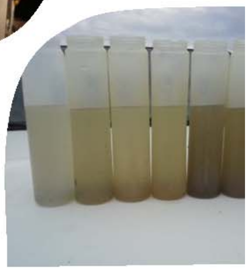
Sustainable Technologies
EVALUATION PROGRAM

Planning and Design

Presented by: Jenny Hill



STEP Water is a partnership between:

Toronto and Region Conservation for The Living City

CVC Credit Valley Conservation

Lake Simcoe Region conservation authority

Sustainable Technologies
EVALUATION PROGRAM

Low Impact Development Stormwater Management Planning and Design Guide (2010)

LOW IMPACT DEVELOPMENT STORMWATER MANAGEMENT PLANNING AND DESIGN GUIDE

Version 1.0

2010

CVC
CREDIT VALLEY CONSERVATION

Toronto and Region Conservation
for The Living City

Popular Contents
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4.1 Rainwater Harvesting
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4.3 Roof Downspout Disconnection
4.4 Soakaways, Infiltration Trenches and Chambers
4.5 Bioretention
4.6 Vegetated Filter Strips
4.7 Permeable Pavement
4.8 Enhanced Grass Swales
4.9 Dry Swales
4.10 Perforated Pipe Systems

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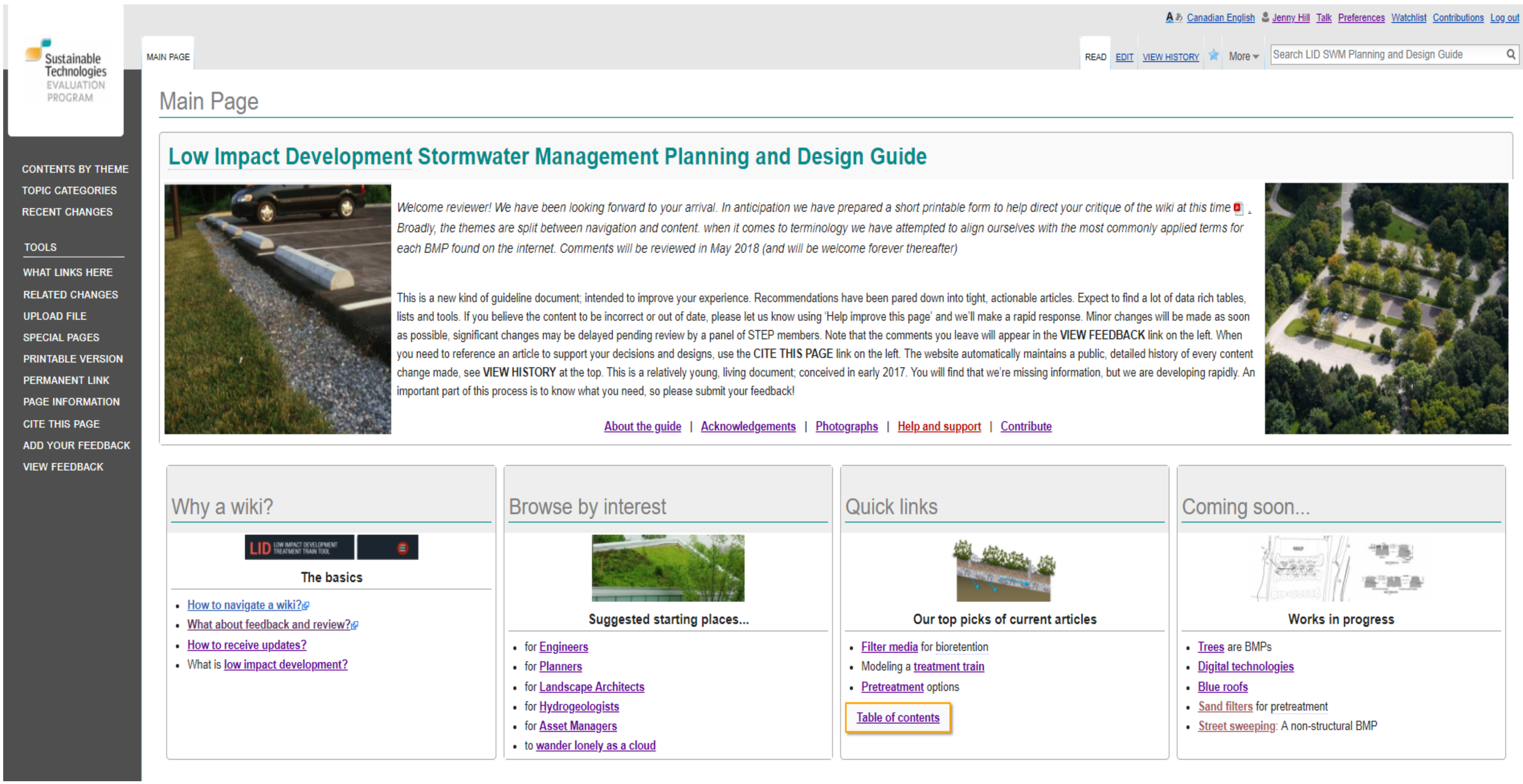
wiki.sustainabletechnologies.ca (2018)



Contents

Structural BMP types

- Bioretention
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- Infiltration trenches
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Planning

- Integrated design
- **Site design strategies**
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  - On industrial and commercial properties
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Other topics

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- Cost analysis resources and Funding
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Background material

- Definition of Low Impact Development
- History and context
- Evolution of SWM

Navigate with keywords

Swales

This article is about installations designed to capture and convey surface runoff along a vegetated
For underground conveyance which promotes infiltration, see Exfiltration trenches.

Contents [show]

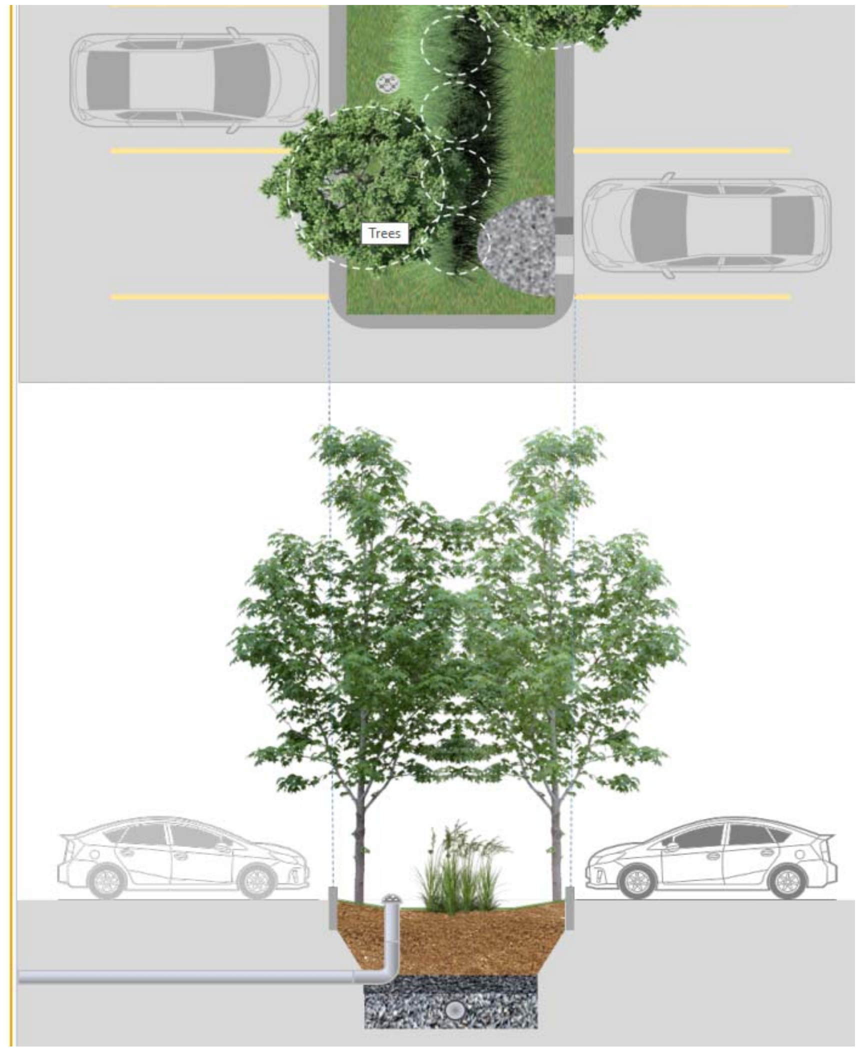
Overview [edit]

Swales are linear landscape features consisting of a drainage channel with gently sloping sides. U
with engineered soil and/or contain a water storage layer of coarse gravel material. Two variations
recommended as low impact development strategies, although using a combination design of both
Bioswales are sometimes referred to as 'dry swales', 'vegetated swales', or 'water quality swales'.
bioretention with a long linear shape (surface area typically >2:1 length:width) and a slope which c
Enhanced grass swales are a lower maintenance alternative, but generally have lower stormwat
enhancement over a basic grass swale is in the addition of check dams to slow surface water flow
pools of water which can infiltrate the underlying soil.
Retention swales can be imagined as linear, sloped dry ponds. They make a relatively little contri
quality control than many other BMPs, but they may feature as part of a site-wide treatment train a

Navigate with clickable images

arking lot bioretention sharing underground reservoir with adjacent permeable paving, Edwards gardens, Toronto

The sunken curb holds the edge of the asphalt pavement and lets water freely flow to the bioretention cell beside the 7sigma parking lot in Minneapolis, MN (USA)
Photo credit:BrianAsh



After surveying the longitudinal profile of the swale, the number of check dams for the swale can be calculated by using the following equation:

$$Number\ of\ dams = \frac{L\,(S_i - S_e)}{h}$$

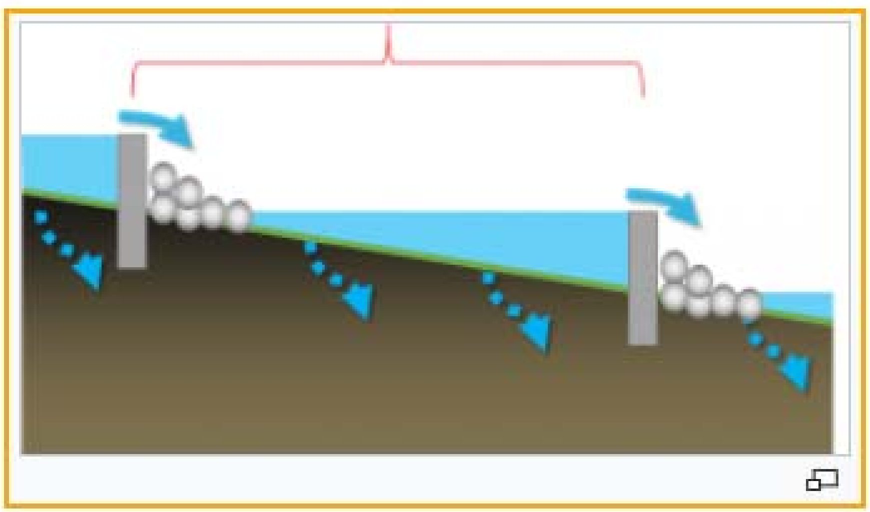
Where:

L: Length of swale (m)

S_i: Initial existing slope ratio of the swale (rise/run)

S_e: Desired effective slope of the enhanced swale (between 0.005 - 0.01, rise/run)

h: The average effective height of the check dams in m (excluding foundations)



Ponding depth (mm)

To calculate permissible ponding depth in mm

Infiltration coefficient (mm/hr) 15

Time (hrs) 48

Submit

WolframAlpha

BETA

Number of check dams

To calculate the required number of check dams

Length of swale (m) 80

Existing mean slope ratio 0.035

Desired effective slope ratio 0.005

Height of check dams (m) 0.5

Submit

WolframAlpha

OPS aggregates

Of the standard granular materials in the standard OPSS.MUNI 1010 only **Granular O** is recommended as a substitute for clear stone.

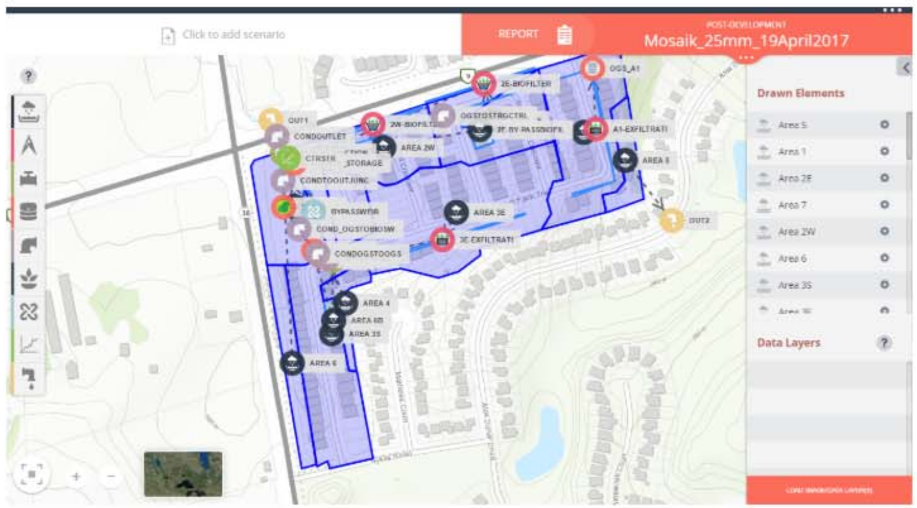
- *Where Granular O is substituted for clear stone in underground reservoir structures, the void ratio used in design calculations shall be **0.3** unless laboratory testing proves otherwise.*

All other mixes must be avoided for free drainage or storage as they are permitted to contain a higher enough proportion of fines to reduce permeability below 50 mm/hr.

Treatment Train Tool

Low Impact Development Treatment Train Tool

The Low Impact Development Treatment Train Tool (LID TTT) has been developed by Lake Simcoe Region Conservation Authority (LSRCA), Credit Valley Conservation (CVC) and Toronto and Region Conservation Authority (TRCA) as a tool to help developers, consultants, municipalities and landowners understand and implement more sustainable stormwater management planning and design practices in their watersheds. The purpose of the tool is to analyze annual and event based runoff volumes and pollutant load removal by the use of Best Management Practices (BMP)'s and Low Impact Development (LID) techniques. The LID TTT provides preliminary water budget analysis (i.e. surface ET, surface runoff, infiltration to soil) and pollutant load removal estimates for pre- and post-development scenarios. The tool is built upon the open source EPA SWMM5 model providing a user-friendly interface for novice modelers and cross-compatibility with SWMM5 for further model development.



LID is a stormwater management strategy that seeks to mitigate the impacts of increased runoff and stormwater pollution by managing runoff

What's New

» The latest release is *Release Version 1.2.1* (6 April 2018)

Release Notes for LID-TTT Version 1.2.1

To report issues please contact STEP@trca.on.ca

Downloads

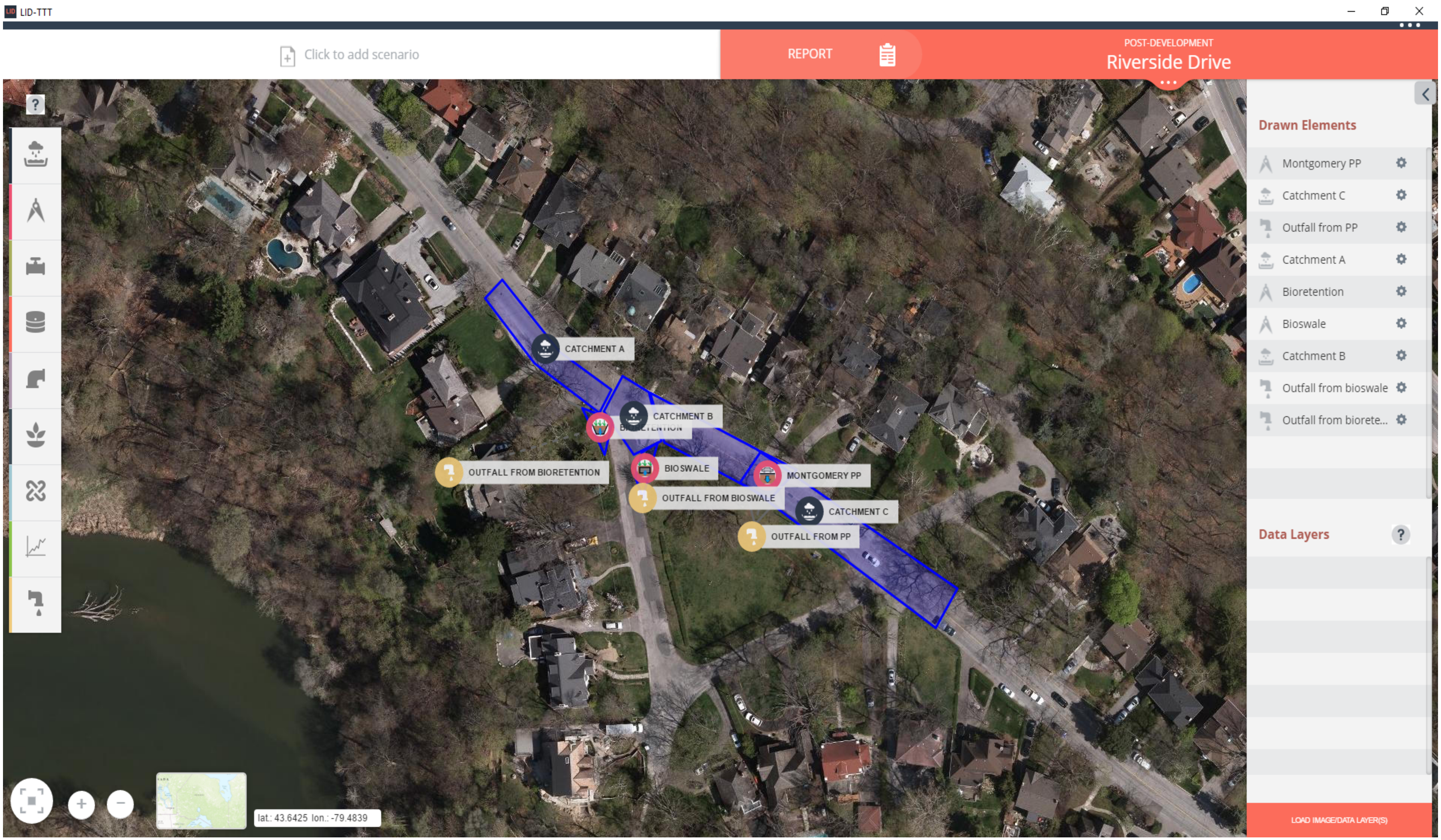
» Example scenarios

» Beta 2.7.4

» Beta 2.7.9

» Release v1.0 (4 Dec 2017)

Download "LID TTT v1.2.1"
LID-TTT-win32-x64.zip – Downloaded 222 times – 106 MB


LID-TTT
Click to add scenario
REPORT
POST-DEVELOPMENT
Riverside Drive
Drawn Elements
Montgomery PP
Catchment C
Outfall from PP
Catchment A
Bioretention
Bioswale
Catchment B
Outfall from bioswale
Outfall from biorete...
Data Layers
LOAD IMAGE/DATA LAYER(S)
CATCHMENT A
CATCHMENT B
BIOSWALE
MONTGOMERY PP
OUTFALL FROM BIORETENTION
OUTFALL FROM BIOSWALE
CATCHMENT C
OUTFALL FROM PP
lat.: 43.6425 lon.: -79.4839

Configuring a bioretention

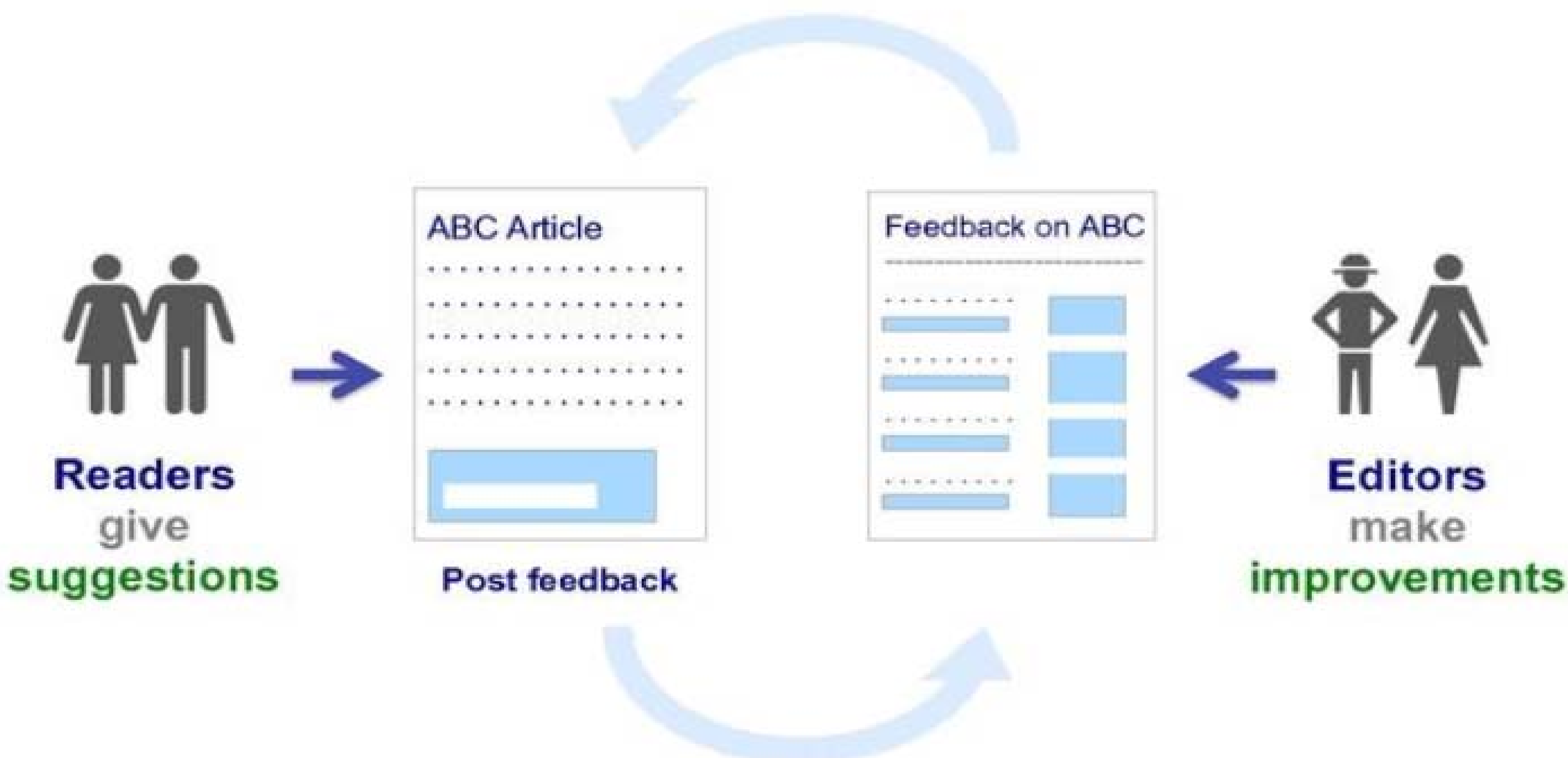
Bioretention: TTT

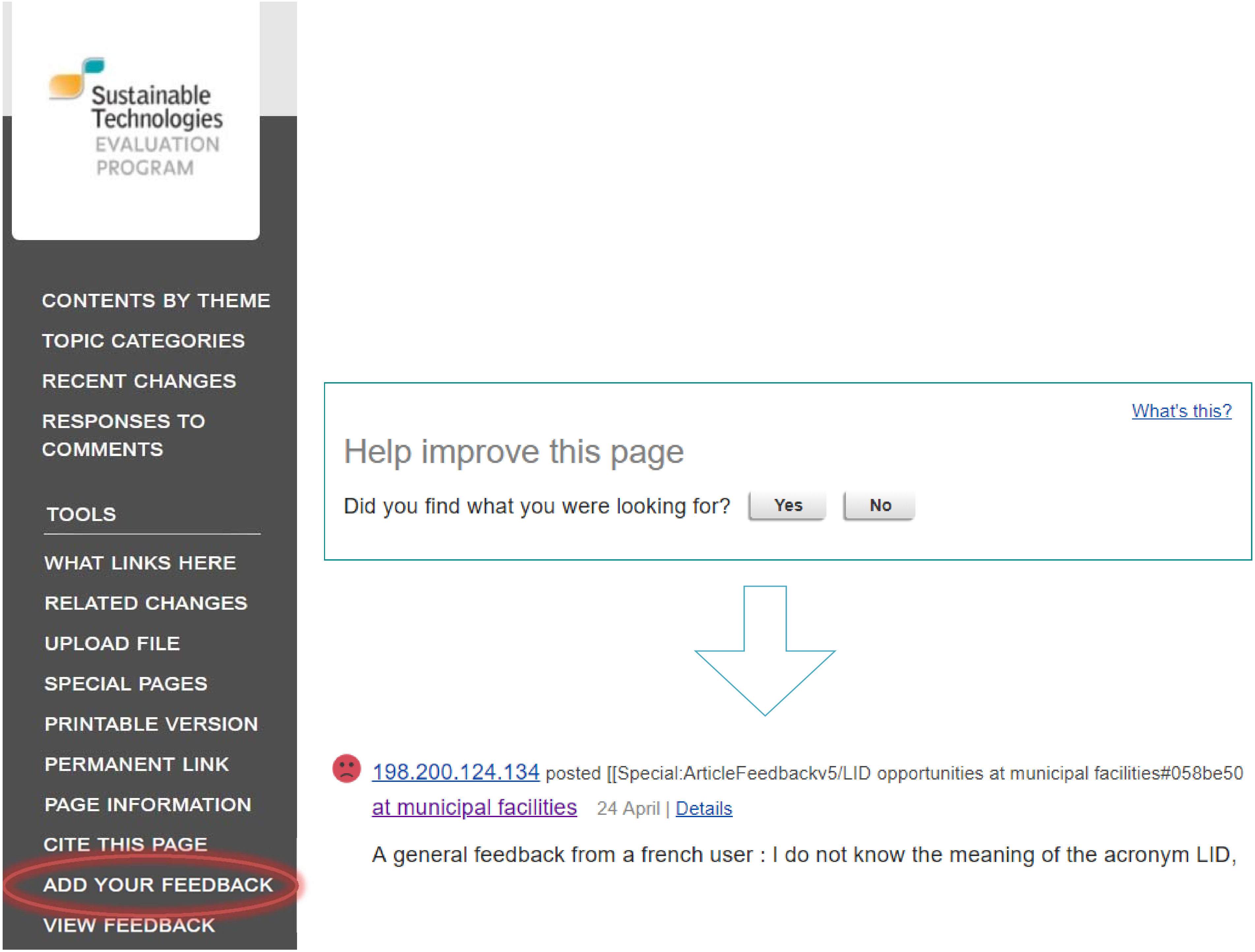
LID LOW IMPACT DEVELOPMENT TREATMENT TRAIN TOOL

Surface	
Berm height (mm)	Sometimes referred to as the bowl depth
Surface roughness (Manning's n)	Lower numbers indicate less surface obstruction and result in faster flow Suggested ranges: • Mown grass (dependent on density) 0.03 – 0.06[1] • Stone 0.03 – 0.05 • Planted (highly dependent on density) 0.05 – 0.15
Surface slope (%)	If the slope > 3% a series of Check dams or weirs should be included in the design.
Soil (bioretention filter media)	
Thickness (mm)	Depth of filter media
Porosity (fraction)	Suggest range 0.3 – 0.35 unless otherwise tested
Field capacity (fraction)	Suggested range 0.10 - 0.12 [1]
Wilting point (fraction)	Suggested value 0.03 [1]
Conductivity (mm/hr)	Suggested range 25 – 250 mm/hr
Conductivity slope	Suggested value 45 [1]
Suction head (mm)	Suggested range 50 - 60 [1]

Bioretention cells are found within the LID toolbox

Feedback flow




Sustainable Technologies EVALUATION PROGRAM
CONTENTS BY THEME
TOPIC CATEGORIES
RECENT CHANGES
RESPONSES TO COMMENTS
TOOLS
WHAT LINKS HERE
RELATED CHANGES
UPLOAD FILE
SPECIAL PAGES
PRINTABLE VERSION
PERMANENT LINK
PAGE INFORMATION
CITE THIS PAGE
ADD YOUR FEEDBACK
VIEW FEEDBACK
What's this?
Help improve this page
Did you find what you were looking for?
Yes
No
198.200.124.134 posted [[Special:ArticleFeedbackv5/LID opportunities at municipal facilities#058be50
at municipal facilities
24 April | Details
A general feedback from a french user : I do not know the meaning of the acronym LID,

Responses to comments

24 April 2018

A general feedback from a french user - I do not know the meaning of the acronym LID, used profusel very helpful to have a definition for all the acronyms by hovering the mouse cursor over them, just like the definition of "Rainwater harvesting". This type of definition should be available for all the acronyms acronym per page.

- 'LID' has been added to the terms using the same definition for 'Low Impact Development'. We will

10 April 20180

Do you have any specs for designing berms around a bioretention pond?

- Please see Berms

23 March 2018

Is it possible to get the the planting list updated to include native species?

- Certainly! This information will be added as we review the plant tables in summer 2018.

21 March 2018

Is there a reliable set of estimated design infiltration rates for sites where only soil type is currently knc looking for numbers to begin an estimate, and a reasonable basis for those numbers.

- The curators of Minnesota's stormwater wiki have conducted a very thorough literature review to e The lowest value on their table for clayey soils is 15 mm/hr, we believe that this is a reasonable es correction to this number before undertaking their design calculations.

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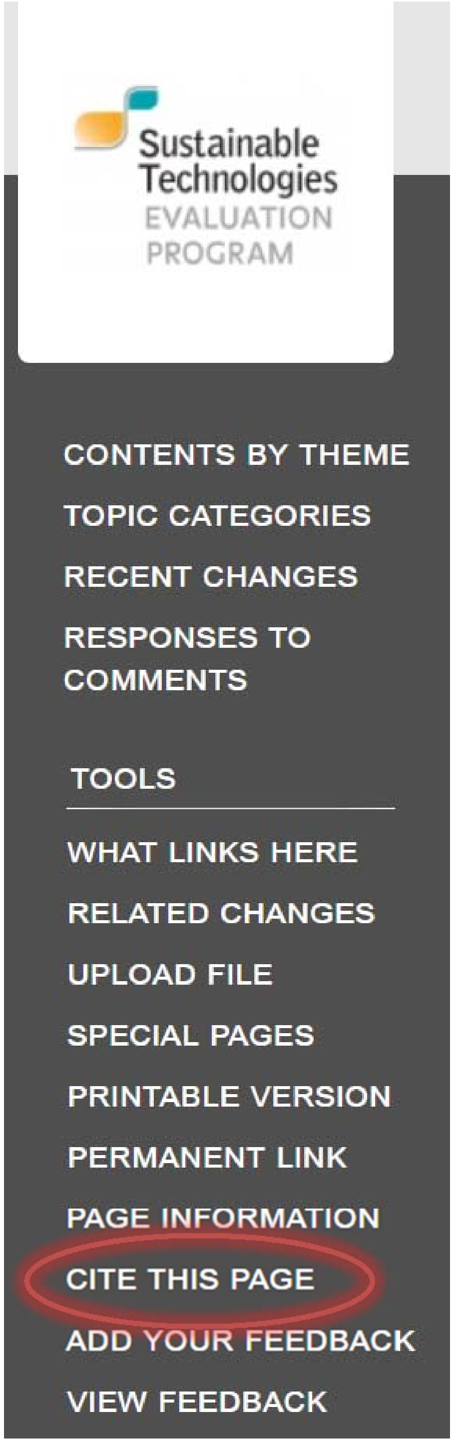
1. ↑ Minnesota Stormwater Manual contributors, "Design infiltration rates," Minnesota Stormwater title=Design_infiltration_rates&oldid=37031 (accessed May 11, 2018).



Also formated to copy/paste:

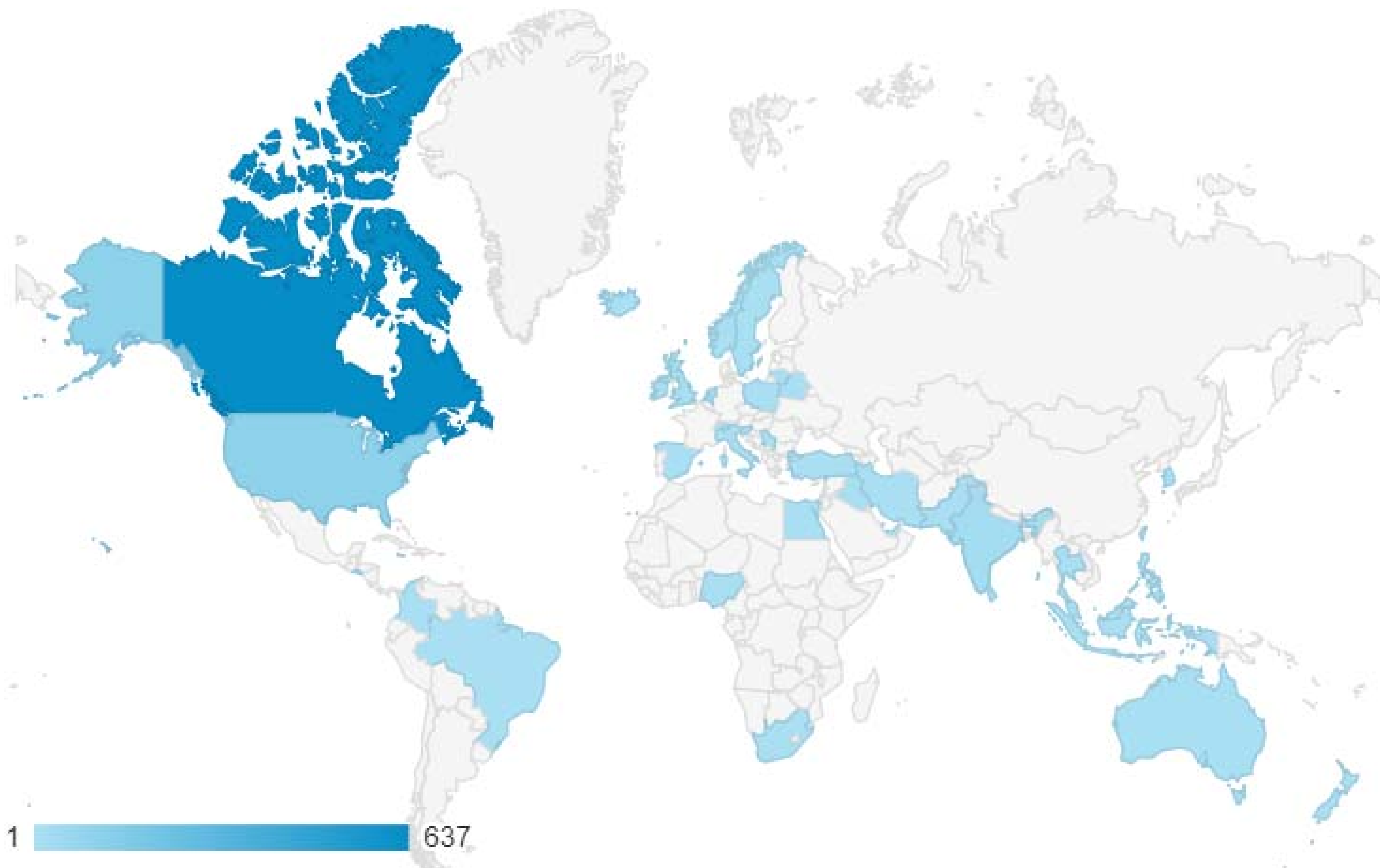
- APA style
- Chicago style

etc.

- Even code for LaTeX users!

Popular pages

1. /wiki/Main_Page
2. /wiki/Gravel_diaphragms
3. /wiki/Evapotranspiration
4. /wiki/Engineering_hub
5. /wiki/Hydrogeology_hub
6. /wiki/Check_dams
7. /wiki/Runoff_volume_control_targets
8. /wiki/Table_of_contents
9. /wiki/Exfiltration_trenches
10. /wiki/Infiltration_chambers


1
637

Free tools for you

1. Treatment train tool

   sustainabletechnologies.ca/low-impact-development-treatment-train-tool/

2. Planning and design guide

   wiki.sustainabletechnologies.ca

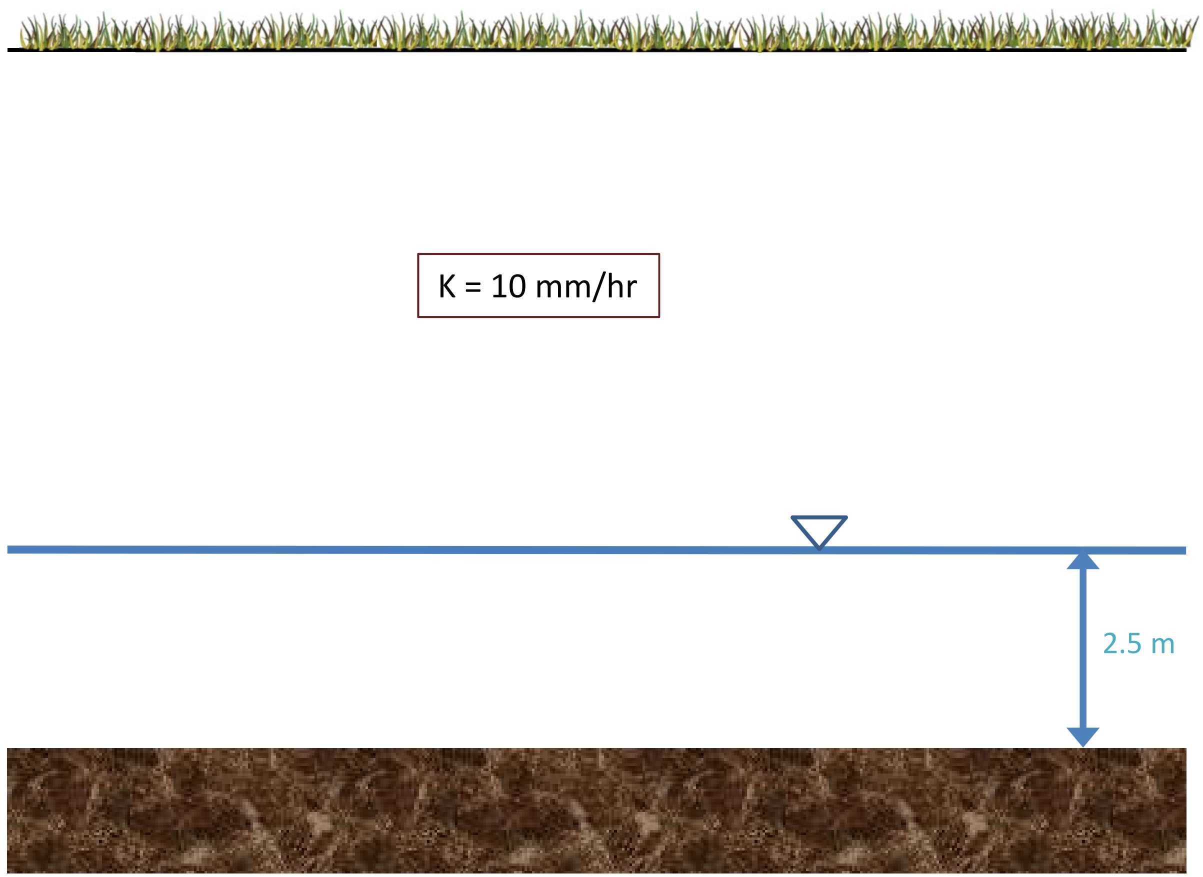
3. Lifecycle costing tool

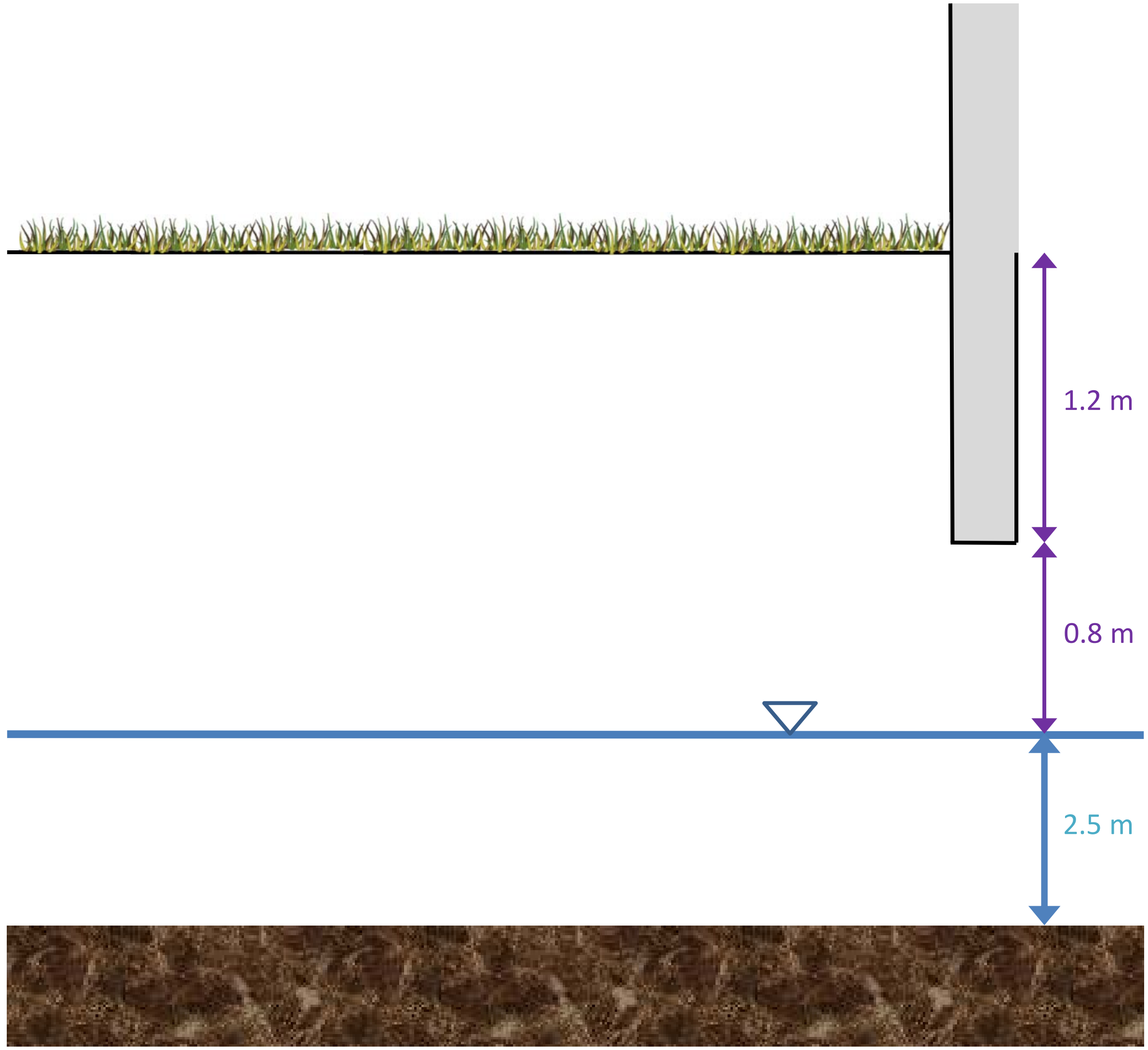
   sustainabletechnologies.ca/low-impact-development-life-cycle-costs/

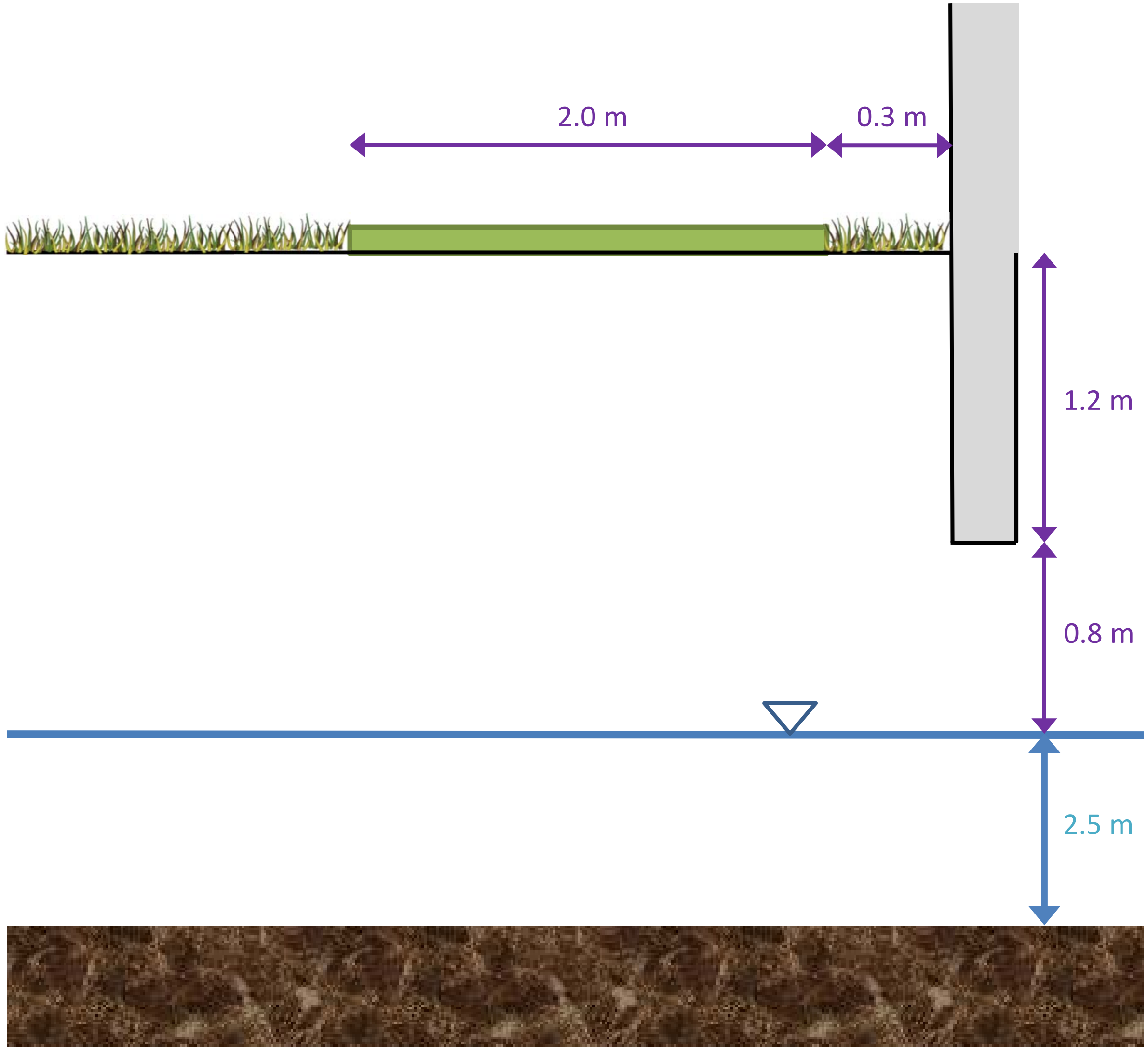
4. Inspection and maintenance guide

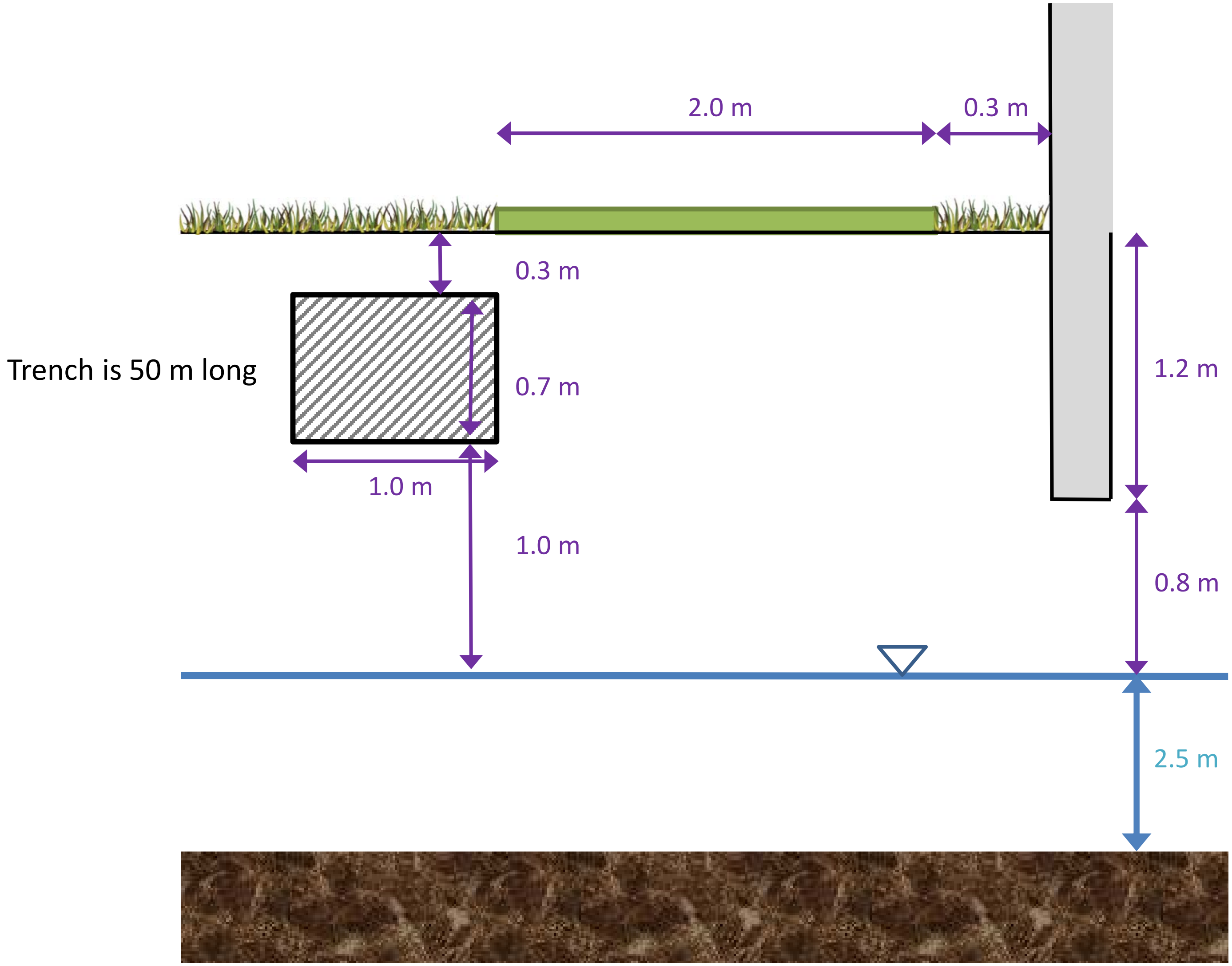
   sustainabletechnologies.ca/low-impact-development-stormwater-practice-inspection-and-maintenance-guide/

An infiltration design problem


K = 10 mm/hr
2.5 m


1.2 m
0.8 m
2.5 m

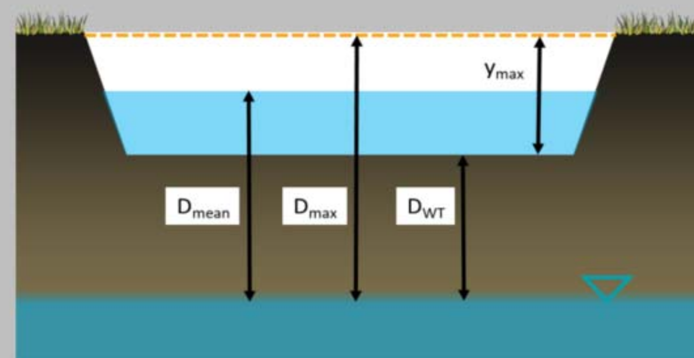

2.0 m
0.3 m
1.2 m
0.8 m
2.5 m

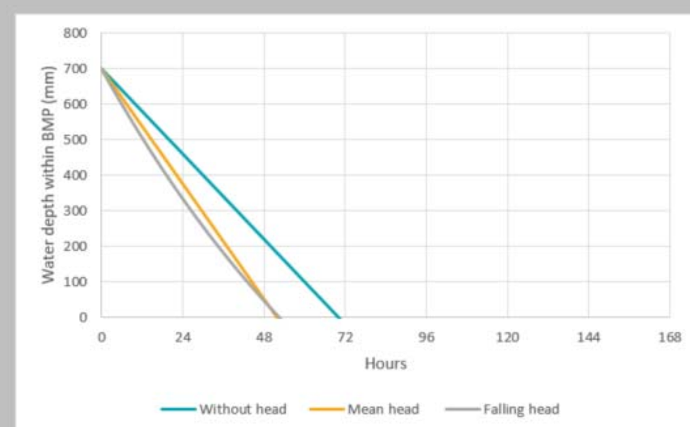

2.0 m
0.3 m
0.3 m
Trench is 50 m long
0.7 m
1.2 m
1.0 m
1.0 m
0.8 m
2.5 m

1 dimensional drainage

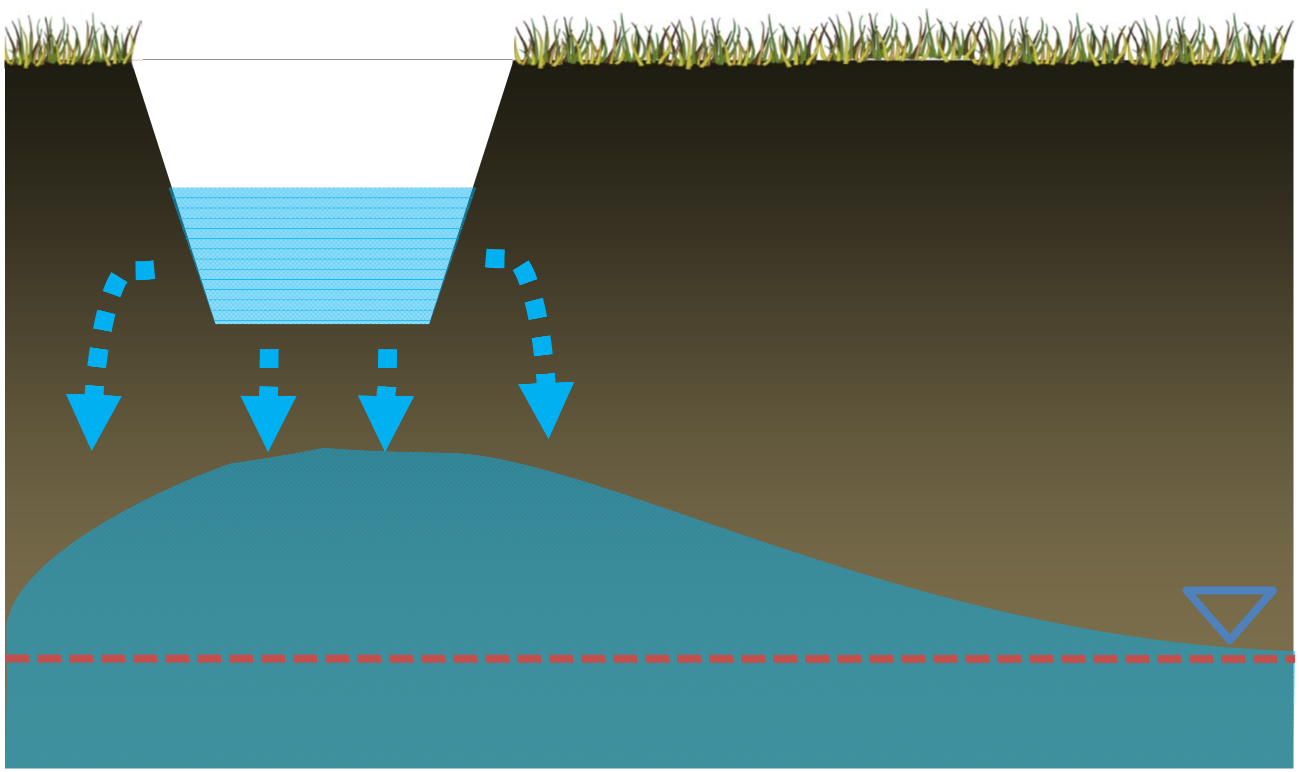
K_{fs} native soil (mm/hr)	10
BMP depth (y_{max}, m)	0.7
BMP depth (y_{max}, mm)	700
Distance to GW (D_{WT}, m)	1
Distance to GW (D_{WT}, mm)	1000

Time (hours)	Without head	Mean head	Falling head
0	700	700	700
2	680	673	666
4	660	646	633
6	640	619	600
8	620	592	568
10	600	565	537
12	580	538	506
14	560	511	476
16	540	484	446
18	520	457	417
20	500	430	389
22	480	403	361
24	460	376	334
26	440	349	307
28	420	322	281
30	400	295	256
32	380	268	230
34	360	241	206
36	340	214	182
38	320	187	158
40	300	160	135
42	280	133	112
44	260	106	90
46	240	79	68
48	220	52	47
50	200	25	26
52	180	-2	5
54	160	-29	-15





Groundwater mounding



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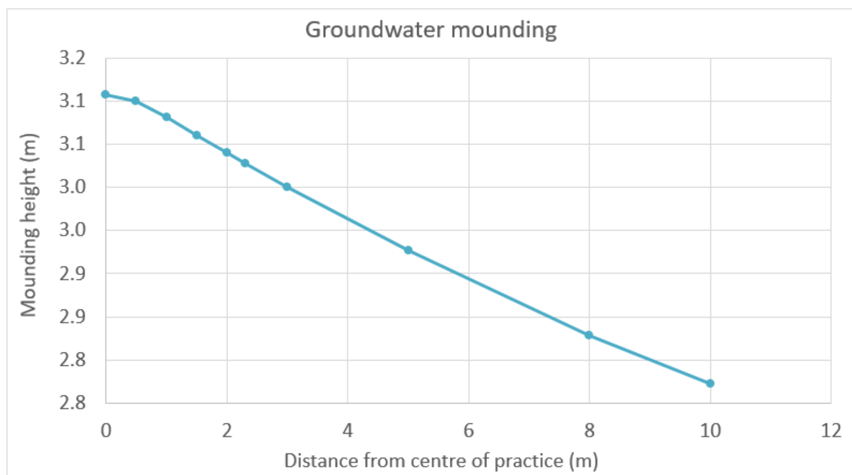
Groundwater mounding Hantush model

This spreadsheet will calculate the height of a groundwater mound beneath an stormwater infiltration BMP.
More information can be found in the U.S. Geological Survey Scientific Investigations Report 2010-5102
"Simulation of groundwater mounding beneath hypothetical stormwater infiltration basins".

Go to the USGS report

	Input Values	
Recharge (infiltration) rate (m/day)		*R*
Specific yield, S_y (dimensionless)		Sy
Horizontal hydraulic conductivity, K_h (m/day)		K
1/2 width of LID practice (x direction, in m)		x
1/2 length of LID practice (y direction, in m)		y
Duration of infiltration period (days)		t
Initial thickness of saturated zone (m)		hi(0)

CALCULATE



Distance from center of infiltration BMP (m)	Ground-water mounding (m)
0	3.11
0.5	3.10
1	3.08
1.5	3.06
2	3.04
2.3	3.03
3	3.00
5	2.93
8	2.83
10	2.77

IF YOU CHANGE THE SCALE OF THE DISTANCE MEASUREMENTS (OR ANY OTHER PARAMETER), YOU MUST RECALCULATE!!

Recharge rate

	Input Values	
Recharge (infiltration) rate (m/day)		*R*
Specific yield, S_y (dimensionless)		Sy
Horizontal hydraulic conductivity, K_h (m/day)		K
1/2 length of basin (x direction, in m)		x
1/2 width of basin (y direction, in m)		y
Duration of infiltration period (days)		t
Initial thickness of saturated zone (m)		hi(0)

$$Days = \frac{54\ hrs}{24\ hrs} = 2.25\ days$$

$$Recharge = \frac{0.7\ m}{2.25\ days} = 0.31\ m/day$$

Specific Yield

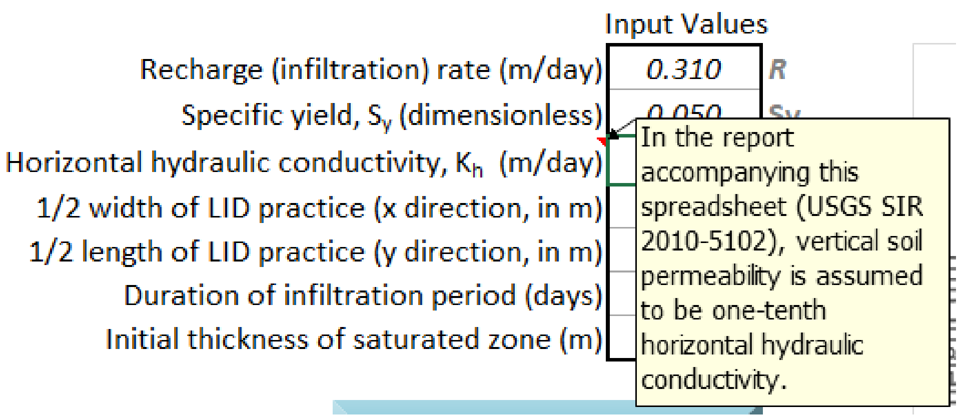
	Input Values	
Recharge (infiltration) rate (m/day)	*0.310*	*R*
Specific yield, S_y (dimensionless)	*0.050*	Sy
Horizontal hydraulic conductivity, K_h (m/day)		K
1/2 width of LID practice (x direction, in m)		x
1/2 length of LID practice (y direction, in m)		y
Duration of infiltration period (days)		t
Initial thickness of saturated zone (m)		hi(0)

Example values

	Specific Yield		
	Max	Min	**Mean**
Clay	0.05	0	**0.02**
Sandy clay	0.12	0.03	**0.07**
Silt	0.19	0.03	**0.18**
Fine sand	0.28	0.1	**0.21**

Abstracted from From Fetter (2001), in turn citing Johnson (1967)

Hydraulic conductivity Anisotropy



$$K_v = 10\ {}^{mm}/_{hr} = 0.24\ m/day$$

Use K_v = Most conservative

In our region a factor of ~5 might be more appropriate.
Conduct testing or consult a geologist.

$$K_h = 5 \times 0.24 = 1.2\ m/day$$

Measuring K

Mostly vertical measurement (smaller scale)

- Borehole permeameter
- Double ring infiltrometer
- Percolation test

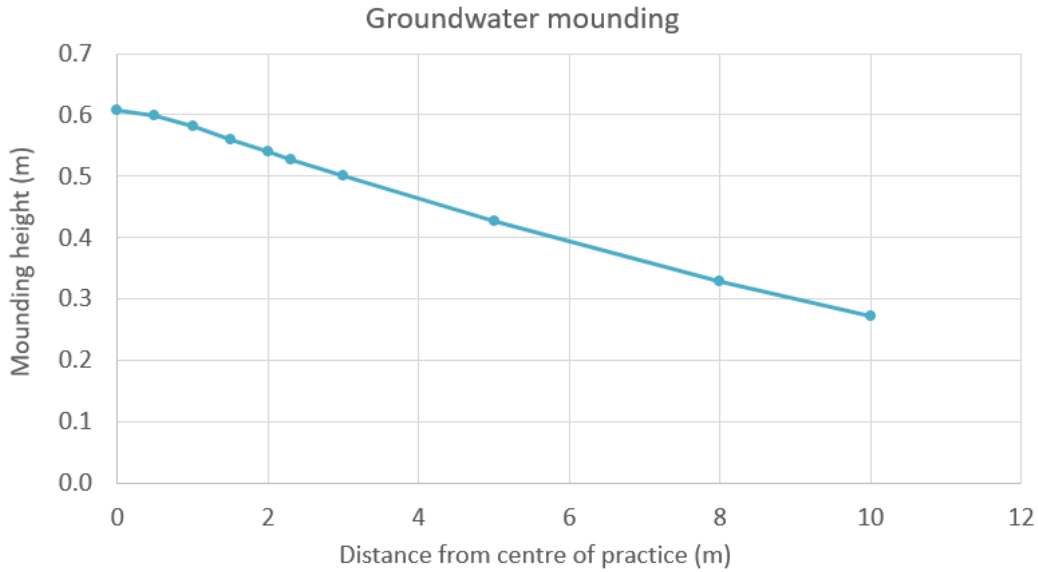
Horizontal measurement (larger scale)

- Pump test
- Slug test

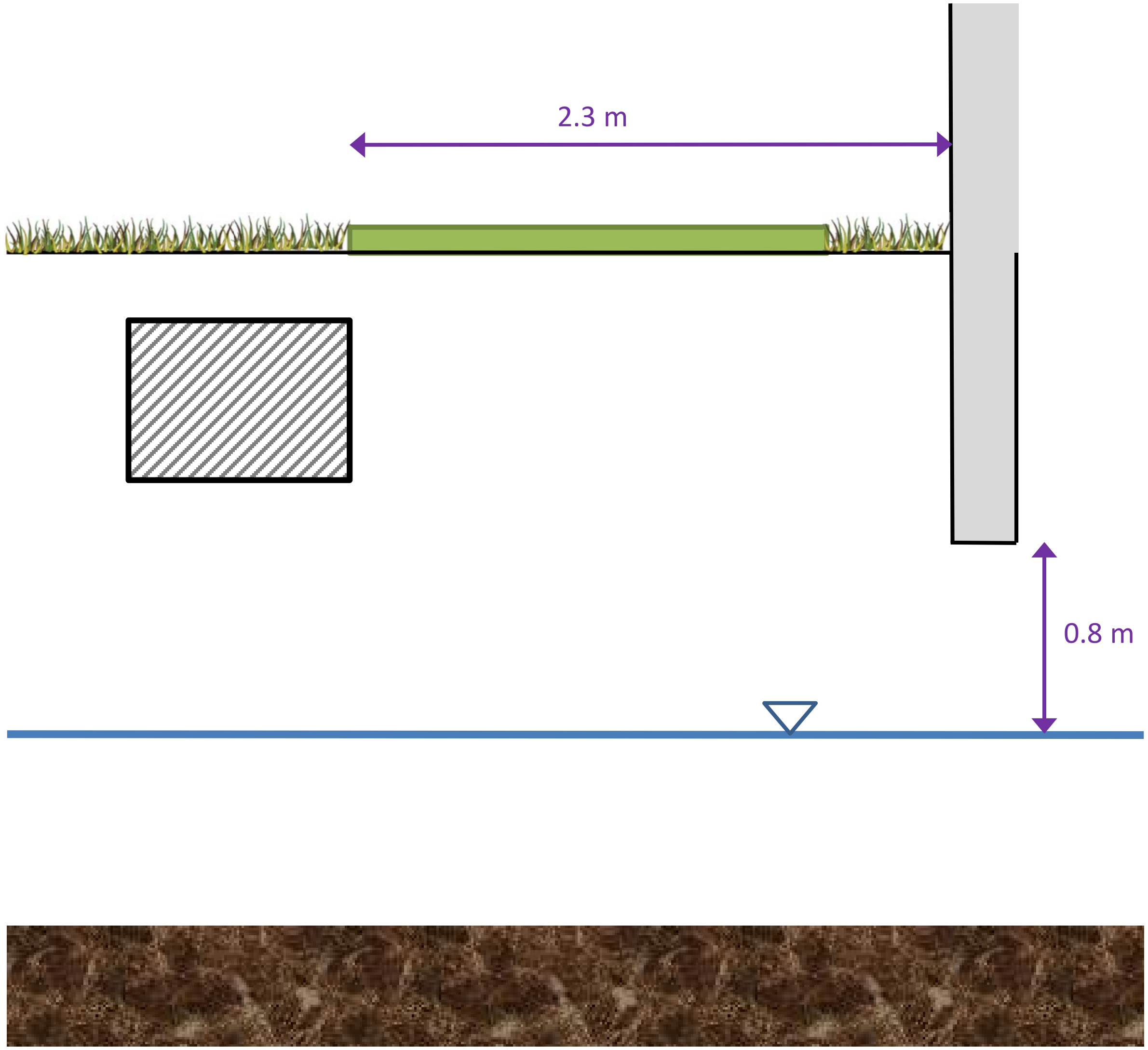
	Input Values	
Recharge (infiltration) rate (m/day)	*0.310*	*R*
Specific yield, S_y (dimensionless)	*0.050*	Sy
Horizontal hydraulic conductivity, K_h (m/day)	1.200000	K
1/2 width of LID practice (x direction, in m)	0.5	x
1/2 length of LID practice (y direction, in m)	25.0	y
Duration of infiltration period (days)	2.25	t
Initial thickness of saturated zone (m)	2.5	hi(0)

CALCULATE

Impact on foundations?



Distance from center of infiltration BMP (m)	Ground-water mounding (m)
0	0.61
0.5	0.60
1	0.58
1.5	0.56
2	0.54
2.3	0.53
3	0.50
5	0.43
8	0.33
10	0.27


2.3 m
0.8 m

Email

- jenny.hill@trca.on.ca

Next webinar

- October 4th
- Real-Time Water Quality Monitoring: a How-To Guide