Sustainable Rainwater Management: What Does It Look Like?

The 'Cowichan Valley Regional Team' presents:

Rainwater Management in the Cowichan Valley

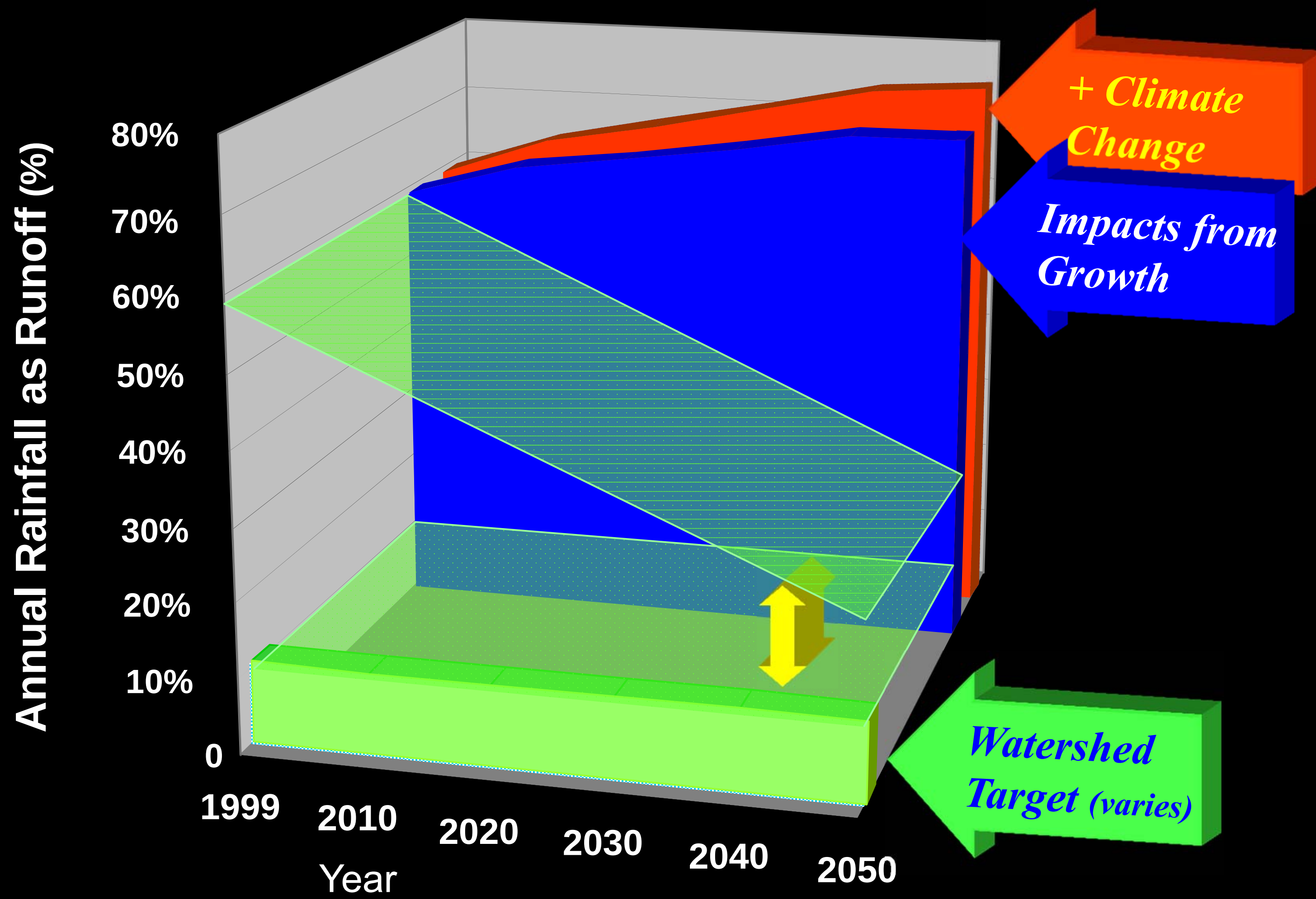
Rainwater Management in Central Saanich

Rainwater Management in a Watershed Sustainability Context

An Introduction to the Rebuilt Water Balance Model

Genesis for Water Balance Model in 2000:

Demonstrate that we could make a difference at a watershed scale, over time, one property at a time

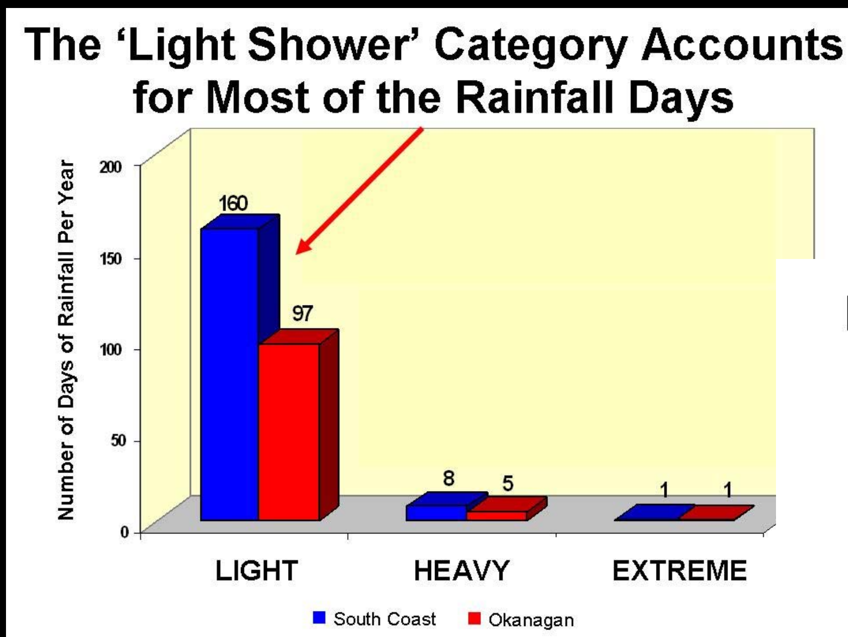


Historical Context for WBM Evolution

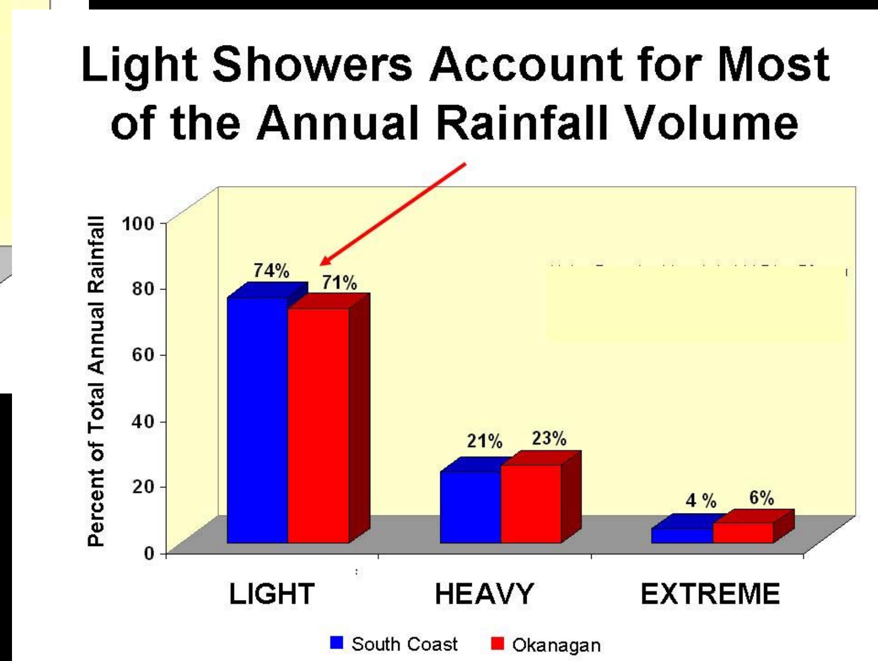
- 2000 – Water Balance Methodology developed
- 2001 – prototype WBM implemented on a spreadsh[illegible]atform
- 2001 – Water Balance Methodology incorp[illegible]book
- 2002 – Stormwater Guidebook rele[illegible]e
- 2003 – web-based WBM la[illegible]M Annual Convention
- 2004 – outreach pr[illegible]t in multiple regions
- 2007 – int[illegible] with QUALHYMO engine
- 200[illegible] rolled out with "Living Water Smart"
- [illegible]eived "Premier's Award for Innovation & Excellence"
- 2[illegible]9 – "The Plan for the Future" released
- 2010 – federal / provincial RAC program funded 4 new modules
- 2011 – "Version 2.1" rebuilt on a Linux / Wordpress platform
- 2012 – "WBM Express for Homeowners" coming next

Almost $3 million invested since 2000!

In 2000, we went back to basics and developed the concept of a Rainfall Spectrum. This led to the Water Balance Methodology.



Days



Volume

In this segment of the workshop, you will learn that the Water Balance Model is a scenario comparison tool that…..

1. Supports 'sustainable rainwater management' because it:
   - Promotes an understanding of how water moves thru soil
   - Promotes an understanding of how trees intercept rainfall
   - Is used to evaluate performance targets
   - Links rainfall to stream health

2. Creates a vision of a future watershed because it:
   - Bridges engineering, planning and ecology
   - Promotes integration of perspectives
   - Enables informed decisions about land use choices
   - Enables informed decisions about green infrastructure practices

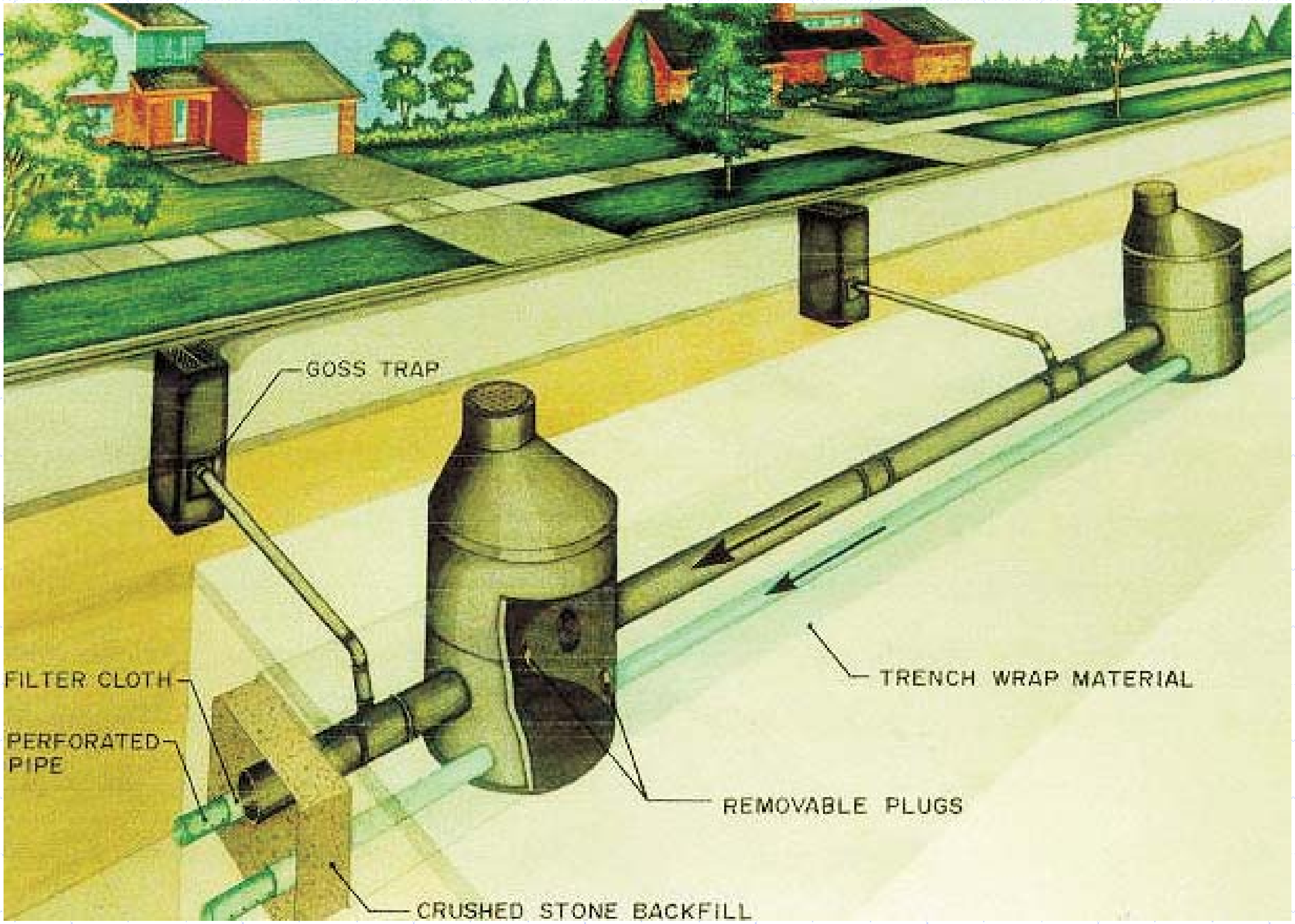
Current Examples

- Numerous Examples
- Green Street
- Modified green streets
- Green highways
- On-Lot
- Everyone has a different favorite application

Green Street

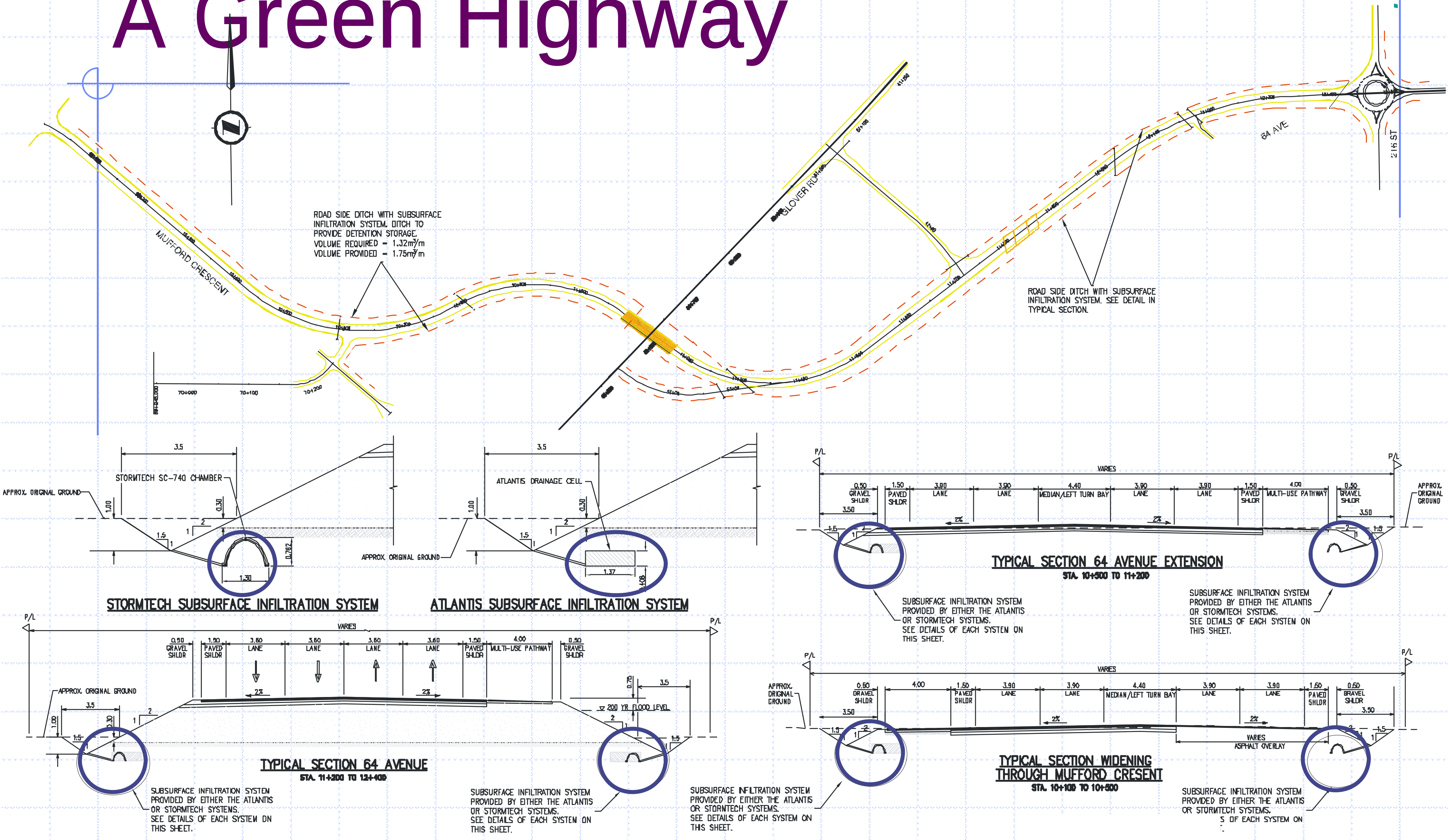
- Sea Street (Street Edge Alternative)

Etobicoke Example

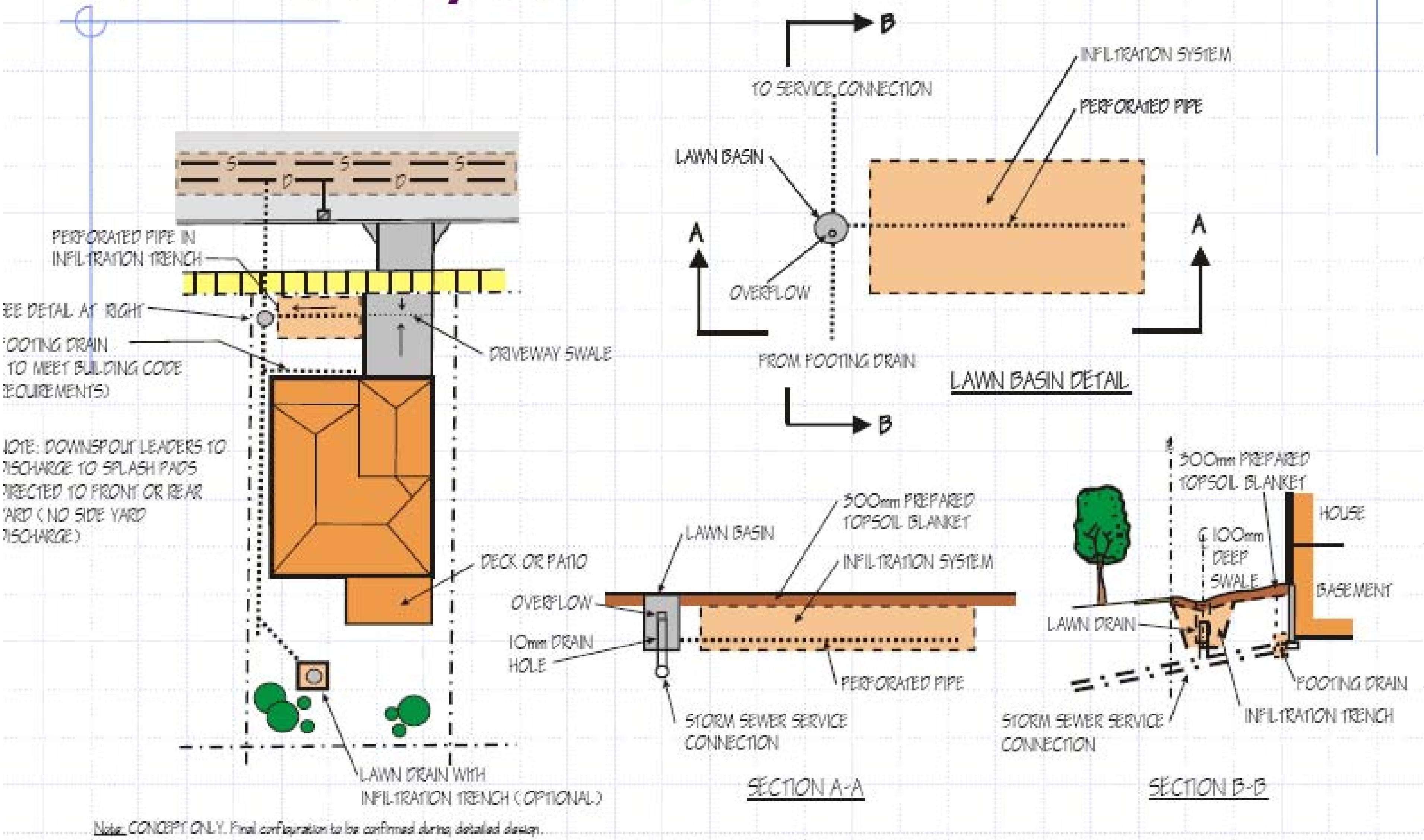


http://www.civil.ryerson.ca/urban/techno/stormwater/source/10-2-8/index.html

A Green Highway



On Lot Systems

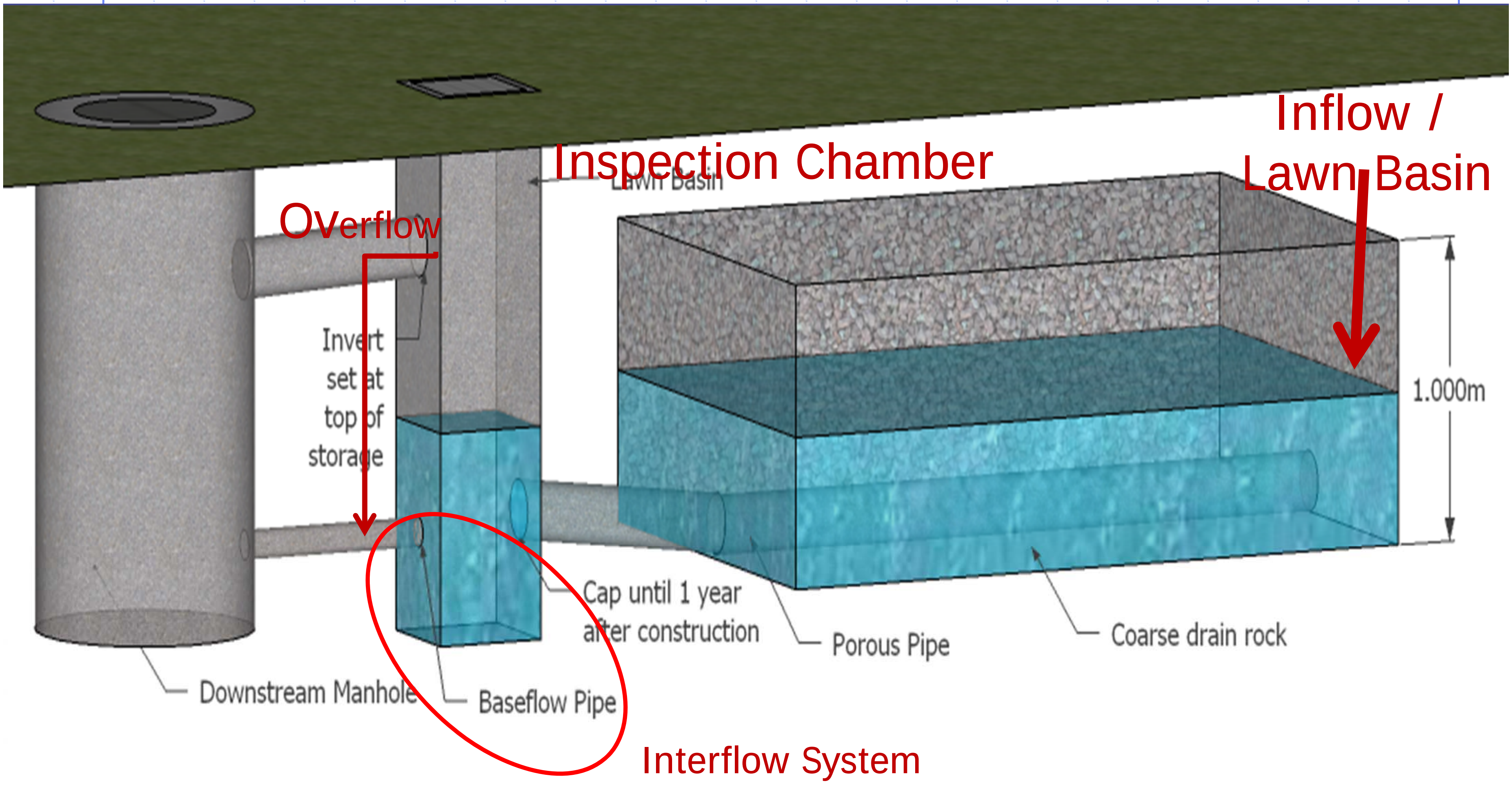


Atlantis Rain Tank

On Lot System

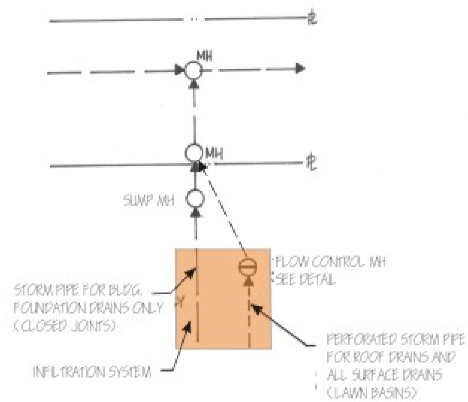
Important lessons:

1. Move the inflow upstream to allow treatment and minimize blockage of controls
2. Allow Interflow

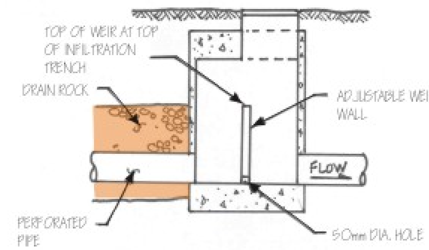


Typical Multi Family Lot

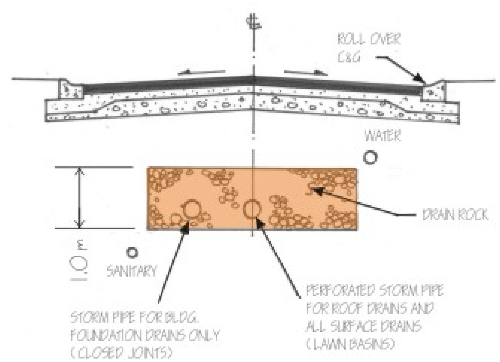
TYPICAL PLAN



PLAN DETAIL



FLOW CONTROL MANHOLE



TYPICAL SECTION

Typical surface area of the infiltration system will be 5% of the total site area.

Stormtech

Current State of Affairs

"I think you should be more explicit here in step two."

Source Control Sizing Options

- **Prescriptive**
  - Very simple methods
  - No analysis
- **Water Balance Methodology**
  - Analysis allows optimization
  - Understand the operation and performance
  - Reduces cost

Prescriptive

- Retain ½ MAS (or some volume)
  - No provision for predevelopment state
  - No provision for system operation
  - MetroVancouver recommends .75MAS
- Assumes:
  - One size is best for all conditions
  - They function as intended
  - Function is good

Water Balance Methodology

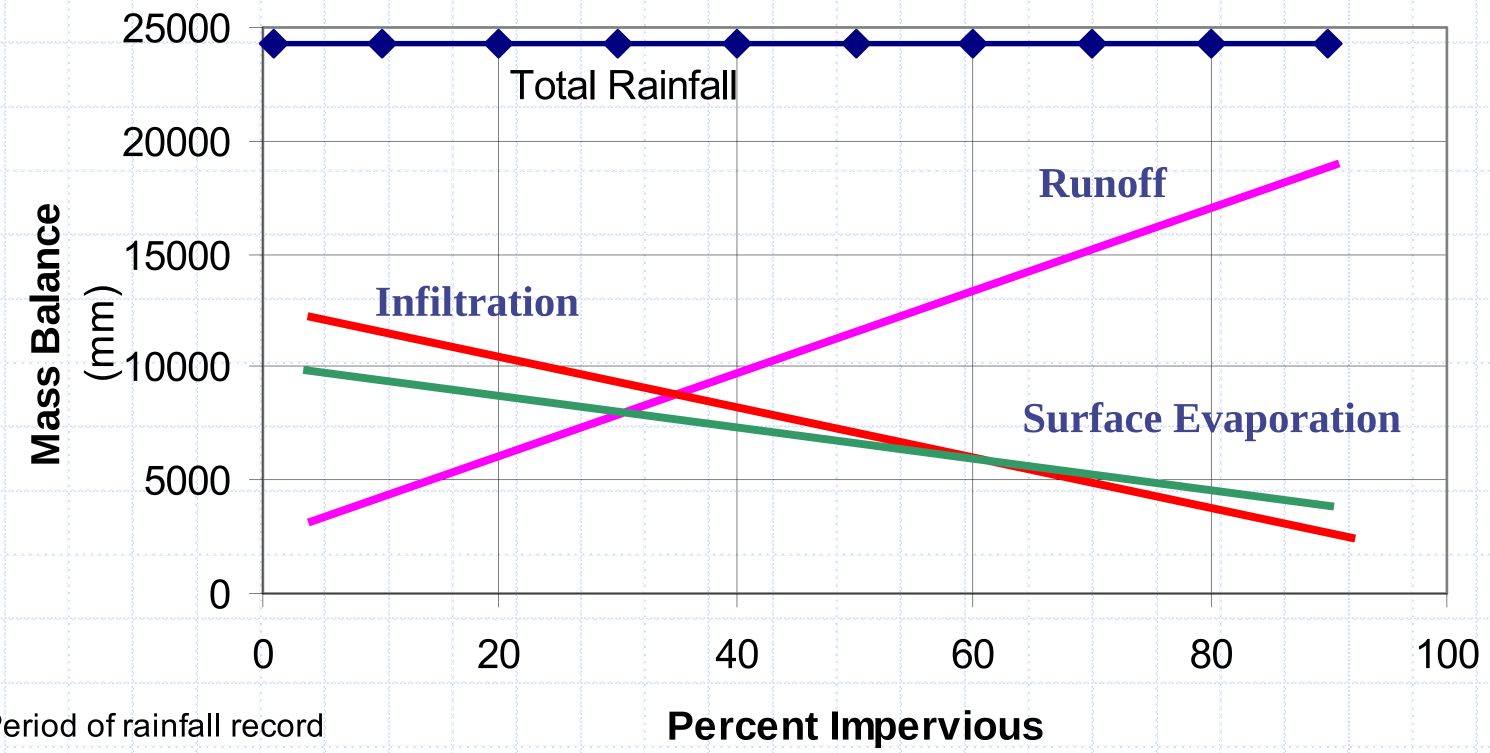
- Integrated process is critical
  - Establish Specific Watershed Objectives
  - Hydrologic Impact Assessment
    - Establish Targets
  - **Optimize** Systems to Achieve Targets
    - **Minimize Cost**
  - Build and Monitor (or just watch)
    - Revise as needed to achieve Targets

Watershed Objectives

- Establish the hydrologic change
  - Rainfall – Discharge relationship
- Streamflow Impacts
  - Flood peaks
  - Flow duration
- Stream Erosion – maintain or reduce
- Water quality and quantity

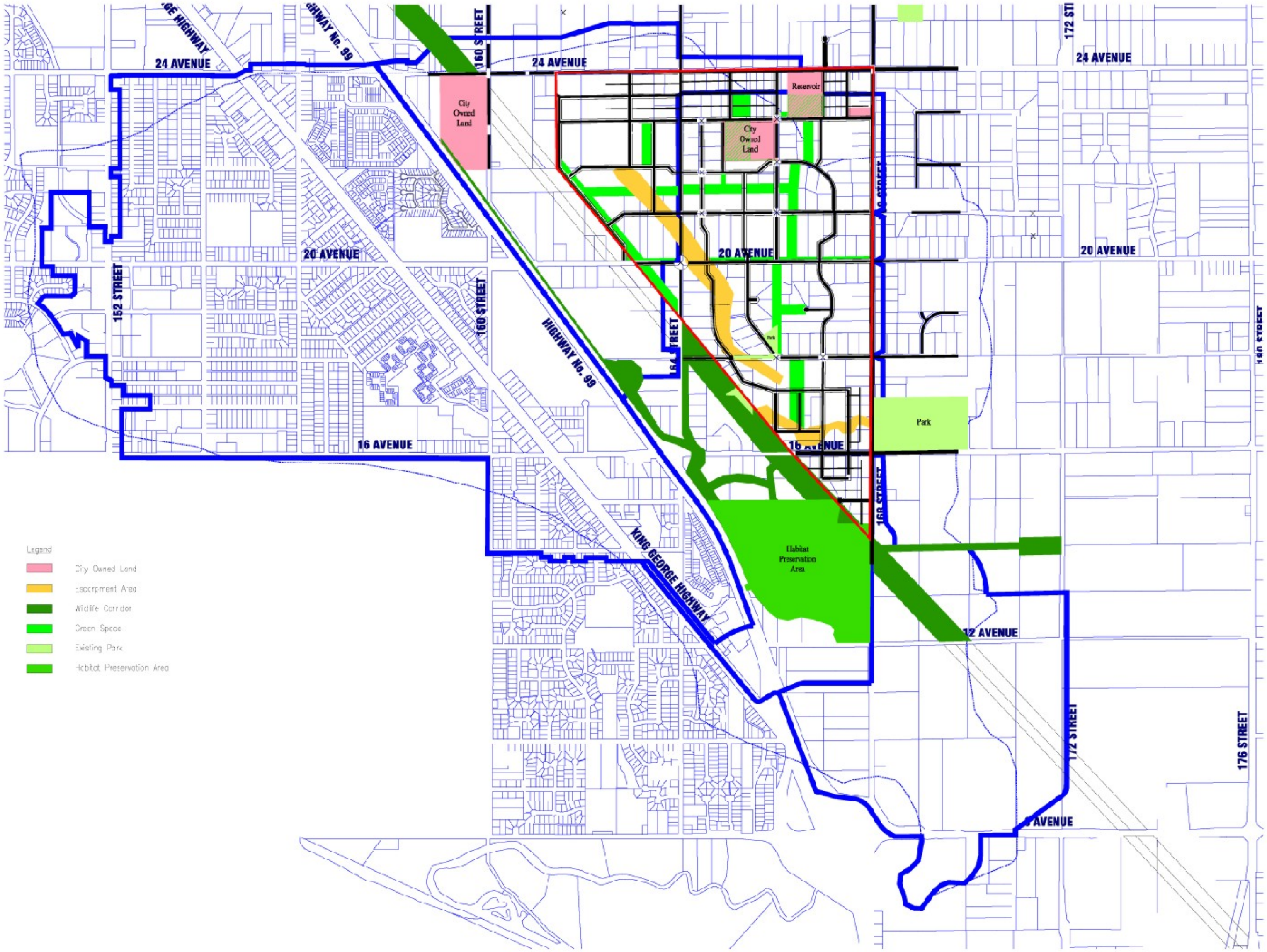
Hydrologic Change

The need is for more than just volume control

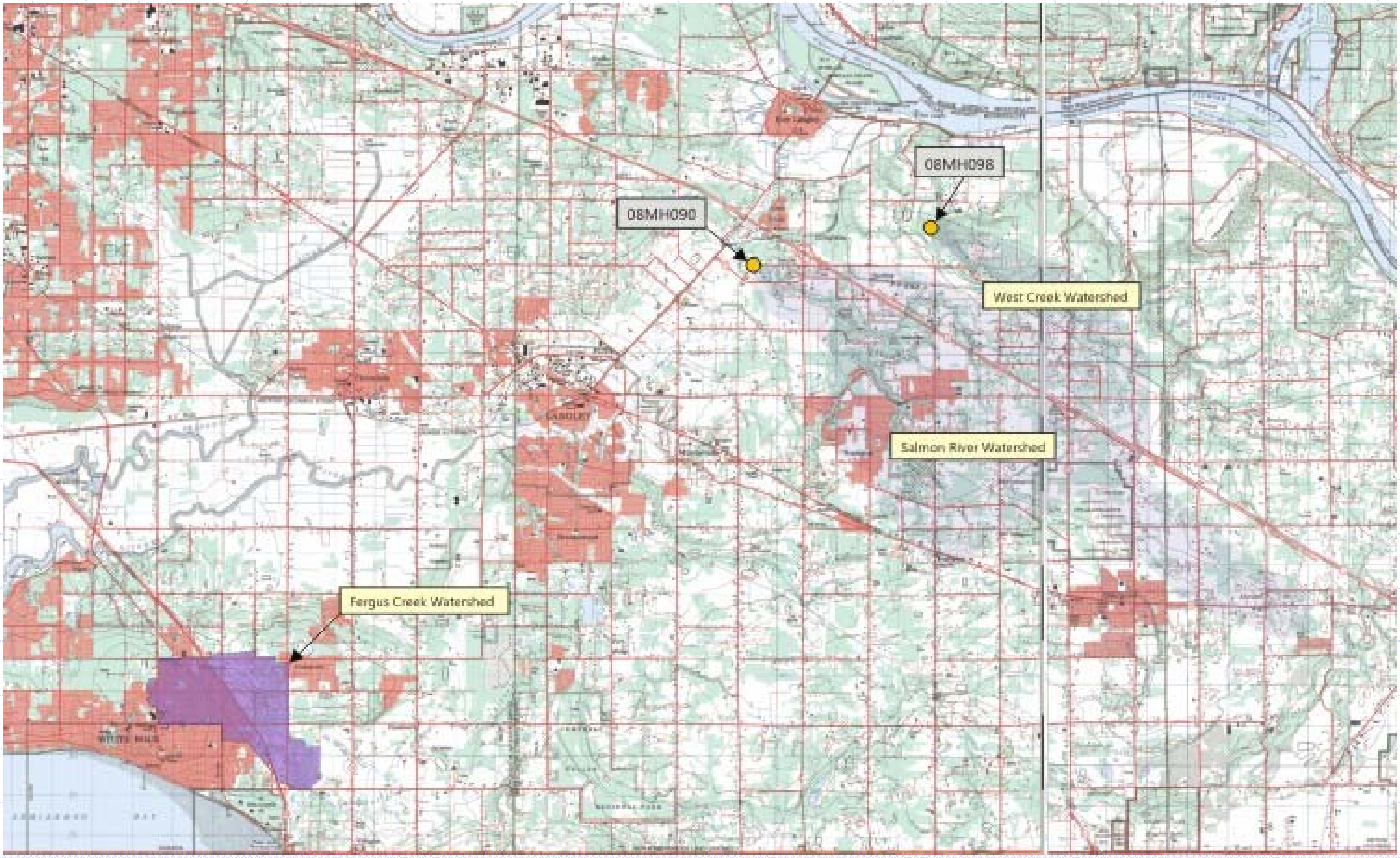


Period of rainfall record
1982 through 1999

Fergus Creek ISMP



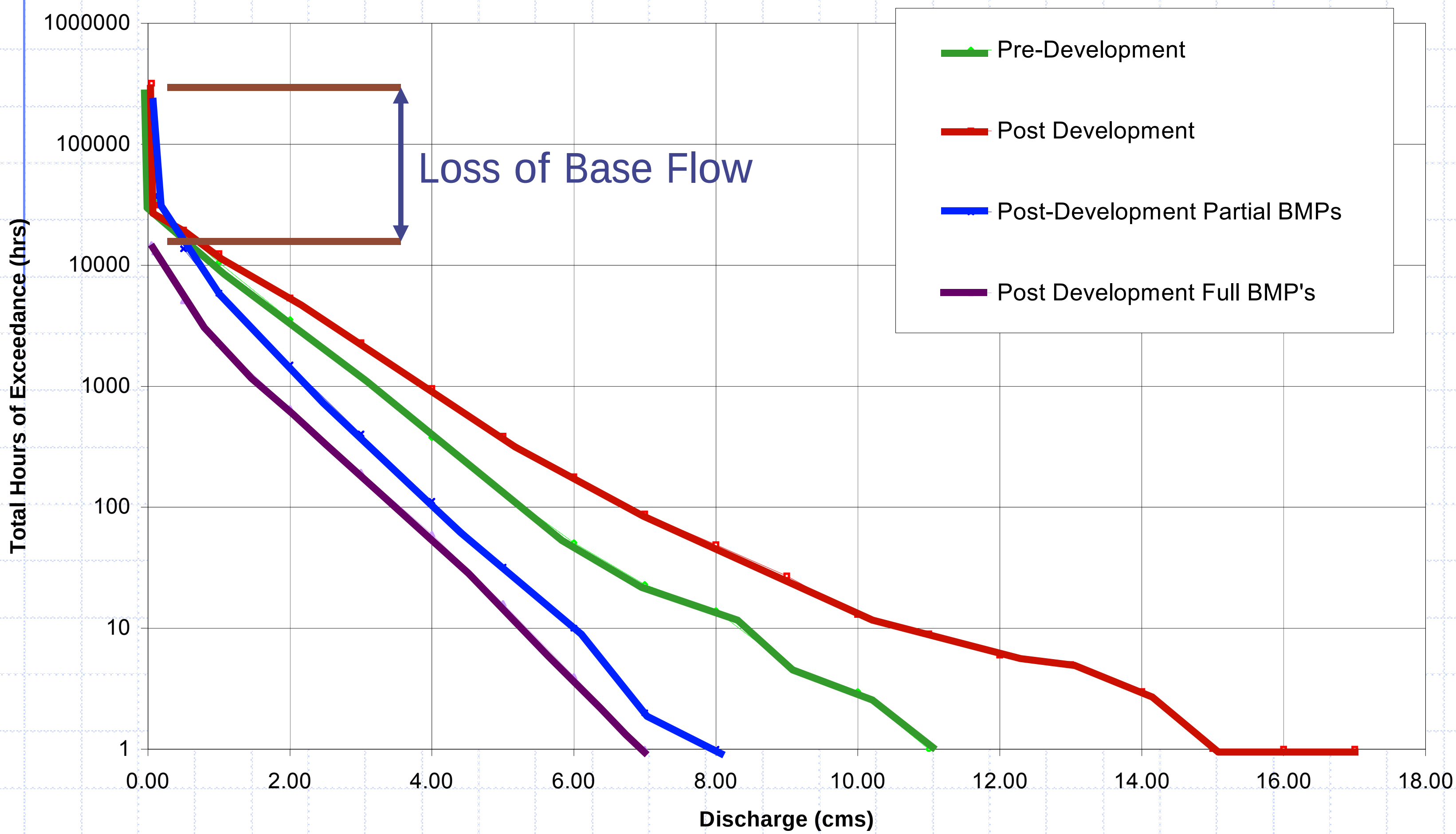
Fergus Creek Watershed



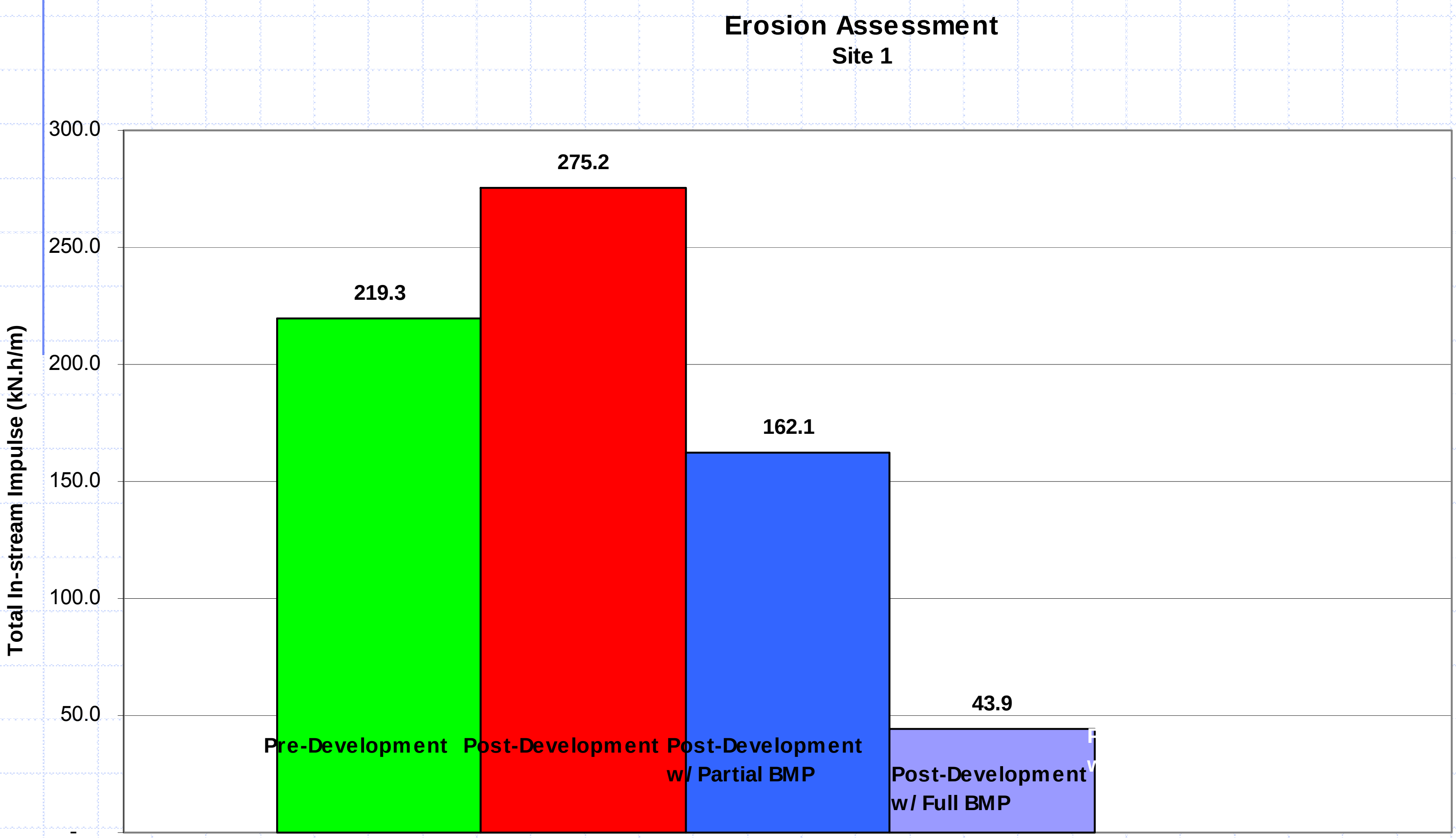
Regional Hydrologic Analysis

- Establish peak flood flows
- Establish hydrograph shape
- Establish discharge volumes for
  - Annual and monthly
- Establish flow duration
- Transfer data to Fergus Creek

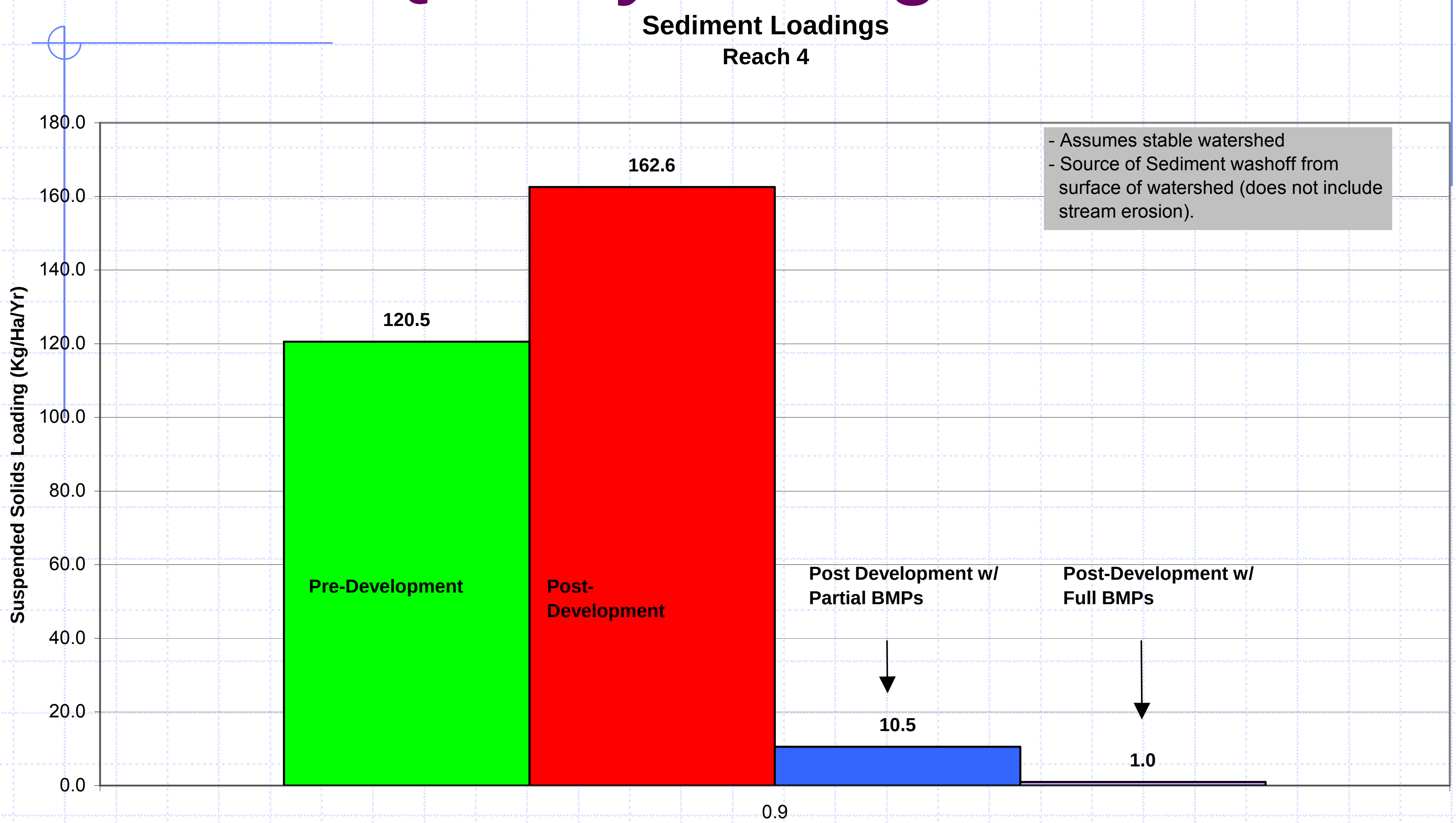
Exceedance - Fergus Creek



Stream Erosion - Fergus Creek



Water Quality - Fergus Creek



Sizing Comparison

- Two projects in Surrey – retention volume
  - Prescriptive **750 m^3/ha**
  - Fergus Creek ISMP **150 m^3/ha**
- Which system will work better?_______
- Is the savings in engineering worth the extra cost in construction?_________
- Your choice; prescriptive or Water Balance Methodology?________

Current State of Affairs

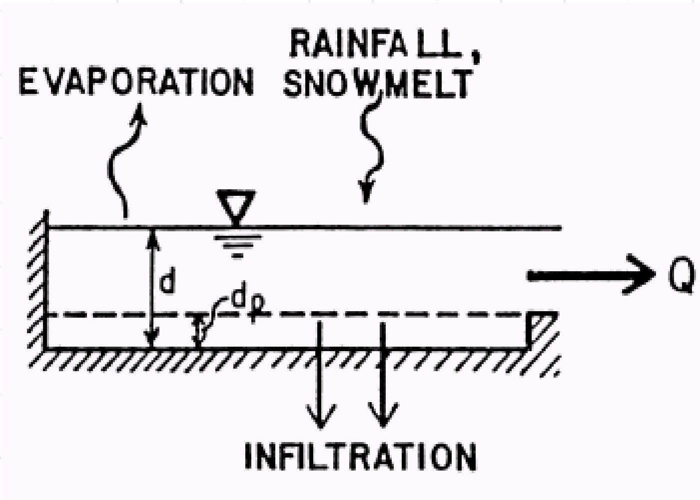
"I think you should be more explicit here in step two."

Modelling Details

- Continuous simulation vs design storm
- Soils
- Infiltration
- Erosion equations
- Process

How is Continuous Modelling Different?

Single Event Model

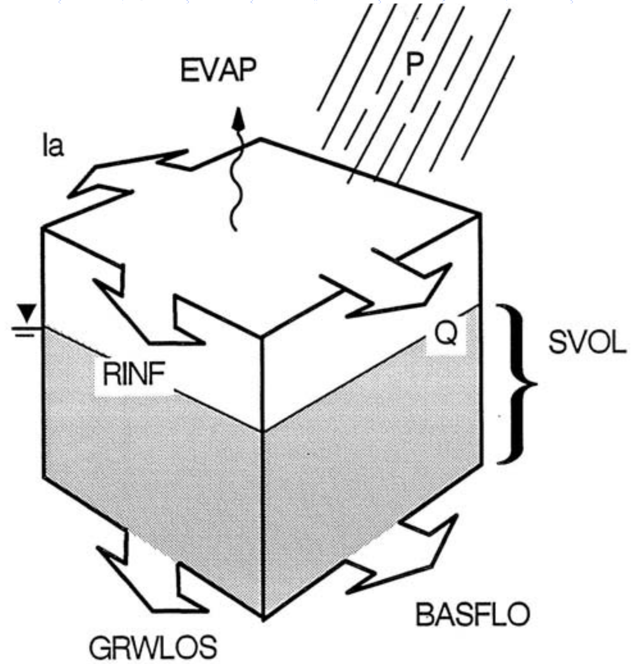


Source USEPA SWMM Manual

Only sees surface runoff

Continuous Model

QUALHYMO



Includes shallow groundwater flow

More than just runoff

Water Balance Methodology

- Data required
  - Rainfall
  - Precipitation
  - Temperature
  - Evaporation
  - Member municipality zoning
  - Soils – native and otherwise
  - Surface conditions

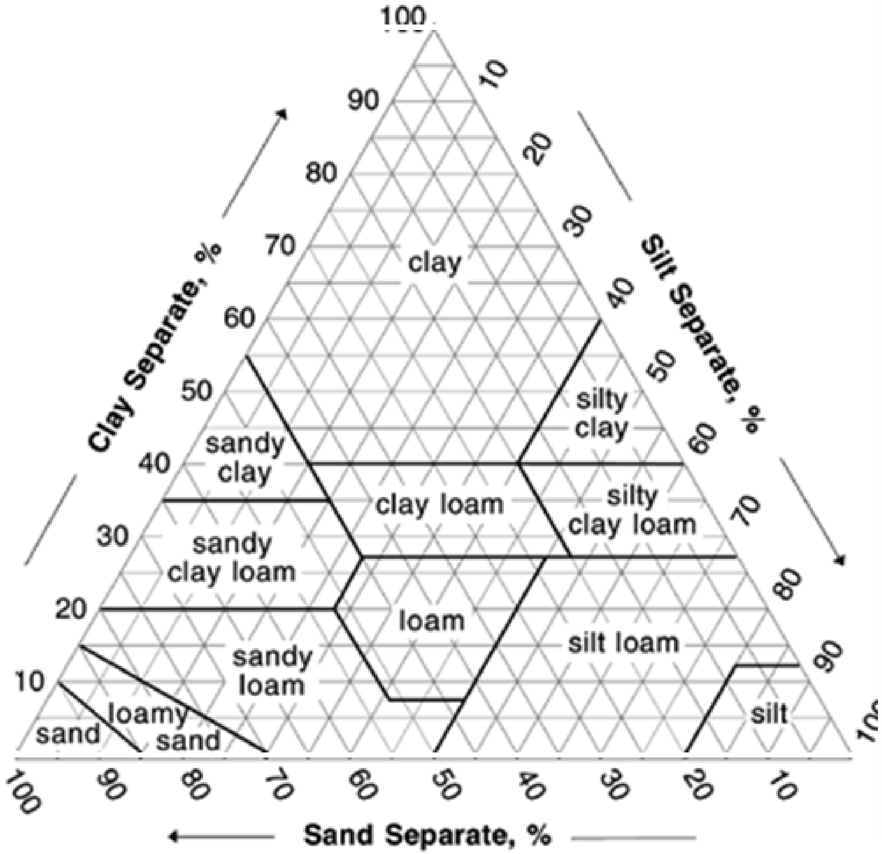
Provided by Water Balance Model

User Supplied

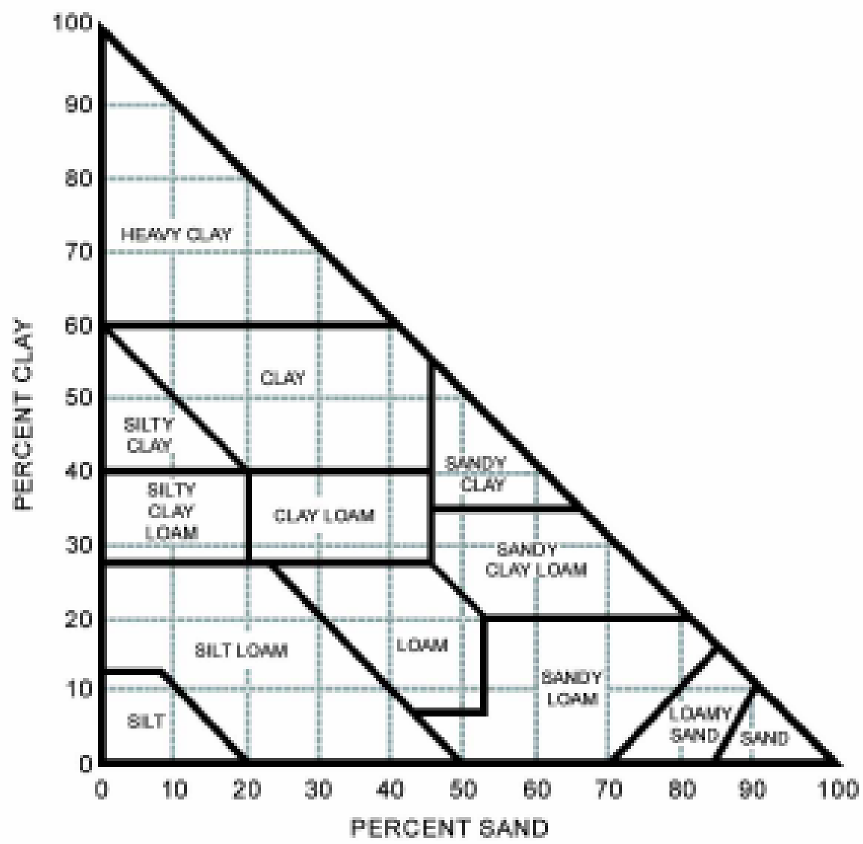
What is a native soil?

- Native soils are the surface soils that, in their natural location and condition, have been modified by weathering and have an accumulation of organic matter
- The Canadian System of Soil Classification describes the soil horizons above the Parent Geological Material
- These have <u>regular exposure</u> to surface water and can be very shallow or very deep
  - Typically about 600 mm

Soil Texture

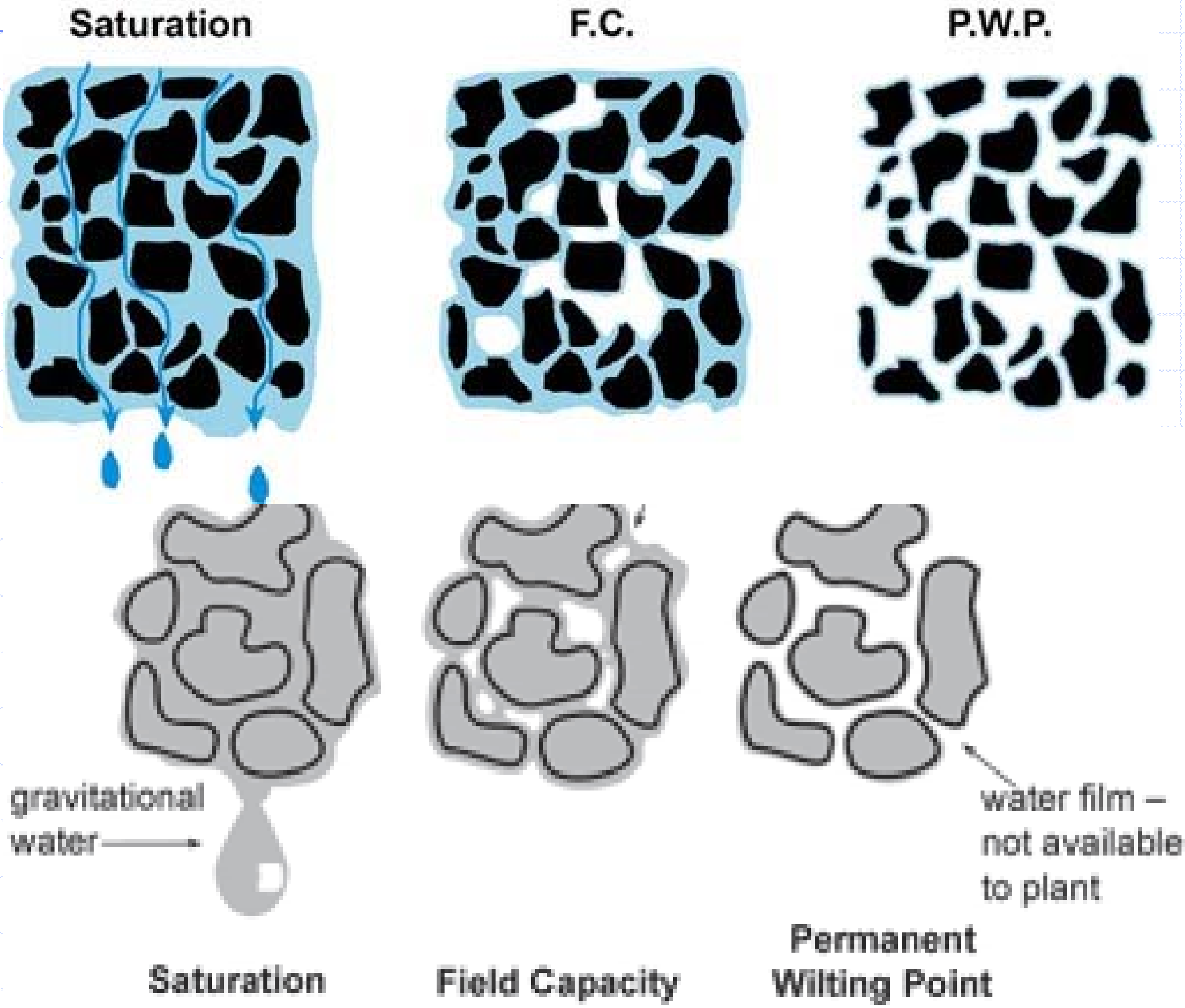


US Version

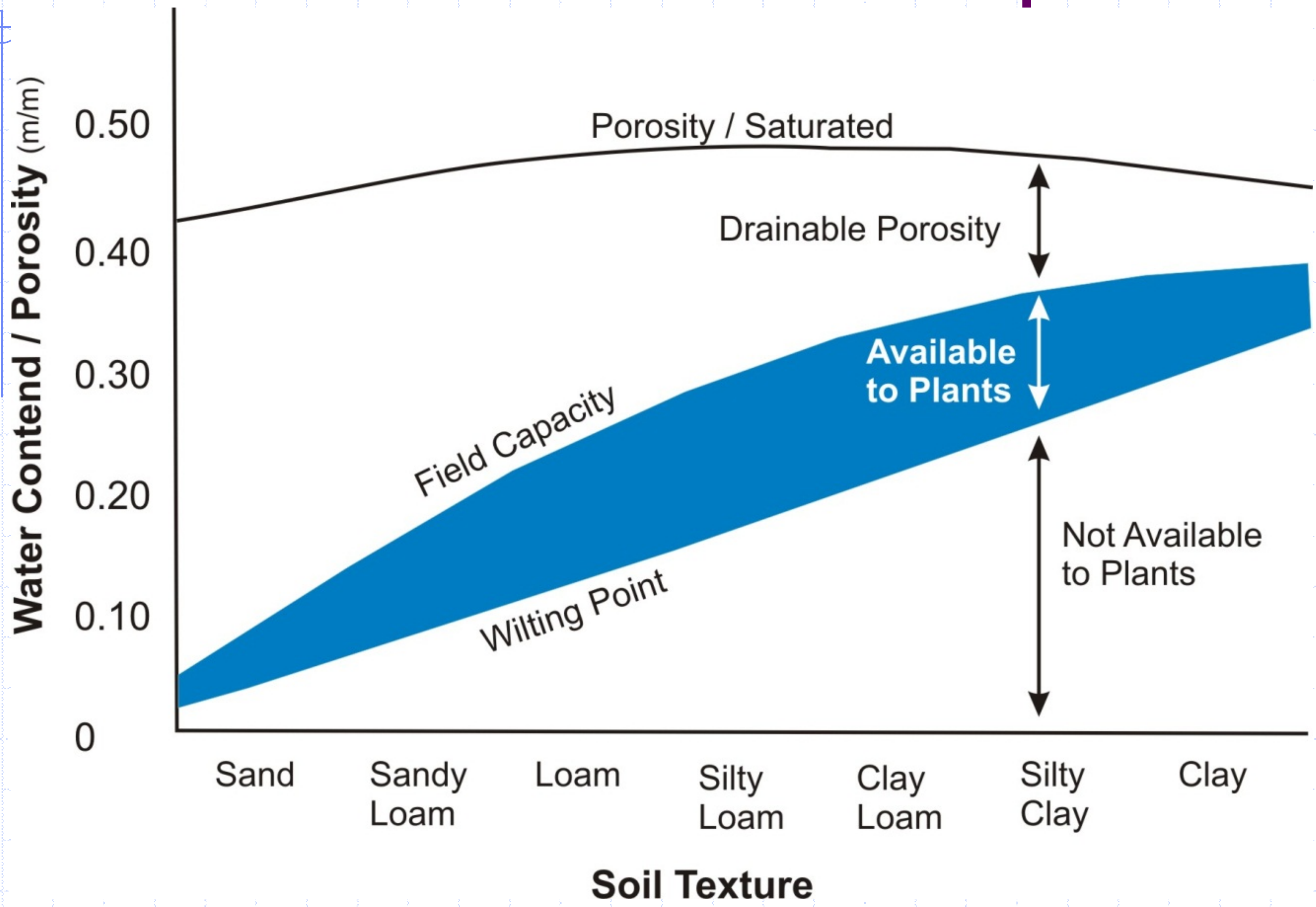


Canadian Version

Soil Moisture



Soil Moisture Relationships



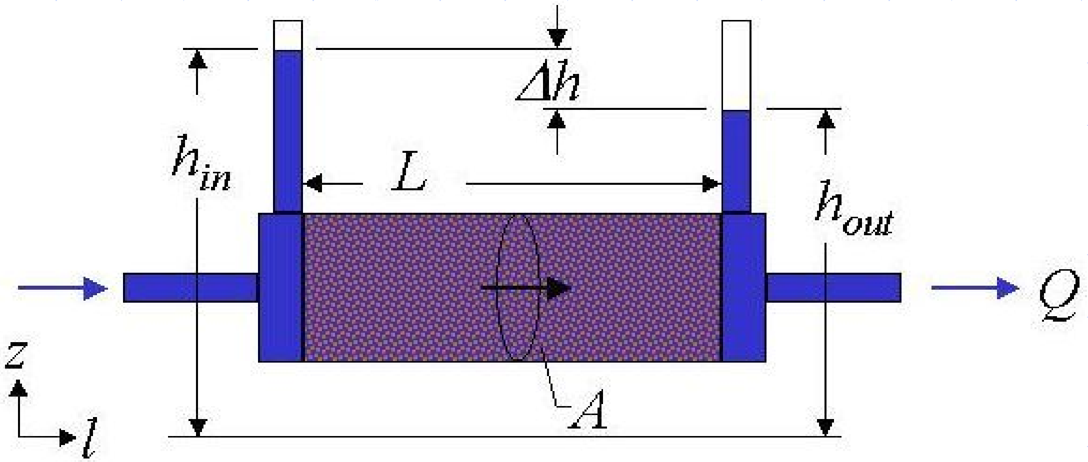
Infiltration or Permeability?

- Needed for Volume Reduction Systems
- Infiltration rate is not permeability
- Both have similar units
  - (distance / time)
- Infiltration measures flow crossing a surface boundary
- Permeability is saturated flow velocity through a porous media

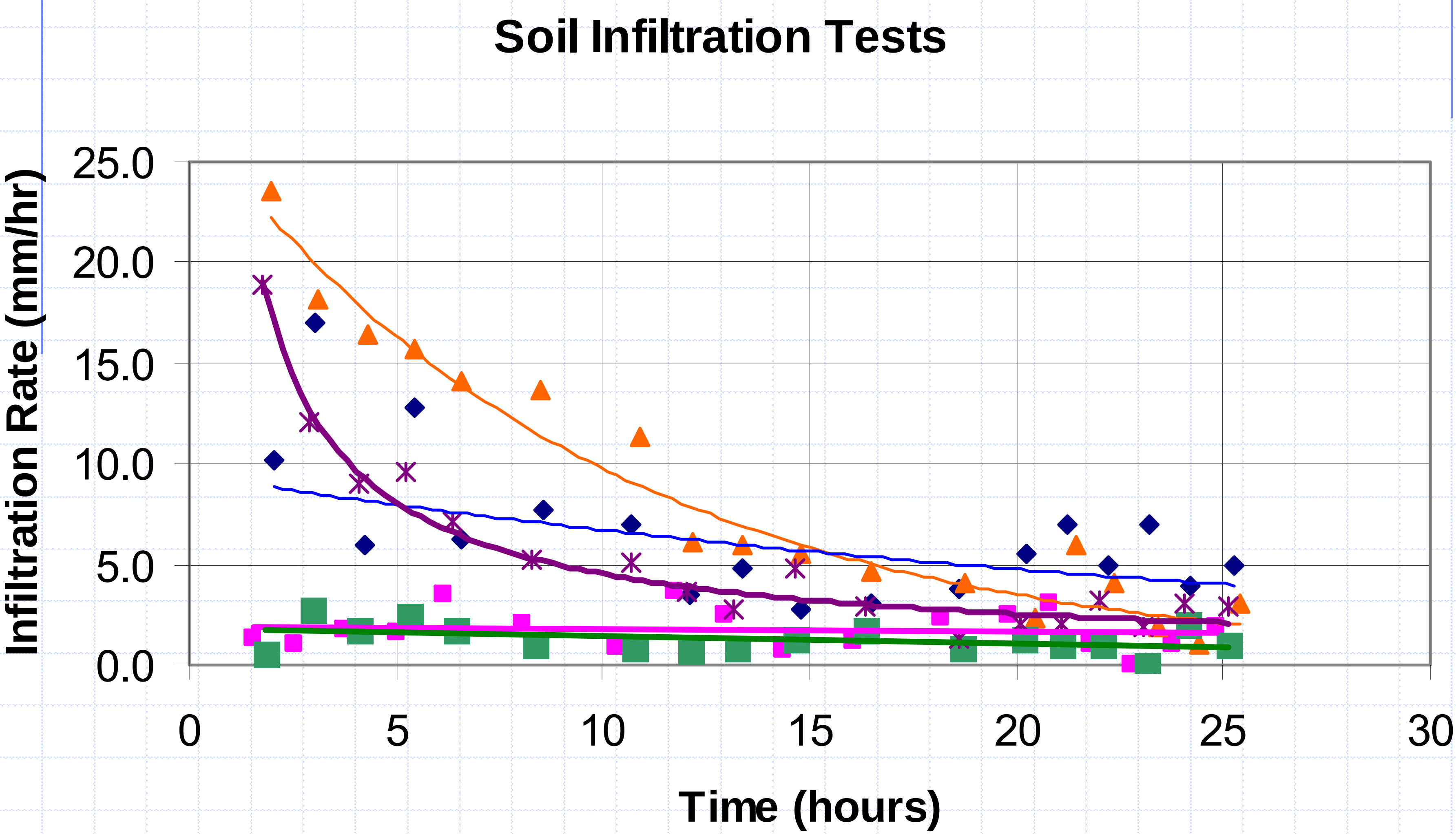
Darcy's Law

$Q = AK\,(\Delta h/\,l)$ (m^3/s), or $V = K\,(\Delta h/\,l)$ (m/s)

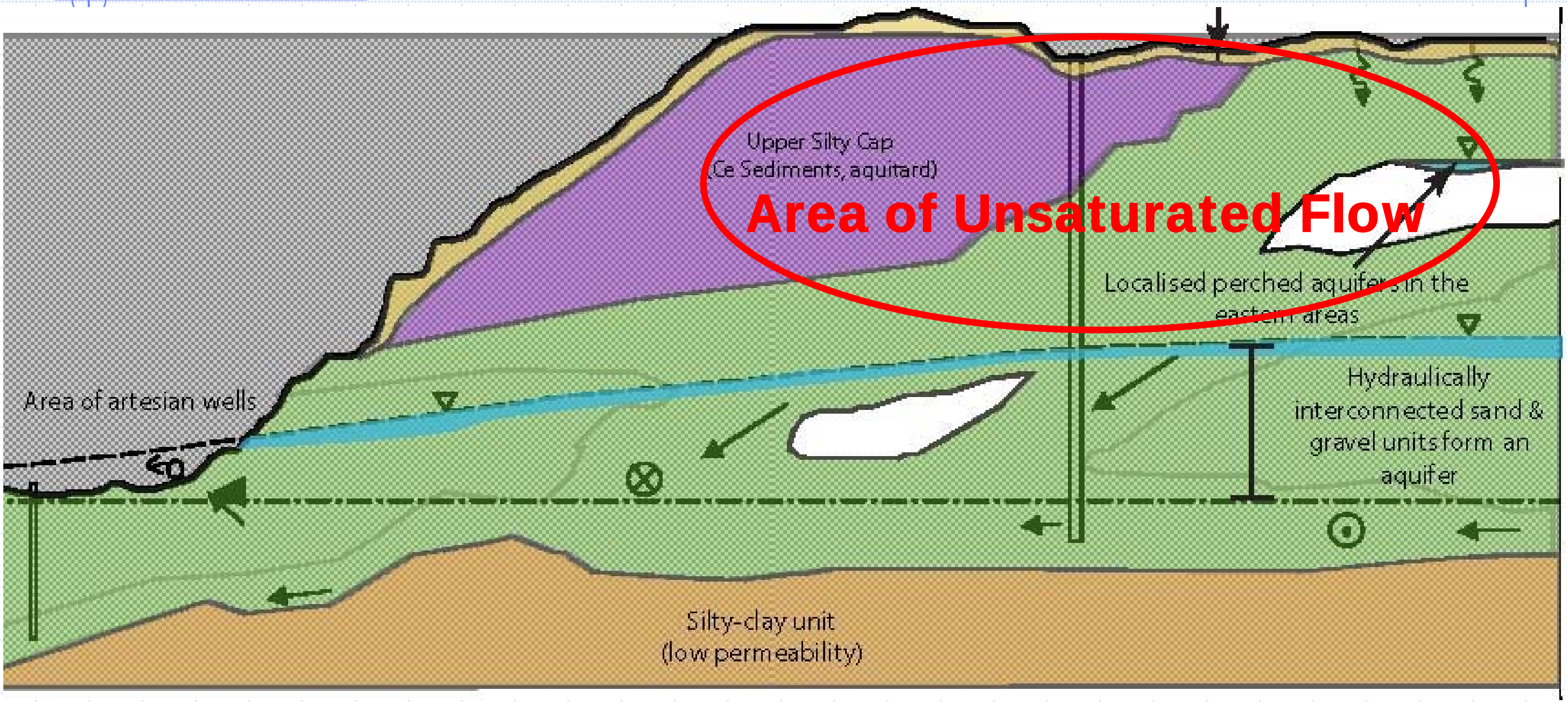
A	= flow area perpendicular to L (m^2)
K	= hydraulic permeability (m/s)
l	= flow path length (m)
Δh	= change in hydraulic head over the path L (m/m)



Typical Subsurface Infiltration



Groundwater



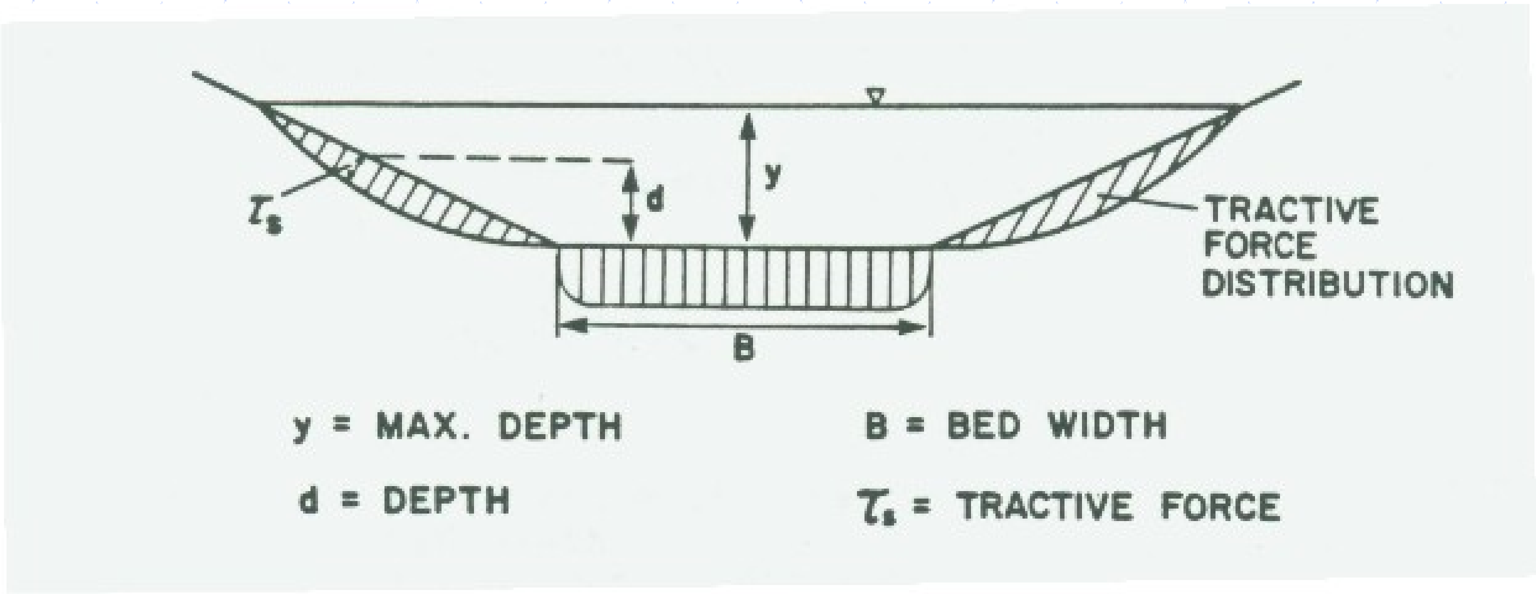
Source: Piteau East Clayton NCP Engineering Support Documentation

- East Clayton uplands to lowlands transition

Stream Erosion Calculations

Tractive Force

Based upon Tractive Force calculations



Tractive Force Equation

$\tau = \sigma Rs$, where

σ = unit weight of water

R = hydraulic radius of flow, and

s = slope of channel

- Simple equation
  - Applicable for a wide, open channels
- Include banks for narrow channels
  - Banks are often the critical part

Impulse Equation

$I = \sum \tau P T$, where

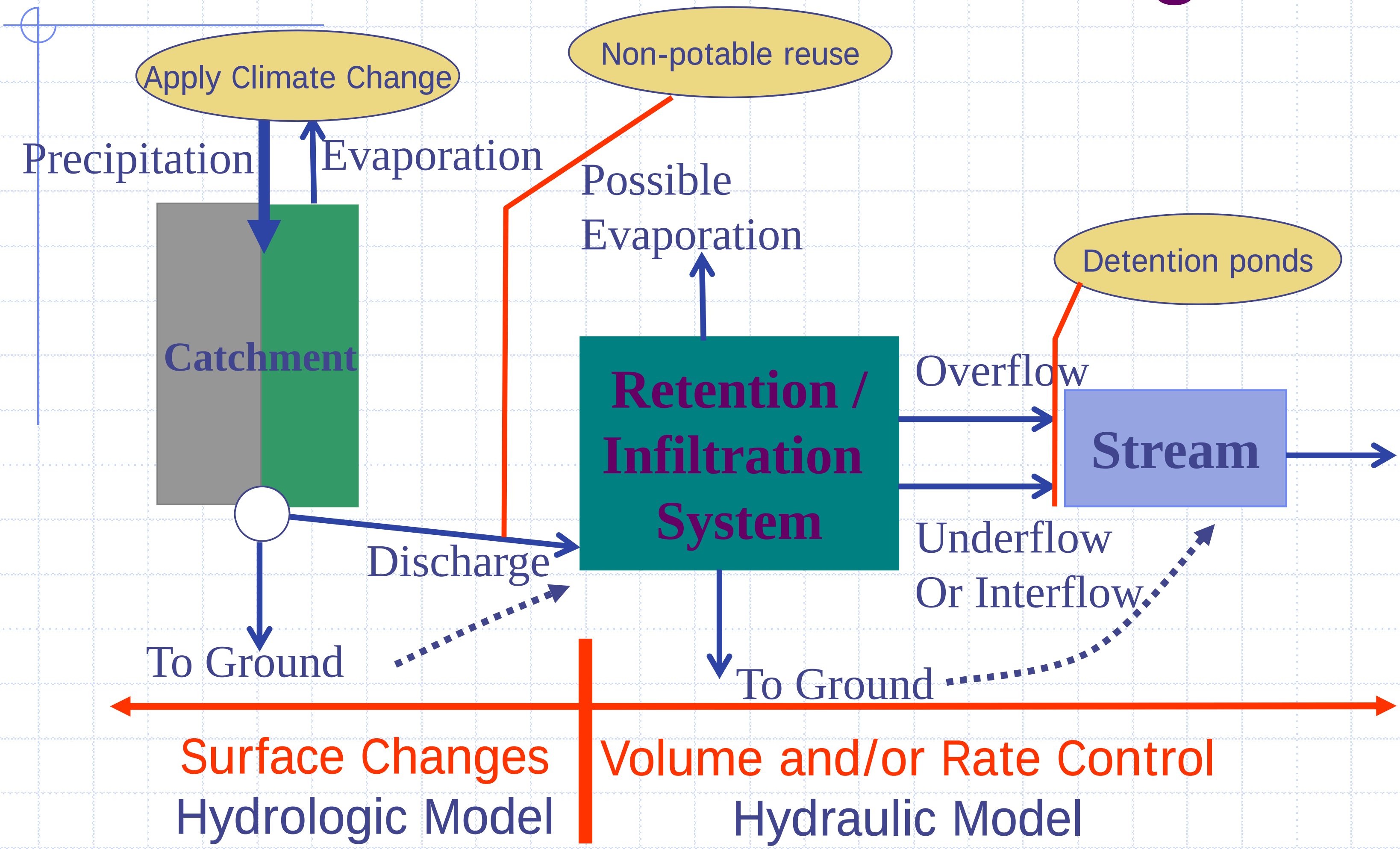
τ = Tractive Force

P = wetted perimeter

T = time

- A measure of energy applied to the stream cross section in the form of friction
- Use duration of flow to estimate total Impulse for a range of flow depths
- Can exclude non-erosive tractive force
- Easy to include in continuous modelling

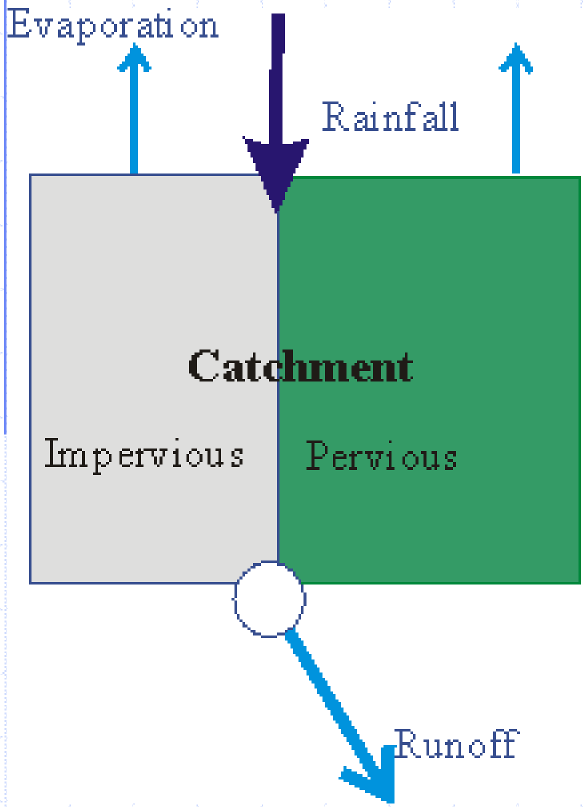
WBM Model Process Diagram



Modelling Surface Changes

- Model Impacts and Mitigation
- Mitigation with Absorbent Landscapes
  - Tree cover density
  - Increased top soil depth
  - Porous pavement
  - Green Roof – Typical
  - Some infiltration swales – without storage
- HYDROLOGIC MODEL

Model Surface Changes



OPERATION

Modifies the surface to change absorption and runoff characteristics.

Alterations occur in:

- Imperviousness
- Surface roughness
- Infiltration rates
- Soil moisture reservoir storage and potential capture

HYDROLOGIC MODEL

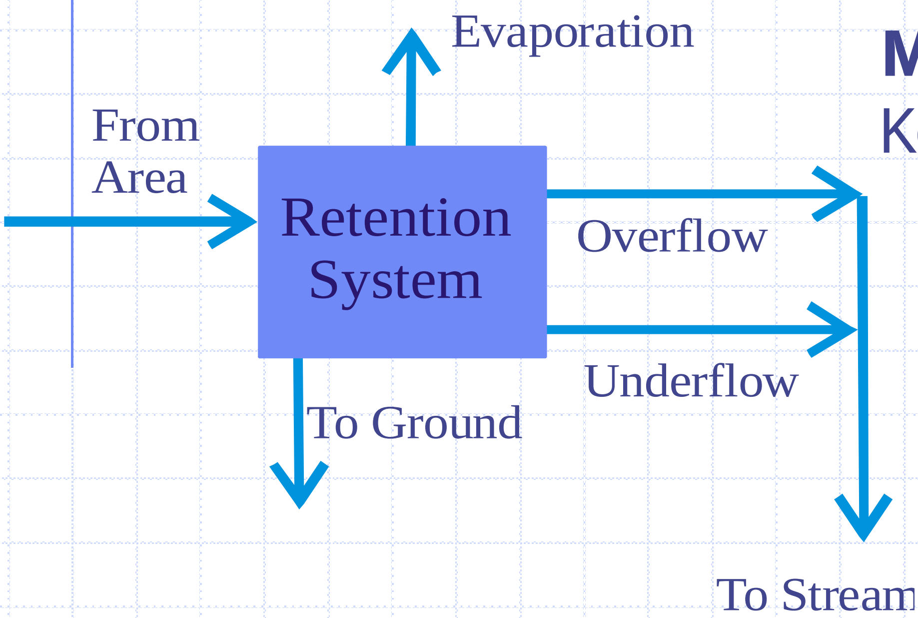
Surface Change Types

Replaces the area to which they are applied

Modelling Volume Reduction

- Capture surface runoff and STORE it
- Infiltration for volume reduction
  - Rain gardens
  - Infiltration swales with storage
    - Surface or subsurface storage
  - Infiltration ponds
  - Underground galleries
- HYDRAULIC MODEL

Model Volume Reduction Systems



OPERATION

Modifies runoff

Key parameters:

- Volume of storage
  - depth and area
- Infiltration rate to ground
- Underflow rate - baseflow
- Overflow rate
- Surface or subsurface
  - evaporation or not

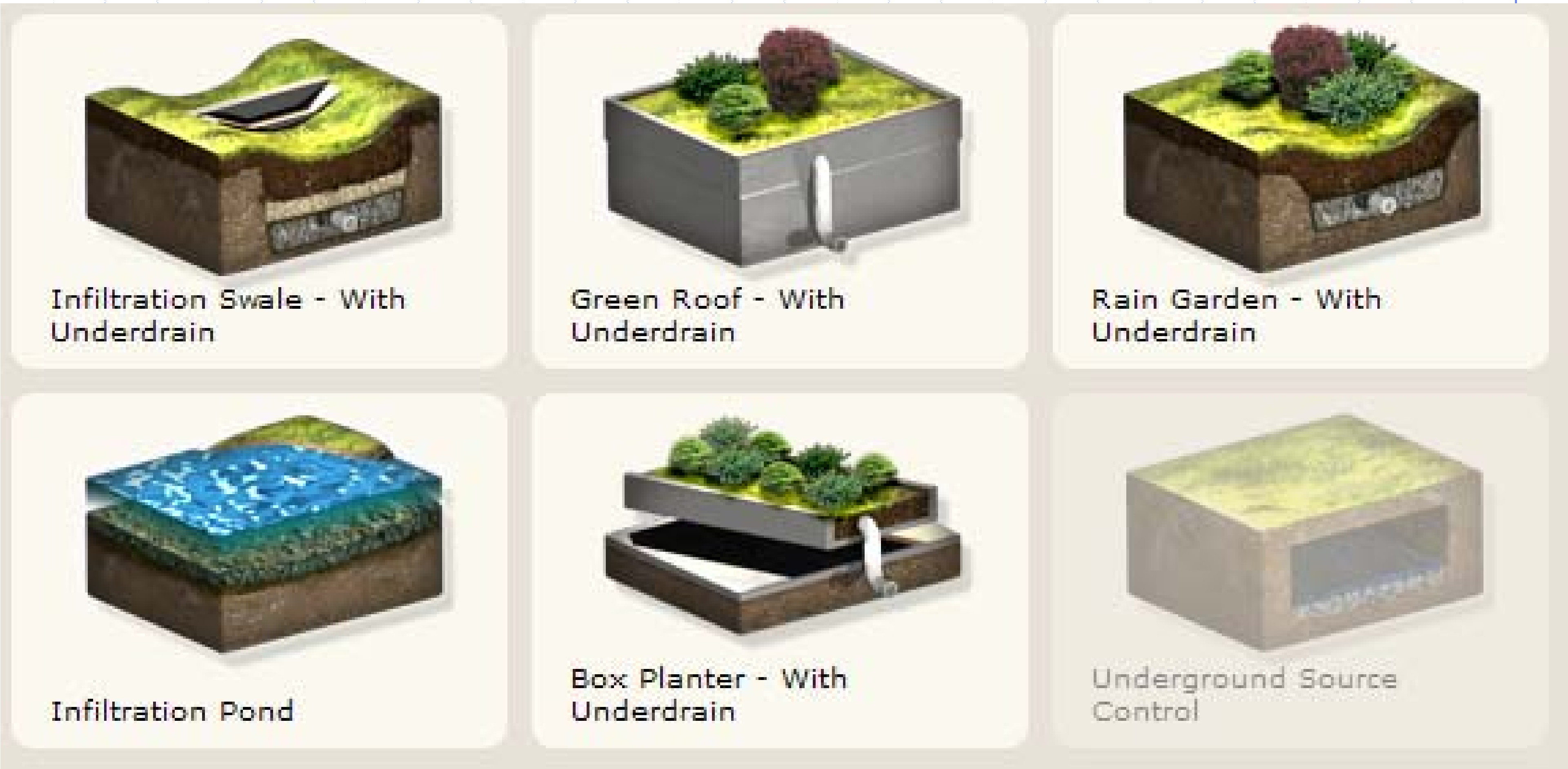
HYDRAULIC MODEL

Process:

Qin = Qout + Change in storage

They all work the same way

Volume Reduction Types



Surface types have evaporation, underground systems do not

Surface types replace the area to which they are applied

Where Next?

- WBM does not do pipe design
  - Solution – Screening Tool a simple to use planning level assessment tool to evaluate drainage system performance
- WBM Express tailored for your Municipality
  - Municipality establishes watershed objectives
  - User selects how to achieve objectives

Town-Hall Sharing

What Do You Wonder?

What Story Would You Like to Tell?