with minimum 10mm diameter rope. Protect root balls against sudden changes in temperature and exposure to heavy rainfall.

- Substitutions: Substitutions to plant material as indicated on planting plan is not permitted unless written approval has been obtained as to type, variety and size. Plant substitutions must be of similar species and of equal size as those originally specified.

- Plants larger than specified will be accepted without liability to extra charges if they meet all specified requirements for their size.

viii. Mulch: Aged Shredded Hardwood (minimum 12 months).

ix. Wound Dressing: Horticulturally acceptable non-toxic, non hardening emulsion.

- ***Execution***

Examination

- Examine site before commencement of installation, and inform Consultant if site conditions will not permit completion of landscaping installed by this Section as specified.
- Ensure that sub grade preparation and drainage is satisfactory for continuing maintenance and growth of specified landscape plant materials.

Preparation

- Stake locations of plant pits for approval before they are excavated.
- Excavate plant pits to a minimum of 600mm and allow at least 150mm of planting soil under rootballs of all shrubs. Ensure that rootballs of trees is firmly supported by undisturbed subgrade.
- Remove rocks, existing and abandoned construction work or similar obstructions to 150mm below bottom of pit. Do not remove any obstruction until approval has been given by Consultant.
- Dispose of surplus excavated material away from site. Surplus material not used for backfilling shall not be spread elsewhere throughout Bioswales such that final grades are altered.
- Test plant pits for water percolation prior to the placement of plant material. Ensure drainage adequate for the plant survival.

Planting Time

- Plant material noted for spring planting only must be planted in dormant period before buds have broken.
- Plant material imported from region with warmer climatic
- Plant evergreens in spring before bud break. Planting of such stock with root balls may start after middle of August. Apply anti desiccant to evergreens before digging.
- Plant only under conditions that are conductive to health and physical conditions of plants.
- Provide planting schedule. Extending planting operations over long period using limited crew will not be acceptable.

Planting Methods

- Partially fill planting pit with biomedia mix
- Set plants plumb and after settlement has taken place, so that they are in the same relation to grade as they originally grew.
- Place bare root plants with roots in their natural position.
- Face shrubs and trees as approved to give best appearance when viewed from prime vantage points.
- Pull away and remove burlap, rope and wire from tops and sides but not bottoms, of root

balls. Ensure that balls rest on a minimum of 150mm of planting soil.

- Do not plant stock with root balls that have been racked or broken during delivery, handling or planting.
- Backfill around roots with planting soil in 150mm layers. Tamp in place to pack firmly and to eliminate all air pockets around roots.
- For each plant, not located in a planting bed, provide an earth saucer at its base of the same diameter as its planting pit in which to retain water.
- Thoroughly water when planting pit is half filled. When water has drained, complete backfilling, and water again.

Trunk Wrapping and Plant Support

- Wrap main tree stems of 50mm caliper, or greater, from grade to just above second branches.
- Before wrapping, spray trunks with a wettable powder of long residual insecticide to provide protection from borers.
- Apply wrapping spirally and snugly with overlap to shed rain, and held in place with cord.
- Brace upright trees and large shrubs with three guys. Install a turnbuckle in each guy to allow for takeup. Use cable or wire and required for anticipated stresses.
- Attach guys to anchors spaced equidistant around plant and 60mm below grade.
- Attach guys to trunks of trees above lower branches and to shrubs where possible, but in all cases so that plant is not subjected to undue strain. Cover guys with rubber hose where they contact plant.

Pruning

- Prune plants a minimum amount after planting, but sufficiently to remove dead or injured members, to compensate for loss of roots when transplanted, and to shape the plant into natural character as intended by landscape design.
- Do not remove leaders.
- Make cuts smooth, clean and flush to branch collar. Leave no stubs beyond branch collar.
- Cut back cambium to living tissue where cuts are made, and at bruises, scars and other injuries. Shape wood to prevent retention of water.
- Paint over pruned cuts of greater than 25mm and other treated areas with tree paint.

Mulch Beds

- Place mulch to an average depth of 75mm distributed uniformly, in planting areas.

Adjustment and Replacement

- At time of final acceptance, at substantial completion, and again at termination of warranty period, landscaping installed by this Section will be inspected by the Engineer/ Contract Administrator. Make required adjustments and replacements of defective landscape installations at no additional cost.
- Commencement of warranty period is predicated on acceptance of landscaping with only minor deficiencies.
- Perform adjustment and replacement of defective landscaping installations with materials of same size, variety and quality of material replaced, as approved by the Engineer/ Contract

Administrator.

- Replace landscaping installations under a warranty of the same length and conditions applicable for original Contract. Date renewed warranty from time of approval of replacement.
- Replace plant stock that is dead, or not in flourishing and satisfactory growing state, or that does not meet specification requirements. Remove dead stock immediately. Replace stock at proper time during planting season. Disapproved but growing stock may be left, its warranty period extended, and inspected again next planting season. At this time request for replacement may be made.
- After settlement has occurred at planting saucers in sodded areas, backfill with biomedia and mulch around base of plant, ensure that grades blend smoothly with adjacent grades.
- Remove tree wrapping, tree stakes and guy wires at end of warranty period.
- Ensure that all paved areas, structures and adjacent landscape elements are clean and all debris is disposed of.

- ***Measurement of Payment***

Measurement for this item shall be for each unit supplied and installed. Payments made to the Contractor under this item shall include all labour, materials, and equipment for the supply, installation, and maintenance of these items at the applicable unit prices tendered. All planting accessories and appurtenances shall be included in the applicable unit prices tendered under this item.