

Source: Toronto Official Plan July 2015 Map 13 Land Use Plan
Trans-Northern Pipelines Inc.

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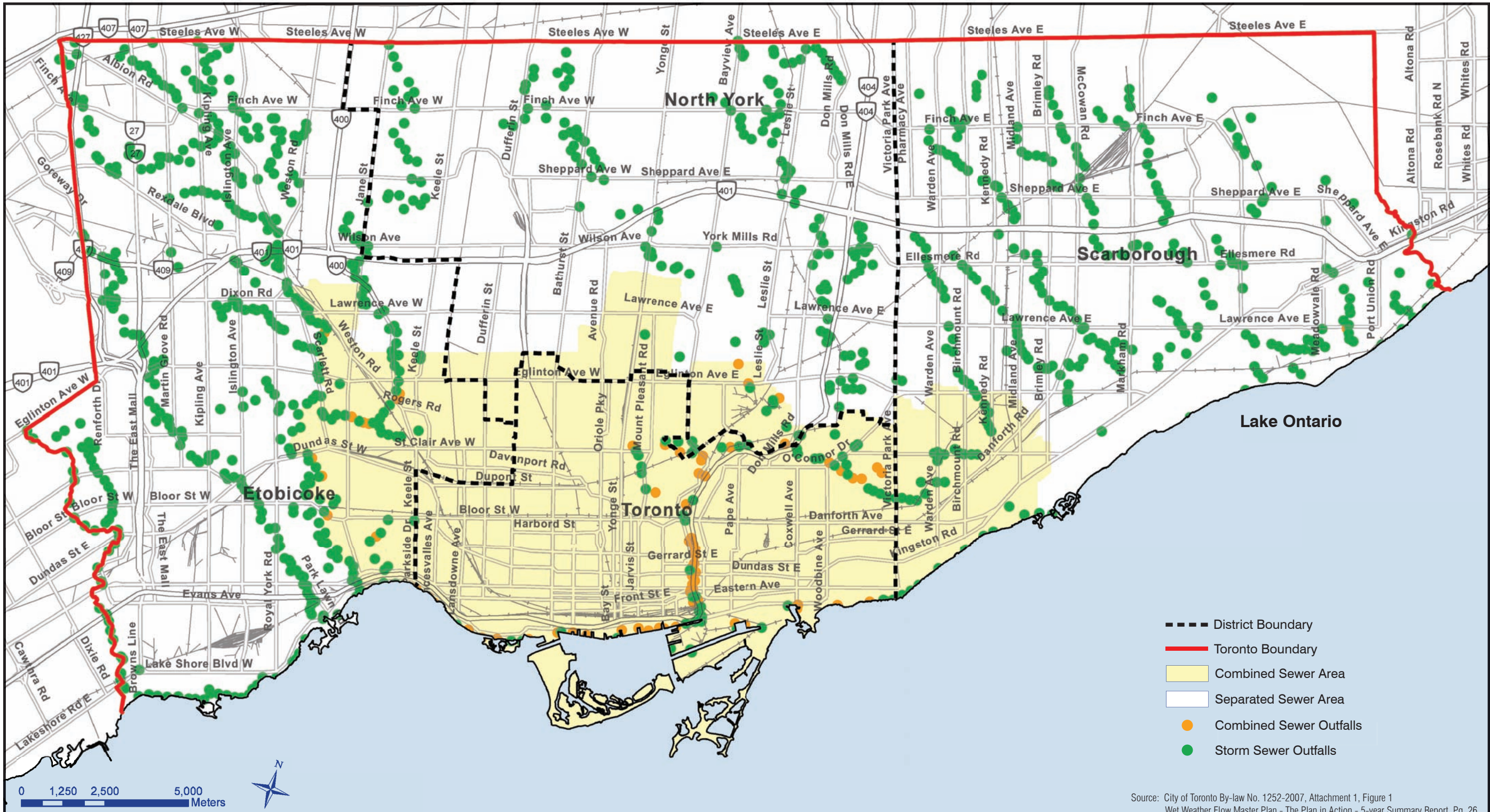


November 3, 2015

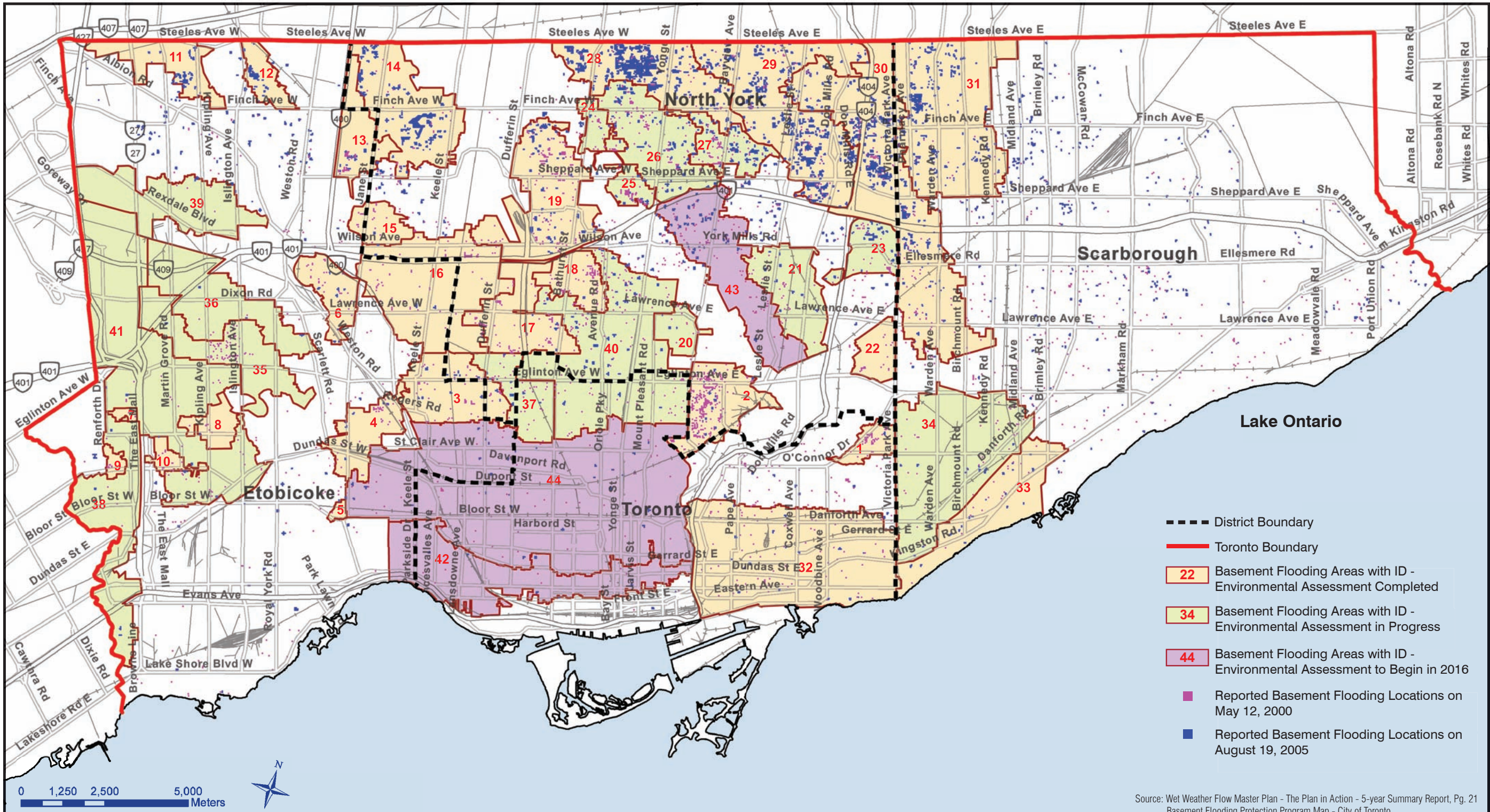
**GREEN STREETS
TECHNICAL GUIDELINES**

MAJOR UTILITY CORRIDORS

Map 8.0 - Major Utility Corridors



Map 9.0 - Combined and Separated Sewers



Source: Wet Weather Flow Master Plan - The Plan in Action - 5-year Summary Report, Pg. 21
 Basement Flooding Protection Program Map - City of Toronto







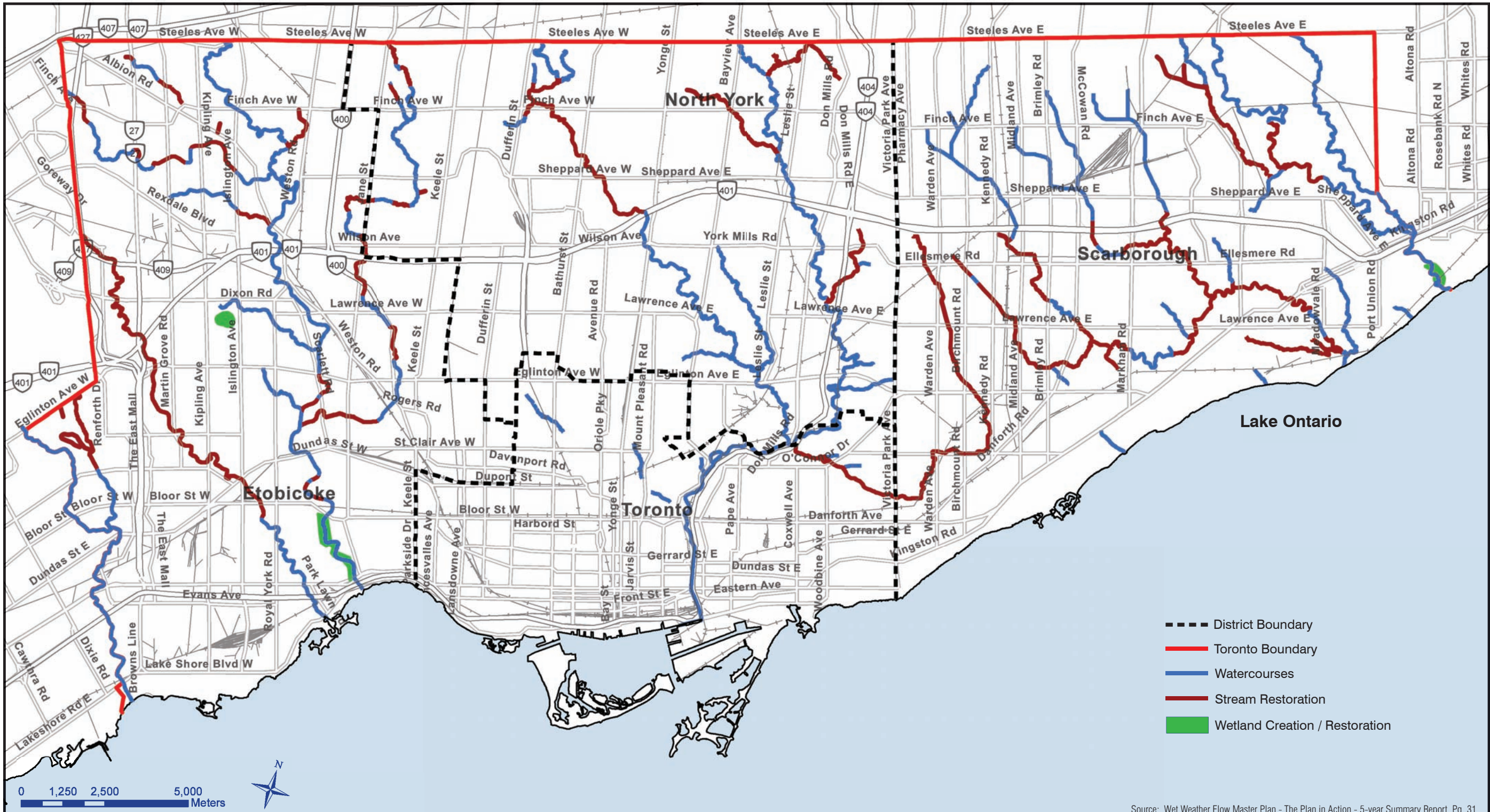

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August 3, 2016

**GREEN STREETS
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PROXIMITY TO FLOODING AREAS

Map 10.0 - Proximity to Flooding Areas



Source: Wet Weather Flow Master Plan - The Plan in Action - 5-year Summary Report, Pg. 31


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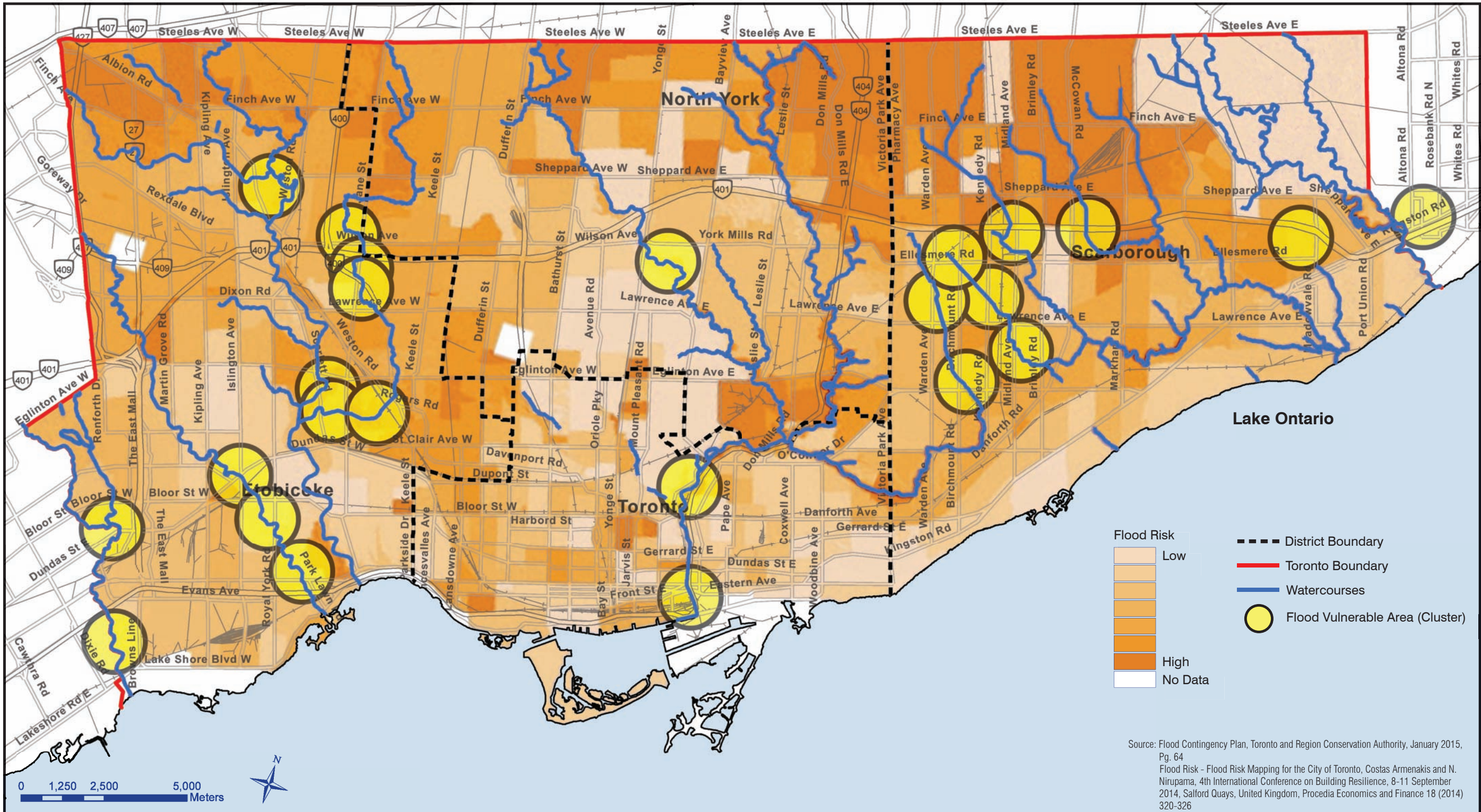


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STREAM RESTORATION

Map 11.0 - Stream Restoration Areas



Source: Flood Contingency Plan, Toronto and Region Conservation Authority, January 2015, Pg. 64
 Flood Risk - Flood Risk Mapping for the City of Toronto, Costas Armenakis and N. Nirupama, 4th International Conference on Building Resilience, 8-11 September 2014, Salford Quays, United Kingdom, Procedia Economics and Finance 18 (2014) 320-326

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GREEN STREETS TECHNICAL GUIDELINES
FLOOD RISK AREAS

Map 12.0 - Flood Risk Areas



F.0

APPENDIX F - OPERATIONS & MAINTENANCE PROTOCOLS



ECOLOGY	Green Infrastructure / LID Option	Operations & Maintenance Protocols (OMP)	Inspections/Monitoring	Repairs / Replacement
	<p>E-1 NATURAL TREE CANOPY</p>	<p>E1_OMP #1 Description: Removal of garbage and natural debris on or around tree base Timing: Once in spring and after major wind storm events as required Equipment: Handwork Personnel: One individual Hours: Area dependent</p> <p>AQ3_OMP #2 Description: Watering Timing: New trees - weekly, mature trees as required Equipment: Irrigation system (if available) / water truck Personnel: One individual Hours: Area dependent</p> <p>AQ3_OMP #3 Description: Weeding & pest control Frequency: Weeding & pest control as necessary Equipment: Handwork Personnel: One individual Hours: Area dependent</p> <p>AQ3_OMP #4 Description: Pruning Frequency: Pruning annually (by Certified Arborist) Equipment: Handwork Personnel: One individual Hours: Area dependent</p> <p>AQ3_OMP #4 Description: Mulch placement over root system Frequency: As required - maintain 50mm-100mm depth Equipment: Handwork - shredded bark, wood chip or pine needles Personnel: One individual Hours: Area dependent</p>	<p><u>INSPECTION / MONITORING</u></p> <p>KEY AREAS OF CONCERN / INSPECTION FREQUENCY:</p> <ul style="list-style-type: none"> • Structural integrity inspection (Annually) • Tree health inspection (Bi-annually) • Girdling at tree grate (Bi-annually) • Pest and disease inspection (Bi-annually) <p>• Inspection and maintenance log</p> <p><u>SPECIALIZED EQUIPMENT / TRAINING</u></p> <p>SPECIALIZED TRAINING:</p> <ul style="list-style-type: none"> • Irrigation systems training • Arborist certification for tree pruning/care 	<p>TRUNK AND CROWN INJURY REPAIRS</p> <ul style="list-style-type: none"> • Pruning • Cabling/bracing • Remove bark <p>ROOTZONE AERATION</p> <ul style="list-style-type: none"> • Vertical mulching or radial aeration <p>NOTES:</p> <ul style="list-style-type: none"> • Irrigation to occur at night or in early morning
	<p>E-2 NATIVE HERBACEOUS PLANTING</p>	<p>E2_OMP #1 Description: Watering Timing: As required (seasonal/temperature dependent) Equipment: Irrigation system / water truck Personnel: One individual Hours: Area dependent</p> <p>E2_OMP #2 Description: Weeding Frequency: As necessary Equipment: Handwork Personnel: One individual Hours: Area dependent</p> <p>E2_OMP #3 Description: Fertilizing Frequency: Once in spring Equipment: Through irrigation system Personnel: One individual Hours: Area dependent</p>	<p><u>INSPECTION / MONITORING</u></p> <p>KEY AREAS OF CONCERN / INSPECTION FREQUENCY:</p> <ul style="list-style-type: none"> • Irrigation and drainage systems - if applicable (As required) • Vegetation density/health/composition (As required) • Plant fertility - Soil testing (As required) • Pest and disease inspection (Bi-annually) <p>• Inspection and maintenance log</p> <p><u>SPECIALIZED EQUIPMENT / TRAINING</u></p> <p>SPECIALIZED EQUIPMENT:</p> <ul style="list-style-type: none"> • Water truck <p>SPECIALIZED TRAINING:</p> <ul style="list-style-type: none"> • Irrigation Systems Training 	<p>PLANT REPLACEMENT</p> <ul style="list-style-type: none"> • As required <p>NOTES:</p> <ul style="list-style-type: none"> • Irrigation to occur at night or in early morning
	<p>E-3 ECOPASSAGES</p>	<p>E3_OMP #1 Description: Clear ecopassage of vegetation, silt and refuse Timing: Bi-annually - Annually Equipment: irrigation system/water truck Personnel: Two Hours: Area dependent</p> <p>E3_OMP #2 Description: Re-establish internal environment Frequency: As necessary Equipment: Visual / handwork Personnel: Two Hours: Area dependent</p>	<p><u>INSPECTION / MONITORING</u></p> <p>KEY AREAS OF CONCERN / INSPECTION FREQUENCY:</p> <ul style="list-style-type: none"> • Unobstructed passageway • Condition of crossing structures • Internal environment of the passageway • Wildlife crossing signage <p>• Inspection and maintenance log</p> <p><u>SPECIALIZED EQUIPMENT / TRAINING</u></p> <p>SPECIALIZED TRAINING:</p> <ul style="list-style-type: none"> • None 	<p>WILDLIFE FENCE</p> <ul style="list-style-type: none"> • Repair or replace as required
	<p>E-4 LIGHT LIMITATION</p>		<p><u>INSPECTION / MONITORING</u></p> <p>KEY AREAS OF CONCERN / INSPECTION FREQUENCY:</p> <ul style="list-style-type: none"> • Light pass into natural heritage areas (Bi-Annually) 	<ul style="list-style-type: none"> • Reorient lighting as required



AIR QUALITY	Green Infrastructure / LID Option	Operations & Maintenance Protocols (OMP)	Inspections Method / Frequency	Repairs / Replacement
	<p>GREEN WALL (AQ-1)</p>	<p>AQ1_OMP #1 Description: Watering Frequency: As required (seasonal / temperature dependent) Note: Irrigation to occur at night or in early morning Equipment: Irrigation system Personnel: One individual Hours: Area dependent</p> <p>AQ1_OMP #2 Description: Weeding Frequency: As necessary Equipment: Handwork Personnel: One individual Hours: Area dependent</p> <p>AQ1_OMP #3 Description: Fertilizing (injection through irrigation system) Frequency: Once in spring Equipment: Irrigation system Personnel: One individual Hours: 1hr/system</p> <p>AQ1_OMP #4 Description: Irrigation start-up and winterization Frequency: Spring and fall Equipment: Air compressor Personnel: One individual Hours: 1hr/system</p>	<p><u>INSPECTION / MONITORING</u></p> <p>KEY AREAS OF CONCERN / INSPECTION FREQUENCY:</p> <ul style="list-style-type: none"> • Structural integrity inspection (Annually) • Irrigation system inspection (Monthly) • Drainage system inspection (Annually or after every rain event >60mm) • Vegetation density / health / composition (Bi-Annually) • Irrigation system testing (Annually) • Plant fertility - Soil testing (Annually) <p>• Inspection and maintenance log</p> <p><u>SPECIALIZED EQUIPMENT / TRAINING</u></p> <p>SPECIALIZED EQUIPMENT:</p> <ul style="list-style-type: none"> • Air compressor (OMP #4) <p>SPECIALIZED TRAINING:</p> <ul style="list-style-type: none"> • Green Wall Maintenance Training • Irrigation Systems Training • Drainage System Training 	<p>PLANT REPLACEMENT</p> <ul style="list-style-type: none"> • To occur under supervision of Green Wall maintenance specialist <p>IRRIGATION SYSTEM REPAIR AND REPLACEMENT</p> <ul style="list-style-type: none"> • By irrigation specialist familiar with green walls
<p>STREET TREES (AQ-2)</p>	<p>AQ2_OMP #1 Description: Removal of garbage and natural debris on or around tree base Timing: Bi-annually (spring / late fall) Equipment: Handwork Personnel: One individual Hours: Dependent on number of trees</p> <p>AQ2_OMP #2 Description: Watering Timing: New trees - weekly, mature trees as required Equipment: Irrigation system (if available) / water truck Personnel: One individual Hours: Dependent on number of trees</p> <p>AQ2_OMP #3 Description: Weeding Frequency: As necessary Equipment: Handwork Personnel: One individual Hours: Dependent on number of trees</p> <p>AQ2_OMP #4 Description: Pruning, pest control & rootzone aeration Frequency: Pruning, pest control & rootzone aeration annually (by Certified Arborist) Equipment: Handwork Personnel: One individual Hours: Dependent on number of trees</p> <p>AQ2_OMP #4 Description: Mulch placement over root system Frequency: As required - maintain 50mm-100mm depth Equipment: Handwork - shredded bark, wood chip or pine needles Personnel: One individual Hours: Dependent on number of trees</p>	<p><u>INSPECTION / MONITORING</u></p> <p>KEY AREAS OF CONCERN / INSPECTION FREQUENCY:</p> <ul style="list-style-type: none"> • Structural integrity inspection (Annually) • Tree health inspection (Bi-annually) • Girdling at tree grate (Bi-annually) • Pest and disease inspection (Bi-annually) <p>• Inspection and maintenance log</p> <p><u>SPECIALIZED EQUIPMENT / TRAINING</u></p> <p>SPECIALIZED TRAINING:</p> <ul style="list-style-type: none"> • Arborist certification for pruning / rootzone aeration 	<p>TRUNK AND CROWN INJURIES</p> <ul style="list-style-type: none"> • Pruning • Cabling/bracing • Remove bark <p>IMPROVE ROOTZONE AERATION</p> <ul style="list-style-type: none"> • Vertical mulching or radial aeration 	



AIR QUALITY	Green Infrastructure / LID Option	Operations & Maintenance Protocols (OMP)	Inspections Method / Frequency	Repairs / Replacement
	<p>PLANTING IN HARD SPACES (AQ-2)</p> <p>AQ-2A (Tree in) Soil Cells</p> <p>AQ-2B (Tree in) Open Planters</p> <p>AQ-2C Planter Boxes / Movable Planters</p> <p>AQ-2D Precast Tree Planters</p>	<p>AQ2A_OMP #1 Description: Removal of litter and debris from tree opening Frequency: Bi-annually Equipment: Handwork Personnel: One individual Hours: Area dependent</p> <p>AQ2A_OMP #2 Description: Sediment removal from tree opening (if required) Frequency: As necessary (>5cm depth) Equipment: Handwork Personnel: One individual Hours: 0.25hrs/tree</p> <p>AQ2A_OMP #3 Description: Pruning Frequency: Annually (by Certified Arborist) Equipment: Handwork/chainsaw Personnel: One individual Hours: 0.25hrs/tree</p> <p>AQ2A_OMP #4 Description: Watering Frequency: Under 2yrs - Weekly, Over 2yrs - as required Equipment: Gatorbags / Water truck Personnel: One individual Hours: 0.25hrs/tree</p> <p>AQ2A_OMP #5 Description: Flush sub-drain (if applicable) Frequency: Annually Equipment: Water Truck Personnel: One individual Hours: System dependent</p> <p>AQ2A_OMP #6 Description: Pest Management Frequency: As required Equipment: Case dependent Personnel: Case dependent Hours: Case dependent</p>	<p>INSPECTION / MONITORING</p> <p>KEY AREAS OF CONCERN / INSPECTION FREQUENCY:</p> <ul style="list-style-type: none"> • Structural integrity of surface treatment (Annually) • Tree opening - Soil settlement (Annually) • Tree opening - Clogging (Spring and fall or after every rain event >60mm) • Sediment accumulation inspection (Bi-annually) • Standing water (Monthly or after every rain event >60mm) • Garbage (Weekly) • Tree <ul style="list-style-type: none"> • Safety (Spring or after every rain event >60mm) • Health (Spring / fall) • Root girdling (Every 4-5 years) • Mulch on root collar (Annually) • Damage from pests and animals (Bi-annually) <p>SOIL CELLS</p> <ul style="list-style-type: none"> • Soil cell structure (only required if facility shown sign of damage due to excessive load) • Air / water Inlet - clogging / proper operation (Annually / after major storms) • Energy dissipation component - proper operation (Annually / after major storms) • Flow restrictor - proper operation (Annually / after major storm) • Distribution pipe - proper operation (Annually) • Underdrain pipe - proper operation (Annually) <p>• Inspection and maintenance log</p> <p>SPECIALIZED EQUIPMENT / TRAINING</p> <p>SPECIALIZED EQUIPMENT:</p> <ul style="list-style-type: none"> • Chainsaw (OMP #3) • Gatorbags (OMP #4) • Water truck & hose (OMP #4) <p>SPECIALIZED TRAINING:</p> <ul style="list-style-type: none"> • Inspection and cleanout procedures • Sediment removal procedure • Sub-drain flushing procedure • Identification of monuments and extent of facility • Soil cell repair training 	<p>STRUCTURAL SOIL CLOGGING</p> <ul style="list-style-type: none"> • Remove and replace top 15cm of soil to alleviate fine texture clogging: as necessary <p>POOR PLANT GROWTH</p> <ul style="list-style-type: none"> • Replace top 5cm of soil with compost: as necessary • Amend soil with limestone or compost/sulphur to raise or lower pH of soil as required. Soil should have a pH of 6.0-7.8 • Replace dead/ diseased trees: as required <p>SALT ACCUMULATION</p> <ul style="list-style-type: none"> • Flush with fresh water to alleviate excess salt in the soil: as necessary <p>ACCESS TO UTILITIES</p> <ul style="list-style-type: none"> • Remove and reuse panels or remove and replace as necessary in accordance with manufacturers recommendations
<p>AQ-3 PHOTOCATALYTIC PAVING</p>	<p>AQ3_OMP #1 Description: Sweep Frequency: Annually (Spring) Equipment: Mechanical Sweeper Personnel: One Individual Hours: Area dependent</p>	<p>INSPECTION / MONITORING</p> <p>KEY AREAS OF CONCERN / INSPECTION FREQUENCY:</p> <ul style="list-style-type: none"> • Structural integrity inspection (Annually) • Inspection and maintenance log <p>SPECIALIZED EQUIPMENT / TRAINING</p> <p>SPECIALIZED EQUIPMENT:</p> <ul style="list-style-type: none"> • Mechanical sweeper <p>SPECIALIZED TRAINING:</p> <ul style="list-style-type: none"> • Training on mechanical sweeper 	<p>RESURFACING (As necessary)</p>	



	Green Infrastructure / LID Option	Operations & Maintenance Protocols (OMP)	Inspections/Monitoring	Repairs / Replacement
GREENHOUSE GAS EMISSIONS / ENERGY EFFICIENCY	GHG-1 LED Lights	GHG1_OMP #1 Maintenance agreement with utility owner	<u>INSPECTION / MONITORING</u> KEY AREAS OF CONCERN / INSPECTION FREQUENCY: • Proper functioning of lights (Annually)	Replace as necessary
	GHG-2 Solar Photovoltaic Panels	GHG2_OMP #1 Maintenance agreement with utility owner	<u>INSPECTION / MONITORING</u> KEY AREAS OF CONCERN / INSPECTION FREQUENCY: • Proper functioning of solar photovoltaic panels (Annually)	Repair or replace as necessary
	GHG-3 Solar Roads	GHG3_OMP #1 Maintenance agreement with utility owner	<u>INSPECTION / MONITORING</u> KEY AREAS OF CONCERN / INSPECTION FREQUENCY: • Proper functioning of solar roads (Annually)	Repair and replace as necessary
	GHG-4 Solar Paving Lights	GHG4_OMP #1 Maintenance agreement with utility owner	<u>INSPECTION / MONITORING</u> KEY AREAS OF CONCERN / INSPECTION FREQUENCY: • Proper functioning of paver lights (Annually)	Repair or replace as necessary
	GHG-5 Photoluminescent Road Markings	GHG5_OMP #1	<u>INSPECTION / MONITORING</u> KEY AREAS OF CONCERN / INSPECTION FREQUENCY: • Visibility of photoluminescing properties	Repaint as necessary
	GHG-6 Wind Energy	GHG6_OMP #1 Maintenance agreement with utility owner	<u>INSPECTION / MONITORING</u> KEY AREAS OF CONCERN / INSPECTION FREQUENCY: • Proper functioning of wind mill	Repair or replace as necessary
	GHG-7 Cool Pavements	GHG7_OMP #1 Description: Sweep Frequency: Annually (Spring) Equipment: Mechanical Sweeper Personnel: One Individual Hours: Area dependent	<u>INSPECTION / MONITORING</u> KEY AREAS OF CONCERN / INSPECTION FREQUENCY: • Structural integrity inspection (Annually) • Inspection and maintenance log <u>SPECIALIZED EQUIPMENT / TRAINING</u> SPECIALIZED EQUIPMENT: • Mechanical sweeper SPECIALIZED TRAINING: • Training on mechanical sweeper	RESURFACING (As necessary)



WATER - QUALITY, QUANTITY AND EFFICIENCY	Green Infrastructure / LID Option	Operations & Maintenance Protocols (OMP)	Inspections/Monitoring	Repairs / Replacement
	<p>BIORETENTION (WQ-A)</p> <p>WQ-1 Bioretention Planters</p> <p>WQ-2 Stormwater Planters</p> <p>WQ-3 Bioretention Curb Extensions / Bump-Outs</p> <p>WQ-4 Bioretention Cells</p> <p>WQ-5 Rain Gardens</p>	<p>WQA_OMP #1 Description: Inspect & clean inlets Timing: Bi-annually (spring / late fall) Equipment: Handwork Personnel: One individual Hours: 0.25hrs/inlet</p> <p>WQA_OMP #2 Description: Cultivate surface and weed planting bed Timing: Once in spring Equipment: Handwork Personnel: One individual Hours: 0.25hrs/linear metre</p> <p>WQA_OMP #3 Description: Removal of litter and debris Frequency: Bi-annually (to coincide with routine plant maintenance) Equipment: Handwork Personnel: One individual Hours: 0.10hrs/linear metre</p> <p>WQA_OMP #4 Description: Sweep contributing areas and remove sediment from pretreatment (if applicable) Frequency: Bi-annually to Annually Equipment: Mechanical sweeper / handwork Personnel: One individual Hours: Area dependent</p> <p>WQA_OMP #5 Description: Pruning Frequency: Prune annually (by Certified Arborist) Equipment: Handwork Personnel: One individual Hours: 0.25hrs/linear metre</p> <p>WQA_OMP #6 Description: Watering Frequency: Bi-weekly through establishment only (modify schedule in periods of wet) Equipment: Water truck Personnel: One individual Hours: 0.25hrs/linear metre</p> <p>WQA_OMP #7 Description: Redistribute mulch to maintain >5 cm depth throughout Frequency: Quarterly Equipment: Handwork / rake Personnel: One individual Hours: 0.25hrs/linear metre</p> <p>WQA_OMP #8 Description: Flush sub-drain (if applicable) Frequency: Annually Equipment: Water truck & hose Personnel: One individual Hours: 0.25hrs /sub-drain segment</p>	<p>INSPECTION / MONITORING</p> <p>KEY AREAS OF CONCERN / INSPECTION FREQUENCY:</p> <ul style="list-style-type: none"> Contributing drainage area condition (Bi-annually) Inlet structural integrity / obstruction / erosion (Annually) Inlet sediment accumulation (Bi-annually) Pretreatment sediment accumulation inspection (Bi-annually) Side slope erosion (Annually) Surface ponding - Perimeter / Filter bed (Annually) Standing water - Filter bed (Monthly through warranty period, Bi-annually beyond warranty) Garbage (Bi-annually) Filter bed erosion/sediment accumulation/surface sinking (Monthly through warranty period, Bi-annually beyond warranty) Mulch depth (Annually) Vegetation density / health / composition (Bi-annually) Monitoring well condition (Annually) Overflow outlet obstruction (Monthly through warranty period, Bi-annually beyond warranty) Sub-drain obstruction (Monthly through warranty period, Bi-annually beyond warranty) Sediment accumulation testing (Bi-annually) <p>SPECIALIZED EQUIPMENT / TRAINING</p> <p>SPECIALIZED EQUIPMENT:</p> <ul style="list-style-type: none"> Inspection and maintenance log Quantitative flow monitoring Water quality monitoring <p>SPECIALIZED TRAINING:</p> <ul style="list-style-type: none"> Mechanical sweeper (OMP #4) Water truck & hose (OMP #6) Vacuum truck Inspection and cleanout procedures Drainage system training Sediment removal procedure Sub-drain flushing procedure Arborist certification for tree pruning/care 	<p>MULCH REPLACEMENT</p> <ul style="list-style-type: none"> Add mulch to maintain 5-10 cm depth: Every two years <p>SURFACE PONDING</p> <ul style="list-style-type: none"> Remove accumulated sediment and till filter media to 20 cm. If unsuccessful remove and replace plant material along with top 15cm of filter media. <p>CONCENTRATION OF FLOWS</p> <ul style="list-style-type: none"> Add flow spreading device or regrade existing to level: as required <p>FILTER MEDIA CLOGGING</p> <ul style="list-style-type: none"> Remove mulch and plantings. Core aerate to 30 cm and replace with non-compacted filter media: as necessary <p>POOR PLANT GROWTH</p> <ul style="list-style-type: none"> Remove mulch, replace top 5 cm of filter media with compost and restore 5 to 10 cm of mulch, as necessary Amend soil with limestone or compost/sulphur to raise or lower pH of soil as required. Soil should have a pH of 6.0-7.8 Replace dead/diseased plant material: Bi-annually-Annually <p>SALT ACCUMULATION</p> <ul style="list-style-type: none"> Flush with fresh dechlorinated water to alleviate excess salt in the soil: as necessary <p>SEDIMENT ACCUMULATION</p> <ul style="list-style-type: none"> Remove accumulated sediment with vacuum truck. In extreme cases remove plant material and top 5 cm of contaminated filter media. Replace with 5 cm of new filter media and plant material, if necessary. <p>OBSTRUCTED SUB-DRAIN (if applicable)</p> <ul style="list-style-type: none"> Snake or vacuum truck to remove obstruction: as required.



WATER - QUALITY, QUANTITY AND EFFICIENCY	Green Infrastructure / LID Option	Operations & Maintenance Protocols (OMP)	Inspections/Monitoring	Repairs / Replacement
	<p>SWALES (WQ-B)</p> <p>WQ-6 Enhanced Grass Swale</p> <p>WQ-7 Bioswale / Dry Swale</p>	<p>WQB_OMP #1 Description: Inspect & clean inlets Timing: Bi-annually (Spring & Fall) Equipment: Handwork Personnel: One individual Hours: 0.10hrs/inlet</p> <p>WQB_OMP #2 Description: Removal of litter and debris Frequency: Bi-annually Equipment: Handwork Personnel: One individual Hours: 0.10hrs/linear metre</p> <p>WQB_OMP #3 Description: Sweep contributing areas and remove sediment from pretreatment Frequency: Bi-annually Equipment: Mechanical sweeper / handwork Personnel: One individual Hours: Area dependent</p> <p>WQB_OMP #4 Description: Mowing (if applicable) Frequency: Bi-monthly or as required (do not mow in wet conditions) Equipment: Light weight riding mower Personnel: One individual Hours: 1hr/hectare</p> <p>WQB_OMP #5 Description: Weeding Frequency: Weed bi-annually Equipment: Handwork Personnel: One individual Hours: Area dependent</p> <p>WQB_OMP #6 Description: Pruning (if applicable) Frequency: Prune annually (by Certified Arborist) Equipment: Handwork Personnel: One individual Hours: Area dependent</p> <p>WQB_OMP #7 Description: Watering Frequency: Bi-weekly through establishment only (modify schedule in periods of wet) Equipment: Water truck Personnel: One individual Hours: 1hr/hectare</p> <p>WQB_OMP #8 Description: Redistribute mulch to maintain >5 cm depth throughout (if applicable) Frequency: Bi-annually Equipment: Handwork / rake Personnel: One individual Hours: 0.25hrs /linear metre</p> <p>WQB_OMP #9 Description: Flush sub-drain (if applicable) Frequency: Annually Equipment: Water truck & hose Personnel: One individual Hours: 0.25hrs /subdrain</p>	<p>INSPECTION / MONITORING</p> <p>KEY AREAS OF CONCERN / INSPECTION FREQUENCY:</p> <ul style="list-style-type: none"> • Contributing drainage area condition (Bi-annually) • Inlet structural integrity / obstruction / erosion (Annually) • Inlet sediment accumulation (Bi-annually) • Pretreatment sediment accumulation inspection (Bi-annually) • Side slope erosion (Annually) • Surface ponding - Perimeter / Filter bed (Annually) • Standing water - Filter bed (Monthly through warranty period, Bi-annually beyond warranty) • Garbage (Bi-annually) • Filter bed erosion/sediment accumulation/surface sinking (Monthly through warranty period, Bi-annually beyond warranty) • Check dam condition and function (Annually) • Mulch depth (Annually) • Vegetation density / health / composition (Bi-annually) • Monitoring well condition (Annually) • Overflow outlet obstruction (Monthly through warranty period, Bi-annually beyond warranty) • Sub-drain obstruction (Monthly through warranty period, Bi-annually beyond warranty) • Sediment accumulation testing (Bi-annually) <p>• Inspection and maintenance log • Quantitative flow monitoring • Water quality monitoring</p> <p>SPECIALIZED EQUIPMENT / TRAINING</p> <p>SPECIALIZED EQUIPMENT:</p> <ul style="list-style-type: none"> • Aerator • Mechanical sweeper (OMP #3) • Light weight riding mower or mulching mower (OMP #4) • Water truck & hose (OMP #7 & #9) <p>SPECIALIZED TRAINING:</p> <ul style="list-style-type: none"> • Inspection and cleanout procedures • Aerator operation • Mower operation • Flushing of subdrain procedures • Arborist certification for tree pruning/care 	<p>BARE SOIL AREAS</p> <ul style="list-style-type: none"> • Reseed bare soil areas: Bi-annually-Annually • Add mulch (maintain 5-10 cm depth) planted bioswales: Every two years <p>POOR PLANT GROWTH</p> <ul style="list-style-type: none"> • Replace top 5 cm of topsoil with compost: as necessary • Amend soil with limestone or compost/sulphur to raise or lower pH of soil as required. Soil should have a pH of 6.0-7.8 • Replace dead/ diseased plant material (if applicable): Bi-annually-Annually <p>EROSION AREAS</p> <ul style="list-style-type: none"> • Regrade & replant eroded areas: As necessary • Add flow spreading or turf reinforcing device: if required <p>SEDIMENT ACCUMULATION</p> <ul style="list-style-type: none"> • Remove sediment accumulation >5 cm depth with rake and shovel where feasible: as necessary <p>COMPACTED SOILS</p> <ul style="list-style-type: none"> • Core aerate; or remove stone and vegetation cover and till topsoil to a depth of 20 cm; or remove and replace with non-compacted filter media or topsoil that meets design specifications - once every 3-5 years <p>SALT ACCUMULATION</p> <ul style="list-style-type: none"> • Flush with fresh water to alleviate excess salt in the soil: as necessary <p>SURFACE PONDING</p> <ul style="list-style-type: none"> • Remove accumulated sediment. Till filter media to 20 cm or remove and replace top 15 cm of filter media: as necessary



	Operations & Maintenance Protocols (OMP)	Inspections/Monitoring	Repairs / Replacement
WATER - QUALITY, QUANTITY AND EFFICIENCY GUTTERS (WQ-C) WQ-8 Green Gutter	WQC_OMP #1 Description: Inspect & Clean Inlets Frequency: Bi-annually (spring / late fall) Equipment: Handwork Personnel: One individual Hours: 0.10hrs/inlet	INSPECTION / MONITORING KEY AREAS OF CONCERN / INSPECTION FREQUENCY: <ul style="list-style-type: none"> Contributing drainage area condition (Bi-annually) Inlet structural integrity/obstruction/erosion (Annually) Pretreatment sediment accumulation inspection (Bi-annually) Standing water (Monthly through warranty period, Bi-annually beyond warranty) Garbage (Bi-annually) Engineered soil erosion/sediment accumulation/surface sinking(Monthly through warranty period, Bi-annually beyond warranty) Vegetation density/health/composition (Bi-annually) Overflow outlet structure (Monthly through warranty period, Bi-annually beyond warranty) Sediment accumulation testing (Bi-annually) • Inspection and maintenance log • Quantitative flow monitoring SPECIALIZED EQUIPMENT / TRAINING SPECIALIZED EQUIPMENT: <ul style="list-style-type: none"> Vacuum / JetVac SPECIALIZED TRAINING: <ul style="list-style-type: none"> Inspection and cleanout procedure Sediment removal procedure 	BARE SOIL AREAS <ul style="list-style-type: none"> Reseed bare soil areas: Bi-annually-Annually EROSION AREAS <ul style="list-style-type: none"> Regrade & replant eroded areas: As necessary Add flow spreading or turf reinforcing device as required SEDIMENT ACCUMULATION <ul style="list-style-type: none"> Remove sediment accumulation >5 cm depth with rake and shovel where feasible: as necessary SALT ACCUMULATION <ul style="list-style-type: none"> Flush with fresh water to alleviate excess salt in the soil: as necessary SURFACE PONDING <ul style="list-style-type: none"> Remove accumulated sediment. Till filter media to 30 cm or remove and replace top 15 cm of filter media, as necessary.
	WQC_OMP #2 Description: Removal of litter and debris Frequency: Twice per year (min.) Equipment: Handwork Personnel: One individual Hours: 0.10hrs/linear metre		
WQC_OMP #3 Description: Sediment removal (pretreatment) Frequency: Annually Equipment: Handwork Personnel: One individual Hours: 0.25hrs/linear metre			
WQ-9 Filter Strip / Buffer Strip	WQD_OMP #1 Description: Inspect & clean inlets Timing: Bi-annually Equipment: Handwork Personnel: One individual Hours: 0.5hrs/facility	INSPECTION / MONITORING KEY AREAS OF CONCERN / INSPECTION FREQUENCY: <ul style="list-style-type: none"> Contributing drainage area condition (Bi-annually) Inlet structural integrity/obstruction/erosion (Annually) Standing water (Monthly through warranty period, Bi-annually beyond warranty) Garbage (Bi-annually) Filter bed erosion/sediment accumulation/surface sinking (Monthly through warranty period, Bi-annually beyond warranty) Vegetation density/health/composition (Annually) Overflow outlet obstruction (Annually) • Inspection and maintenance log • Water quality monitoring SPECIALIZED EQUIPMENT / TRAINING SPECIALIZED EQUIPMENT: <ul style="list-style-type: none"> Water truck (OMP #2) Lightweight mower or mulching mower (OMP #3) SPECIALIZED TRAINING: <ul style="list-style-type: none"> Inspection and cleanout procedure Sediment removal procedure 	BARE SOIL AREAS <ul style="list-style-type: none"> Reseed bare soil areas: Bi-annually-Annually CONCENTRATION OF FLOWS <ul style="list-style-type: none"> Realign pretreatment stones (if applicable):Quarterly - Bi-annually Replenish stone cover (if applicable) to maintain 5-10cm cover in non vegetated areas. Add flow spreading device or regrade existing to level: as required FILTER MEDIA CLOGGING <ul style="list-style-type: none"> Core aerate and replace with non-compacted topsoil: every 3-5 years Remove and replace top 15cm of topsoil to alleviate fine texture clogging: as necessary POOR PLANT GROWTH <ul style="list-style-type: none"> Amend top 5cm of topsoil with compost: as necessary Amend soil with limestone or compost/sulphur to raise or lower pH of soil as required. Soil should have a pH of 6.0-7.8 Replace dead/ diseased plant material: Bi-annually-Annually SALT ACCUMULATION <ul style="list-style-type: none"> Flush with fresh water to alleviate excess salt in the soil: as necessary SEDIMENT ACCUMULATION <ul style="list-style-type: none"> Remove plant material and top 15cm of contaminated topsoil. Replace with 15cm of new topsoil and plant material: as necessary
	WQD_OMP #2 Description: Watering Frequency: As required (May-September) Equipment: Water truck Personnel: One individual Hours: 0.25hrs /facility		
	WQD_OMP #3 Description: Mowing (5-10cm ht) Frequency: Monthly - Bi-monthly Equipment: Lightest mower or mulching mower available (do not mow in wet conditions) Personnel: One individual Hours: 0.25hrs/facility		
	WQD_OMP #4 Description: Removal of litter and debris Frequency: Quarterly - Semi-annually Equipment: Handwork Personnel: One individual Hours: 0.25hrs/facility		
	WQD_OMP #5 Description: Sediment removal (pretreatment) Frequency: Bi-annually - Annually Equipment: Handwork Personnel: One individual Hours: 0.25hrs/facility		
	WQD_OMP #6 Description: Remove undesirable species Frequency: Quarterly - Bi-annually Equipment: Handwork Personnel: One individual Hours: 0.5hrs/facility		
	WQD_OMP #7 Description: Tree/shrub pruning Frequency: Annually Equipment: Handwork (by Certified Arborist) Personnel: One individual Hours: 0.5hrs/facility		



WATER - QUALITY, QUANTITY AND EFFICIENCY	Green Infrastructure / LID Option	Operations & Maintenance Protocols (OMP)	Inspections/Monitoring	Repairs / Replacement
	<p>UNDERGROUND INFILTRATION SYSTEMS (WQ-E)</p> <p>WQ-10 Drainage Well</p> <p>WQ-11 Perforated Pipe</p> <p>WQ-12 Soakaway</p> <p>WQ-13 Infiltration Trench</p> <p>WQ-14 Infiltration Chamber</p>	<p>WQE_OMP #1 Description: Removal of litter and debris from contributing drainage area, inlets, pretreatment devices and overflow outlets Frequency: Quarterly - Bi-annually Equipment: Handwork Personnel: Two Hours: 1hr/facility</p> <p>WQE_OMP #2 Description: Reseed bare soil in contributing areas (if applicable) Frequency: Bi-annually - Annually Equipment: Handwork Personnel: One individual Hours: Area dependent</p> <p>WQE_OMP #3 Description: Removal accumulated sediment (Inlets/outlets/control structure) Frequency: Bi-annually - Annually Equipment: Handwork Personnel: One individual Hours: 1hr/facility</p> <p>WQE_OMP #4 Description: Removal accumulated sediment (sub-drain) Frequency: Annually Equipment: Vacuum/JetVac Personnel: Two Hours: System dependent</p> <p>WQE_OMP #5 Description: Removal of oil and grease from pretreatment device (if applicable) Frequency: As needed Equipment: Vacuum Truck Personnel: One Individual Hours: 0.5hrs/facility</p>	<p>INSPECTION KEY AREAS OF CONCERN / INSPECTION FREQUENCY:</p> <ul style="list-style-type: none"> Contributing drainage area condition (Bi-annually) Inlet structural integrity / obstruction (Annually) Pretreatment sediment accumulation (Bi-annually) Filter bed erosion/sediment accumulation (Annually) Control structure condition and sediment accumulation (Annually) Monitoring well condition (Annually) Overflow outlet obstruction (Monthly through warranty period, Annually beyond warranty) Sub-drain obstruction (Monthly through warranty period, Annually beyond warranty) <p>MONITORING</p> <ul style="list-style-type: none"> Monitoring well condition (Annually) Monitor flows - Flow meters - inlet/outlet (if applicable) Inspection and maintenance log <p>SPECIALIZED EQUIPMENT / TRAINING</p> <p>SPECIALIZED EQUIPMENT:</p> <ul style="list-style-type: none"> Vacuum / JetVac (OMP #4) <p>SPECIALIZED TRAINING:</p> <ul style="list-style-type: none"> Inspection and cleanout procedure Sediment removal procedure Oil and grease removal and disposal training Confined space entry training 	<p>CLOGGING</p> <ul style="list-style-type: none"> Remove accumulated sediment from when >5 cm depth or obstructing inflow into the system with hydrovac truck Add pretreatment device to prevent debris from entering the facility Snake or pressure vacuum to remove sub-drain obstructions. Replace missing or damaged sub-drain caps <p>CONTROL STRUCTURE/PIPE CONNECTION LEAK</p> <ul style="list-style-type: none"> Drain facility and repair/seal leak <p>NOTES:</p> <ul style="list-style-type: none"> Prohibit storage of soil, compost, sand, salt or unwashed granular in contributing drainage area and inlets
<p>PERMEABLE PAVEMENT (WQ-F)</p> <p>WQ-15i Pervious Concrete</p> <p>WQ-15ii Porous Asphalt</p> <p>WQ-15iii Permeable Interlocking Concrete Pavers</p>	<p>WQF_OMP #1 Description: Removal of litter and debris Frequency: Quarterly - Bi-annually Equipment: Handwork Personnel: One individual Hours: 0.25hrs/Area dependent</p> <p>WQF_OMP #2 Description: Remove accumulated surface sediment (sweep or vacuum) Frequency: Bi-annually - Annually Equipment: High efficiency regenerative air or pure vacuum sweeper Personnel: One individual Hours: Area dependent</p> <p>WQF_OMP #3 Description: Replace / top up joint material (if applicable) Frequency: Bi-annually Equipment: Handwork Personnel: One individual Hours: Area dependent</p> <p>WQF_OMP #4 Description: Repaint parking space divisions (if applicable) Frequency: Every three years Equipment: Road marking machine Personnel: Two Hours: Area dependent</p> <p>WQF_OMP #5 Description: Flush sub-drain (if applicable) Frequency: Annually Equipment: Handwork Personnel: One individual Hours: 0.25hrs/facility</p> <p>WQF_OMP #6 Description: Snow removal Frequency: As required Equipment: Snow plow (to be raised 0.6 cm above surface) Personnel: As required Hours: Area dependent</p>	<p>INSPECTION / MONITORING KEY AREAS OF CONCERN / INSPECTION FREQUENCY:</p> <ul style="list-style-type: none"> Contributing drainage area condition (Bi-annually) Standing water (Bi-annually) Garbage (Quarterly) Pavement surface condition/sediment accumulation (Annually) Monitoring well condition (Annually) Subdrain / overflow obstruction (Annually) Control structure condition / sediment accumulation (Annually) <p>• Inspection and maintenance log</p> <p>• Quantitative flow monitoring</p> <p>SPECIALIZED EQUIPMENT / TRAINING</p> <p>SPECIALIZED EQUIPMENT:</p> <ul style="list-style-type: none"> Mobile sweeper / Vacuum / JetVac (OMP #2) Road marking machine (OMP #4) Snow plow (OMP #6) <p>SPECIALIZED TRAINING:</p> <ul style="list-style-type: none"> Sediment removal procedure Road marking procedure Snow plowing procedure for Permeable Paving 	<p>CRACKED / MISSING PAVEMENT</p> <ul style="list-style-type: none"> Fill with materials consistent with original (if applicable) For large potholes, cut and replace surface layer (if applicable) Replace or reset unit pavers (if applicable) <p>SURFACE PONDING</p> <ul style="list-style-type: none"> Sweep/vacuum thoroughly Pressure wash or wire brush may also be required for heavily clogged areas <p>SUBDRAIN OBSTRUCTION</p> <ul style="list-style-type: none"> Snake or pressure vacuum for removal: as required <p>NOTE:</p> <ul style="list-style-type: none"> Prohibit access by construction vehicles Prohibit storage of snow, soil, compost, sand, salt or unwashed granular Adjacent landscape areas must be covered with vegetation with no soil runoff possibility Minimize application of deicers 	



WATER - QUALITY, QUANTITY AND EFFICIENCY	Green Infrastructure / LID Option	Operations & Maintenance Protocols (OMP)	Inspections/Monitoring	Repairs / Replacement
	<p>STORMWATER TREE PITS / TRENCHES (WQ-H)</p> <p>WQ-16 Stormwater Tree Pits</p> <p>WQ-17 Stormwater Tree Trenches</p>	<p>WQG_OMP #1 Description: Inspect & clean inlets Timing: Bi-annually (Spring / late fall) Equipment: Handwork Personnel: One individual Hours: 0.25hrs/inlet</p> <p>WQG_OMP #2 Description: Cultivate surface and weed planting bed Timing: Once in spring Equipment: Handwork Personnel: One individual Hours: 0.25hrs/linear metre</p> <p>WQG_OMP #3 Description: Removal of litter and debris Frequency: Bi-annually (to coincide with routine plant maintenance) Equipment: Handwork Personnel: One individual Hours: 0.10hrs/linear metre</p> <p>WQG_OMP #4 Description: Sweep contributing areas and remove sediment from pretreatment (if applicable) Frequency: Bi-annually to Annually Equipment: Mechanical sweeper / handwork Personnel: One individual Hours: Area dependent</p> <p>WQG_OMP #5 Description: Pruning Frequency: Prune annually (by Certified Arborist) Equipment: Handwork Personnel: One individual Hours: 0.25hrs/linear metre</p> <p>WQG_OMP #6 Description: Watering Frequency: Bi-weekly through establishment only (modify schedule in periods of wet) Equipment: Water truck Personnel: One individual Hours: 0.25hrs/linear metre</p> <p>WQG_OMP #7 Description: Redistribute mulch to maintain >5cm depth throughout Frequency: Quarterly Equipment: Handwork / rake Personnel: One individual Hours: 0.25hrs/linear metre</p> <p>WQG_OMP #8 Description: Flush sub-drain (if applicable) Frequency: Annually Equipment: Water truck & hose Personnel: One individual Hours: 0.25hrs /sub-drain segment</p>	<p>INSPECTION / MONITORING</p> <p>KEY AREAS OF CONCERN / INSPECTION FREQUENCY:</p> <ul style="list-style-type: none"> Contributing drainage area condition (Bi-annually) Inlet structural integrity / obstruction / erosion (Annually) Inlet sediment accumulation (Bi-annually) Pretreatment sediment accumulation inspection (Bi-annually) Standing water - Filter bed (Monthly through warranty period, Bi-annually beyond warranty) Garbage (Bi-annually) Filter bed erosion/sediment accumulation/surface sinking (Monthly through warranty period, Bi-annually beyond warranty) Mulch depth (Annually) Sediment accumulation testing (Bi-annually) Tree pit guard (Annually) <p>• Inspection and maintenance log • Quantitative flow monitoring • Water quality monitoring</p> <p>SPECIALIZED EQUIPMENT / TRAINING</p> <p>SPECIALIZED EQUIPMENT:</p> <ul style="list-style-type: none"> Mechanical sweeper (OMP #4) Water truck & hose (OMP #7 & #9) <p>SPECIALIZED TRAINING:</p> <ul style="list-style-type: none"> Inspection and cleanout procedures Sediment removal procedure Sub-drain flushing procedure Arborist certification for tree pruning and care 	<p>MULCH REPLACEMENT</p> <ul style="list-style-type: none"> Add mulch (maintain 5-10 cm depth): Every two years <p>SURFACE PONDING</p> <ul style="list-style-type: none"> Remove accumulated sediment. Till filter media to 20 cm or remove and replace top 15 cm of filter media: as necessary <p>FILTER MEDIA CLOGGING (If applicable)</p> <ul style="list-style-type: none"> Remove mulch and plantings. Core aerate to 20 cm and replace with non-compacted filter media: as necessary <p>POOR PLANT GROWTH</p> <ul style="list-style-type: none"> Remove mulch, replace top 5 cm of filter media with compost and restore 5 to 10 cm of mulch, as necessary Amend soil with limestone or compost/sulphur to raise or lower pH of soil as required. Soil should have a pH of 6.0-7.8 Replace dead/ diseased plant material: Bi-annually-Annually <p>SALT ACCUMULATION</p> <ul style="list-style-type: none"> Flush with fresh water to alleviate excess salt in the soil: as necessary <p>SEDIMENT ACCUMULATION</p> <ul style="list-style-type: none"> Remove accumulated sediment with vacuum truck. In extreme cases remove plant material and top 5 cm of contaminated filter media. Replace with 5 cm of new filter media and plant material, if necessary.
<p>RAINWATER HARVESTING (WQ-G)</p> <p>WQ-18 Rain Cistern</p>	<p>WQH_OMP #1 Description: Removal of litter, debris and sediment from contributing drainage area, inlets, pretreatment devices and overflow outlets Frequency: Quarterly - Bi-Annually Equipment: Visual / handwork/ snake or pressure/vacuum Personnel: Two Hours: 1hr/facility</p> <p>WQH_OMP #2 Description: Prune trees in contributing areas Frequency: Annually Equipment: Handwork / Chainsaw (by Certified Arborist) Personnel: Two Hours: Area dependent</p> <p>WQH_OMP #3 Description: Removal accumulated sediment (cistern) Frequency: Annually Equipment: Pressure washer and Vacuum/JetVac Personnel: Two individual Hours: System dependent</p>	<p>INSPECTION / MONITORING</p> <p>KEY AREAS OF CONCERN / INSPECTION FREQUENCY:</p> <ul style="list-style-type: none"> Contributing drainage area condition (Bi-annually) Inlet structural integrity / obstruction(Annually) Pretreatment sediment accumulation inspection (Bi-annually) Overflow outlet obstruction (Annually) Control structure condition (Annually) Cistern structural integrity/sediment accumulation (Annually or as required) Cistern water quality monitoring (turbidity, discoloration) Cistern pump testing <p>• Inspection and maintenance log</p> <p>SPECIALIZED EQUIPMENT / TRAINING</p> <p>SPECIALIZED EQUIPMENT:</p> <ul style="list-style-type: none"> Chainsaw (OMP #2) Pressure washer / Vacuum / JetVac (OMP #3) <p>SPECIALIZED TRAINING:</p> <ul style="list-style-type: none"> Sediment removal procedure 	<p>INLET PIPE DAMAGE/DISPLACEMENT</p> <ul style="list-style-type: none"> Repair or replace <p>CISTERN CRACK OR LEAK</p> <ul style="list-style-type: none"> Repair in accordance with manufacturers specification <p>CISTERN PUMP OR MAKE-UP WATER SUPPLY MALFUNCTION</p> <ul style="list-style-type: none"> Identify cause and repair in coordination with manufacturer/vendor, licensed plumber or electrician. <p>OUTLET OBSTRUCTION</p> <ul style="list-style-type: none"> Snake or vacuum. 	



G.0

APPENDIX G - FOUNDATIONAL WORK

Part I | Foundation and Framework (April to November 2015)

1. Work session with Complete Streets team
2. City staff & stakeholder interviews
 - 31 interviews
 - 10 departments
 - Engineering and Construction Services
 - Business Improvement Standards – Engineering Support Services
 - Toronto Water
 - City Planning
 - Transportation Services
 - Parks, Forestry and Recreation
 - Toronto Parking Authority
 - Economic Development and Culture - BIA
 - Forestry Operations
3. Product supplier interviews
4. Precedent research

Part II | Exploration and Evaluation of Opportunities (May 2015 to January 2016)

1. Review meetings with project team and Advisory Group
2. Working group presentations

Part III | Green Streets Technical Guidelines (January 2016 to August 2017)

1. Complete Streets integration
2. Generation of a long list of green infrastructure options, refinement to a shortlist of options
3. Development of an green infrastructure Selection Tool and a Vegetation Selection Tool
4. Preparation of Technical Drawings
5. Preparation of the Technical Guideline Document - including Operations and Maintenance Manual
6. Working and Advisory Group review sessions
7. Senior Staff review

SUMMARY OF CONSULTATION PROCESS

City of Toronto
Green Streets Technical Guidelines



INTERVIEW SESSIONS SUMMARY MATRIX

Schollen & Company Inc. / TMIG / UFA / Bousfields Inc. / DPM
 October 2015

Comments				
Document Format / Contents	<ul style="list-style-type: none"> Document should be concise and simple Provide index for ease of use Provide table of contents (not necessarily numbered) Provide matrix for plant species selection Post document on the internet – City has requirements Format should integrate with City’s standard specification format Guidelines should be structured like specifications Maintenance recommendations Recommendations related to requirements for up front testing should be provided 	<ul style="list-style-type: none"> Material testing and specifications should be provided Specify standard bioretention soil mix Guidance for developers – LID applications Cost/benefit summary should be provided Existing conditions graphic versus targeted system Screening tool should address: <ul style="list-style-type: none"> proximity to building depth to subsurface structures “Pull-out” sheets for maintenance 	<ul style="list-style-type: none"> Map out implementation process Provide realistic cost estimate (per linear metre) Provide funding recommendations PPT showing what has already been done “Green Street” examples Standards for planting specifications should be provided 	
Integration	<ul style="list-style-type: none"> Guidelines will need to integrate with: <ul style="list-style-type: none"> Urban Design Streetscape Guideline Healthy Street Guideline – Active Living Design Guideline Bikeway Guideline By-laws for boulevard treatments Specification format City standard drawings Utility standards and specifications Toronto Green Standard Urban forest details Streetscape details Beautiful Streets Toronto Draft BMP Guideline 	<ul style="list-style-type: none"> Fully integrated with capital planning process Integration with NHS Integration with BIA initiatives Other publications: <ul style="list-style-type: none"> TAC Manual for Greener Roads (TAC Manual Addresses Climate Change) 		
Street Typologies	<ul style="list-style-type: none"> Street Typologies - There is a need to sub-classify to address driveway and on-street parking configurations. Suburban streets verses urban streets present different opportunities Rural cross-sections – Definitely a City policy (or practice), they exist in the City. 	<ul style="list-style-type: none"> Rolled curbs – Toronto does not have this as a standard detail. Standard sub-drain below curb – could be a SWM initiative. Permeable pavers in laneways are good candidates for Green Streets. 	<ul style="list-style-type: none"> The design standards for roads will need to be changed to accommodate ‘Green Streets’ initiatives. There is more opportunity in the suburbs compared to the downtown area. The standard location of utilities may require changes. 	

SUMMARY OF CONSULTATION PROCESS

Comments			
Challenges	<ul style="list-style-type: none"> • There is need for integration with by-laws for boulevard treatments • ‘Silva Cells’ have been installed but they are laboursome to install correctly and are expensive. There is a need for a better ‘Silva Cell’ solution • Use of unshrinkable fill (City’s standard requirement) increases extent of impervious area but does provide benefits in terms of quality of repair of road cuts for utilities • Underground utilities surveys are lacking and the accuracy of utility locations as shown on drawings is suspect • Geotechnical investigations need to be done upfront and early in the design process • Soil compaction is an issue • Planting trees over infrastructure is problematic – sanitary sewers in particular pose a problem • Challenge: Lack of expertise is specifying materials • Key Challenges <ul style="list-style-type: none"> ○ Delivery system ○ Contractor lack of training • Flexibility is required to accommodate a suite of options • Problems with Stormceptors – City only credits 50% TSS instead of manufacturer’s claim of 80%. • Resistance factors – Affordability, life cycle, operation and maintenance (keep is simple) (road operations people prefer simple solutions) – Needs to be safe – Can’t sacrifice on safety. • City is standardizing lighting – New Cobrahead – example Yonge/Dundas. • Silva cell installations – Costly and complex. • Streetscape details – Issue: What is structural capacity of concrete slab? City to retain structural engineer to verify detail. H2O loading. • Materials need to be available for a long duration (many years). • Who is taking care of streetscape? Neighbouring commercial owners take responsibility but condos / residential can be problematic. • Issue – Limited space and lack of accuracy in locating underground utility infrastructure. • Major conflict – Trees and pedestrian clearway. • Bioretention cell – Specified soil mixture could not be delivered in timely manner. • Specification is overly complicated – Contractor can’t deliver bioretention mix. Provide simple specification –review bioretention soil specification. Mario to send specification for review. • Testing turn-around time is an issue. 	<ul style="list-style-type: none"> • Need to do more up front testing / investigation prior to final design to locate utilities, characterize soils. • Permeable pavement – Transportation does not want to maintain pavement that is installed on granular base. • Street lighting – Toronto Hydro does in-house design and wants to do construction but this is problematic. • Interlock surface – Bedding is the key issue. • Requirement to install curbs – Key issue with rolled curbs relates to people driving/parking on grass but this is not problematic. Rolled curbs are presently discouraged. • Minimum planting distance of trees to signs and signage is an issue. • Disagreements on standards and details – Varies between CA staff. • Certain infrastructure is not appropriate, for example, idealistic street tree details. • Different definition of “boulevard” for different districts is a problem. • Risk adversity is an issue. • Develop contractor expertise. • Prequalifications for contractor – Provide an outline in the guideline. • Challenges – Operations. <ul style="list-style-type: none"> – Fitting things into the street • Many users within road R.O.W.. <ul style="list-style-type: none"> ○ Surface of roads/sidewalks – Transportation ○ Replanting trees / storm / sanitary – Respective areas ○ Bioretention systems – Frequency/cost • Majority of SWM is now on private property with be exception of super pipes / OGS, which are occasionally allowed within the public ROW. • Utilities are an issue <ul style="list-style-type: none"> ○ Gas lines too shallow ○ Inaccurate as-builts for gas mains • Snow storage is an issue. • Need to build properly – Frost heave/sub-base can be saturated causing long-term problems. • Mature trees can limit options for ditches. • Complexity – Everything in the ground requires approvals – 11-12 utilities – design is complicated. • Utilities place restrictions on streetscape design. • Challenges: <ul style="list-style-type: none"> ○ Reduction in walkable space ○ Maintenance ○ Public realm implements project and expects BIA to maintain them 	<ul style="list-style-type: none"> • Utilities cuts are a challenge. • Cost is a problem - \$10000 for a tree pit is too expensive and is a dis-incentive to BIAs planting trees. • Should be a balance between cost and requirements: <ul style="list-style-type: none"> ○ Cost can be too prohibitive ○ Rather see more trees than one costly tree • No department has budget for trees. • Audience – Utility providers need to be educated. • Challenges: <ul style="list-style-type: none"> ○ Not sure what LID entails. ○ Pework not done to support LID design – i.e. survey/geotechnical investigations. ○ Utility company coordination. • SWM/Bioswales – Difficulties stem from: <ul style="list-style-type: none"> ○ Concern with lack of education for the public. ○ Lack of information circulated to homeowners/developers ○ Problems fall back to Operations. • Liability issue in the event of failure of LID system: <ul style="list-style-type: none"> ○ Who is liable? ○ By-law policy needs to be tightened up to address homeowner obligations. ○ Worst case scenario needs to be considered during the design process. • Water table is an issue – Needs to be considered. • Challenges occur mostly in winter – plowing scenario is the biggest challenge. • Leaf litter can be problematic. • Adequate drainage is necessary – Sub-drainage/swales. • Private impervious areas are a problem. Capacity exceedances are an issue due to runoff from private lands. • How trees get placed in relation to street lighting is an issue. • Existing neighbourhoods – increase in % impervious area due to infill/tear-down and rebuild. • Sidewalk width is an issue: <ul style="list-style-type: none"> ○ Cabbagetown – Pavers raised due to tree growth present trip hazards. ○ Walkable space is an issue – Risk and liability are issues with the grates, pavers, pits, etc. • Soil mix is specified but is not correct, causing mortality. • Critical to select planting priorities. Why plant trees when they have little chance of survival? • Need to screen properly for street trees in terms of soils, microclimate and other criteria.

SUMMARY OF CONSULTATION PROCESS

Comments			
Implementation	<ul style="list-style-type: none"> • There is a need to address implementation to find out what works and what doesn't work • Silva Cells – Contractor oversight is essential since the installation is complex • Focus on road reconstruction projects • It is important that the designer is involved in construction review • Placement of Biofiltration Soils – How to handle the soils so there is no segregation? 	<ul style="list-style-type: none"> • Sequencing of the work is an issue as is protection of LIDs during construction. CVC document provides some guidance • Concerns about inspection and certification requirements • Having a Landscape Architect as ESC would be beneficial • A prequalification list of contractors would be beneficial to ensuring quality of installation. • Good to have supplier involved in installation (i.e. Silva cells). • Technical issues – Had to pave with asphalt during construction to protect sub-base. 	<ul style="list-style-type: none"> • Requirement for more training – Use Nashdene as training site – Specialized repair crew would be an asset. • Treat as a utility – One call system for locates is one method of identifying when Silva cells exist. • Icons in sidewalk to delineate location of soils cells: <ul style="list-style-type: none"> ○ 1 icon for SWM ○ 1 icon for tree related installation
Project Examples	<ul style="list-style-type: none"> • There is a good example of where street trees are thriving with a simple detail (Adderley and John Streets). This may be worth considering. • The Scarborough stormwater project (Danforth) designed by Aquafor Beech is a good prototype • Keele Street Project – There was information lacking and a need for coordination with Urban Forestry and other departments • Coxwell Project – There were issues with soil mix/compaction and soil underdrain issues. Details need to be provided • Fairport Project – Problem with the skills of the contractor • The 'Six Points' project (Dufferin Street/Kipling Avenue) is an example of integrating 'Green' initiatives into the streetscape. • 2828 Danforth project will include a tree protection fence detail that should assist in protecting trees from damage. These can be customized to include different graphics/logos • Queen's Quay – Irrigation system – Not intended to maintain the system so MOECC approval was not requiring. • Pilot projects – "Over analysis" is a problem: <ul style="list-style-type: none"> ○ Maintenance aspects need to be considered ○ Repair methods must be spelled out ○ Just do it – Compare products and learn ○ Need to allocate operating budget • Bioswales on Bay Street south of Davenport. • Permeable pavement in boulevard areas. • Eastwood – Gerrard/Coxwell – Reconstruction with permeable asphalt – Issues with installation. • Fairfort (Coxwell) & Danforth projects: <ul style="list-style-type: none"> ○ Challenges – contractor issue on Fairfort <ul style="list-style-type: none"> ▪ unable to produce shop drawings, materials ▪ contractor knowledge was deficient ▪ specialized expertise was required • Danforth – Soil cells and bioretention. • Porous pavement – Canadian Tire Leslie/Sheppard – Good performance and longevity. 	<ul style="list-style-type: none"> • Kilgour Estates / CNIB – Unit stone pavement system functioning well. • Riverview Street (Bloor and south Kingsway) has potential for swales. Park-like area that could be used for bioretention – Bands of interlocking paving. • Yorkville – Bay and Avenue Road – Concrete base with unit stone paver. • Has implemented bump-outs (Lower Sherbourne). • New parking lot for Eastville Training Centre is an example. • Lawrence Park EA as an example – One size fits all is a non-starter. • Toronto East York District – bioswales have been implemented and LIDS are being incorporated into Toronto Community Housing developments. • Lawrence Heights – Bioswales. • Stanley Green – Bioswales. • Bayview Avenue <ul style="list-style-type: none"> ○ Ditch in existing road, but only because it was not possible to connect to the trunk storm sewer ○ Homes have sumps. • Cedarview project <ul style="list-style-type: none"> ○ Exfiltration drain, gallery below, clean outs ○ Retrofit of ditches ○ Flooding under high flow events is a problem ○ Never implemented, as City could not agree on who would maintain them • Prince Edward Drive, north of Berry Road: <ul style="list-style-type: none"> ○ Moduloc pup CB south of Bloor ○ Leaky catchbasins • Steven Road Etobicoke – MOE. • Queensway projects – Silva cells – Good for new builds. Silva cells also incorporated into Six Points redevelopment (under construction). • 201 Claremont – Living wall. 	<ul style="list-style-type: none"> • BIAs have implemented green streets – Lots of trees, parkettes. <ul style="list-style-type: none"> ○ Permeable Pavers – Yonge Street Granby/McGill. • Danforth Village - Large planters were too large for BIA to maintain. • Yorkville project/'Greening of Yorkville' is underway. • Green Streets Project – South Station is an example. <ul style="list-style-type: none"> ○ Problems – Encroachment on private property (underground garage). • Roncesvalles: <ul style="list-style-type: none"> ○ Issue with technical specifications - collapsed planters were a problem. ○ Support design and structure of slabs may have been the problem. ○ Something new – Not sure if detail on construction was the issue. • Permeable concrete – East side of Bayview, south side of Eglinton – 3 years in streetscape. • Balmoral subdivision – SE corner Wilson Heights and Sheppard – Cul-de-Sac replacement – 200mm concrete base, subdrains to catchbasins. • Skymark – 40 years ago – Interlocking pavers on roadway. Street is a bus loop – Set for repair in 2017. Could be great opportunity for permeable pavement. • Bloor Yorkville BIA – Soil augmentation not well done – All clay. Once soil was replaced, trees are thriving. • City Projects: <ul style="list-style-type: none"> ○ Moore Avenue, August 31, 2010. ○ Chine Drive, January 31, 2014. ○ Redlea Avenue Phase I, May 20, 2014. ○ Meadowvale Road, January 13, 2015. ○ Redlea Avenue Phase II, ECA approval pending. • Development Projects: <ul style="list-style-type: none"> ○ Queen's Wharf, October 8, 2010. ○ Bridgepoint Hospital, December 24, 2009.

SUMMARY OF CONSULTATION PROCESS

Comments			
Policy Considerations	<ul style="list-style-type: none"> Streetscape Manual is a Tool – It is flexible to accommodate ‘Green Street’ options Not all projects require MOECC approval only those with the intent of operating in perpetuity need MOECC approval Ontario Regulation 5258 – Requires that facility be located within only 1 lot or parcel of land Testing procedures are different for different manufacturer’s products. Standardized testing is required. Maintenance requirements from MOECC can be too stringent. MOECC has the right to inspect at any time and review log books to ensure compliance. Target – 5mm is standard. Hybrid systems – Building Code vs Water Resources Act 	<ul style="list-style-type: none"> Permeable pavement – No approvals are required. Mechanisms to support permeable pavement: Municipal consent agreements Input into municipal code and property standards – Could require for driveways – Big difference in flood mitigation of permeable pavement driveways are wide spread. Trees – Boulevards – Silva Cells with trees – if trees fail in Silva Cell, this is a costly problem – Can tree by-law be amended to allow for “tree harvesting”? Recommendation to have MOECC guideline to coordinate with City policies/guidelines. Standard Operating Procedures exist for all departments City-wide. 	<ul style="list-style-type: none"> Standard Operating Procedures – May need to change with respect to Operations – Snow plow damage for example might necessitate different equipment. Mandated maintenance requirements for MOECC approval. Some outcomes are mandated by MOECC (sewer overflows) are others. Water balance is not mandated. Sole source is an issue therefore ‘performance’ specifications are necessary to ensure products are effective, resilient and maintainable. Typically requires 3 quotes for replacement parts, this is an issue if you do not have specifications for component parts from original supplier.
Techniques	<ul style="list-style-type: none"> Jelly Fish – Operations does not like to maintain – Difficult to access and weighs much more when full. Mitigation vs adaptation – Example: warm asphalt – less GG emissions. Using recycled products is a “Green” initiative. Provide plants that support insect / wildlife populations. Reduce light level when it snows – Central control would be useful. Stormwater planters – Not an issue with loading. If sidewalk is hard surfaced it should be able to take a load. Mapping the location of Silva cells, etc is not done and should be implemented. 	<ul style="list-style-type: none"> Trench drain – Need to standardize detail. Curb inlet detail is custom. Porous asphalt – Not favoured due to performance issues. How much transpiration per tree? Brian will send numbers for consideration. Green initiatives – Push towards LID vs OGS devices. OGS devices only remove larger particles instead of fine particles with pollutants attached. Silva cell – Promoted as full maturity growth system may be not realistic. Porous CBs – MOE required analysis for each CB – to onerous. 	<ul style="list-style-type: none"> Planter boxes – Snow clearing is not a problematic. Have Used P.C. permeable pavement on laneways. Porous Asphalt has been used. Maintaining ditches is a ‘Green Streets’ initiative. Permeable pavement in laneways – What are safeguards re: extreme low temperatures and potential for malfunction. Need to specify a ‘Performance Standard’ – ‘Soil Cell’ is the generic name. <ul style="list-style-type: none"> Add to Performance Standard – ‘Require detailed O+M Manual’. Manual needs to address ‘LID’ complexities. Soil volume standards have changed the way of thinking with respect to design process.
Green Street Objectives	<ul style="list-style-type: none"> Social objectives – These should be considered as well. Good street design has the potential to uplift socially challenged communities. We need to have regard for social needs. There is also an opportunity for social/beautification funding. Green Streets – Adopt a ‘Best Efforts’ approach rather than ‘Hard Targets’. Priority – Bring nature back to the City and strengthen connections to the natural environment. Enhance placemaking and make the City more habitable. Bring parks to the streets. Climate change – What are the targets (affordability vs “making things better”). Urban biodiversity is an objective. Cultivating stewardship – Drawing attention to non-human occupants of the city. 	<ul style="list-style-type: none"> SWM – Enhance biodiversity. Trees are foundations of habitat. Needs: <ul style="list-style-type: none"> A variety of species A variety of structural habitat Connectivity Green streets intersection with NHS – Opportunities for crossings for heptiles CSO areas – Lower target would be 10mm. Climate change/building in resilience is important. Shade canopy – need to have effective shade. <ul style="list-style-type: none"> Provision of shade is a common public concern Partnering with Public Health to promote shade Water quality is the hook to bring Toronto Water in (WWFMMP objectives). 	<ul style="list-style-type: none"> Need to tie into principles – WWFMMP as well as: <ul style="list-style-type: none"> Well being Nature attention deficit disorder Health and mental health Air quality Social improvements Operation and Maintenance are key issues. Operational Challenges: <ul style="list-style-type: none"> Winter maintenance – Major Issues. Spring/summer/fall – No real issues – Maintenance is routine. Snow storage capacity is a key consideration. Narrow roads/pedestrian areas limit space between curb and sidewalk. Training and information – Responsibilities are unclear. 40 year life cycle for trees would be great/5 year is typical today.

SUMMARY OF CONSULTATION PROCESS

Comments			
Potential Opportunities	<ul style="list-style-type: none"> • There is lots of room in boulevards for 'Green' initiatives • There is the potential for redistribution of gas mains/hydro • The space in the boulevard, next to the curb, is an ideal spot for permeable pavement as are medians. There is an example of a solar P.V. installation in a median. • Permeable Pavement – Not for use on travelled lanes but is appropriate for low use areas, for example culs-de-sac islands • Bikes Lanes – Is there an opportunity for LID in bike lanes? • Photovoltaics – Could be used as shade structures or street furniture • Private driveways present an opportunity • Solar Panels – There is an example in Korea Town done by the BIA. Solar panels may be appropriate for use in the streetscape. • Educational value of initiatives should be capitalized upon. • Promote Green Streets – LID initiatives can reduce reliance on big pipes. • Potential for incentives for permeable pavement. • Pilot projects are low risk – Great way to learn quickly. • Crossings at hydro corridor / open space provide animal movement / biodiversity opportunities. • Cycling of trees – Valid concept. 	<ul style="list-style-type: none"> • Permaculture has potential. • Email Kelly to request information on animal crossing protocols. • Laneways are a candidate for permeable pavement. • High reflectivity pavement – Is problematic for some people with eye disabilities. • Green Streets – Reducing lane with cars provides benefits re: CB locations conflicts and provides street tree opportunities. • Green Street – Technical detail re: bump outs / curb relocation is required. • There may be the potential for a project in East York <ul style="list-style-type: none"> ○ East York – Janet Davis's Ward ○ Wants Green Streets to move forward ○ Climate change adaption ○ Scarborough Southwest EA Study established a precedent for public acceptance of Green initiatives • Healthy benefits. • Joint utility trenches. • Over 500 environmental requirements are set out in contract. <ul style="list-style-type: none"> ○ Energy efficient lighting ○ Green roofs on transit shelters have been done • Urban farming – is an overlay (i.e. need to discourage people from gardening in bioswales due to risk of contamination). 	<ul style="list-style-type: none"> • Projects have been done for decades. Incorporating different types of treatments including: <ul style="list-style-type: none"> ○ Ditches ○ More trees ○ Narrowing roads ○ Infiltration ○ Exfiltration ○ Permeable Pavement <ul style="list-style-type: none"> ▪ Laneways ▪ Parking Lay-bys • 'Tree – cycling' might only be suitable for downtown core where sites are constrained for long term sustainable tree growth. • Opportunities on private property should be explored. • Generally opposed to 'Tree Cycling' concept: <ul style="list-style-type: none"> ○ Need to be aware of timeframes for maintenance of infrastructure but ambition should be to grow the urban forest. • Applying 'Forestry' principles (Phil) to urban forestry: <ul style="list-style-type: none"> ○ Tree canopy can be timed to correspond with service life of underground infrastructure. • Construction techniques change over time for example torpedoing/lining. • Potential for living structures in Streetscapes? • Tree Planting – potential to add to private realm to offset lost opportunities in streets.

SUMMARY OF CONSULTATION PROCESS

Comments			
Maintenance Considerations	<ul style="list-style-type: none"> • There is a need for an LID maintenance manual • Maintenance – There is a need to spell out on-going maintenance requirements during the period prior to assumption by the City • Permeable Pavers – R.C.M. is something Mr. Cheung would like to do. Larger areas are better than smaller installations with regard to maintenance. • Who maintains is a question – Toronto Water or Transportation Services. • Maintenance is a concern MOECC has the right to request reports. • Need to find out criteria for who maintains what. Toronto Water vs Transportation Services. • What is cheaper to maintain – Vegetated swale or super pipes? Practical solutions need to be affordable to maintain • Road cuts are an issue – Will repairs be done correctly by utility contractors? • Snow removal is a concern with respect to potential damage to LIDs. • City delivery vs Contractor delivery: <ul style="list-style-type: none"> ○ Street sweeping is internal ○ Winter operations – Contracted out ○ CB clearing: Toronto Water – First foot below grade – Transportation Services beyond 1 foot below ground • Utility Cuts – Repairs are contracted out. • Maintenance of “new” installations / technologies is more costly. • Need to define one consolidated operations protocol Green Streets operations / maintenance by a dedicated body. • BIAs also maintain but require proper direction, BIAs have maintenance agreements. • Maintenance – Can maintenance requirements be defined/quantified in Green Streets Guidelines. • Use life cycle cost as a lens. • Maintenance must be realistic. • Standardized maintenance is important. • Biggest component – Maintenance: <ul style="list-style-type: none"> ○ Book 7 – Need to close a lane must be considered ○ Takes over Orphan Spaces where feasible (some are not maintainable) • Transportation rights-of-way outside of public realm would be maintained by transportation or someone else. • Maintenance is done internally. • Importance in implementing LID/SWM – Requires funding for training. 	<ul style="list-style-type: none"> • Maintenance – Corktown Common – Maintenance manual with pull out sheets for maintenance schedule is very effective. • Operation and Capital programming need to be convinced. • Need a budget item for maintenance. • Maintenance <ul style="list-style-type: none"> ○ Who does it? ○ Is adjacent landowner accountable for maintenance within public right-of-way. • Temporary patch is done by utility providers. • Realistic costing for implementation and maintenance should be provided: <ul style="list-style-type: none"> ○ Factors of multiplication in comparison to base treatment • Maintaining bioswales – As a homeowner responsibility can't tie that responsibility to homeowner. • Bring LID options up sooner than later – Maintenance is a big issue. • Councillors need to be aware of maintenance. Silva cells repair is an issue. Cost implications on repair. • Watering trees is a good example – “if you can't water the trees don't plant trees”. • Repair of utility cuts is an issue. • Build things that we can maintain. • Littering issues, needles collect in bioswales in more concealed areas / susceptible to drug use. • Inspect once a month (probably not enough). • Winter maintenance requirements – Salt is used – No salt / sand mix calibration rates with salt. • Looking to incorporate application rates / limits into future winter maintenance contracts. • Smart About Salt Council. • Maintenance – Push back is a problem. • We need to define responsibilities for ‘Green’ drainage systems: <ul style="list-style-type: none"> ○ Who looks after what? ○ Once water reaches below surface it should be Toronto Water's responsibility. • Optimal dimension for snow storage – 3 - 5m – Absolutely minimum should be at least 1-1.5m. • Snow removal is costly - \$5 million/day City-wide. • Levels of service – Maintenance is based on road classifications. <ul style="list-style-type: none"> ○ High pedestrian load – 2cm threshold for snow removal. ○ Local Streets – 8cm threshold for snow removal. 	<ul style="list-style-type: none"> • Silva Cell – O+M Manual is provided – Warranty is void if product is cut. • Need to provide minimum maintenance standards to overcome long term council/budget changes. • Maintenance indications – Nuisance failure should be evident prior to catastrophic performance failure. • O+M is a concern – Budget constraints are in issue. • Snow removal is an issue – Design should consider that everything is under 2' of snow. • Utility cuts – Integration with green infrastructure is an issue. • Sometimes Forestry is required to fix problematic designs but they are not designers. • Operations manual is required for all installations. • Hardware is not always readily available. • Type of soil determines irrigation requirements – irrigation systems are problematic. • Pilot project with LEAF – Store owners water trees and this has been successful – Needs to be promoted as a program. • Soil augmentation/watering should be done simultaneously. High volume of commercial trees throughout the City require watering. • Present watering proposed places an onus on trees that are stressed/newly planted. • Forestry splits City in half (southwest/northwest). Focus is on commercial trees in hard spaces. • Issue with existing trees pits – What do we do? How do you deal with retrofit situations due to tree growth? Rubber curbs/plow damage? Artificial turf is a problem. • Transportation services do not clean tree pits. This is an issue. Cigarettes butts are a big issue. • Silva cell maintenance is still being discussed – Forestry is not well suited to do this. • Working with Hydro on response to 2013 ice storm – Hydro has asked that there be no branches over primary wires. • Infiltration facilities should be designed so that they can operate and be maintained in all seasons. The access to the infiltration system and the pipe size used need to be considered. • The facility design should provide for the possibility that its function may be disrupted if an existing utility needs to be repaired that is in conflict with or in close proximity to the infiltration trench. Should this occur, the reinstatement of the infiltration facility will be required by the utility company. This may require changes to municipal consent process when work is proposed within a City road allowance.

SUMMARY OF CONSULTATION PROCESS

Comments	
Monitoring	<ul style="list-style-type: none"> Initial installations could be subject to more intense monitoring. Accurate mapping of utilities is critical.
Design Process	<ul style="list-style-type: none"> Development Application Review – City should ask for LIDs upfront. Presently the request comes too late in the process. There should be a pre-screening exercise Geotechnical investigations are done too late in the design process Collaboration throughout the design process is important Sustainability office has a role to play. Public realm department has been established. Procedural recommendations to be provided PINS (Project Information Notices) – Biodiversity would like to be included in circulation. Relationship between Toronto Water / Transportation Services needs to be defined. DIPS (Development Infrastructure Planning Manual) standards – Standard cross-sections. Confirm if MOEEC approval is required up front in the process. ECS is responsible to design / contract admin for Transportation Services / Toronto Water. Process – Can be an uncooperative relationship with ECS. Issue: lack of notification of opportunities – Existing system is not working. There is no vehicle for construction outside of ECS process, except BIA office (BIA is client) – This is problematic. Community and councillor driven initiatives do not fit in typical process. Obstacles in process: <ul style="list-style-type: none"> Cooperation during design Difficulty is at implementation/operational stages Implementation – “curb to curb” asphalt and pipes – No expertise in curb to building face street line. Implementation is a challenge due to lack to education/understanding Maintenance Areas for improvement: <ul style="list-style-type: none"> Roster of specs and details is lacking Tendering practises – No prequalification for streetscape / landscape contractors City inspectors need more education regarding specifications Circulation list – Needs to be a “dream team” of contacts from utilities and internal departments – Build on successes set up a group like “AHT”. “Orphan Space Program” – PFR or contractor – Spaces with no defined owner – Horticultural maintenance is undertaken. Process: how are projects identified? <ul style="list-style-type: none"> Review / assessment should be done with a team rather than through as a list of capital projects as is the present protocol Catalyst is repair/resurfacing for getting a street on the list – There is a need to have an assessment once the street is identified to identify Green Streets opportunities. Funding is not adequate to accommodate Green Streets initiatives as part of road reconstruction at the present time. Allocation of funding – Offsets for Green Streets should be considered. Communication <ul style="list-style-type: none"> Poster idea might be helpful Training sessions Design checklist Who needs to be trained on what and when? Notification timing is 2 years prior to project. PIN – Project Information Notification – Need to re-instate. More information required upfront – “Complete Streets” will address this. Need to discuss with MCIC – Focus is on “curb to curb”. Funding opportunities open up if there is a tangible SWM benefit. WWFMMP changes – More advocacy, unit flow rates, rectification of deficiencies. Toronto Water is open to pilot projects. Funding is a big issue – Constraint to implementation of Green Streets. Parks branch is not feasible to fund implementation. ECS is focussed on implementation – Internal conflicts between Water and Transportation are a barrier. Issue is who pays? Cost sharing is a problem. Capital planning exercise needs to account for Green Streets. Need to simplify process. Strong suggestion – 12 years have past since pilot projects have been implemented. It is time to move forward. Division heads need to be involved. Budget should be established for green initiatives. Utility permitting – Road Operations Group manages this. Municipal Consent Requirements – Access Agreement – set of rules and permit requirements. LID requests from clients – Requires expertise/complexity. <ul style="list-style-type: none"> Less than a year to design projects. Expertise is not available in-house. LIDs can delay / put project at risk. Budget schedule and biggest impact. Capital Delivery Managers in ECS need to be consulted. ECS works on functional not district basis: <ul style="list-style-type: none"> Linear Underground Major infrastructure More lead time required for LID. Projects come from MCIC. 5 year delivery model: <ul style="list-style-type: none"> Based on asset management protocol for Toronto Water List is sent to MCIC Based on assets approval – Life cycle management for Transportation Services There is not a fulsome circulation for review, particularly for transportation projects – This is problematic. Delays and cost over-runs are a problem for ECS – They take the blame. Horizon is five years – Project start to completion. Budgets get set by asset owners – They establish budget. Fulsome site assessment with a wide lens. Additional of LIDs should be at project concept stage. MCIC circulates project list (FROST) – How many people read it? Need to identify at the stage of asset review. Need to ensure there is a mechanism to easily allow future new ideas for SWM/LID to get incorporated into City standards. Key issue – Cost allocation. Public buy-in is very important. Public information meeting is usually held at 60% detailed design. Cost sharing is an issue. Public meetings – Courtesy thing – Changing the street is a big issue – can influence design. When do public meetings happen – 6-5 months before design (drop in centres). Data Base – Pavement management system data base informs capital programs 5 year timeframe with 10 year horizon. <ul style="list-style-type: none"> Certain Streets – Green Streets initiatives have been flagged as part of capital planning process.

SUMMARY OF CONSULTATION PROCESS

Comments			
<p>Design Process (con'd)</p>	<ul style="list-style-type: none"> • Categories of types of projects. <ul style="list-style-type: none"> ○ RE/Re Pave – Limited opportunities. ○ Reconstruction – Much more opportunity – Depends on Street type. • Toronto Water – Identifies needs in conjunction with transportation (closely coordinated). • ECS process – If transportation/Toronto Water identifies project BIA will 'Piggy Back' on these projects. • EDC flags projects from MCIC that are located in BIAs. • Scope decided by the City 1-2 years in advance of construction – Not a lot of time given the complexity of BIA projects. • Good ideas come in too late.Process from conceptual design to detailed design to quickly to accommodate integration of Green Streets ideas. • Scope Expansion – New technical requirements, i.e. survey, are problematic. • Need to ensure ideas are workable: <ul style="list-style-type: none"> ○ If it does not work – ECS has a problem. ○ Deal with urban planning for LID initiation/integration. • Hesitant to try new things due to: <ul style="list-style-type: none"> ○ Time/schedule constraints. ○ Warranty issues. • ECS takes project from concept to technical drawings. • ECS tenders TTC works as part of City contract. • Upfront assessment for Green Streets opportunities would be helpful. 	<ul style="list-style-type: none"> • Right now ECS does the assessment and they are not experts. • All planning decisions should be made before project gets to ECS. • Time is a big constraint. • Time delays: <ul style="list-style-type: none"> ○ Research. ○ Conceptual Design. ○ Utility complications. • Need to know – Technical checklist: <ul style="list-style-type: none"> ○ What needs to be done? ○ How it should be done? ○ When it needs to be done in order to facilitate schedule adjustments and plug Green Streets modules into schedule. • Time needs to be allocated for: <ul style="list-style-type: none"> ○ Technical investigations. • Not all projects necessarily require public consultation – address in checklist to define which projects should be subject to public consultation. • Hard surface vs. soft surface solutions tend to be the decision point for public consultation. • Feed back – ECS only hears about problems, not successes. • Not yet circulated with ECS planning (5 years). Would like to be part of project scoping. • Public education – needs to be bolstered. • Managing expectations is necessary. 	<ul style="list-style-type: none"> • Transportation has initiation 2 new positions that will be the decisions markers with respect to what components are included in street projects. <ul style="list-style-type: none"> ○ Financial scope to be confirmed early on. ○ Need for review 30% (funding confirmed), 60%, 90% review. • Telegraphing multiple years in advance (3 years is optimal). • Green Streets team needs to be implemented to assist ECS another to coordinate initiatives. • MCIC – Process will be assisted by bringing Green Streets decisions forward early. • 3 year look ahead is the target for transportation/water. <ul style="list-style-type: none"> ○ To provide notice. ○ To provide opportunities to secure funding. • Lost opportunity to do infrastructure/appearances presented by reconstruction when Forestry is not consulted in the process. • Standardization is essential. • Forestry does not oversee construction – Transportation inspector may not be paying attention to planting techniques. • Lack of communication amongst departments is an issue. PF&R are not always provided information on when/where trees have been planted (i.e. on road reconstruction projects). • Forestry operations should be involved in all projects that involve tree plantings. Involvement needs to be up-front in the process.
<p>Consultation Process</p>			

SUMMARY OF CONSULTATION PROCESS

Comments			
Design Considerations	<ul style="list-style-type: none"> • There is a need to ensure that bioretention cells have a minimum width/depth/slope so that they are recognizable to pedestrians. • Trench Drains – There is a concern about maintenance, litter and blockage, grates being covered by leaves, grates being damaged. • Side Inlet Catch Basins – Small opening does not work with City’s equipment and litter is a concern. • Design – Provide a ‘Factor of Safety’. Drawdown time 24-48 hours. • Street tree plantings should be designed for a life span of 30 years. Wood could then be salvaged for alternate uses. This would allow for maintenance of LIDs. Concept of ‘cycling’ the urban forest was discussed. • Avoid conflicts between trees and utilities. • What can be done to increase storage in LIDs? • Fact sheet would be helpful regarding ‘Green Streets’. • Details need to be simple/not too expensive. • Porous Concrete – Testing? <ul style="list-style-type: none"> ○ Laneway construction – May be appropriate • Laneway drainage is an issue. • Validity of examining solar orientation – Solar exposure related to tree growth. • Patrick Cheung – CBs that pump water back into tree (irrigation system). • Loading is an issue on slabs. • Trees need access for root systems and area calculations should not be divided by property lines. 	<ul style="list-style-type: none"> • 1.5m clearance width required for sidewalk snow removal: <ul style="list-style-type: none"> ○ Free of obstructions. ○ Must be continuous sidewalk. ○ On-street parking complicates clearing. ○ Etobicoke 90% of sidewalks are cleared. ○ Scarborough 95% of sidewalks are cleared. ○ North York 95% of sidewalks are cleared. • Sand is not predominant in mix 20% sand/80% salt. • Pre-treatment is required to mitigate icing. • Brine is used on roadways only – Effective to minus 9 degrees Celsius. • Beet juice is good to minus 30 degrees Celsius. • Long term availability of replacement materials is an issue (i.e. colours and styles of unit stone pavers change over time). • Need tangible numbers for maintenance on a per linear meter basis. • Service laterals pose an issue – utility cuts, access, frequency of interference. • Identify priorities based on extent of lateral series connections required (parks, schools have fewer laterals to deal with in the streetscape). • Tree pits could be enhanced as part of utility cut repair (sidewalk repair). • Planters – Removed and replant at grade is preferred. • Containers – Not precast – Cast-in-place planters at grade are good – University Avenue for example. Planters provide salt protection and aid in protecting trees. 	<ul style="list-style-type: none"> • Biodiversity improved in planters (raised) due to ability to utilize less salt-tolerant species. • Trip Hazards – Tree pits can pose a trip hazard. • Metal grate over pits can be too slippery. This required Forestry to undertake remedial action. • Trip hazard mitigation/slip free surface is essential. • More complex planting techniques = Increase maintenance costs. • Concerns – Quality of soil itself and not necessarily soil volume is the issue: <ul style="list-style-type: none"> ○ Quality of soil is more important. ○ Soil augmentation is important • Tree rails work well with sedum to protect from trampling. • Perennials work better for deterring cigarettes butts – But how do you maintain? • Collar girdling – Expandable rings/maintenance solutions need to be explored so that trees in tree pits can grow large. • Minimize garbage accumulation - Weeding is also an issue. • BIAs – Some want custom tree grates – Need a standard for selection with options for customization. • Small fences with BIA logo could work. • Tree grates are important - Tree rails are excellent. Tree guards are also effective. • Species limitations – What will survive in which locations?
Funding	<ul style="list-style-type: none"> • Established pot of funding for ‘Green Streets’ initiatives would be good. • Transportation funding is based on is ‘State of good Repair’ criterion. • Funding of tree plantings in road reconstruction projects – should it be ECS or Forestry? • Friction related to who pays for what is a problem. 	<ul style="list-style-type: none"> • New budget is required to address Green Streets initiatives but Operations does not get new funding – Need to flag in the report. • Need to make an economic case to justify Green Streets. • Green infrastructure to ‘cost avoid’ grey infrastructure. • Cost avoidance – with added benefits in terms of objectives. 	<ul style="list-style-type: none"> • Order of magnitude increase in cost over conventional servicing is an issue • Utilities costs are in issue. • Money is an issue – Funding needs to be prescribed based on a certain standard. Capital funding runs short.

A number of government agencies throughout North America have prepared manuals and guideline documents that are aimed at directing the implementation of “Green Street” initiatives. The foci of these various documents differ; some are aimed primarily at promoting the implementation of initiatives to manage stormwater runoff while others address a broader range of ‘green’ initiatives including reduced urban heat island effect, multi-modal transportation or urban forest enhancement. In addition, each of the precedent documents that were reviewed adopted a different level of detail with some focussing on ‘the big picture’ and others delving into more technical detail. Documents reviewed were sourced from different geographic locations throughout North America. Some share a similar climatic context with Toronto and others do not. This broad spectrum of documents was selected in order to examine a diverse range of Green Street possibilities that could be adapted to the Toronto context. The following documents were reviewed:

- New York City, Green Infrastructure Plan, 2010
- New York City, Environmentally Protection Standards for Green Infrastructure, 2014
- City of Cleveland, Complete and Green Streets, 2012
- City of Milwaukee, Green Streets Stormwater Management Plan, 2013
- United States Environmental Protection Agency (US EPA), Managing Wet Weather Flow with Green Infrastructure Municipal Handbook – Green Streets, 2008
- City of Los Angeles, Low Impact Development Manual (LID), 2011
- City of Boston, Boston Complete Streets Design Guidelines, 2013
- City of Philadelphia, Green Streets Design Manual, 2014
- City of Edmonton, LID Best Management Practices Design Guide - Edition 1.0, 2011
- City of Portland, NE Holladay Green Street Corridor Plan - Achieving EcoDistrict Goals, 2012
- City of Portland, 2012 Revisions for the Public Works Details, 2012
- City of Chicago, The Chicago Green Alley Handbook, 2010
- Streetscape Guidelines for the City of Chicago Streetscape and Urban Design Program, 2003
- District of Columbia, A Guide to Green Infrastructure in the District of Columbia, 2014,
- City of Omaha, Green Streets for Omaha, 2003
- City of Omaha, Omaha Streetscape Handbook, 2008

Each of the documents listed above was reviewed on the basis of the following:

- 1. Level of Guidance** | The level of detail at which the document addressed the design of Green Street initiative ranging from general to technical.
- 2. Range of Green Street Objectives Addressed** | The focus of the document ranging from one-dimensional, stormwater management based options to multi-dimensional environmental, social and ecological solutions.
- 3. Types of Green Infrastructure / Green Street Alternatives Recommended and Rationale** | Recommendations related to green infrastructure applicability and performance.
- 4. Document Status** | Status of approval and relationship between the document and other related guidance documents / policies.
- 5. Organization by Street Typologies**
- 6. Implementation Strategies and Recommendations** | Has the document been implemented and what are the results?
- 7. Operations and Maintenance** | Degree of guidance that the document provides related to the operations and maintenance of Green Streets initiatives.
- 8. Cold Climate Guidance** | Does the document provide specific recommendations to address implementation and operation in cold climate conditions?
- 9. Lessons Learned** | A Summary of the key lessons learned as a result of the implementation of the recommendation set out in the document.
- 10. Other Comments** | A list of comments related to components of the document that were particularly relevant for consideration in the process of generating the City of Toronto Green Streets Technical Guidelines.

A precedent summary outlining drivers that have influenced creation of the City of Toronto Green Streets Technical Guidelines document has been provided on page G13 and the findings from each precedent document are described on pages G14 - G29.

PRECEDENT RESEARCH - IMPLICATIONS AND INFLUENCES

1. Level of Guidance / Components

- Provide limited “overview” section
- Provide rational / targets related to each Green Street objective
- List green infrastructure opportunities
- Describe precedent projects throughout city
- Provide examples of typical installations, locations, benefits
- Provide Green Street selection tool / flowchart
- Provide tree selection tool / matrices
- Provide catalogue of schematic construction details
- Include sizing calculations
- Provide illustrative sections / details
- Provide “fact sheets” for easy reference
- Provide retrofit versus new construction options

2. Range of Green Street Objectives to be Addressed

- Stormwater management
- Rain gardens
- Street trees / urban forest
- Electric vehicle charging stations
- Permeable surfaces
- Impervious area reduction
- Reduced urban heat island effect
- Dark sky compliance
- Walkability
- Increased cycle access
- Energy conservation / generation
- Sustainable materials

3. Types of LID / Green Street Alternatives Recommended and Rationale

- Perforated pipe systems
- Bioswales
- Stormwater inlets
- Bioswales with stone columns
- Sediment pad
- Steel guards for planted areas
- Bioretention systems
- Tree trenches
- Street trees / tree boxes
- Planter boxes
- Dry wells
- Infiltration systems
- Filter strips
- Bioinfiltration systems
- Vegetated swales
- Raised tree beds
- Stormwater planters
- Community gardens with rainwater harvesting
- Green roofs
- Blue roofs
- Permeable pavements
- Swales
- Tree pits
- Storage chambers
- Green walls
- Vegetated stormwater management systems
- Street lights (state-of-the-art)
- Clean energy / renewable energy
- Stormwater “bump-out”
- Green gutters
- Stormwater drainage wells

4. Organization by Street Typologies

- Organize Green Street recommendations based on “Complete Streets” typologies
- Provide “typology-based” selection tool

5. Document Status

- Standalone but integrated with “Complete Streets”
- Coordinated and formatted to correspond with City standard, specifications and details
- Coordinated with Streetscape Design Manual and other urban design guideline documents
- Consider annual reports / updates

6. Implementation Strategies and Recommendations

- Identify priority areas based on CSO, flood mitigation, etc.
- Recommend project tracking database and mapping program
- Provide recommendations for post-construction monitoring and data management
- Provide standardized details
- Provide examples of successful implementation
- Discuss barriers to implementation and remedies
- Provide implementation principles
- Recommend project development and review process
- Identify funding opportunities / needs
- Identify regulations / approval requirements
- Provide guidance on selection and application
- Set out range of costs

7. Operations and Maintenance

- Provide recommendations for:
 - Maintenance
 - Maintenance equipment
 - Winter maintenance
 - Landscape maintenance
 - Catchbasin cleaning
 - Maintenance agreements
 - Life-cycle maintenance
 - Utility coordination and repair
- Recommendations should be specific to each LID type
- Provide matrix with general operation and maintenance requirements
- Identify security and safety consideration
- Provide recommendations to coordinate maintenance with design

8. Cold Climate Guidance

- Snow storage and clearance
- Provide winter maintenance recommendations for each LID type

9. Lessons Learned

- Incorporate stone gabion in bioswales to enhance performance
- Avoid groundwater influx
- Avoid introduction of surface flow from adjacent vegetated areas
- Use correct materials / construction techniques
- Avoid soil compaction
- Complete infiltration tests prior to design
- Introduce a new process that is aimed at:
 - Assessing necessary function of the road with the objective of reduction in lane widths and impervious cover
 - Enhancing streetscape elements to manage stormwater
 - Integrating transportation and environmental planning

10. Other Comments

- New York Standards for Green Infrastructure provides a comprehensive compendium of details. These should be reviewed in detail for applicability
- Los Angeles document sets out a broad range of LID options for exploration
- Provide an index of acronyms at beginning of document
- Provide a detailed, searchable index
- Provide a matrix that illustrates the suitability of each “Green Street” option to each street typology
- Provide a glossary of terms
- Edmonton document is the best source for cold climate operation, design and maintenance recommendations
- Portland Public Works details provides a comprehensive catalogue of details that should be reviewed for applicability
- Provide general land area / impervious area calculations for road rights-of-way to demonstrate potential positive implications of “Green Streets” options
- Provide performance standards for each “Green Streets” option

PRECEDENT RESEARCH - DOCUMENT REVIEW

New York City Infrastructure Program

2010

PlaNYC

NYC Environmental Protection



1. Level of Guidance

- Urban ROW LIDs: includes standard details for bioswales, planting and guard details, rain gardens
- Lists green infrastructure opportunities, estimated performance and costs for priority Combined Sewer Overflow (CSO) watersheds in new development, existing development, in ROWs, in parks
- Describes LID test projects throughout the city

2. Range of Green Street Objectives Addressed

- Stormwater management

3. Types of LID / Green Street Alternatives Recommended and Rationale

- Community gardens with rainwater harvesting
 - Rain barrels
 - Green roofs
 - Blue roofs (retaining water on roofs)
 - Permeable pavements
 - ROW swales and tree pits
 - Storage chambers
 - Perforated pipe
- Aim is to minimize stormwater runoff from entering the combined sewer system
- Goal is to manage stormwater from 10% of the impervious surfaces in the combined sewer contributory area

4. Organization by Street Typologies

- Addresses varying right-of-way (R.O.W.) widths

5. Document Status

- Approved
- Standalone document with yearly annual reports

6. Implementation Strategies and Recommendations

- Implemented area-wide green infrastructure in priority CSO tributary areas: 42 design and construction contracts
- Growth of green infrastructure schoolyards partnership with Trust for Public Land
- Development of project-tracking and asset management system
- Report for Post-Construction Monitoring Green Infrastructure
 - Green Infrastructure met or exceeded runoff management expectations
 - Green Infrastructure managed 1-inch runoff across 10% of impervious surfaces

7. Operations and Maintenance

- Not addressed

8. Cold Climate Guidance

- Not discussed

9. Lessons Learned

- Incorporation of the stone gabions in the ROW bioswales improved performance
 - allows water to get from the surface ponding area to the subsurface storage and infiltration zones more rapidly
- ROW bioswales negatively affected by surface flow infiltrating from nearby vegetated areas or groundwater seeping from high bedrock areas

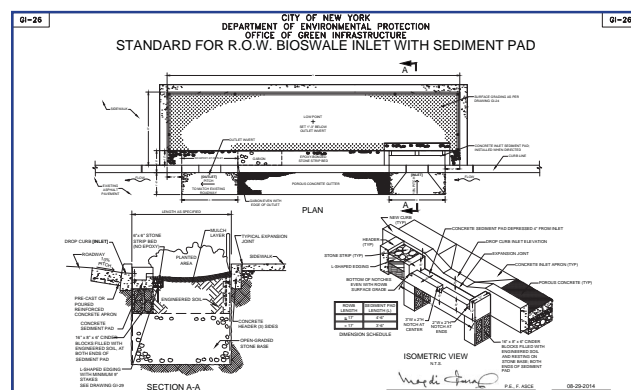
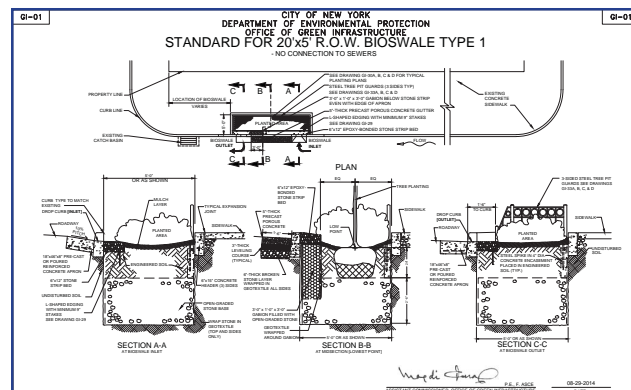
10. Other Comments

- N/A

PRECEDENT RESEARCH - DOCUMENT REVIEW

New York City Environmentally Protection Standards for Green Infrastructure 2014

City of New York, Department of Environmental Protection
Office of Green Infrastructure



1. Level of Guidance

- Specific construction details

2. Range of Green Street Objectives Addressed

- Stormwater management
- Urban forest

3. Types of LID / Green Street Alternatives Recommended and Rationale

- Bioswale
- Stormwater inlet
- Stormwater chamber
- Bioswale with stone columns
- Rain garden
- Perforated pipe
- Sediment pad
- Planting plans for bioswales and rain gardens
- Steel guard for planted areas

4. Organization by Street Typologies

- No

5. Document Status

- Approved

6. Implementation Strategies and Recommendations

- Standard details for implementation

7. Operations and Maintenance

- Not addressed

8. Cold Climate Guidance

- Not discussed

9. Lessons Learned

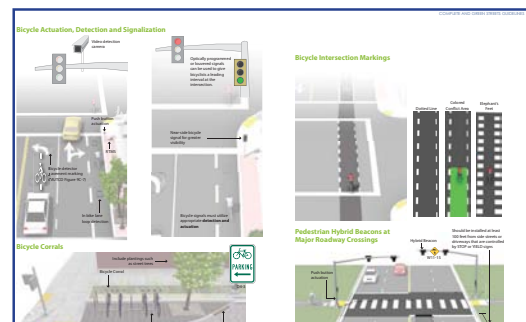
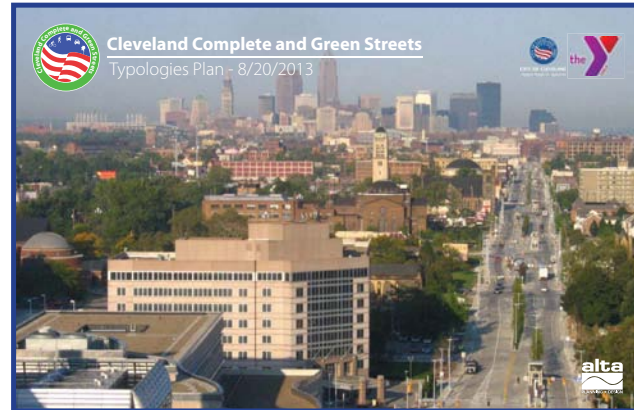
- Not discussed

10. Other Comments

- Excellent compendium of technical details

PRECEDENT RESEARCH - DOCUMENT REVIEW

City of Cleveland Completed and Green Streets
2012
City of Cleveland
YMCA



1. Level of Guidance

- Includes 3 pages on Green Infrastructure for the Right of Way – General recommendations
- Discusses the importance of healthy soils, street trees, and sheet flow dispersion
- Includes recommended cross-sections of ROWs

2. Range of Green Street Objectives Addressed

- Stormwater management with a focus on minimizing of runoff entering the combined sewer system
 - Roadway widths
 - Transportation nodes
 - Roadway features (vegetation, parking)
 - Traffic management
 - Connectivity
 - Design speeds

3. Types of LID / Green Street Alternatives Recommended and Rationale

- Bioretention
- Pervious paving

4. Organization by Street Typologies

- Addresses varying right-of-way widths

5. Document Status

- Standalone planning level right-of-way guidance document

6. Implementation Strategies and Recommendations

- No information provided

7. Operations and Maintenance

- Not addressed

8. Cold Climate Guidance

- Not discussed

9. Lessons Learned

- Not discussed

10. Other Comments

- N/A

PRECEDENT RESEARCH - DOCUMENT REVIEW

City of Milwaukee – Green Streets Stormwater Management Plan

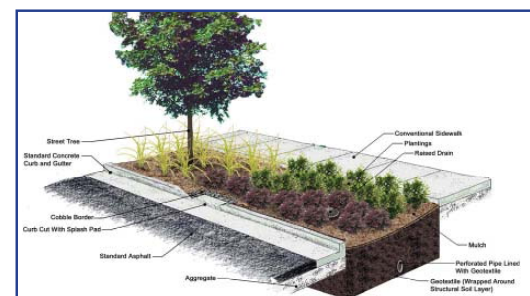
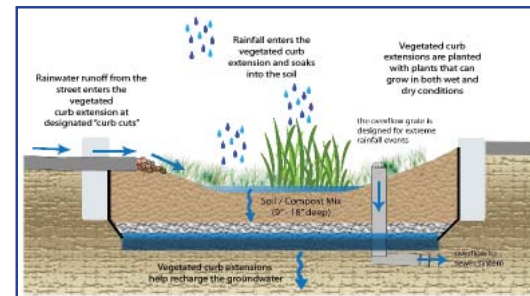
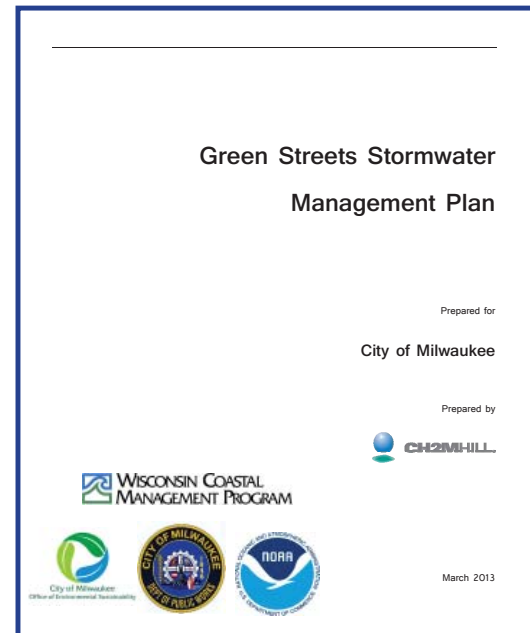
2013

Wisconsin Coastal Management Program

City of Milwaukee Office of Environmental Sustainability

City of Milwaukee Department of Public Works

National Oceanic and Atmospheric Administration



1. Level of Guidance

- Provides green street stormwater strategies to reduce stormwater quantity and improve quality through implementation on streets and alleys recommendations
- Provides examples of typical installation locations, benefits, and maintenance considerations
- Provides cross-sectional renderings of example applications
- Provides flow charts for LID technique evaluation

2. Range of Green Street Objectives Addressed

- Stormwater management

3. Types of LID / Green Street Alternatives Recommended and Rationale

- Bioretention
- Pervious paving
- Tree trench

Aim is to minimize stormwater runoff from entering the combined sewer system

4. Organization by Street Typologies

- Defines best LID solution for a specific right-of-way location

5. Document Status

- Approved
- Standalone document

6. Implementation Strategies and Recommendations

- Provides examples of successful implementations
- No quantitative results

7. Operations and Maintenance

- Provides recommendations for
 - Maintenance
 - Maintenance equipment
 - Winter maintenance
 - Landscape maintenance by Forestry Services
 - Catchbasin cleaning

8. Cold Climate Guidance

- Winter maintenance recommendations provided

9. Lessons Learned

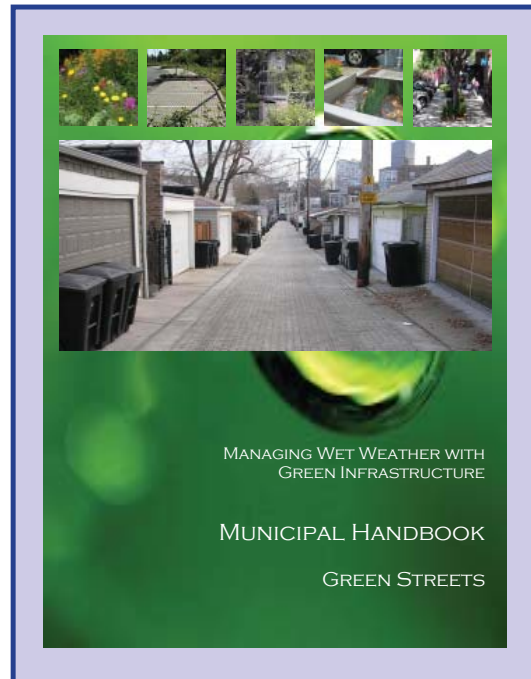
- Benefits of LID are contingent on use of correct materials, proper construction techniques
- Compaction of native soils, improper soil mixes and the use of heavy equipment in areas designed for infiltration can cause problems that may be difficult to observe visually but will have detrimental impacts on performance
- Recommended that Green Street strategies receive an infiltration test to confirm that they were constructed properly and are achieving the design goals before maintenance of the devices is handed over to the City. Ideally this test would be conducted after new plantings had a chance to become established
- Infiltration testing could include double ring infiltration tests, filling of devices to capacity with water trucks, or monitoring during a specified storm

10. Other Comments

- N/A

PRECEDENT RESEARCH - DOCUMENT REVIEW

United States Environmental Protection Agency (US EPA) – Managing Wet Weather Flow with Green Infrastructure Municipal Handbook – Green Streets
2008



1. Level of Guidance

- General guide
- Details the opportunities and benefits of treating stormwater within the ROW
- Establishes the green streets goal - to provide source control of stormwater, limit its transport and pollutant conveyance to the collection system, restore predevelopment hydrology to the extent possible, and provide environmentally enhanced roads
- Lists municipalities with specifications and standard details for swales, permeable pavements, healthy tree volume

2. Range of Green Street Objectives Addressed

- Stormwater management

3. Types of LID / Green Street Alternatives Recommended and Rationale

- Street trees/tree boxes
- Permeable pavements
- Bioretention
- Swales

4. Organization by Street Typologies

- N/A

5. Document Status

- Approved
- Part of a set of street guidance documents: Funding Options Handbook, Green Infrastructure Retrofit Policies Handbook, Rainwater Harvesting Policies Handbook, Incentive Mechanisms Handbook, and more policy guides and tools
- USEPA 'Regular Inspection and Maintenance Guidance' sheets for various LID types

6. Implementation Strategies and Recommendations

- Discusses implementation hurdles
- Portland, OR – list of green street pilot projects
 - Stormwater curb extensions – captured 85% runoff volume in a simulated 25-year storm event flow test, reduced peak flow by 88%
 - Each of the pilot projects have been well documented by the Portland Bureau of Environmental Services using a consistent format to describe pilot background, features, engineering design, landscaping, project costs, maintenance, monitoring, and lessons learned <http://www.portlandonline.com/BES/index.cfm?c=34598>
- Chicago, IL – Green Alleys Program
 - Repaving the alleys with impermeable pavement ranged in cost from \$120,000 to \$150,000, whereas a total Green Alley reconstruction was more along the lines of \$200,000 to \$250,000
 - Additional benefits of the Green Alley Program include not only urban heat island effect reduction, material recycling, energy conservation, and light pollution reduction, but also the creation of a new market

7. Operations and Maintenance

- Not addressed

8. Cold Climate Guidance

- Not discussed

9. Lessons Learned

- Elements necessary for a successful green streets program:
 - Pilot projects are critical
 - Leadership in sustainability from the top
 - Buy-in from all municipal infrastructure departments
 - Documentation
 - Public outreach
- The green options available demonstrate the flexibility of green infrastructure to satisfy road function and environmental objectives and highlight why transportation corridors are well suited for green infrastructure
- developing a green streets program requires an institutional re-evaluation of how right-of-ways are most effectively managed. This process typically includes:
 - Assessing the necessary function of the road and selecting the minimum required street width to reduce impervious cover
 - Enhancing streetscaping elements to manage stormwater and exploring opportunities to integrate stormwater management into roadway design
 - Integrating transportation and environmental planning to capitalize on economic benefits

10. Other Comments

- N/A

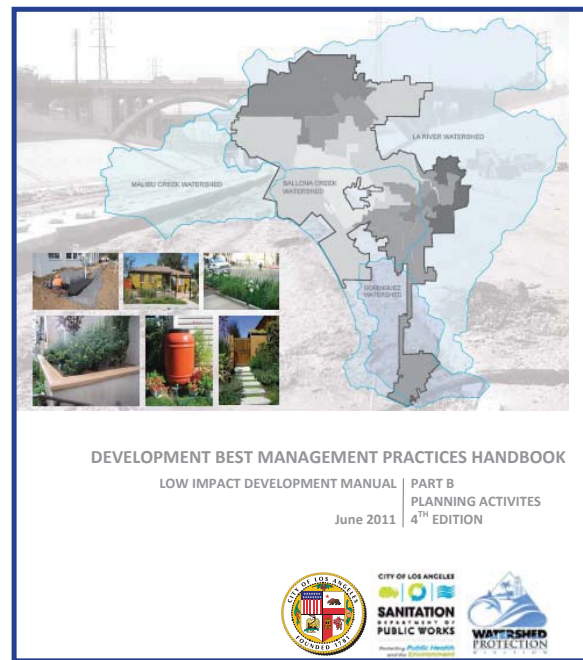
PRECEDENT RESEARCH - DOCUMENT REVIEW

City of Los Angeles – Low Impact Development Manual

2011

City of Los Angeles Department of Public Works

Watershed Protection Division



1. Level of Guidance

- Provides guidance for individuals involved in new development and redevelopment projects, a result of a city ordinance requiring all dev./redev. to capture and manage 100% of the first 3/4" (19mm) storm event onsite
- Includes details, cross-sections, sample calculations of LID types
- Includes infiltration sizing calculations

2. Range of Green Street Objectives Addressed

- Stormwater management

3. Types of LID / Green Street Alternatives Recommended and Rationale

- Residential LIDS:
 - Rain barrels
 - Permeable pavements
 - Planter boxes
 - Rain gardens
 - Dry wells
- Other LID types
 - Infiltration basins
 - Infiltration trenches
 - Infiltration galleries
 - Bioretention
 - Permeable pavements
 - Dry wells
 - Hybrid bioretention/Dry wells
 - Bioretention with underdrain
 - Planter boxes
 - Bioinfiltration
 - High-flow biotreatment with raised underdrain
 - Vegetated swales
 - Filter strips

4. Organization by Street Typologies

- N/A

5. Document Status

- Approved
- Standalone document, with yearly annual reports

6. Implementation Strategies and Recommendations

- Not information provided

7. Operations and Maintenance

- Not addressed

8. Cold Climate Guidance

- Not discussed

9. Lessons Learned

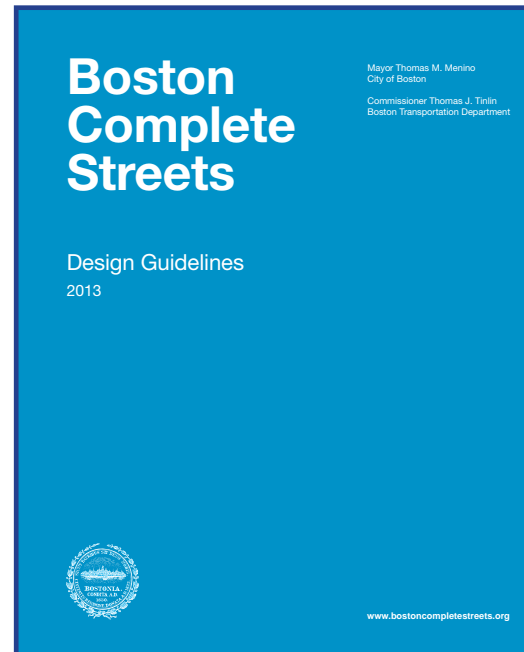
- Not discussed

10. Other Comments

- Broad range of LID examples provided

PRECEDENT RESEARCH - DOCUMENT REVIEW

Boston Complete Streets Design Guidelines,
Boston Transportation Department
2013
City of Boston



1. Level of Guidance

- General with schematic sketches and some dimensions provided
- Specific direction provided relating to tree specification

2. Range of Green Street Objectives Addressed

- Bus lanes and transit prioritization
- Intelligent signals and traffic cameras
- Bicycle and car share stations
- Minimum lane widths
- Rain gardens
- Street trees
- Electric vehicle charging stations
- Ease of maintenance
- Accessible surfaces
- Permeable surfaces
- Smart parking meters
- Bicycle lanes and cycle tracks
- Digital tags and information panels
- Wide sidewalks / pedestrian zones

3. Types of LID / Green Street Alternatives Recommended and Rationale

- Green walls:
 - Stormwater management
 - Energy efficiency
 - Air quality
- Sidewalk materials – Provides list of perforated materials for sidewalk zones
- Permeable paving materials
- Greenscape
 - Street trees
 - Vegetated stormwater management
 - Soils selection and management
- Urban forest
 - Tree selection
 - Root environment
 - Open tree trenches
 - Covered tree trenches
 - Raised tree beds
 - Tree pits
- Stormwater management
 - Stormwater planters
 - Rain gardens
- Street lights – State-of-the-art
- Clean energy – Vehicle charging linked to renewable energy

4. Organization by Street Typologies

- Downtown commercial
- Downtown mixed-use
- Neighbourhood main street
- Neighbourhood connector
- Neighbourhood residential
- Industrial
- Shared street
- Parkway
- Boulevard

5. Document Status

- Approved
- Standalone document with yearly annual reports

6. Implementation Strategies and Recommendations

- Being implemented
 - Implementation principles provided
 - Project development and review process recommended
 - Public involvement process recommended

7. Operations and Maintenance

- General maintenance guidance provided
 - Maintenance agreement
 - Life cycle maintenance for roadways
 - Utility coordination
 - Snow storage and clearance

8. Cold Climate Guidance

- Specific to each type of LID / green street option
- General guidelines for snow storage and clearance provided

9. Lessons Learned

- Not discussed

10. Other Comments

- Provides an index of acronyms includes a detailed index

PRECEDENT RESEARCH - DOCUMENT REVIEW

City of Philadelphia Green Streets Design Manual

2014

Philadelphia Water Department

Streets Philadelphia

Mayor's Office of Transportation and Utilities

City of Philadelphia Green Streets Design Manual



1. Level of Guidance

- General with schematic details and photo illustrations as well as design details and specifications
- Fact sheets provided with general guidance and 30 illustrative details
- Provide guidance for location of green stormwater infrastructure (GSI) systems within road right-of-way
- Provides technical design considerations
- Provides list of design requirements

2. Range of Green Street Objectives Addressed

- Stormwater management

3. Types of LID / Green Street Alternatives Recommended and Rationale

- Stormwater management
 - Stormwater trees
 - Stormwater tree trenches
 - Stormwater planters
 - Permeable pavements
 - Stormwater bump-out
 - Permeable pavement (asphalt, concrete, pavers)
 - * Green gutters
 - * Stormwater drainage wells

* under development

4. Organization by Street Typologies

- High volume pedestrian
- Civic / Ceremonial street
- Walkable commercial corridor
- Urban arterial
- Auto-oriented commercial / industrial
- Park road
- Scenic drive
- City neighbourhood
- Low-density residential
- Shared narrow
- Local

5. Document Status

- Approved
- Generally standalone but to be used in conjunction with “GSI Design Requirements and Guidelines Packet” and “GSI Design Manual”
- Supporting detailed document include “Water Department Design Details and Specifications” and “PWD Green Infrastructure Standard Details”

6. Implementation Strategies and Recommendations

- Being implemented
 - Sets out design review and approval process (not relevant to Toronto – Philadelphia specific)
 - Identifies funding opportunities (not specific)

7. Operations and Maintenance

- Provides an outline of requirement for construction and inspection
- Outlines maintenance responsibilities

8. Cold Climate Guidance

- Not discussed

9. Lessons Learned

- Not discussed

10. Other Comments

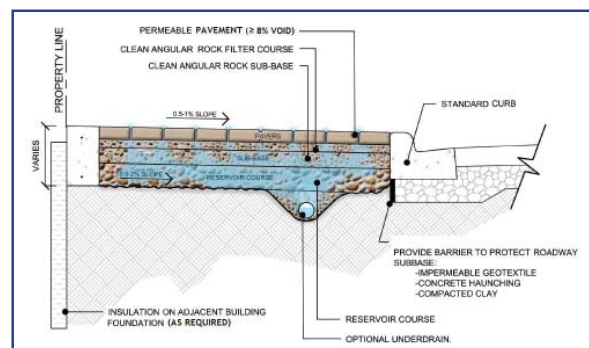
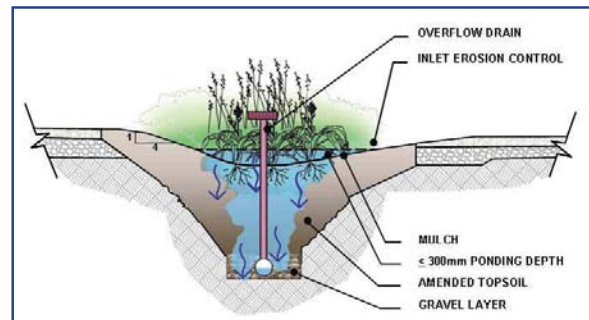
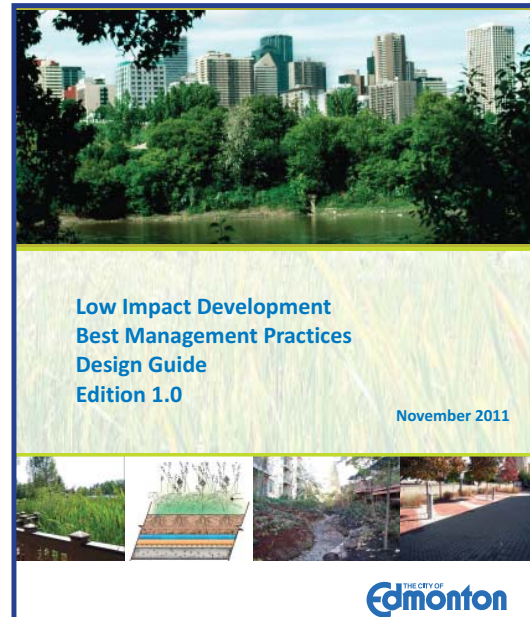
- Matrix provided to illustrated SMP suitability for each street typology

PRECEDENT RESEARCH - DOCUMENT REVIEW

Low Impact Development Best Management Practices Design Guide - Edition 1.0

2011

City of Edmonton



1. Level of Guidance

- Guideline document with specific schematic details for various LID options
- Provides exceptional detail on design, construction and maintenance requirements for each LID type
- Provides plant lists
- Provides facility sizing calculations

2. Range of Green Street Objectives Addressed

- Stormwater management
- Urban forest

3. Types of LID / Green Street Alternatives Recommended and Rationale

- Bioretention / rain gardens
- Bioswales
- Green roofs
- Permeable pavement
- Box planters
- Naturalized drainageways
- Rainwater harvesting for reuse
- Soil amendments

4. Organization by Street Typologies

- No

5. Document Status

- Approved

6. Implementation Strategies and Recommendations

- Addresses regulatory context
- Provides guidance on selection and application

7. Operations and Maintenance

- Provides operation and maintenance recommendations for each LID option
- Provides maintenance program requirements and schedule

8. Cold Climate Guidance

- Addresses winter maintenance
 - Policy
 - Practical recommendations

9. Lessons Learned

- Not discussed

10. Other Comments

- Provides a glossary of terms
- Best resource for cold climate operation, facility sizing and maintenance information

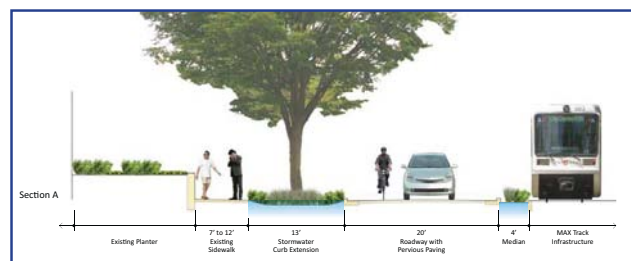
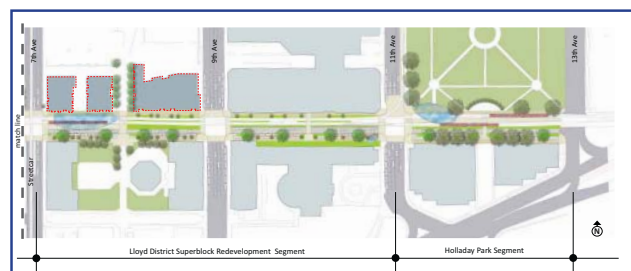
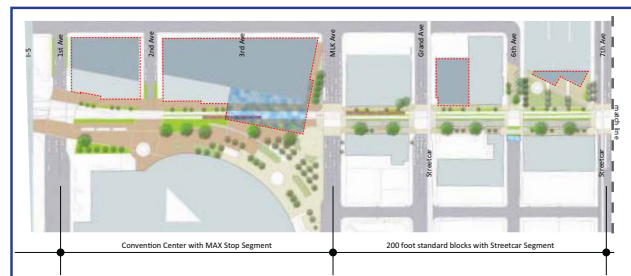
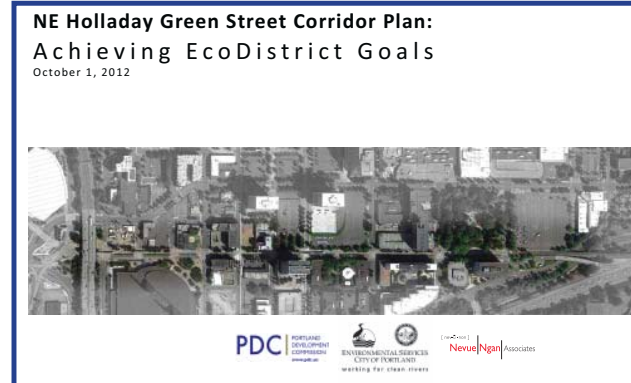
PRECEDENT RESEARCH - DOCUMENT REVIEW

NE Holladay Green Street Corridor Plan - Achieving EcoDistrict Goals

2012

Portland Development Corporation

Environmental Services - City of Portland



1. Level of Guidance

- Plan for a specific street corridor
- Provides design toolbox and schematic details / illustrations

2. Range of Green Street Objectives Addressed

- Impervious area reduction
- Stormwater management
- Urban forest enhancement

3. Types of LID / Green Street Alternatives Recommended and Rationale

- Pervious planters
- Boardwalks
- Green roof at grade
- Pervious paving
- Stormwater curb extension
- Stormwater planters
- Green gutter
- Stormwater canopies, green roofs on transit stops
- Street tree canopy
- Subsurface infiltration and storage
- Movable planters

4. Organization by Street Typologies

- No - Examples provided for one specific street only

5. Document Status

- Unknown

6. Implementation Strategies and Recommendations

- Not addressed

7. Operations and Maintenance

- Not addressed

8. Cold Climate Guidance

- Not discussed

9. Lessons Learned

- Not discussed

10. Other Comments

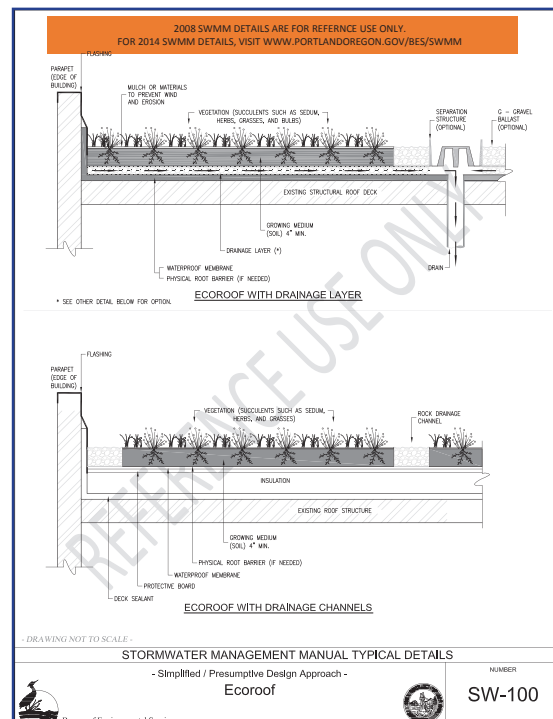
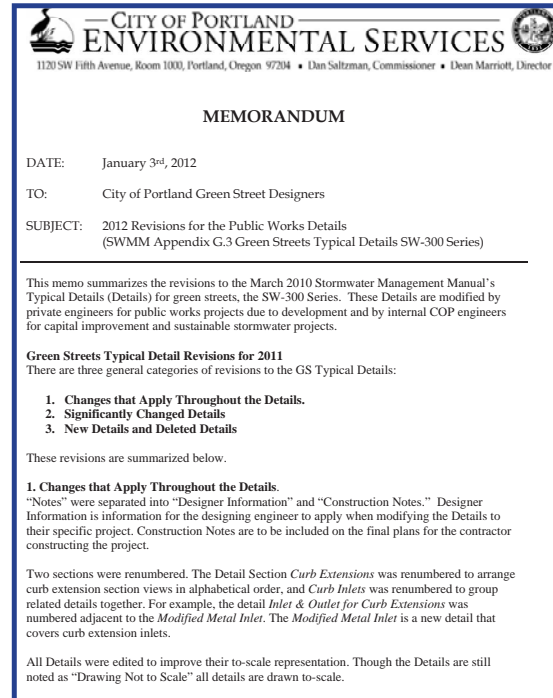
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PRECEDENT RESEARCH - DOCUMENT REVIEW

City of Portland - Revisions to 2012 Public Works Details

2012

City of Portland Environmental Services



1. Level of Guidance

- Specific construction details

2. Range of Green Street Objectives Addressed

- Stormwater management
- Urban forest
- Reduced urban heat island effect

3. Types of LID / Green Street Alternatives Recommended and Rationale

- Ecoroof
- Permeable pavement
- Swale
- Stormwater planter
- Basin
- Overflow configuration
- Filter strip
- Dry well
- Soakage trench
- Sand filter
- Subsurface sand filter
- Street tree
- Curb extensions
- Curb inlets
- Metal inlets
- Channel and grate
- Rock check dam
- Wood check dam
- Concrete check dam
- Overflow drain
- Oil water separators

4. Organization by Street Typologies

- No

5. Document Status

- Approved for reference only

6. Implementation Strategies and Recommendations

- Reference use only

7. Operations and Maintenance

- Not addressed

8. Cold Climate Guidance

- Not discussed

9. Lessons Learned

- Not discussed

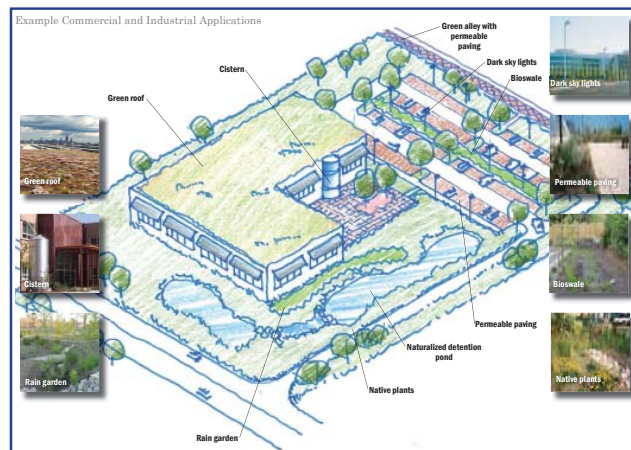
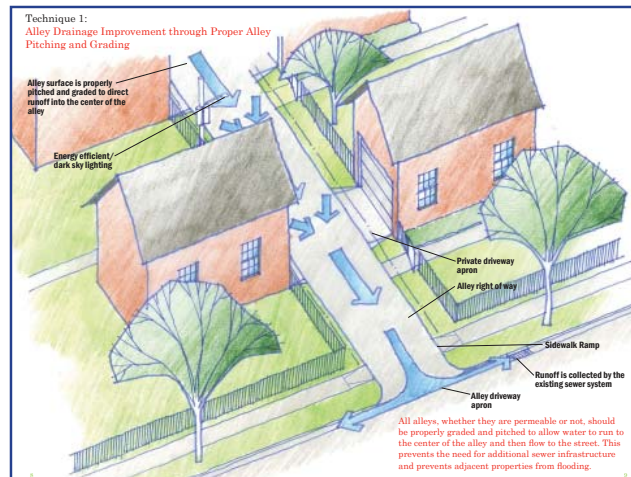
10. Other Comments

- Excellent compendium of technical details

PRECEDENT RESEARCH - DOCUMENT REVIEW

The Chicago Green Alley Handbook 2010

City of Chicago Department of Transportation



1. Level of Guidance

- High level guideline document that is focussed on alley and laneway retrofits
- Provides illustrative examples of various application

2. Range of Green Street Objectives Addressed

- Stormwater management
- Reduced urban heat island effect
- Dark sky compliant lighting

3. Types of LID / Green Street Alternatives Recommended and Rationale

- Permeable pavement
- High reflectivity surfaces
- Tree planting
- Green roofs on garages

4. Organization by Street Typologies

- Laneways only

5. Document Status

- Approved
- Communication tool for property owners

6. Implementation Strategies and Recommendations

- Provides implementaion
- Sets out range of costs

7. Operations and Maintenance

- Not addressed

8. Cold Climate Guidance

- Not discussed

9. Lessons Learned

- Not discussed

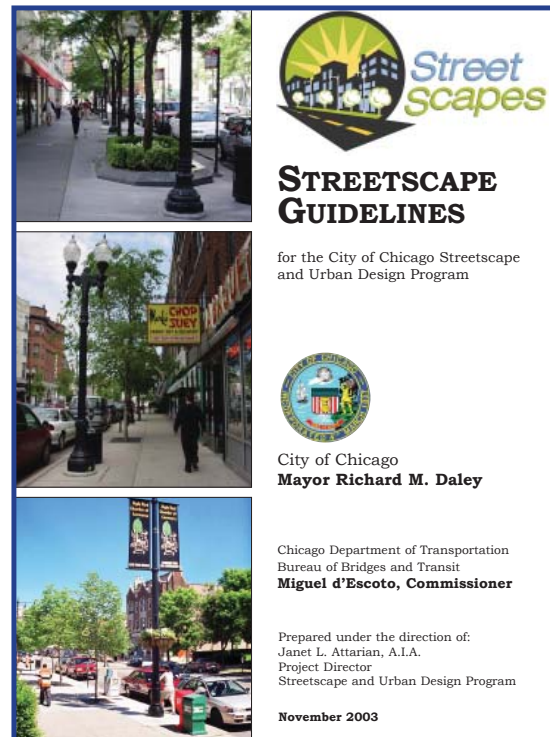
10. Other Comments

- N/A

PRECEDENT RESEARCH - DOCUMENT REVIEW

Streetscape Guidelines for the City of Chicago Streetscape and Urban Design Program 2003

*City of Chicago Department of Transportation
Bureau of Bridges and Transit*



1. Level of Guidance

- “Streetscape” oriented guide with an emphasis on sidewalks, beautification
- Provides “Tool for Community Involvement”
- High level of detail related to curbs, tree grates, etc

2. Range of Green Street Objectives Addressed

- Walkability
- Urban forest

3. Types of LID / Green Street Alternatives Recommended and Rationale

- Sidewalks
- Bikeways
- Urban forest

4. Organization by Street Typologies

- Dissects streetscape into components
- Defines and describes streetscape elements
- Defines pedestrian “Level of Service” (LOS)

5. Document Status

- Approved
- Companion document: Green Alley Handbook

6. Implementation Strategies and Recommendations

- Sets out guidelines for implementation and review process
- Sets out recommended design process
- Identifies funding sources

7. Operations and Maintenance

- Recognizes the need for “post construction” maintenance

8. Cold Climate Guidance

- Not discussed

9. Lessons Learned

- Not discussed

10. Other Comments

- N/A

PRECEDENT RESEARCH - DOCUMENT REVIEW

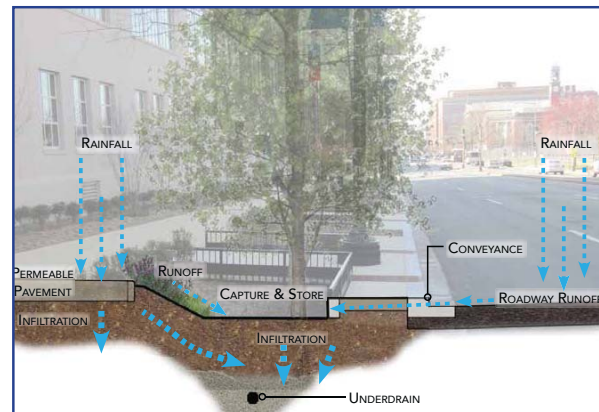
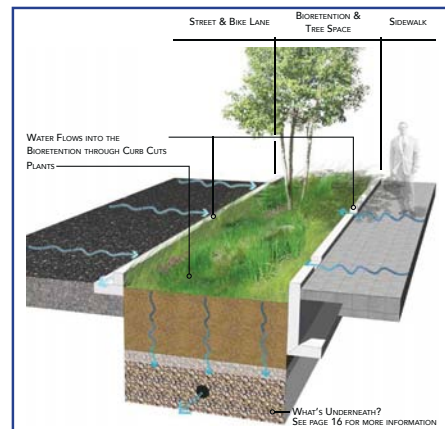
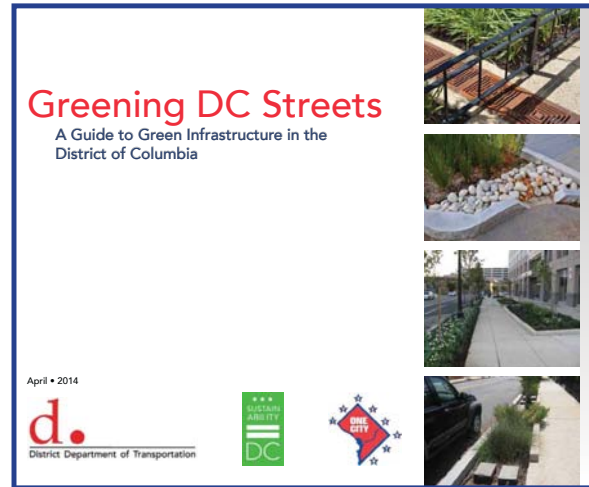
Greening DC Streets - A Guide to Green Infrastructure in the District of Columbia

April 2014

District Department of Transportation

Sustainability D.C.

One City



1. Level of Guidance

- General principles and objectives
- Examples of LID types discussed / illustrated
- Schematic / illustrative details provided
- Fact sheets included
- Provides design examples

2. Range of Green Street Objectives Addressed

- Stormwater management
- Urban forest

3. Types of LID / Green Street Alternatives Recommended and Rationale

- Bioretention (rain gardens)
- Street trees
- Landscape areas
- Permeable pavement
- Removing unnecessary pavement
- Bioretention:
 - Planters
 - Curb extensions
 - Bioswales
- Tree planting:
 - Structural soils
 - Soil cells
 - Suspended sidewalk

4. Organization by Street Typologies

- No

5. Document Status

- Approved
- To be used in conjunction with:
 - DDOT Design and Engineering Manuals
 - DDOT: Standard drawings
 - DDOT: Standard specifications for highways and structures
- Green infrastructure plant list
- Green infrastructure maintenance schedule

6. Implementation Strategies and Recommendations

- Sets out regulatory approval requirements

7. Operations and Maintenance

- General recommendations provided
- Matrix with basic maintenance requirement provided

8. Cold Climate Guidance

- Not discussed

9. Lessons Learned

- Not discussed

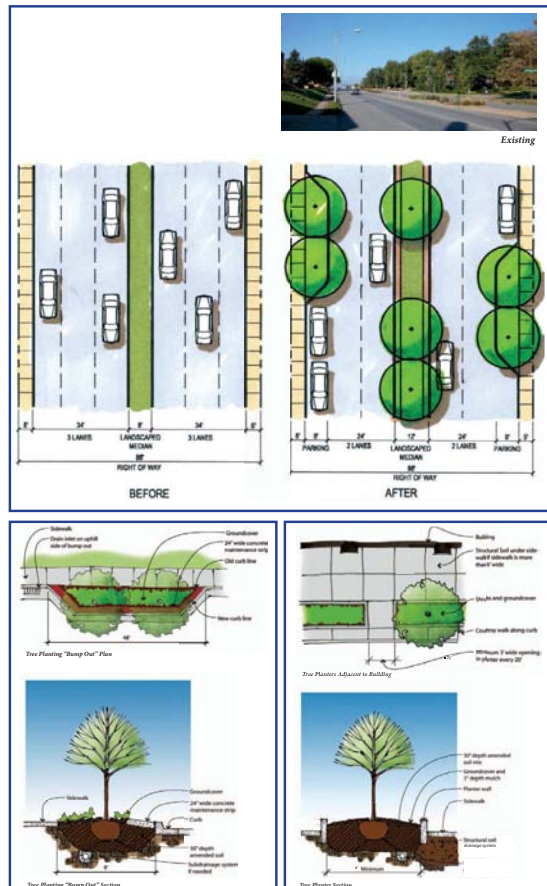
10. Other Comments

- Provides calculation of land area encompassed by road rights-of-way (26% of total land area)

PRECEDENT RESEARCH - DOCUMENT REVIEW

Green Streets for Omaha
2007

Green Streets for Omaha Project Sponsor
City of Omaha Parks, Recreation, and Public Property
Green Streets for Omaha Task Force



1. Level of Guidance

- General
- A compendium of examples of “Green” streets in the city with a description of their characteristics
- Provides a catalogue of “Green Street” prototypes
- Includes “retrofit” concept
- Provides retrofit case studies
- Document is more focussed on urban design than function
- Provides schematic details

2. Range of Green Street Objectives Addressed

- Improve traffic safety
- Increased property values
- Increased pedestrian and bicycle access
- Better stormwater management
- Upgrade development
- Better image and community marketing

3. Types of LID / Green Street Alternatives Recommended and Rationale

- Trails
- Medians
- Sidewalks
- Drainage swales
- Ornamental plantings
- Bike lanes
- Planting details (schematic for):
 - Standard boulevard planting
 - Root path
 - Structural soil
 - Tree planters
 - Trees in medians
- Provides tree species list

4. Organization by Street Typologies

- Defines a set of street typologies
- Major arterial
- Minor arterial
- Special arterial
- Collector
 - Conveyance
 - Neighbourhood
 - Street car avenue
 - Main street
- Boulevards and parkways
- Local streets
- Provides classification for “Green Streets”

5. Document Status

- Approved
- To be used in conjunction with:
 - Omaha Streetscape Handbook
 - Urban Design Handbook for Omaha

6. Implementation Strategies and Recommendations

- Unknown
- Sets out implementation priorities by street name based on a ranking system
- Provides recommendations for funding for capital and maintenance
- Provides cost estimates on a “per mile” basis for new and retrofit projects

7. Operations and Maintenance

- Short section on maintenance aimed primarily at tree plantings

8. Cold Climate Guidance

- Not discussed

9. Lessons Learned

- Not discussed

10. Other Comments

- N/A

PRECEDENT RESEARCH - DOCUMENT REVIEW

Omaha Streetscape Handbook

2008

City of Omaha

American Society of Landscape

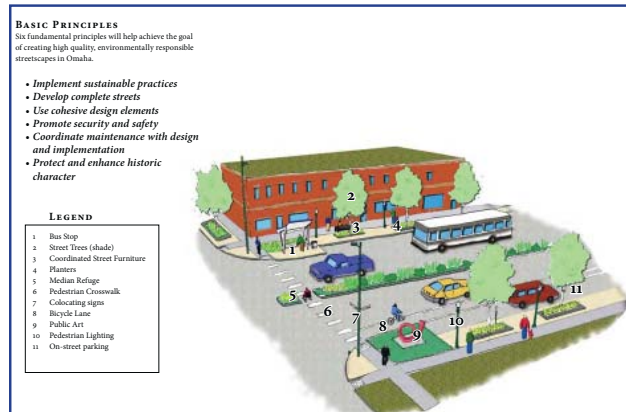
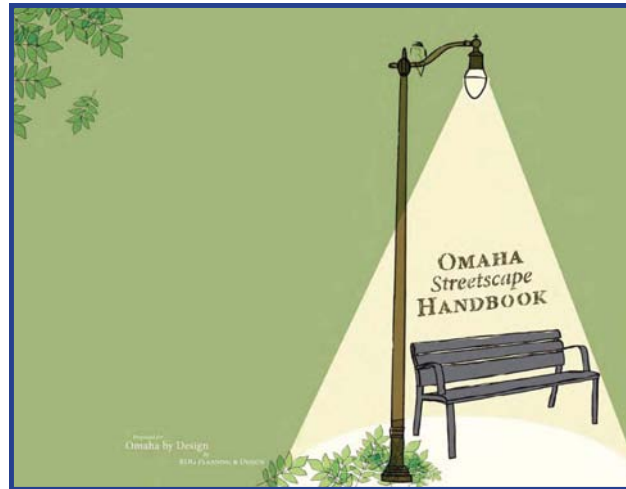
Architects American Institute of

Architects American Society of Civil Engineers

American Planning Association

Omaha Public Power District

Nebraska Department of Roads



1. Level of Guidance

- Establishes principles of streetscape design
- Presents examples in various contexts
- Establishes performance guidelines

2. Range of Green Street Objectives Addressed

- Stormwater management
- Sustainable materials
- Lighting and dark skies
- Landscaping and urban heat island

3. Types of LID / Green Street Alternatives Recommended and Rationale

- Bioswales
- Pervious paving
- Rain gardens
- Rain barrels
- Renewable materials sources
- Local materials
- Recycled content
- Dark sky compliant lighting
- Tree planting
- Reflective paving and roofing materials

4. Organization by Street Typologies

- Provides specific street type examples

5. Document Status

- Approved
- To be used in conjunction with:
 - Green Street Master Plan
 - Suburban Parks Master Plan
 - City of Omaha Public Works Standard Plates
 - Downtown Wayfinding Plan
 - Public Art Commission Guidelines
 - Urban Design Element of the Comprehensive Plan

6. Implementation Strategies and Recommendations

- Unknown
- No implementation recommendations provided

7. Operations and Maintenance

- Addresses security and safety
- Coordinates maintenance with design

8. Cold Climate Guidance

- Not discussed

9. Lessons Learned

- Not discussed

10. Other Comments

- Sets out performance standards for each streetscape component



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TORONTO GREEN STREETS



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TMIG
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