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Establishing Appropriate LID BMP Runoff Capture Targets to Effectively Address Subwatershed Objectives- *How Much is Enough?*

TRIECA Presentation, March 22-23, 2017

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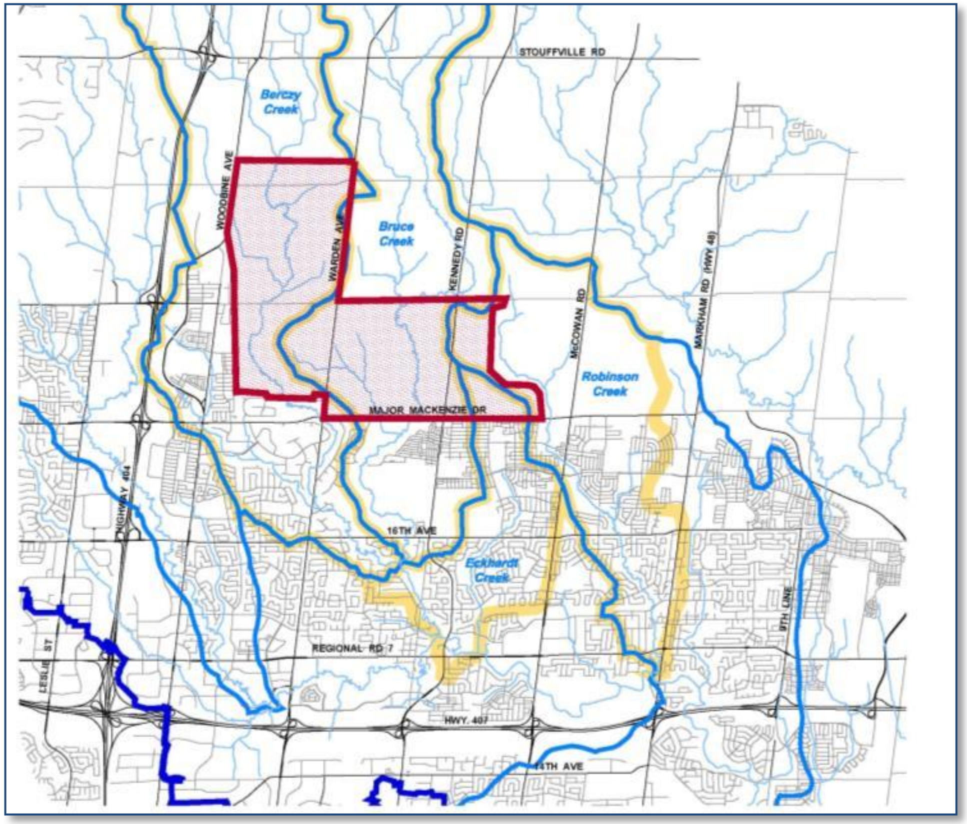


Presentation Outline

1. Core Thesis – How Much is Enough?

2. LID BMP Capture 101 – The Basics!

3. Problem Overview – The Case Study

4. Detailed Analysis / Assessment – The Numerics

5. Recommendations – What's Next?

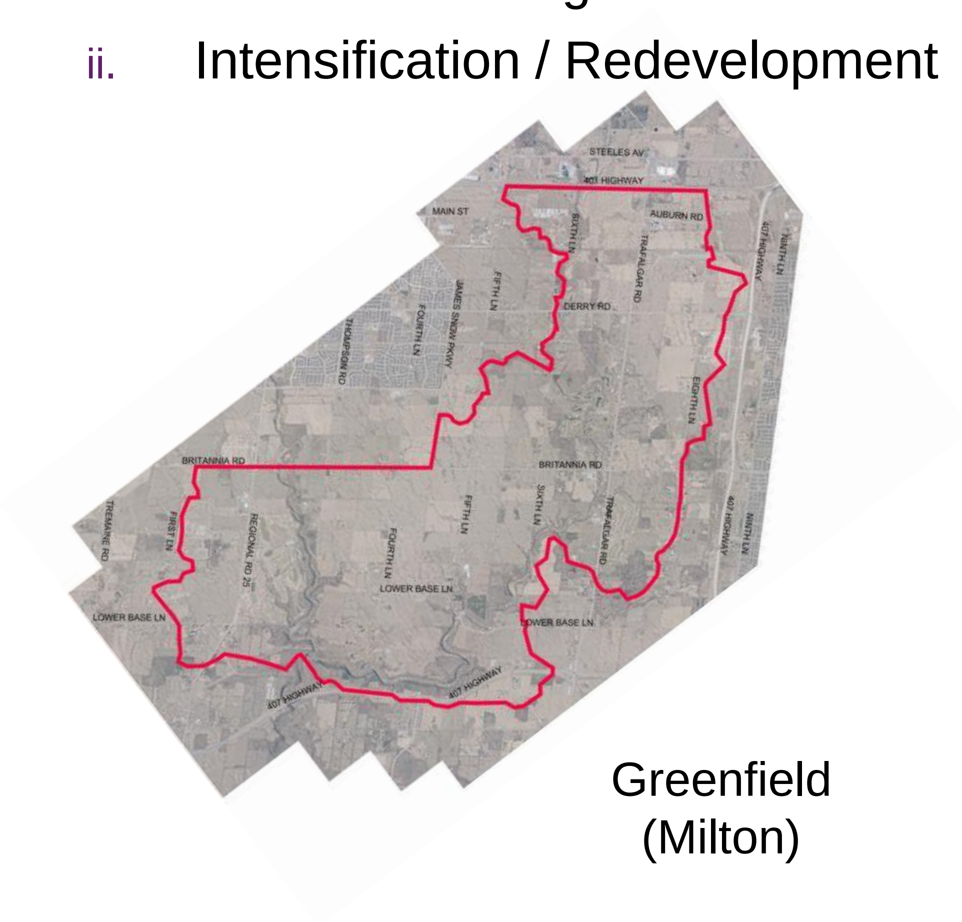
1. Core Thesis

How Much is Enough?

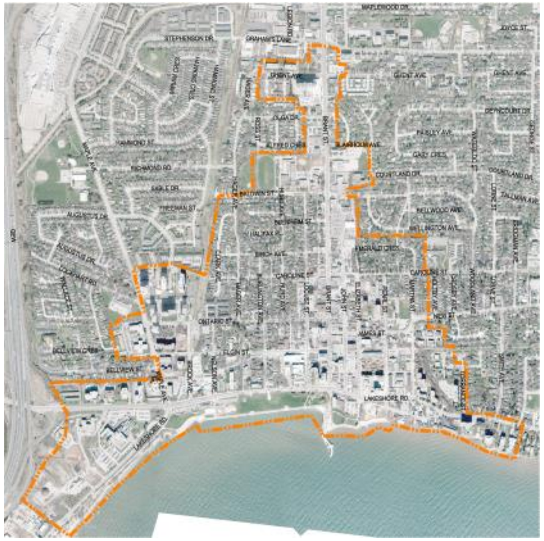
Generally two (2) types of development:

i. Greenfield / Large Scale Infill

ii. Intensification / Redevelopment



Greenfield
(Milton)



Intensification
(Burlington)

1. Core Thesis

How Much is Enough?

- Stormwater management in general needs to be designed to mitigate urbanization impacts related to:
  - Flooding
  - Erosion
  - Water quality (including temperature)
  - Water balance / budget (including groundwater recharge/discharge)

- Contemporary Stormwater Management includes the application of a suite of practices:
  - Source / LID BMPs
  - Conveyance
  - End-of-pipe

1. Core Thesis

How Much is Enough?

- Various Stormwater Management practices are aligned with various functional objectives:

Culvert upgrade – City of Brantford

Flooding (Post- to Pre-Peak Flows)

- Short-term storage areas (ponds, public spaces)
- Conveyance upgrades (pipes, culverts, channels)

Erosion (Cumulative Shear Stress Balance)

- Extended storage areas (ponds, public spaces)
- Volume management (LID BMPs)
- Stabilize receiving system (Natural Channel Design)

Traditional Stormwater Management Pond

1. Core Thesis

How Much is Enough?

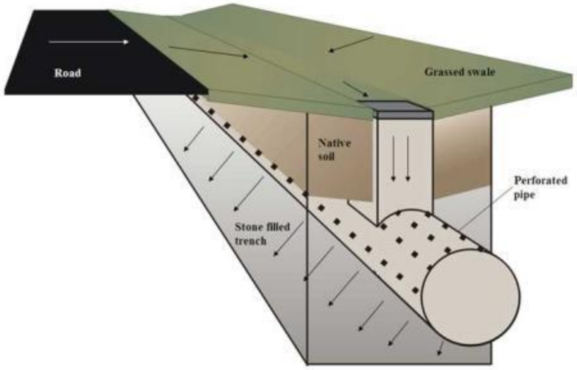
Water Quality (80% TSS removal, T° mitigation)

- Extended storage areas (ponds, public spaces)
- Volume management (LID BMPs)
- Other best practices (salt management, etc.)

Source: UrbanToronto.ca

Water Balance (Post- to Pre-Volumes)

- Volume management (LID BMPs)
- Maintenance of functional recharge/ groundwater level/groundwater discharge connections



Source: sustainabletechnologies.ca

1. Core Thesis

How Much is Enough?

- Fully integrated Stormwater Management Planning and Design needs to consider all potential impacts of urbanization
  - Physical (Stream Morphology)
    - Bankfull flow and duration
    - Sediment transport
  - Social (Risk Management)
    - Major flooding
  - Ecological (Fish / Aquatic Habitat)
    - Baseflow
    - Channel form and stability
    - Temperature/Quality

1. Core Thesis

How Much is Enough?

LID BMPs principally focus on:

- Frequent storm volume control providing benefits to:
  - Erosion
  - Water quality
  - Aquatic habitat
  - Groundwater recharge/discharge
  - Temperature

Source: urbantoronto.ca

1. Core Thesis

How Much is Enough?

Emerging guidance (MOECC) focusses on generic volume control targets:

- 90th percentile event
  - 20-30 mm capture / management

Emphasis is on Lot-level practices:

- Infiltration, water re-use, evapotranspiration, filtration

Source: peacefulparks.org – London Ontario

Source: oaec.org

1. Core Thesis

How Much is Enough?

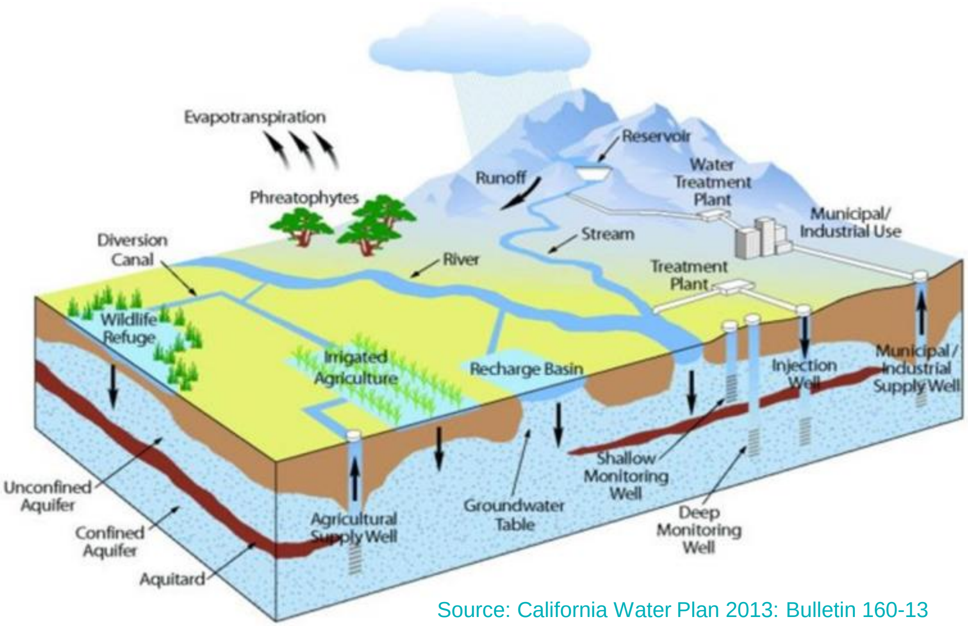
- Application of generic volume capture does not consider subwatershed scale system characteristics:
  - Spatial variability of soil and subsoil properties (infiltration)
  - Temporal dynamics of water movement (discharge)

- If not properly planned generic volume control could lead to issues related to:
  - Groundwater mounding / related infrastructure impacts
  - Reductions / increases in baseflow
  - Imbalance to sediment transport / stream energy
  - Impacts to Natural Heritage Systems: wetland - hydroperiods
  - Headwater drainage features soil moisture

1. Core Thesis

How Much is Enough?

- Integrated surface water – groundwater modelling used to:
  - Characterize function of current system
    - Spatial variability (infiltration/runoff)
    - Temporal dynamics (discharge)
    - Spatial and temporal linkages, discharge areas, NHS
  - Establish Area-specific volume capture (retention targets) for proposed future land use
  - Optimize<over / under control>



Source: California Water Plan 2013: Bulletin 160-13

2. LID BMP Capture 101

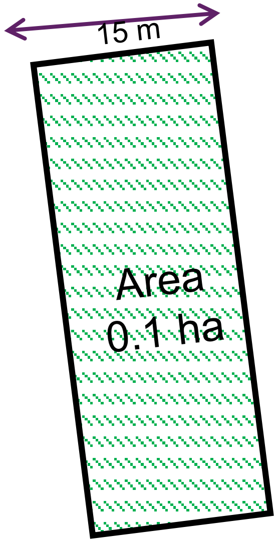
The Basics!

- Total Capture = retention + detention
- Retention = infiltration controls → recharge and ET, re-use
  - Infiltration: residential/bioswales/rain gardens, employment/infiltration systems
  - ET: conversion of forest/agriculture to urban, lower potential
  - Reduction in overall run-off
- Detention = filtration & storage controls → swales, and historically end-of-pipe systems
  - Still counted as run-off

- *Our Capture focus is on amount "retained"*

2. LID BMP Capture 101

The Basics!

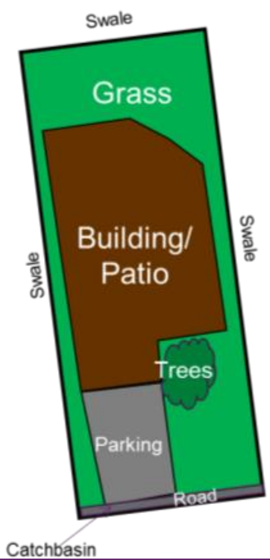


Existing - Greenfield

Total Area = 0.1 ha

Pervious = 100%

Impervious = 0 %



Future - Urbanization

Total Area = 0.1 ha

Pervious = 25%

Impervious = 75%

Precipitation = Runoff + Infiltration + ET

Precipitation = 900 mm/a = 900 m^3

Runoff = 125 mm/a = 125 m^3

Infiltration = 200 mm/a = 200 m^3

ET = 575 mm/a = 575 m^3

Pervious Area reduced by 75%

Infiltration reduction = 150 m^3

ET reduction = 432 m^3

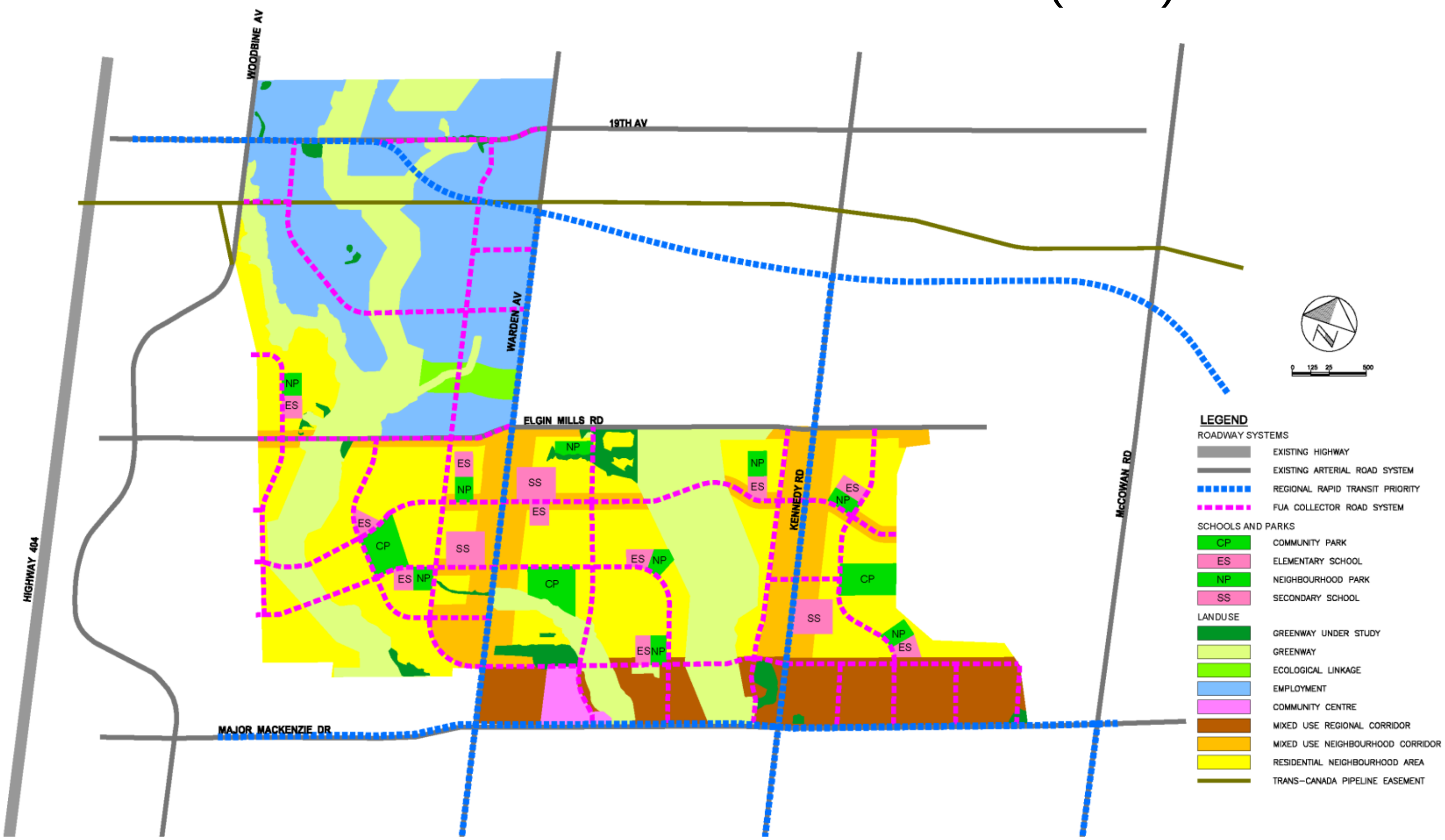
Assume ET in pervious area same potential as pre-development

LID BMPs needed to compensate for loss of both infiltration and ET = 582 m^3

3. Problem Overview

The Case Study

North Markham Future Urban Area (FUA)



3. Problem Overview

The Case Study

North Markham Future Urban Area (FUA)

- 38,000 residents
- 19,000 jobs

Provincial stronghold for Redside Dace

- High quality habitat
- Significant groundwater recharge / discharge

Redside Dace

3. Problem Overview

The Case Study

Provincial Planning Objectives

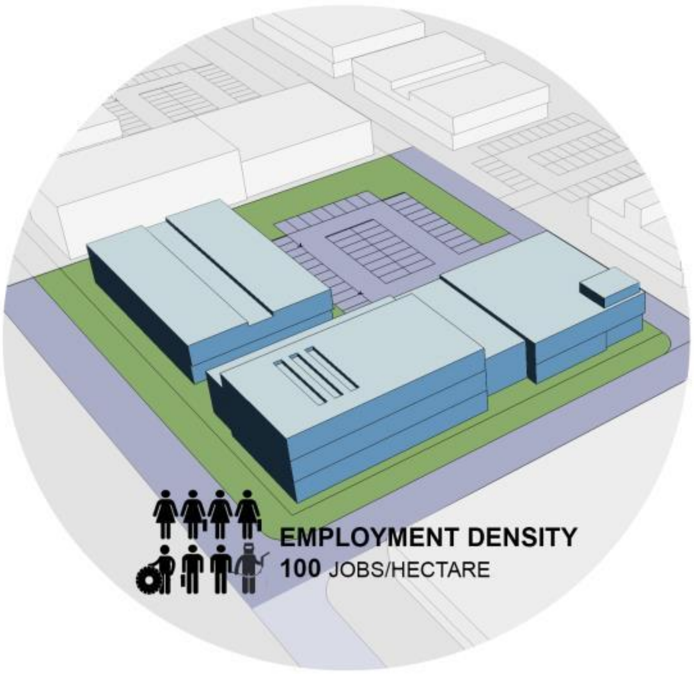
- 2013 – Places to Grow: The Growth Plan for the Greater Golden Horseshoe (Section: 2.2.7.2)
  - 50 people / jobs / ha

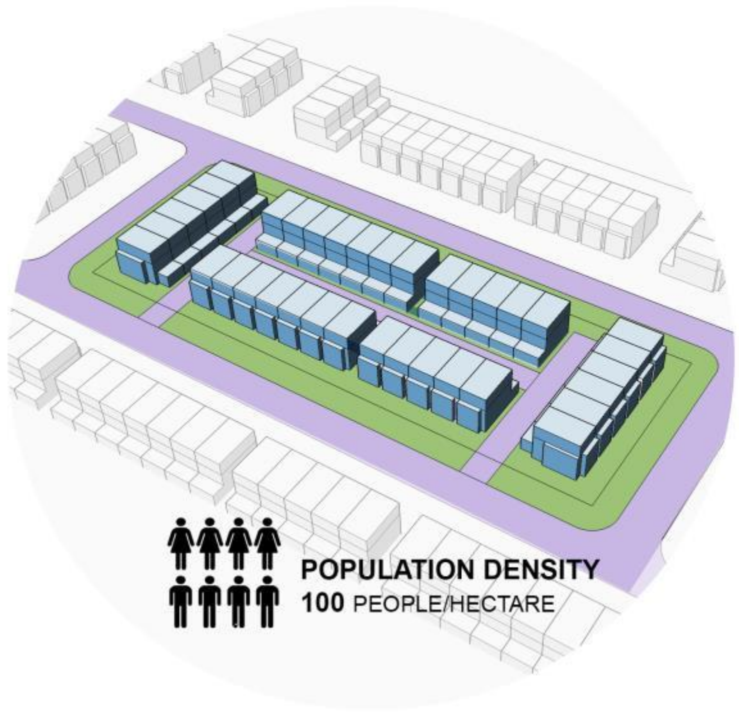
- 2016 – Proposed Growth Plan for the Greater Golden Horseshoe (Section 2.2.7.2 and Section 2.2.4.5)
  - General 80 people / jobs / ha
  - Mobility Hubs 120 people / jobs / ha

3. Problem Overview

The Case Study

The disconnect…





- More people more lot coverage per hectare
- Increasing requirement to infiltrate and manage runoff on-site

4. Detailed Analysis Assessment

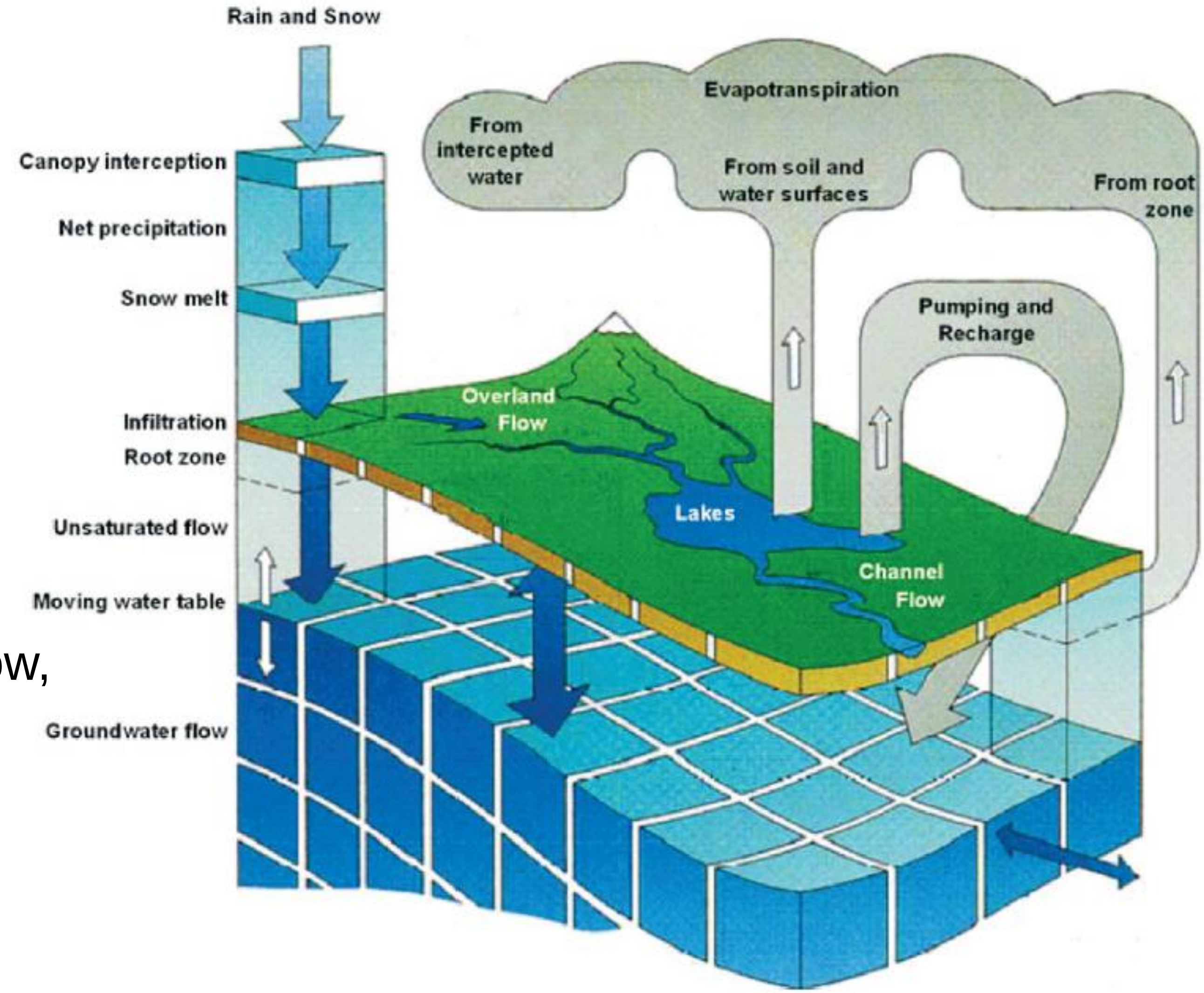
Numerical Representation – Subwatershed

MIKESHE Integrated Surface – Groundwater Model

Represent current conditions

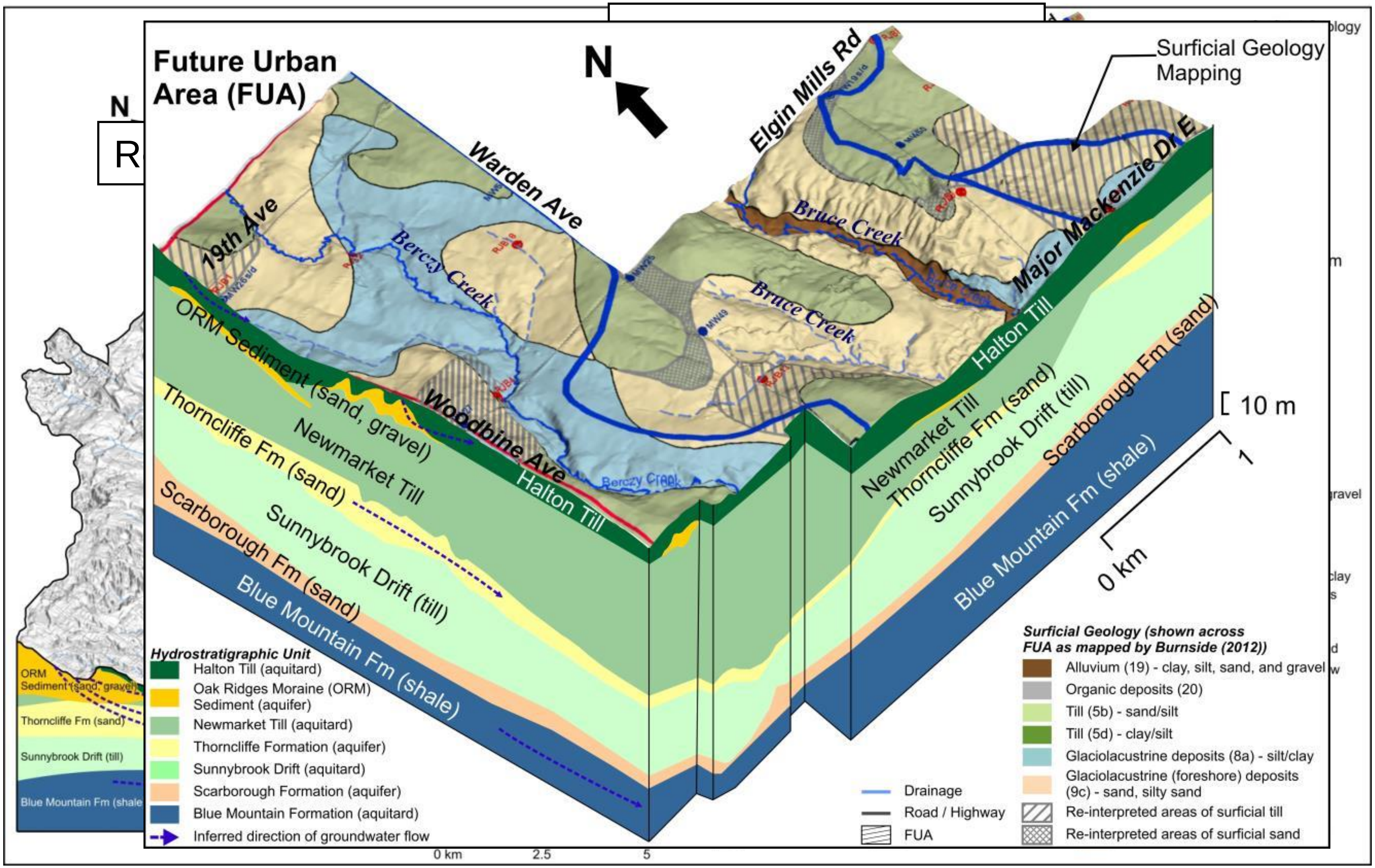
Spatial and temporal characteristics

Calibrated to streamflow, groundwater levels, ponded water



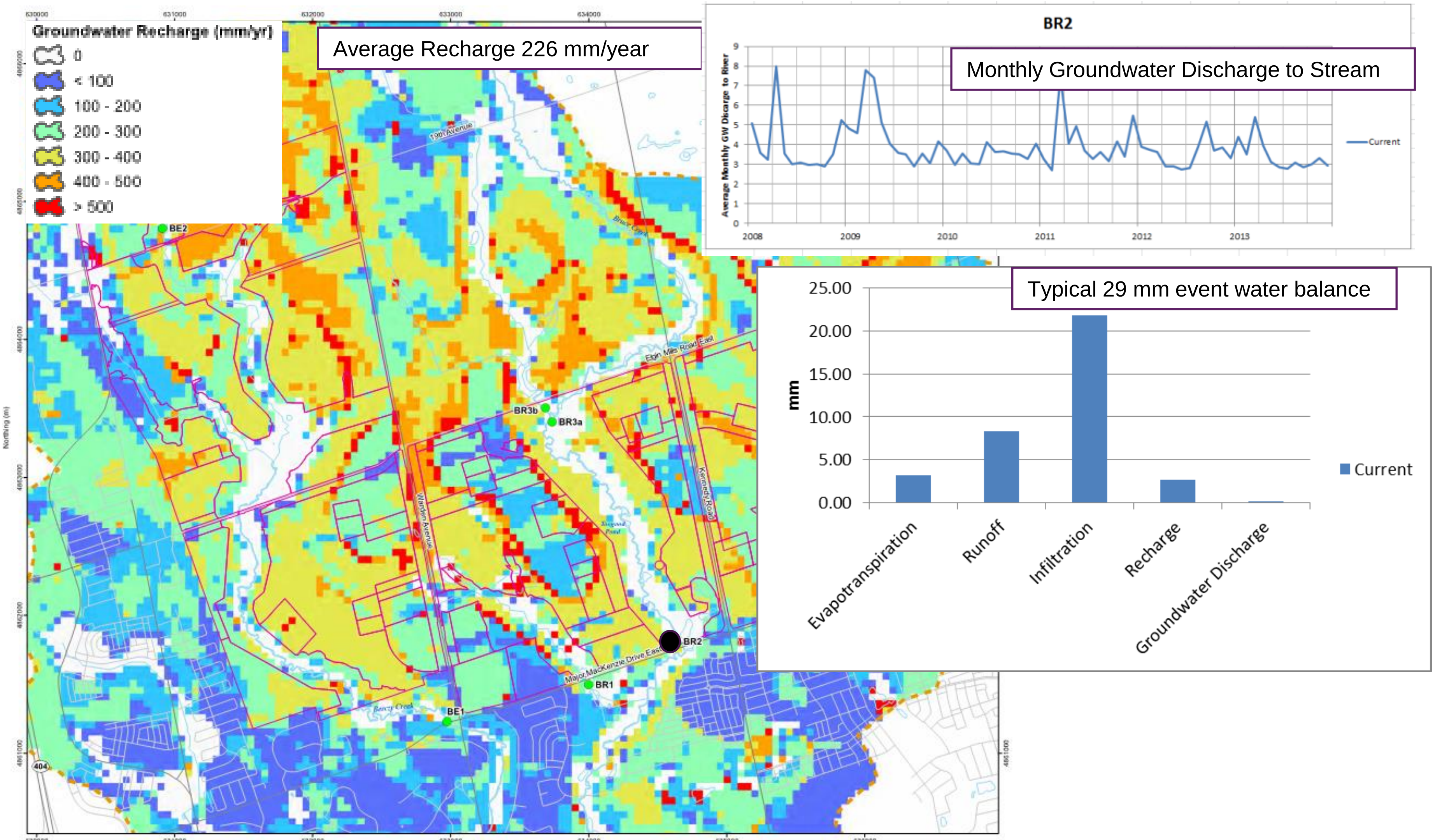
4. Detailed Analysis Assessment

Numerical Representation – Subwatershed



4. Detailed Analysis Assessment

Numerical Representation– Subwatershed



4. Detailed Analysis Assessment

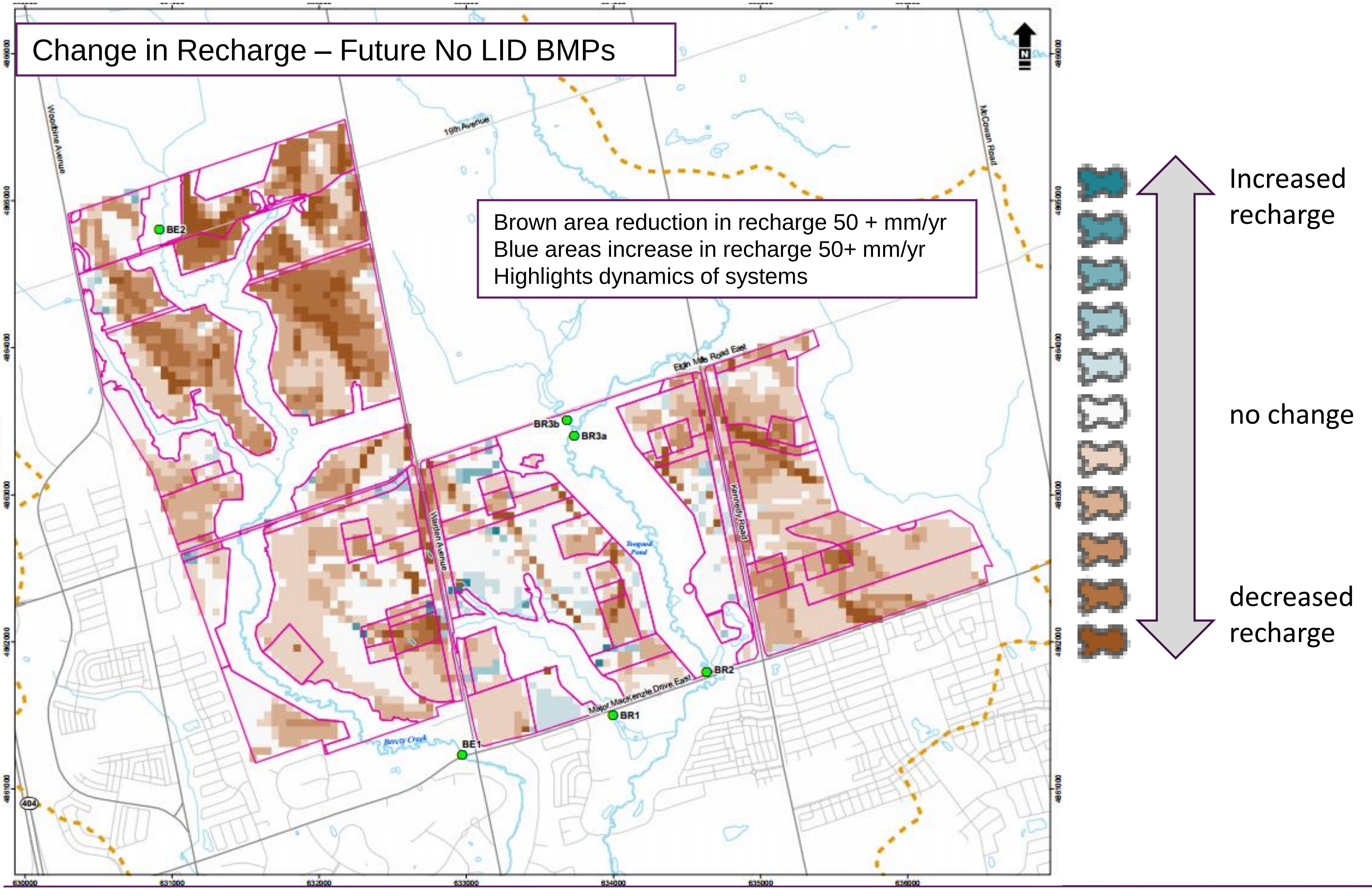
Capture/Retention Testing – Subwatershed

- **Identify strategies to maintain functional objectives based on understanding from existing conditions simulations**
- **Maps**
  - Change in depth to water
  - Change in groundwater discharge
  - Monthly flow plots.
- **Hydrographs showing influence on components of Water Balance**
  - Monthly and events
  - Flow duration curves

Represent future conditions by changing perviousness/direct runoff portion, vegetation, depression storage, roughness

4. Detailed Analysis Assessment

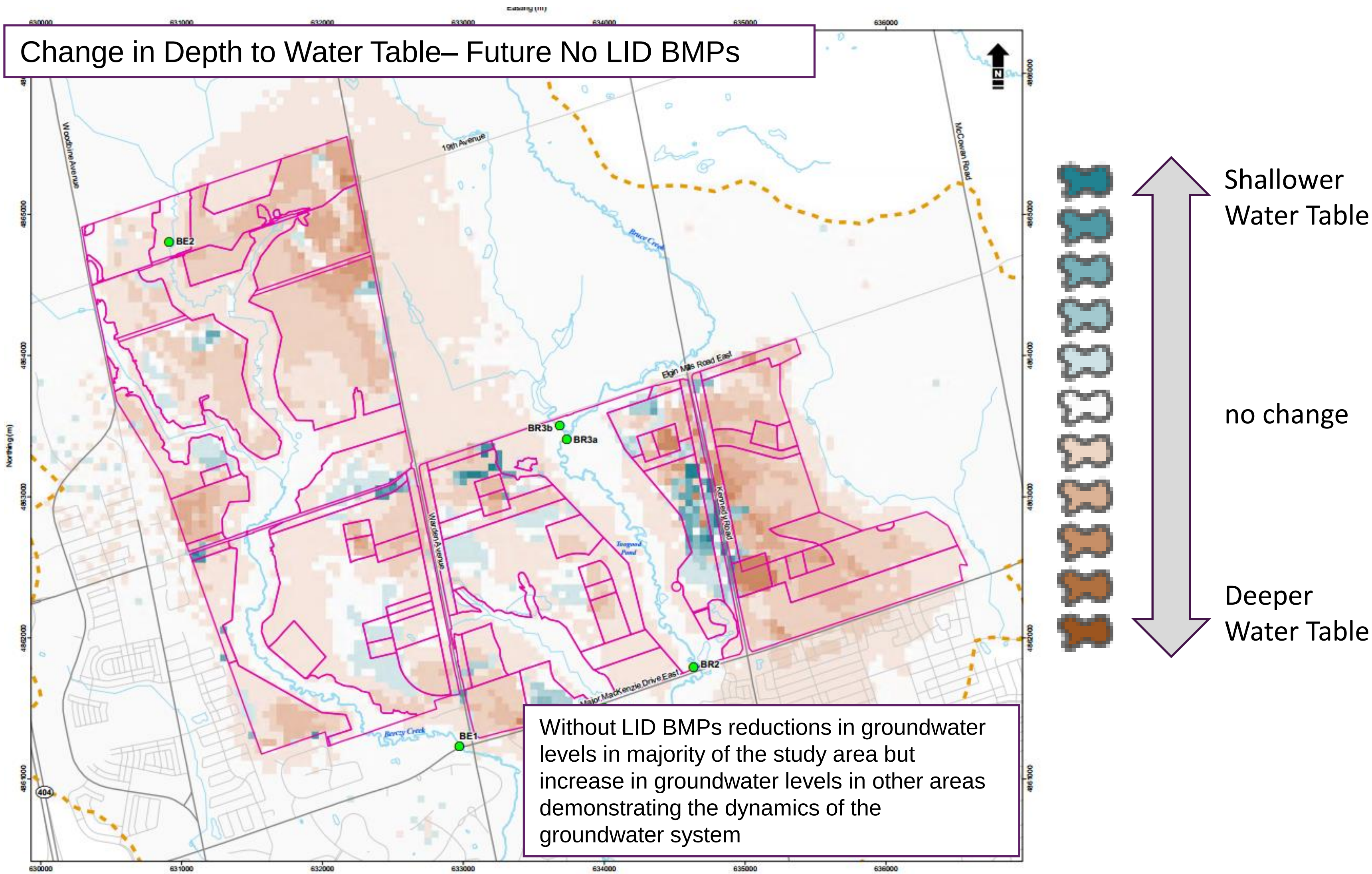
Capture/Retention Testing – Subwatershed



4. Detailed Analysis Assessment

Capture/Retention Testing – Subwatershed

Change in Depth to Water Table– Future No LID BMPs

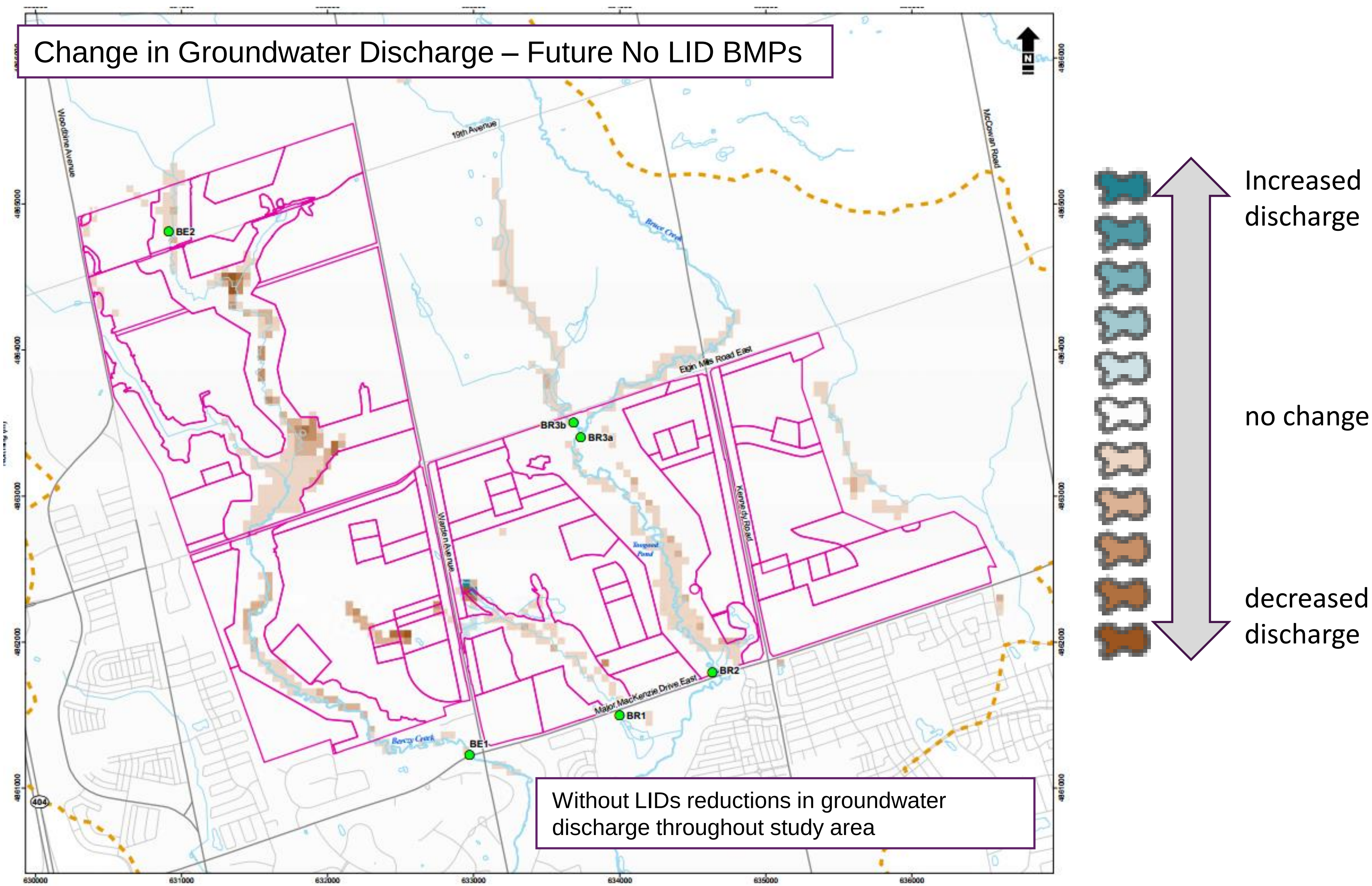


Without LID BMPs reductions in groundwater levels in majority of the study area but increase in groundwater levels in other areas demonstrating the dynamics of the groundwater system

4. Detailed Analysis Assessment

Capture/Retention Testing – Subwatershed

Change in Groundwater Discharge – Future No LID BMPs

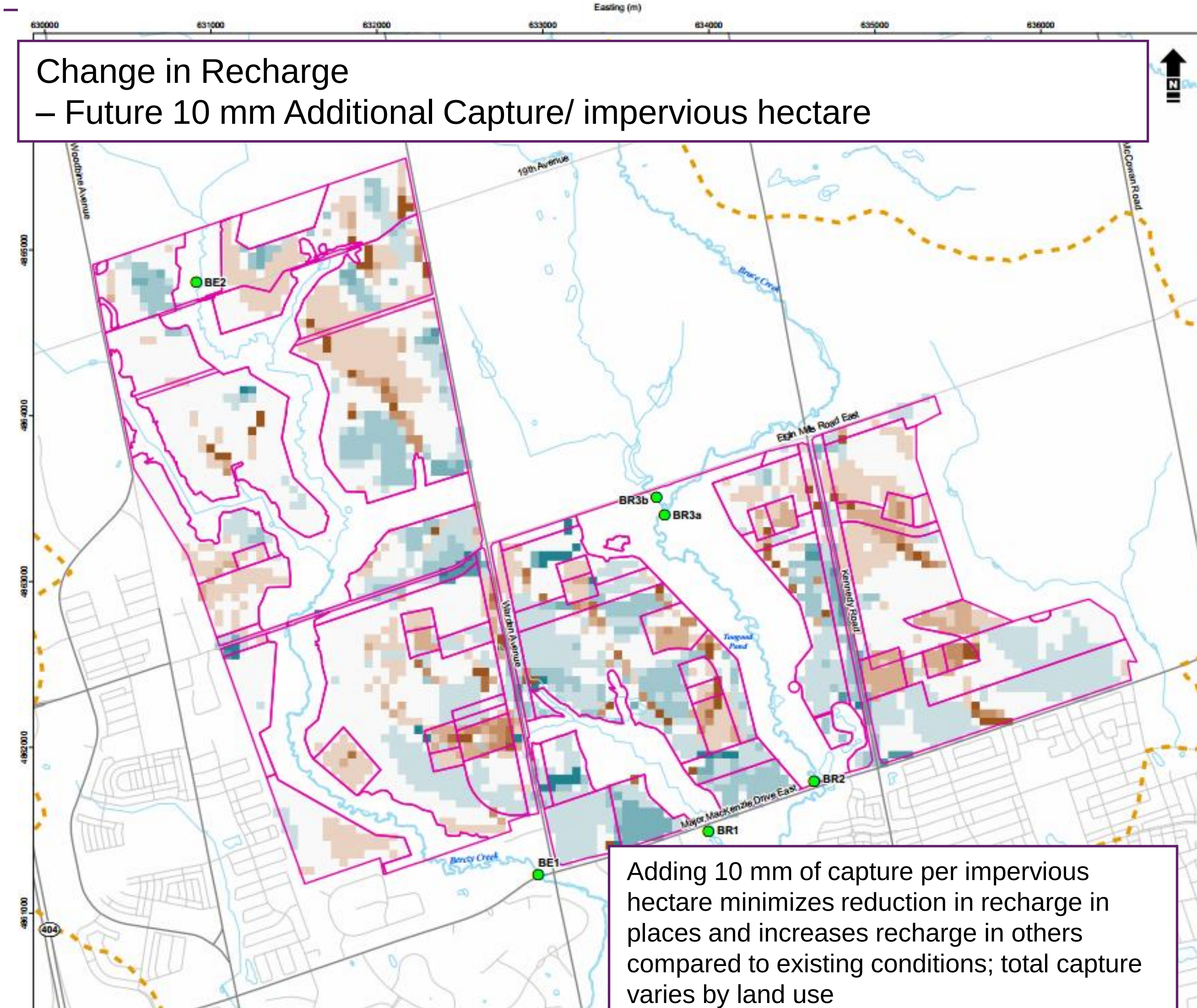


Without LIDs reductions in groundwater discharge throughout study area

4. Detailed Analysis Assessment

Capture/Retention Testing – Subwatershed

Change in Recharge
– Future 10 mm Additional Capture/ impervious hectare



Adding 10 mm of capture per impervious hectare minimizes reduction in recharge in places and increases recharge in others compared to existing conditions; total capture varies by land use

4. Detailed Analysis Assessment

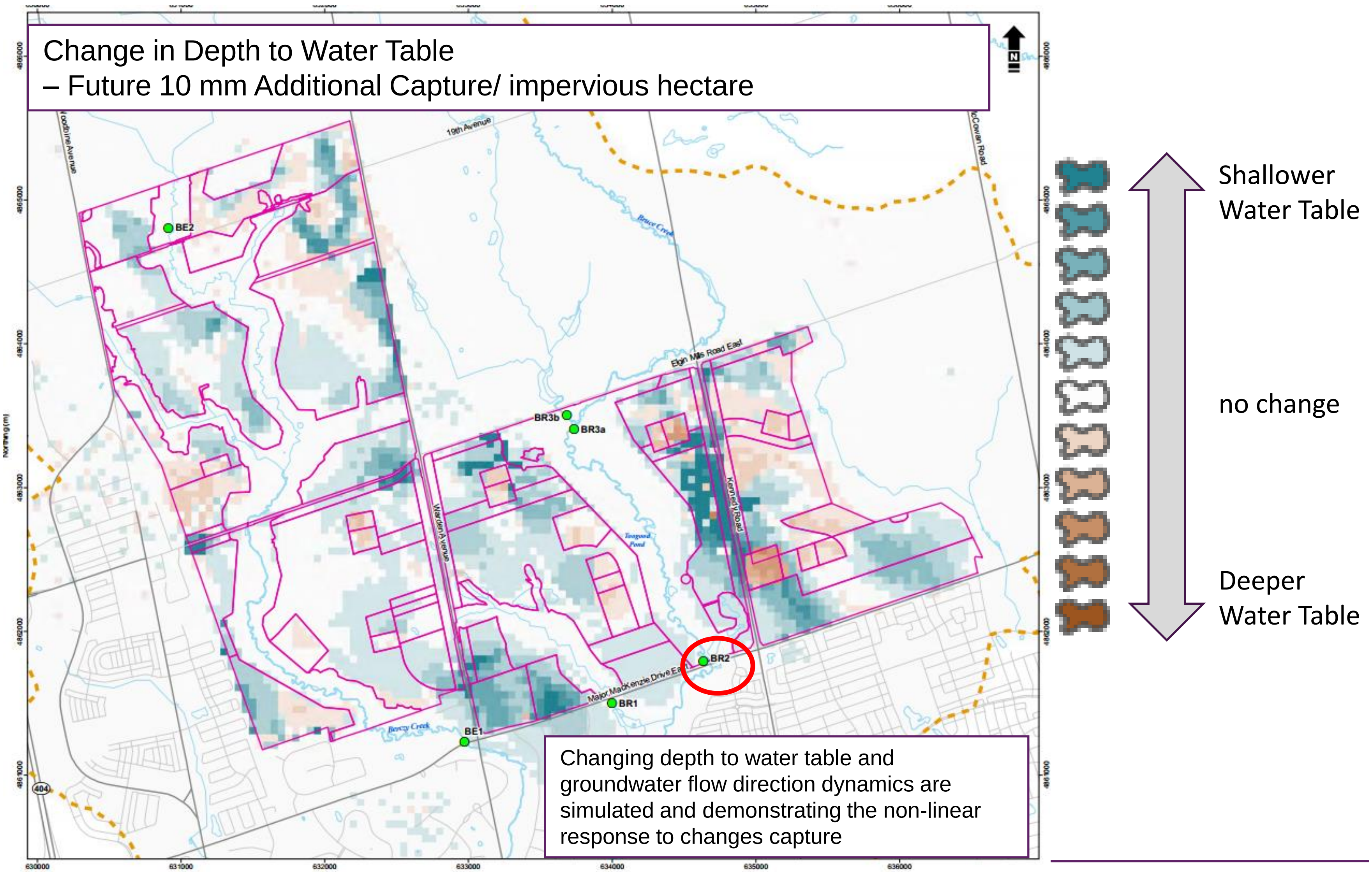
Capture/Retention Testing – Subwatershed

MARKHAM

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

amec foster wheeler

Change in Depth to Water Table
– Future 10 mm Additional Capture/ impervious hectare



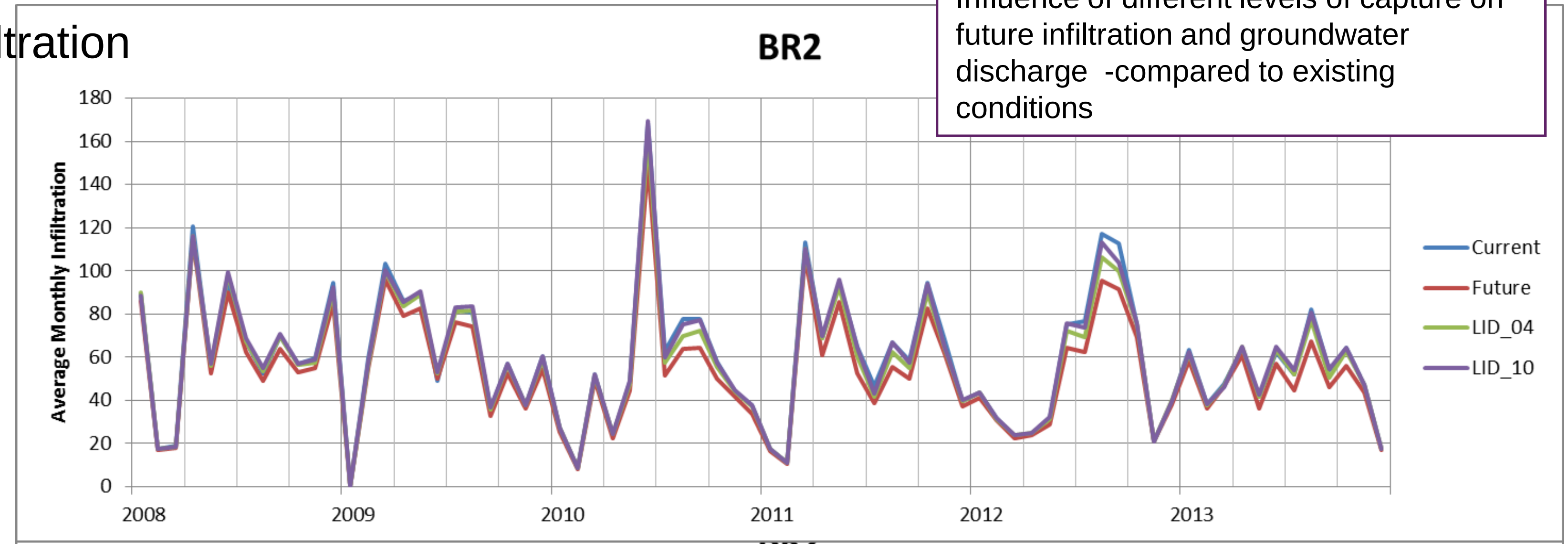
Changing depth to water table and groundwater flow direction dynamics are simulated and demonstrating the non-linear response to changes capture

4. Detailed Analysis Assessment

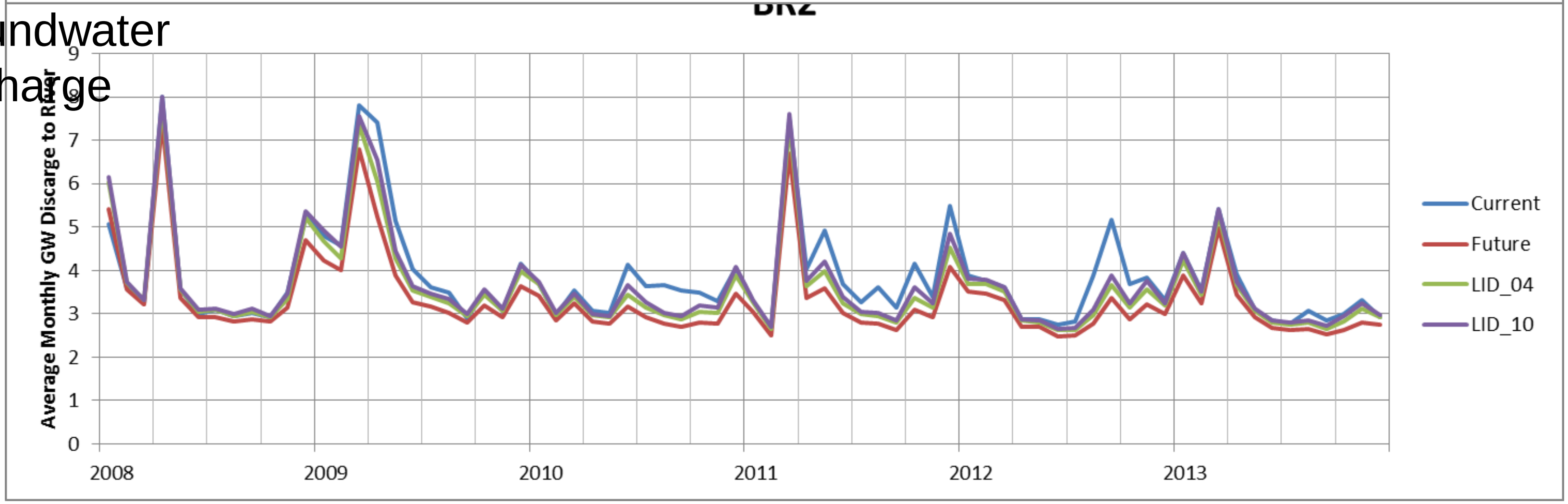
Capture/Retention Testing – Subwatershed

Influence of different levels of capture on future infiltration and groundwater discharge -compared to existing conditions

Infiltration



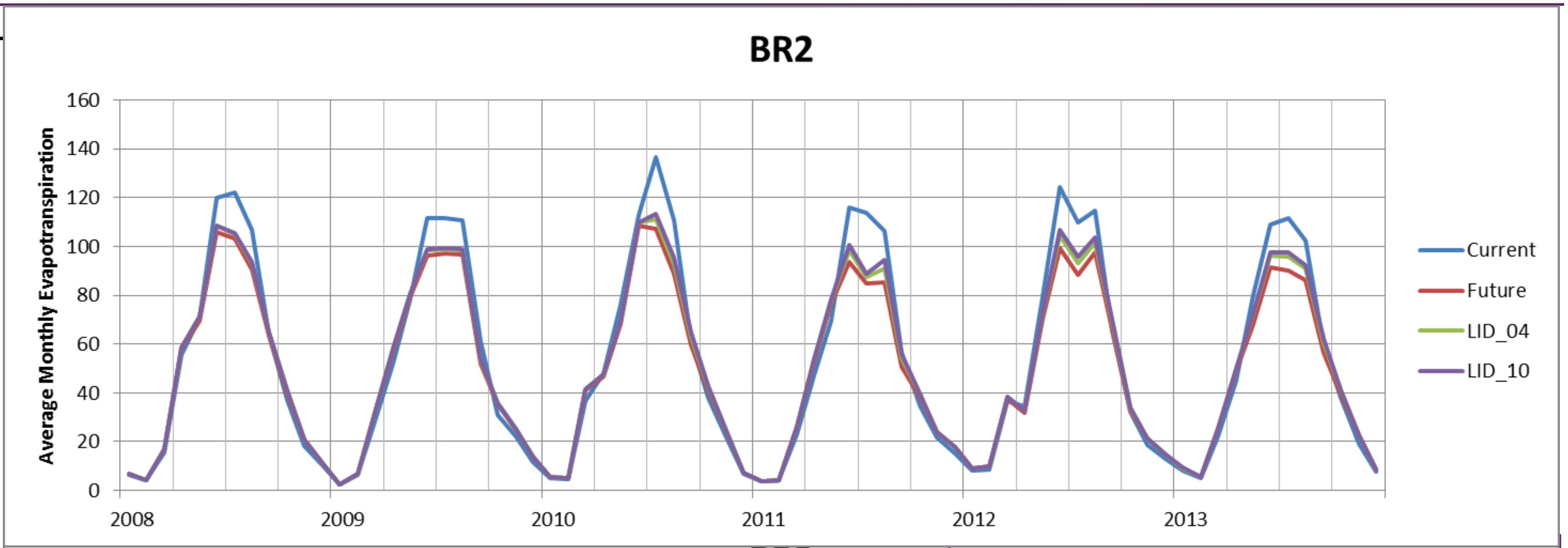
Groundwater Discharge



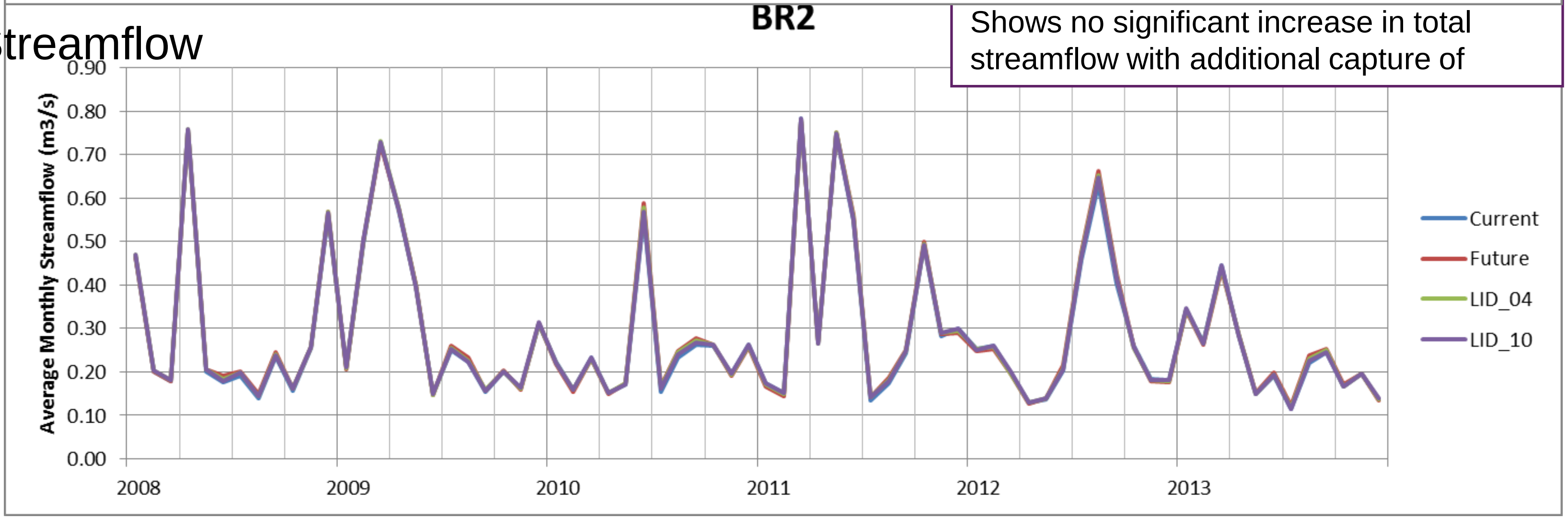
4. Detailed Analysis Assessment

Capture/Retention Testing – Subwatershed

ET



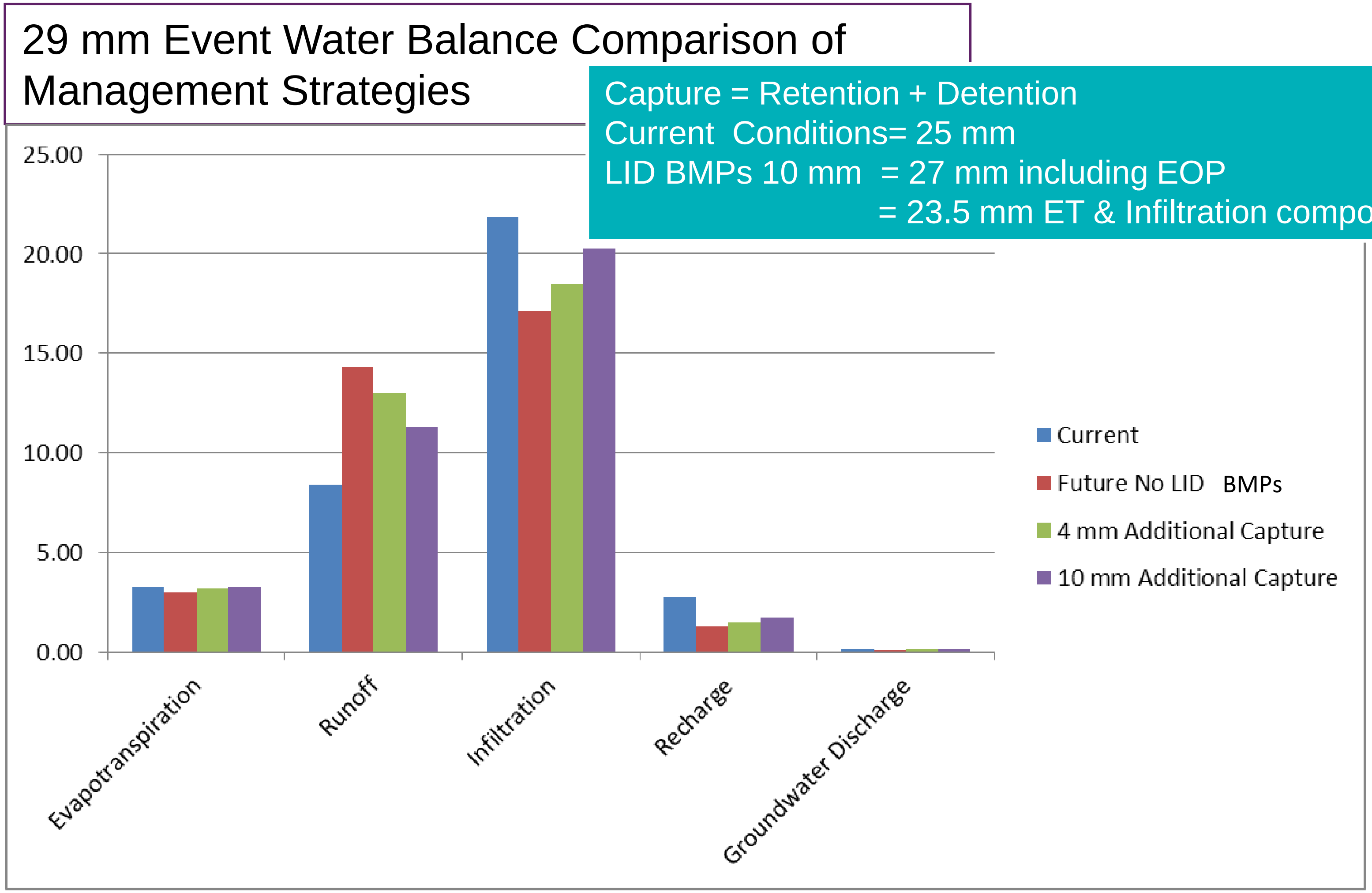
Total Streamflow



Shows no significant increase in total streamflow with additional capture of

4. Detailed Analysis Assessment

Capture/Retention Testing – Subwatershed



Capture = Retention + Detention
Current Conditions= 25 mm
LID BMPs 10 mm = 27 mm including EOP
= 23.5 mm ET & Infiltration components

5. Recommendations / Conclusions

What's Next?

1. Application of generic capture targets (i.e. 90 percentile) can lead to potential negative impacts
   - ► Recommend integrated surface / groundwater assessment for greenfield communities.

2. Increasing lot / land coverage is reducing available land for water / ground contact
   - ► Recommend strategic application of LID BMPs in most functional areas of the landscape.

3. Public Realm versus Private Realm application of LID BMPs
   - ► Recommend distinct strategies for each.

4. Study Scale considerations – Top down guidance
   - ► More Modelling and field work required at site scale