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Great Lakes Chapter

Toronto and Region Conservation for The Living City

3rd Annual TRIECA Conference – March 25 & 26, 2014

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Media Partner

Retrofit of the IMAX Head Office Parking Lot with Low Impact Development Technologies

Amna Tariq - Water Resources Specialist

Phil James – Manager, Urban Watershed Protection & Restoration

March 26th, 2014

Presentation Outline – 45 mins

- WaterTAP Video
- Goals & Drivers for IMAX
- Design Overview
- Monitoring Plan
- Lessons Learned
- Next Steps
- Q&A

Credit Valley Conservation

Play WaterTAP Video

IMAX Corporate Goals

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- Co-Chairman & Co-Chief Executive Officer Richard Gelfond of IMAX, has expressed concern over the shrinking time we have to address environmental issues and the need to escalate action on the environment;
- ***"Need for <u>increased awareness</u> and <u>taking action</u> otherwise our legacy is going to be a barren planet!"***

Lower O&M Costs

Correcting drainage Issues

Better snow storage (source: Smart about Salt)

Cracking, upheavel, potholes

(saturated granular bases, inadequate base, poor drainage)

Need for excessive salt application

Lower O&M Costs

- Concrete pavements have a significantly lower life-cycle cost than alternatives such as asphalt.
- Although the initial cost of pervious installation may be slightly higher, concrete saves money in the long run due to its superior durability and strength.
- It requires fewer repairs than asphalt, and has a longer overall lifespan.

CVC | Credit Valley Conservation

Reduced Liability

- Slips, Trips and Falls result in some of the most common and **costly** liability claims against business owners (*Insurance Bureau of Canada*);
- **Average WSIB claim costs companies $ 22,000!!**
- Pervious pavements exhibit a **high level of functionality** during winter conditions **skid resistance**, and **salt reduction**.

Stormwater Fees

It's raining user fees in Mississauga

013/mississauga-considering-stormwater-user-rate/

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NEWS, ONTARIO

Mississauga Considering Stormwater User Rate

Mississauga moves toward pavement tax

A levy on space devoted to non-absorbent surfaces will help pay for better storm water systems in the wake of the devastating July 8 storm.

Tweet 47 g+1 0 reddit this! + save to mystar

FRED LOEK / MISSISSAUGA NEWS

eluge that hit the GTA on July 8, as damage to this
ater system is badly in need of improvements,
on properties that contribute most to the runoff

Dec 04, 2013 | Vote 0 0

City set to implement stormwater fee in 2016

By Chris Clay

The average homeowner in Mississauga will pay about $94 a year under a new fee program designed to have property owners with a lot of concrete and hard surfaces pay more.

The City of Mississauga's stormwater infrastructure, which includes storm sewers, catch basins, stormwater management ponds, bridges and culverts, is aging and in need of repairs. However, the municipality can no longer afford to pay for them solely through property taxes and development charges.

Taking Action

- Taking local action by reducing IMAX's water footprint protecting our local water resources and building resilience;
- Advancing science, the environment and health by providing the opportunity to test innovative technologies that will inform decision makers, enhance productivity and improve outcomes;
- Aligns with IMAX's corporate greening goals.

Sheridan Creek Watershed

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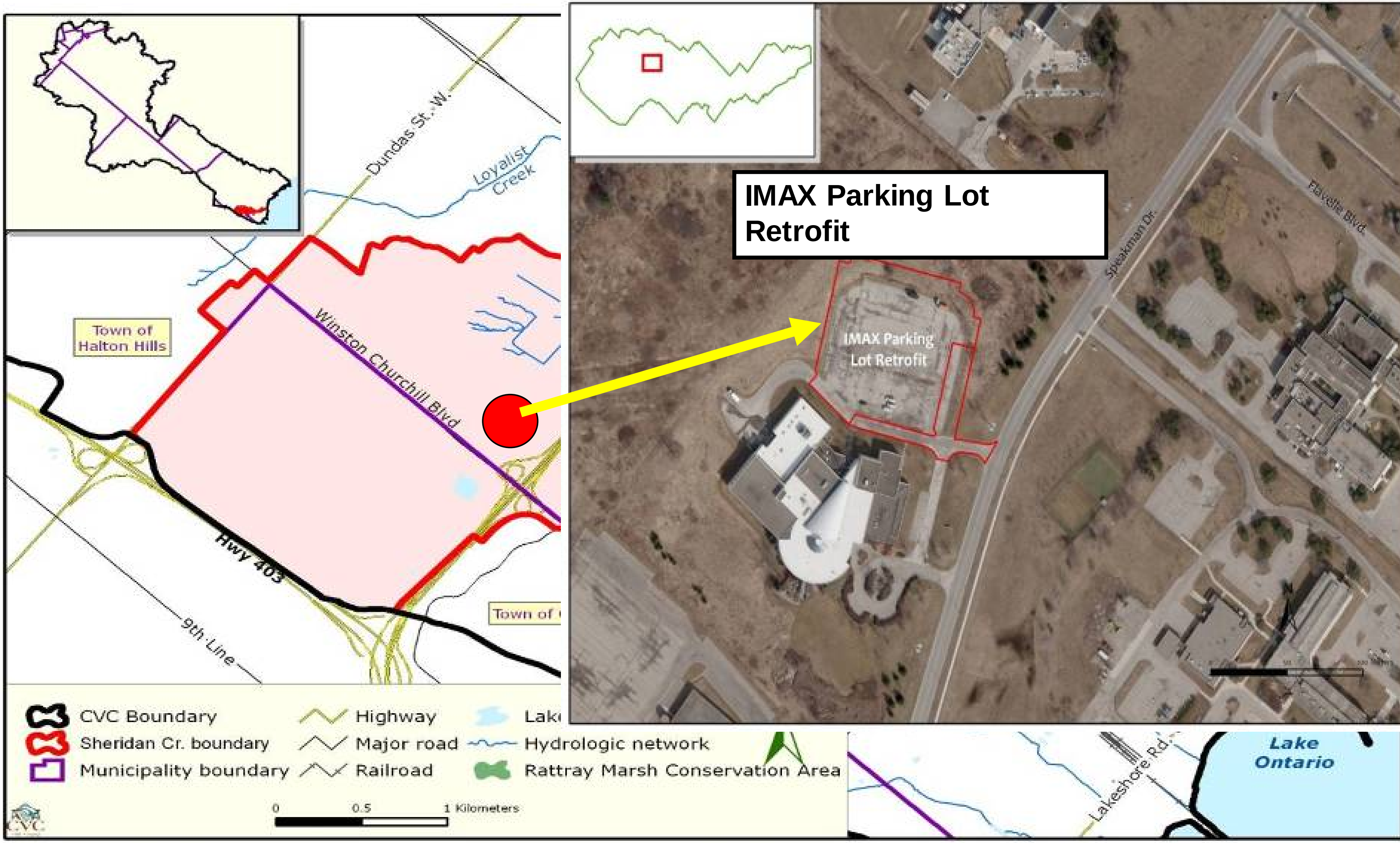
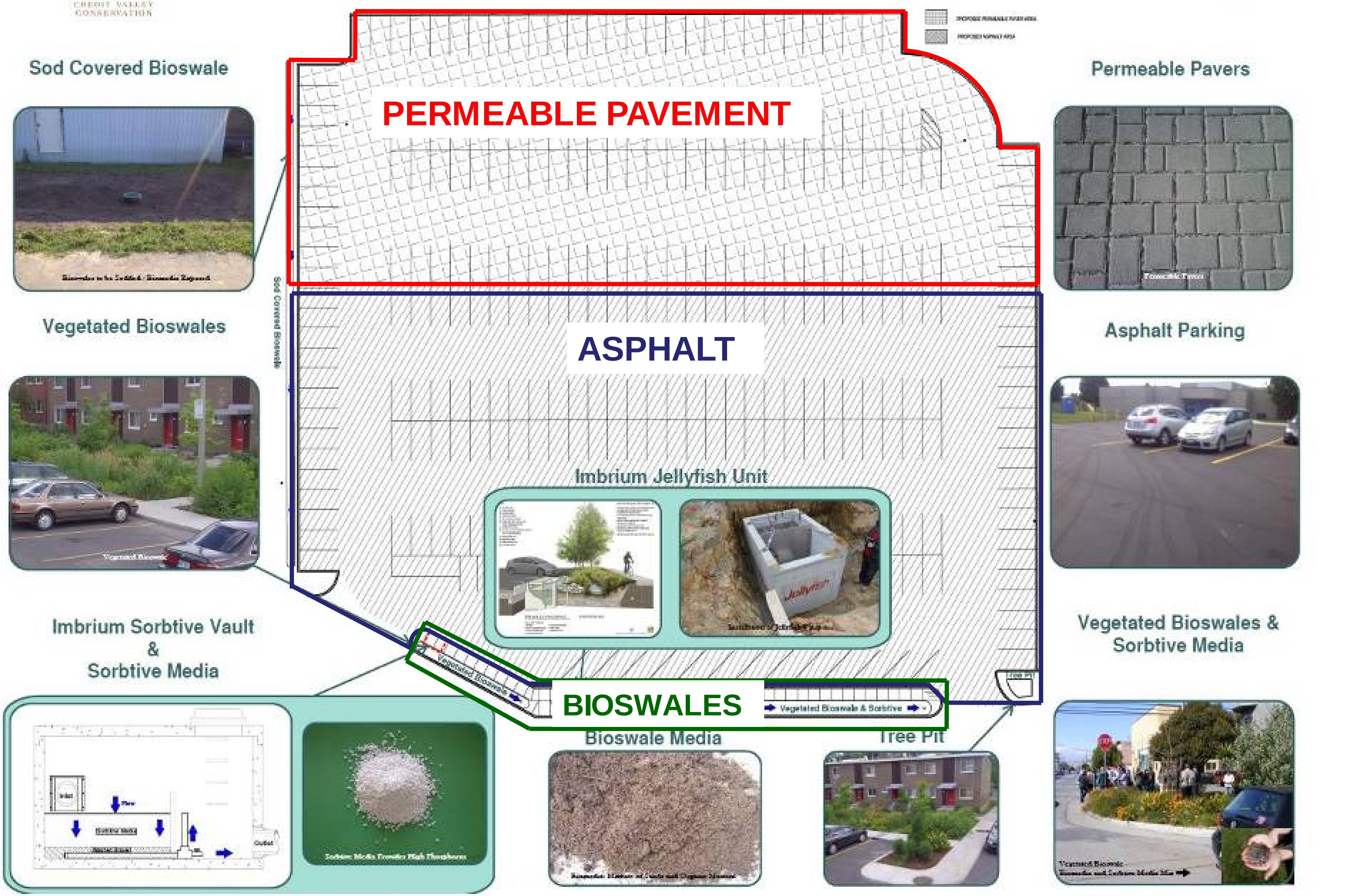


IMAX Corporation
Parking Lot Expansion & Redevelopment



Dec 10, 2012

Permeable Pavement

¾" Clear Stone

- 40% void space/no fines
- 500 mm aggregate depth
- 348 m3 in storage
- 12.2 hrs drawdown time

Granular "O"

- 20% void space/fines
- 350 mm aggregate depth
- 141 m3 in storage
- 4.95 hrs drawdown time

Permeable Pavement Design

System Component/ Parameter	Value	
	Cross-section No. 1: Open Graded angular 20 mm ø stone PICP Cross-section	Cross-section No. 2: Granular 'O' PICP Cross-section
Paver Thickness and Type	80 mm – Eco Optiloc(R) by Unilock	
Bedding	50 mm of No.8 angular chip stone (5-7 mm ø)	
Aggregate Depth	500 mm	350 mm
Geotextile	Woven multi-layered geotextile (RS380i)	
Total PICP Surface Area	3145 m^2	
Approx. Surface Dimensions	48 m x 34 m (1500 m^2)	48 m x 34 m (1645 m^2)
Total Excavation Depth	630 mm	480 mm
Total Storage	348 m^3 *	141 m^3 **
Underdrain System	200 mm ø perforated HDPE main collection pipe	150mm ø perforated HDPE Laterals 200mm ø perforated HDPE main collection pipe
Drawdown time based on max pipe flow –Hydrologic Analysis) Assumes complete dewatering of base material and instantaneous storage)	12.2 hrs	4.95 hrs
* assumes a 40% void ratio ** assumes a 20% void ratio		

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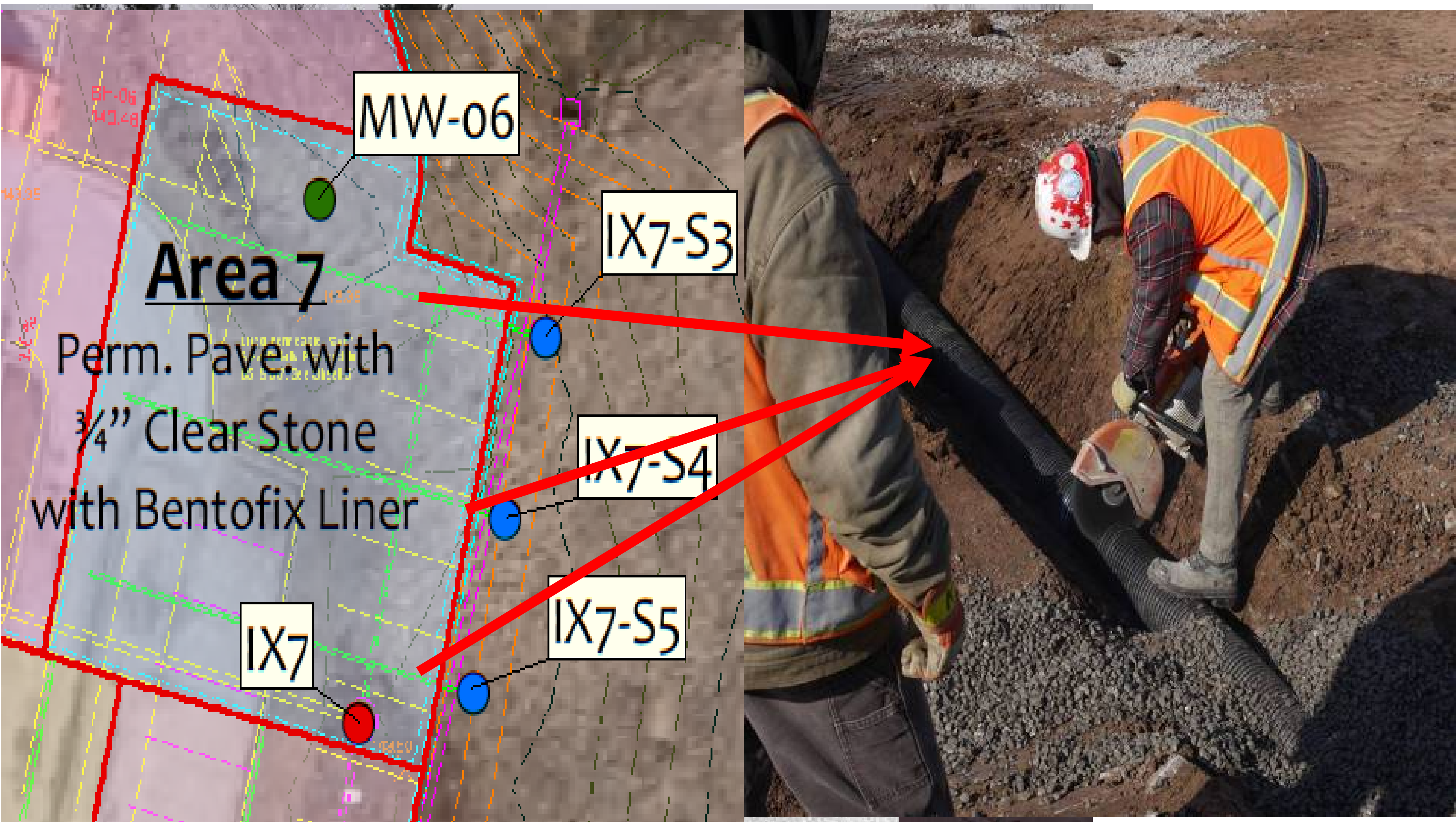
Impermeable Liner




2013/ 9/19 9:04

Parameter	Bioswale #1 – Sorbtive® Vault	Bioswale #2 – Jellyfish® Filter	Bioswale #3 – Stand Alone
Contributing drainage area	1125 m^2	1350 m^2	1566 m^2
Water quality volume (WQV) to be treated *Note: 25 mm event corresponds to 90% of the total annual rainfall depths	28.13 m^3 (25 mm event)	33.75 m^3 (25 mm event)	39.15 m^3 (25 mm event)
Average ponding depth	300 mm		
Engineered media infiltration rate (assumes 50 mm/hr = SF of 2; measured infiltration rates of media range from 80-120 mm/hr)	50 mm/hr		
Native soils infiltration rate	0 - 2.6 mm/hr (bedrock and clay fill respectively)		
Shredded hardwood mulch depth	50 mm		
Drawdown time	24hrs		
Total facility depth Engineered media Gravel detention layer	0.675 m 0.3-0.4 m 0.4 m		
Perforated HDPE underdrain (diameter)	200 mm		
Required surface area of facility*			
Surface area of facility (as designed)	40 m^2	62 m^2	72 m^2
Required surface area of facility to achieve 25 mm water quality treatment	16 m^2	19 m^2	23 m^2
% of 25 mm water quality achieved	100%	100%	100%
Required surface area of facility to achieve 1:10-year(51.7 mm) event water quality treatment*	34 m^2	40 m^2	47 m^2
% of 1:10 year event (51.7mm) mm water quality achieved	100%	100%	100%
Storage assessment (surface ponding and subsurface storage)**			
Total storage volume (as designed)	27.3 m^3	36.6 m^3	41.6 m^3
Required stored and ponded volume -25mm event (% provided)	15.4 m^3 (100%)	20.1 m^3 (100%)	23.3 m^3 (100%)
Required stored and ponded volume -1:10year (51.7 mm) event (% provided)	37.3 m^3 (73.1%)	49.9 m^3 (73.5%)	57.9 m^3 (71.6%)
*Hydraulic facility calculations – Assumes bioswales functions primarily as a filtration unit (not an infiltration unit)			
**Event simulated using a synthetic 25 mm event per Chow, 1983. Assumes no outflow during rain event, facility simulated as a storage unit only.			

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Treatment Train #1 - Bioswale with SorbtiveVAULT

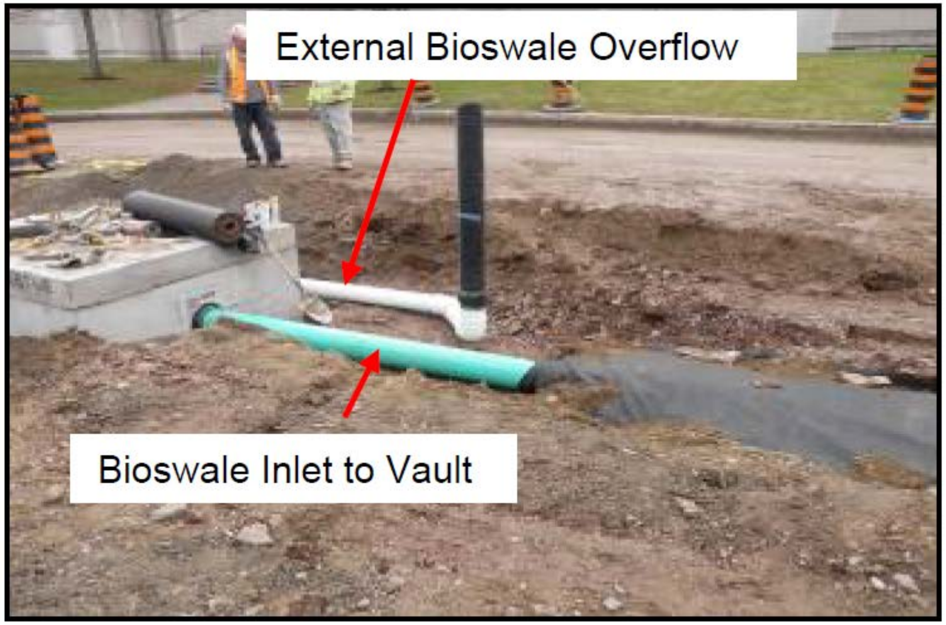
Asphalt to Bioretention to Sorbtive Media Vault

Bioretention
-Primary treatment

Sorbtive Media Vault
- Dissolved nutrient removal

Overflow by-passes Sorbtive Media Vault

SorbtiveVAULT Design Details



SorbtiveVAULT and Media Design	
General Tank Dimensions (m)	1.5 x 1.8
Design Flow Rate (m^3/s)	5.5×10^{-4}
Min. Bed Area Required (m^2)	1.51
Volume of Media Required (m^3)	0.59
Approx. Amount of Media Required (kg)	620

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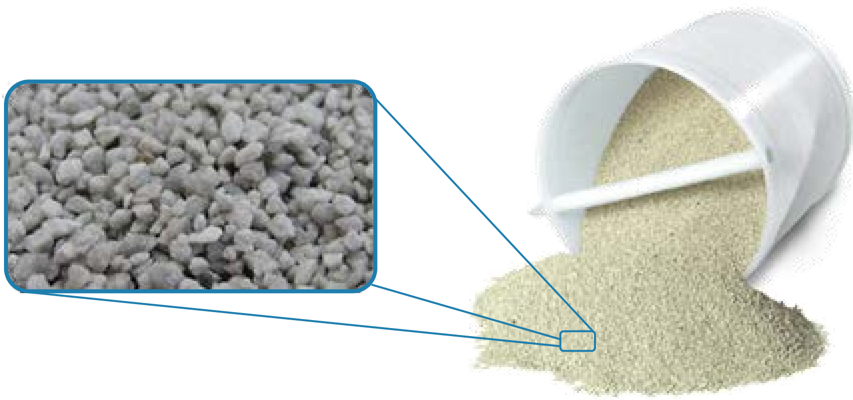
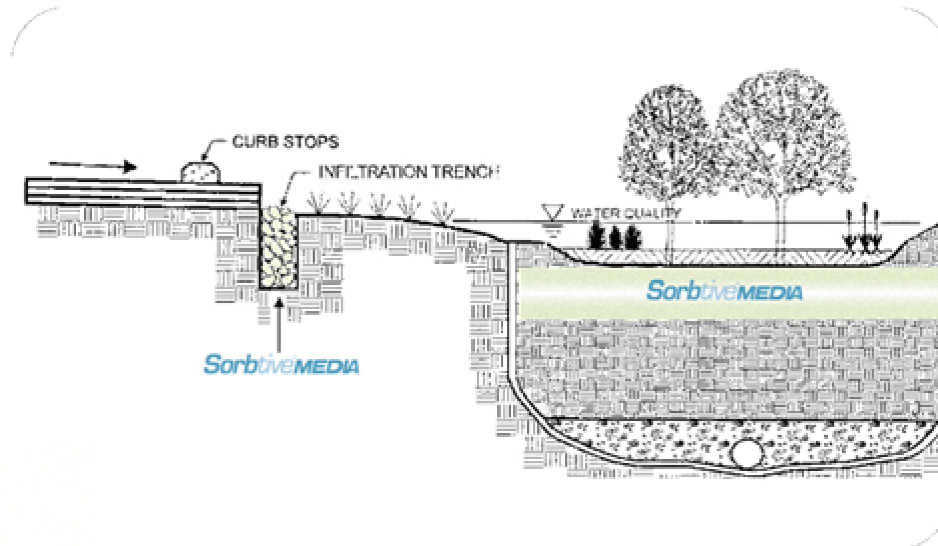
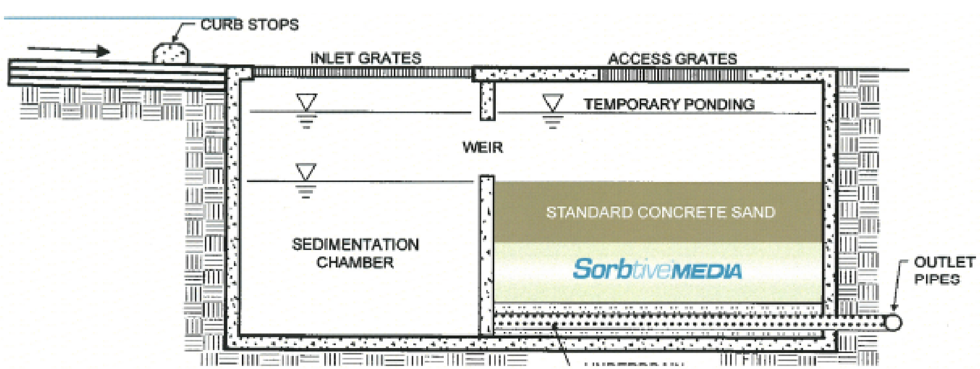
How does Sorbtive®Media work?







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Treatment Train #2 - Bioswale with JellyFish Filter

Asphalt to Jellyfish unit to Bioretention

Jellyfish
-Cartridge filters
-Oils & Greases
-Large & small sediment particles

Bioretention
- Further polishing & Cooling

JellyFish Filter Design Details

Hydrologic Parameters	Value
Design precipitation event (mm)	25
Runoff coefficient	0.95
Water quality discharge (L/s)	9.03
Jellyfish® Filer Design	**Value**
Hi-Flo treatment flow rate (L/s)	5.55
Draindown treatment flow rate (L/s)	1.39
No. of Hi-Flo cartridges required	4
No. of drawdown cartridges required	2
Total treatment flow rate (L/s)	6.94

JellyFish Filter Catchbasin

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Control Bioswale

Control Site

Lessons Learned – Why do LIDs fail?

- Plans without enough detail and instruction;
- Designers who underestimate the complexities of construction;
- Contractors who do not understand the technology or importance of certain procedures;
- Lack of effective erosion and sediment control during construction.

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Full Time Construction Inspection

As-built survey

Lessons Learned - Erosion & Sediment Control

Need to protect infiltration practices!

During construction, access to the permeable pavers was limited to a single location so that conditions could be monitored, and maintained more efficiently.

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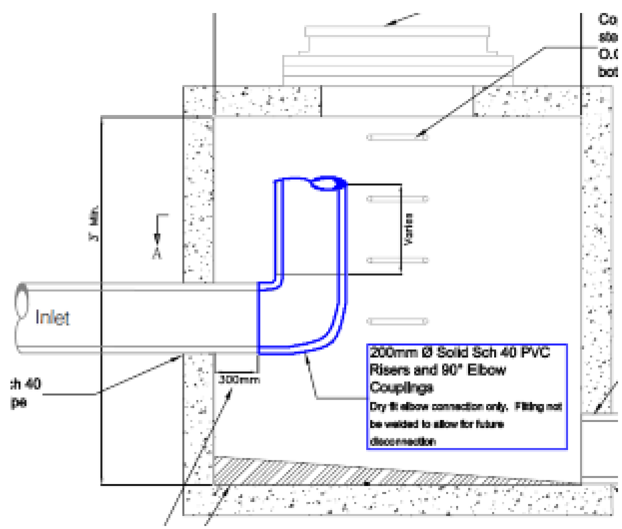
Lessons Learned - Design

- Integrate monitoring infrastructure into the engineering design!
- Incorporate optimization features;
- Add additional surface inlets to minimize the chance of excessive ponding.



Elbow to store & infiltrate additional water

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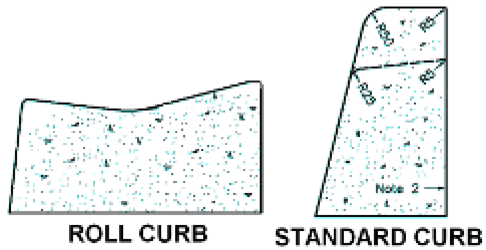
Lessons Learned - Operation & Maintenance



Roll curb allows contractor to push snow completely off the parking lot

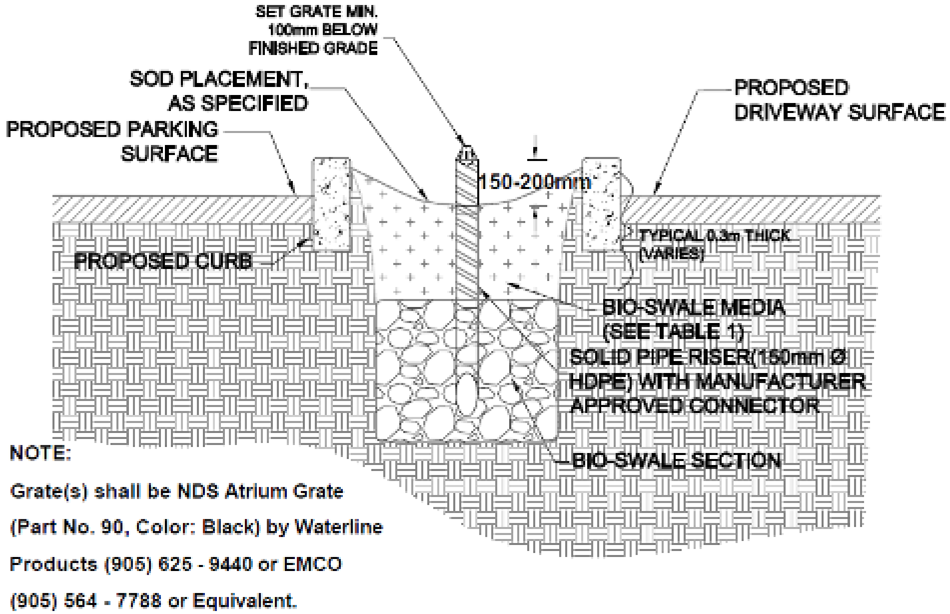
Meltwater does not flow back across asphalt surface creating icy conditions

Contractor pushes snow to perimeter of the parking lot

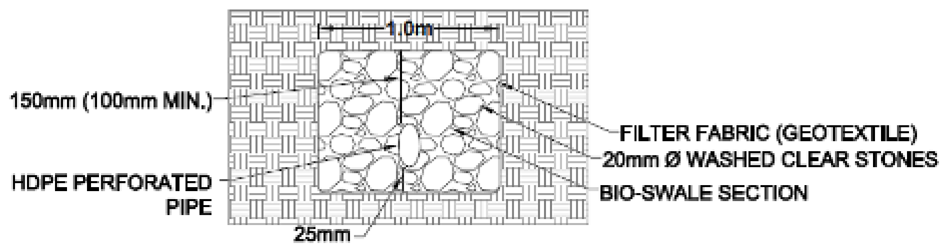
Risk of hitting curbs if curb markers are not in place

Bioretention Design Details

- Filter fabric wrapped around under drain to prevent bioretention media from migrating into the gravel layer
- Chocker coarse of pea gravel



BIO-SWALE DETAIL



Soil Media Testing Before Installation

Lessons Learned - Construction

Compaction around light standards

Fine grading of bioretention areas after planting to stop short circuiting

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Development of an Experimental Design Template

“OCE's Technical Problem Solving program supports short-term projects between industry and academia that address specific technical challenges or opportunities identified by the industry partner that will have a commercial impact. The projects focus on quickly applying research and technical expertise to resolve these challenges and speed innovative products and services to market.”

Ontario Centres of Excellence

University of Guelph

Experimental Design Template

The experimental design will provide the framework for a multi-year performance evaluation of the IMAX parking lot retrofit;

Evaluate the capability, effectiveness and acceptance of novel LID synergies to advance innovative SWM technology acceptance, implementation and product supply and services across Ontario.

Monitoring Plan

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Water Quantity Control

1. Evaluate the performance of various stormwater management practices individually and as a collective system relative to a traditional asphalt-to-catchbasin system.

2. Evaluate LID performance with respect to providing flood and erosion control.

Hydrologic Response

- What is the volume, timing and rate of outflow from LIDs and asphalt?
- What conditions (i.e. rain events) produce no outflow, produce flow and receive full treatment, cause overflow/bypass?

Volume Reduction

- What are the event-based peak flow reductions, volume reductions and lag coefficients?
- What is the overall hydrologic performance statistics for the monitored events (e.g. annual volume reduction, average peak flow reduction, etc.)

Water Quality Treatment

3. Evaluate LID performance in order to improve water quality with respect to the parameters of concern (TSS, metals, nutrients, temperature and pollutant loading etc)

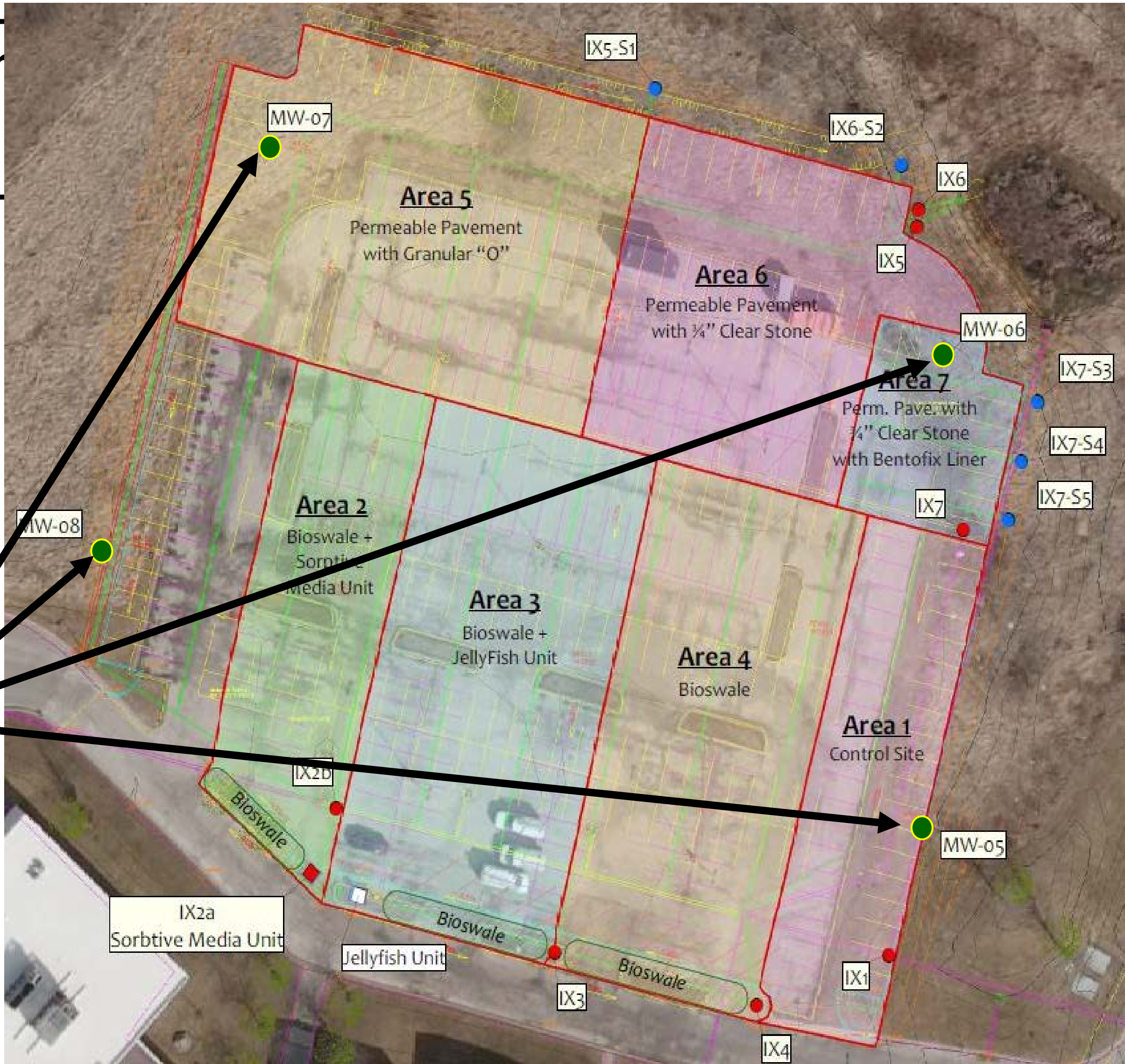
- What is the water quality performance between the various LIDs versus the asphalt control site?
- What are the event-based removal efficiencies and pollutant loadings?
- What is the average annual removal rates?
- What the removal efficiencies on a seasonal basis (spring/summer/fall/winter)?

Groundwater Quality

4. Evaluate any char quality

- Address concern around LID infiltration practices in groundwater sensitive areas

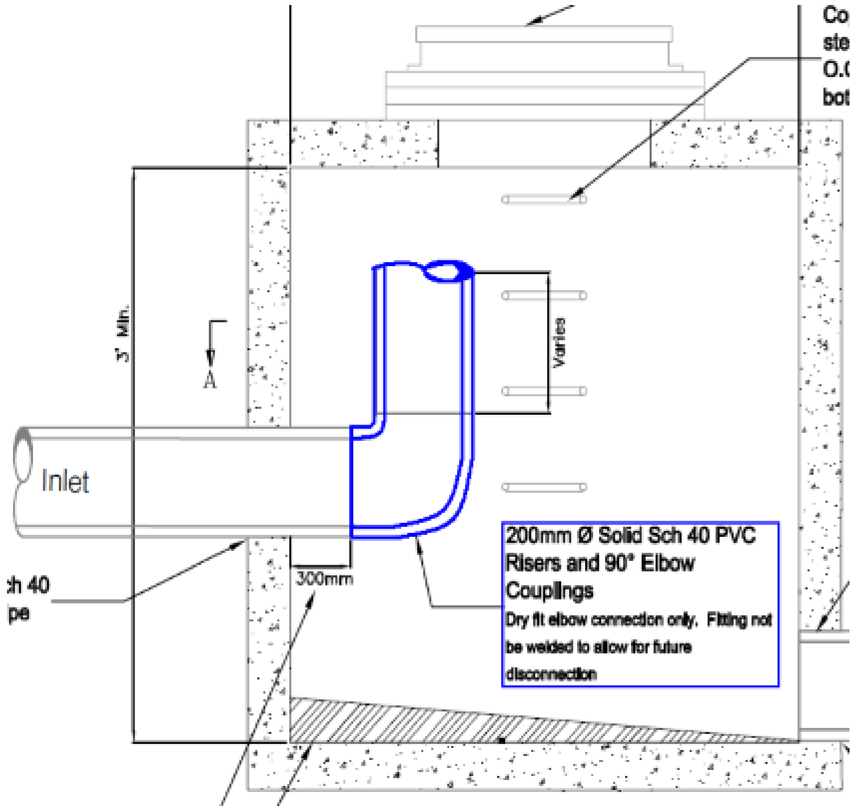
- Monitor groundwater quality through wells



LID Design Optimization

5. Evaluate and refine the design and construction methods and practices to optimize LID performance

- Optimize the design of permeable pavement systems to meet multiple environmental objectives
- Optimize the design of LID treatment trains with enhanced filtration systems
- Compare difference between Granular O and ¾" clear stone in terms of treatment, storage and construction costs.



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Maintenance & Operation

6. Evaluate long-term maintenance needs to optimize LID performance


- When does a drop in performance trigger the need for maintenance?
- What are the Infiltration test results for permeable pavement over time?
- What are the O&M needs such as surface sweeping, inlet structure clean outs, plant survival, weeding, mulching, watering, fertilizing, trash removal, media replacement, sediment removal, etc
- Are there reductions in maintenance costs (i.e. winter maintenance with salt application)?


<u>Inspection and maintenance records will be paired with quantitative monitoring data to evaluate maintenance needs and long term performance.</u>


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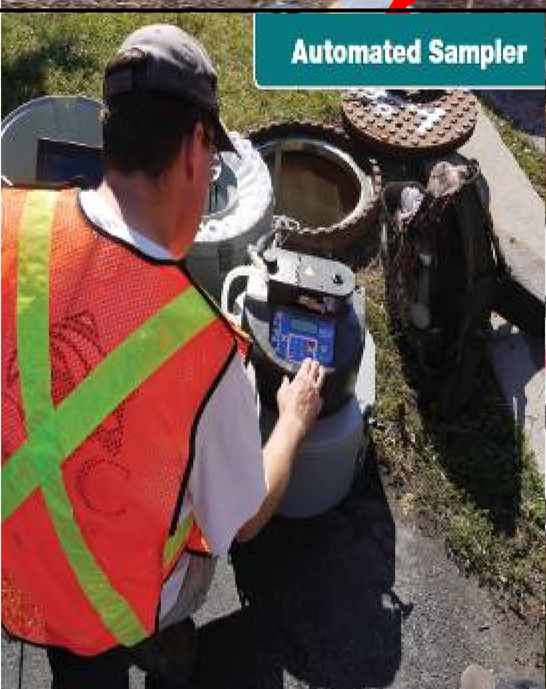
What are your top stakeholder priorities?

- Long term maintenance needs and impact on performance;
- Lifecycle costs;
- Water quality and quantity performance of LID design in low infiltration soils;
- How multiple LID treats and manage stormwater;
- Performance of flood control, erosion control, water quality and natural heritage protection.

Integrate monitoring infrastructure into the design to ensure that you can gather the information you need!!

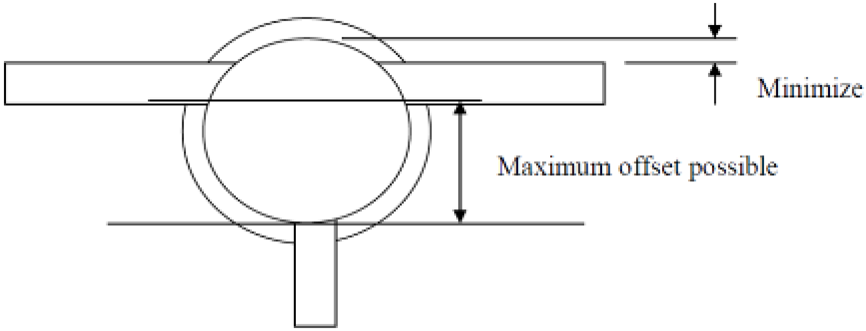
Monitoring Equipment/Data Collection



- Precipitation: Heated rain gauge
- Outflows: V-notch weirs
- Water levels: observational wells
- Water Quality
  - flow-proportioned composite samples
  - 10 events/year
  - general quality, nutrients, metals, oil & grease, temperature

Monitoring Design Lessons Learned

- Incorporate monitoring plan into engineering design
  - Maximum pipe offset to install weir
  - Ensure enough manhole depth to accommodate monitoring equipment



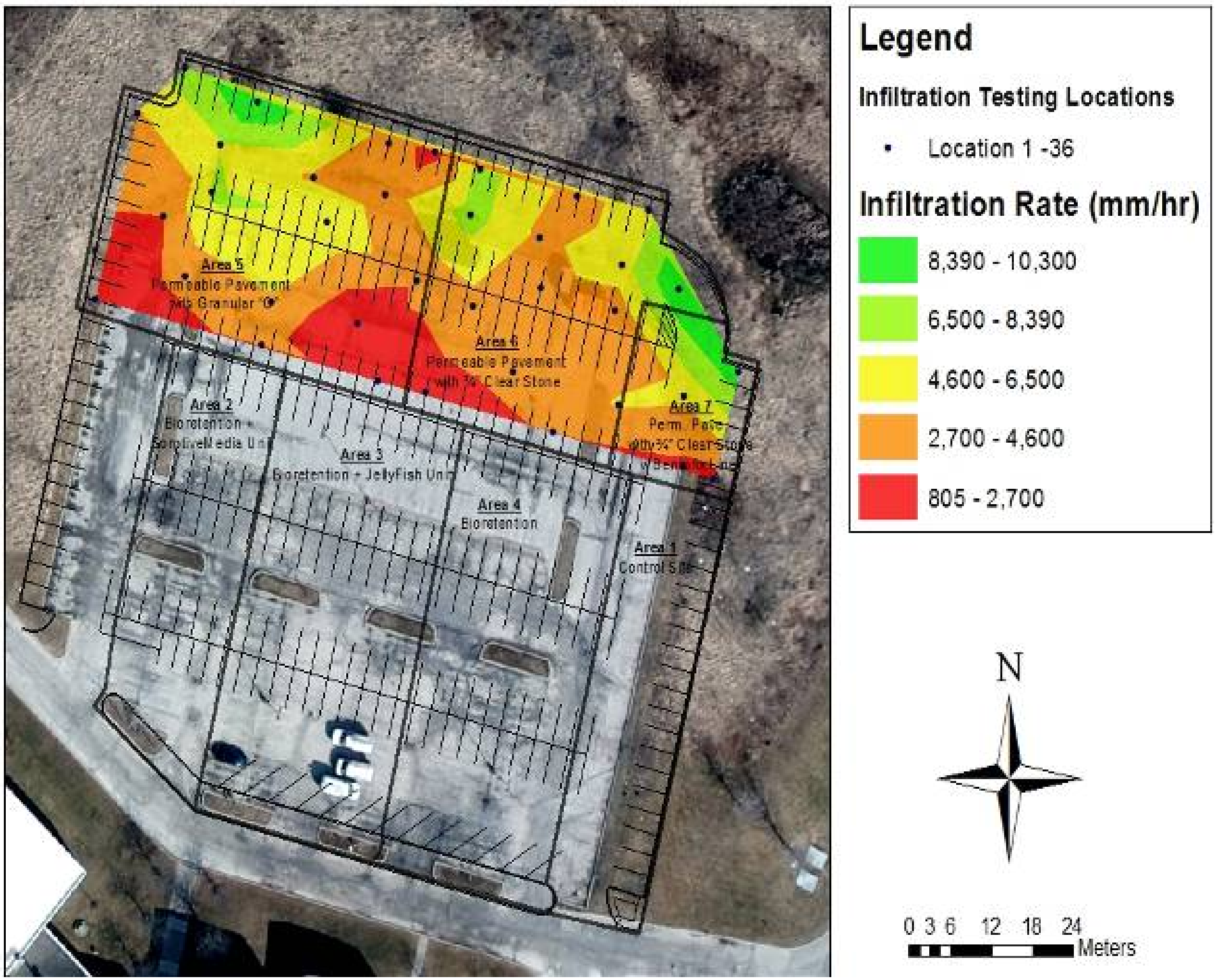
Monitoring Construction Lessons Learned

- Leaking infrastructure (i.e.: catchbasin)
  - Performed water tests/pipe pressure tests

- Bioswale surface grading

Performance Results to Date

Infiltration Rate Contours



- **Sub-base materials:**
  - Granular O average: 4200 mm/hr
  - Clear stone average: 5400 mm/hr
- **Location:**
  - Center of Parking Spot: 5300 mm/hr
  - Laneway: 4500 mm/hr
  - Parking Spot Line: 3700 mm/hr

Water Quantity Performance

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IX-2b Bioretention to SorbtiveVAULT Performance

Event Type	Antecedent Dry Period (days)	Total Precipitation (mm)	Instantaneous Peak Intensity (mm/hr)	Runoff Volume Reduction (%)	Peak Reduction (%)
Largest	5	43.00	30.00	83	81
No Flow Event	1.10	10.60*	12.00	100	100

IX-3 JellyFish Filter to Bioretention Performance

Event Type	Antecedent Dry Period (days	Total Precipitation (mm)	Instantaneous Peak Intensity (mm/hr)	Runoff Volume Reduction (%)	Peak Reduction (%)
Largest	5	43.00	30.00	75	70
No Flow Event	1.10	10.60*	12.00	100	100

Water Quantity Performance

IX-5 Permeable Pavement with Granular “O”

Event Type	Antecedent Dry Period (days)	Total Precipitation (mm)	Instantaneous Peak Intensity (mm/hr)	Runoff Volume Reduction (%)	Peak Reduction (%)
High Intensity/Large	5	43.00	30.00	38	91
Med Intensity/Large	4	29.40	16.80	96	96
No Flow Event	1.10	10.60	12.00	100	100

IX-6 Permeable Pavement with ¾” Clearstone

Event Type	Antecedent Dry Period (days)	Total Precipitation (mm)	Instantaneous Peak Intensity (mm/hr)	Runoff Volume Reduction (%)	Peak Reduction (%)
Largest Event & No Flow Event	-	43.0	30.0	100	100

Preliminary Water Quality Performance

LID Systems	% Load Reduction										
	TSS	TP	OP	N+N	TKN	Cd	Cu	Fe	Pb	Ni	ZN
Bioretention-to-SorbtiveVAULT*	**99**	**100**	100	98	98	100	99	100	99	99	100
JellyFish-to-Bioretention**	**100**	**99**	98	99	99	100	100	100	100	100	100
Permeable Pavement with Granular "O"	**94**	**89**	96	73	63	96	91	91	95	89	92
* Preliminary results based on one sample collected on October 31st, 2013											
** Preliminary results based on 3 samples collected on October 26th, 31st, and November 6th, 2013											

Next Steps

- On-going monitoring for the long term (5 year agreement with IMAX)

- Operation & Maintenance activity tracking

- Life cycle cost tracking

- Technical Report – Spring 2014

Case Study –

http://www.creditvalleyca.ca/wp-content/uploads/2014/02/IMAX_Case_Study_Final_21Feb.pdf

Credit Valley Conservation

IMAX Parking Lot Retrofit

Location: Mississauga
Constructed: 2013

Case Study

Business and Multi-Residential

Project Objectives, Design and Performance

- Design and construct a better functioning parking lot that upgraded stormwater management infrastructure with modern low impact development (LID) features.
- Benefit from project partnerships to enable a variety of innovative stormwater management technologies to be integrated into the IMAX parking lot including permeable pavers, Jellyfish® Filter, bioswales and Sorbtive® Media.
- Conduct infrastructure performance assessment to address knowledge gaps impeding the wide scale adoption of LID technologies in Ontario.

Overcoming Barriers and Lessons Learned

- Challenging soil conditions were encountered on site requiring a conservative design that provided sufficient drainage infrastructure and structural support.
- Coordination and a transparent design process between CVC, product suppliers, the design team and academic experts ensured the successful integration of performance assessment infrastructure into the IMAX parking lot.
- Contractor and IMAX staff worked together to ensure that IMAX could conduct business as usual during the construction phase.
- To ensure that construction is performed properly and proceeds on time, be sure to have an individual experienced in LID construction and design. They act as a resource and liaison between the contractor, client and other stakeholders.

Practices Implemented

Bioretention · Permeable Pavement · Innovative Stuff

Barriers and Issues Encountered

Design · Construction and Commissioning

Case Study Outline

The IMAX case study consists of the following sections:

Overview – Overview of the IMAX site and project.	Page 2
Goals and Drivers – List of goals and drivers that influenced the IMAX project.	Page 2
Project Successes – Outlines the accomplishments of the project team.	Page 3
Overcoming Barriers & Lessons Learned – List of barriers that were encountered during the project, how they were addressed, and the lessons learned from them.	Page 4
Pre-retrofit Site Conditions – Describes the pre-retrofit site conditions at the IMAX site and puts the reasons for implementing LID throughout the parking lot.	Page 6
LID Planning and Regulations – Provides an overview of the approval requirements that were required prior to the construction of the project.	Page 7
Proposed Design Concept – Provides an overview of the retrofit design and the LID practices that were incorporated	Page 8
Pre design Tasks – Describes the in-field tasks undertaken to characterize the site and feed into the detailed design	Page 8
Design Considerations and Constraints – Provides an overview of the different site constraints that impacted the final design concept of the parking lot retrofit.	Page 9
Detailed Design – Provides an overview of the design elements and the coordination efforts between the design team and project partners.	Page 11
Construction and Commissioning – General Issues – Describes the success and challenges of the construction process including lessons learned.	Page 22
Construction and Commissioning – LID Specific – Describes the success and challenges of the construction process relative to the LID practices and the lessons learned.	Page 23
Economic (Capital & O&M Costs) – Provides a breakdown of the capital and O&M costs for the project.	Page 25
Operation and Maintenance – Provides an overview of the general and LID specific maintenance tasks associated with the project.	Page 26
Infrastructure Performance and Risk Assessment – Summarizes the scope of the proposed performance monitoring program and the knowledge gaps it intended to fulfil.	Page 28

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IMAX

Leaders in Action
MAKING IT WORK

Environment Canada / Environnement Canada

Canada

Aquafor Beech Limited

Rattray Marsh Protection Association

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Any Questions?