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HOSTS

Toronto and Region Conservation for The Living City

IECA Great Lakes Chapter

From bogs to marshes, creating the right water balance for a wetland feature

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Toronto and Region Conservation for The Living City

Introduction

Presentation Outline

- Give some background on wetland water balance
- Explain the key steps in completing a wetland water balance
- Discuss design considerations
- Provide some examples through case studies

Key Messages

Collaborative Process

Wetland water balance is an interdisciplinary process involving ecologists engineers and hydrogeologists.

Understand the wetland

You need to understand how water gets to the wetland, how much water it needs, where it needs it and when.

Timing is key

Determining the right quantity of water is important and the timing of delivery is key.

Background

Definition

Hydrology is a key factor that determines a wetland's ecological composition, structure and function.

Potential Effects of Non-Action

If hydrology is not considered through the development process, the wetland's groundwater or surface water flows will likely be altered leading to:

- A community shift either to a drier wetland type or even a shift to an upland community.
- A community shift to a wetter open water aquatic community or total inundation of the wetland.

Background

1	HOW?	EXISTING CONDITIONS
2	HOW MUCH?	WATER QUANTITY
3	WHERE?	OUTLET LOCATION
4	WHEN?	SEASONALITY OF WATER INPUTS

Understand the Wetland

1 **HOW?**

Location in the watershed
Isolated, palustrine, riverine and lacustrine

Inputs

- surface water
- groundwater

→ storage capacity →

Outputs

- surface water
- evapotranspiration
- groundwater

Wetland Water Balance Equation

Change in Storage = Inputs – Outputs

$\Delta S = P + S_i + G_i - ET - S_o - G_o + \text{residual}$

S = Storage
P = Precipitation
S_i = Surface water inflows
G_i = Groundwater inflows
ET = Evapotranspiration
S_o = Surface water outflows
G_o = Groundwater outflows

Understand the Wetland

2 **HOW MUCH?**

Surface Water Monitoring Stations

- ▲ Level Sensor (LS)
- ● Mini-piezometer Nest (PZ)
- ■ CEG Streamflow Monitoring Station (SF)
- ▲ **Existing Wetland Monitoring Station**

Understand the Wetland

3 **WHERE?**

Primary Consideration

The outlet location needs to consider the site topography. Flows should be directed so they outlet in a similar location as they would have predevelopment.

- If the wetland received sheet flow, several outlets along the receiving side may be needed.

Secondary Consideration

Outlet type should be designed based on how the wetland received flows predevelopment.

- Subsurface flows should be promoted using infiltration techniques.
- Surface flows should be directed through surface water LIDS.

Timing is key

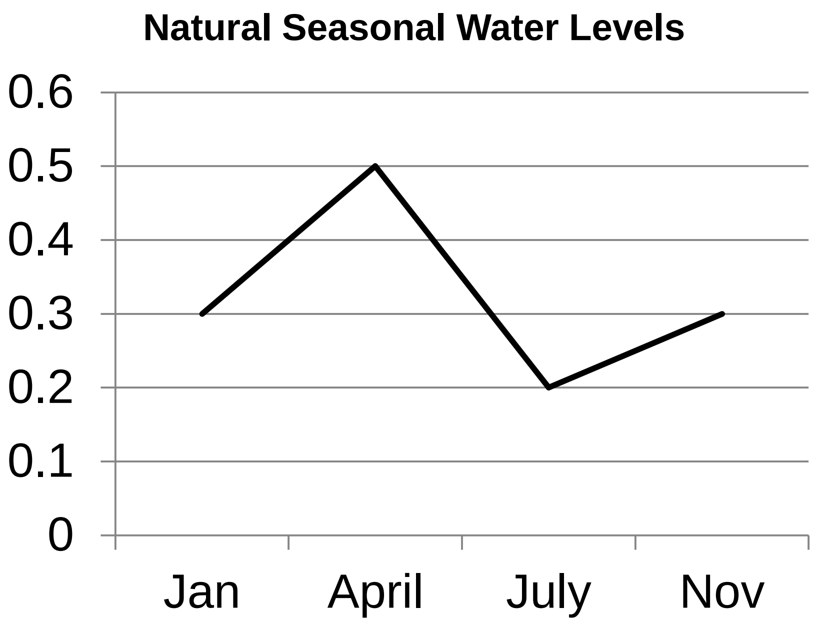
4 **WHEN?**

sending water without mitigation

increased runoff
reduced evapotranspiration

effects on the wetland

higher summer water levels
increased water level fluctuations



Timing is key

4 **WHEN?**

"Water level fluctuation is perhaps the best single indicator of wetland hydrology, because it integrates nearly all hydrologic factors." (Reinelt and Taylor, 2000)

Increased water level fluctuations

- Increase in invasive or aggressive plant species
- Decreased plant diversity
- Loss of rare species
- Decreased amphibian species richness

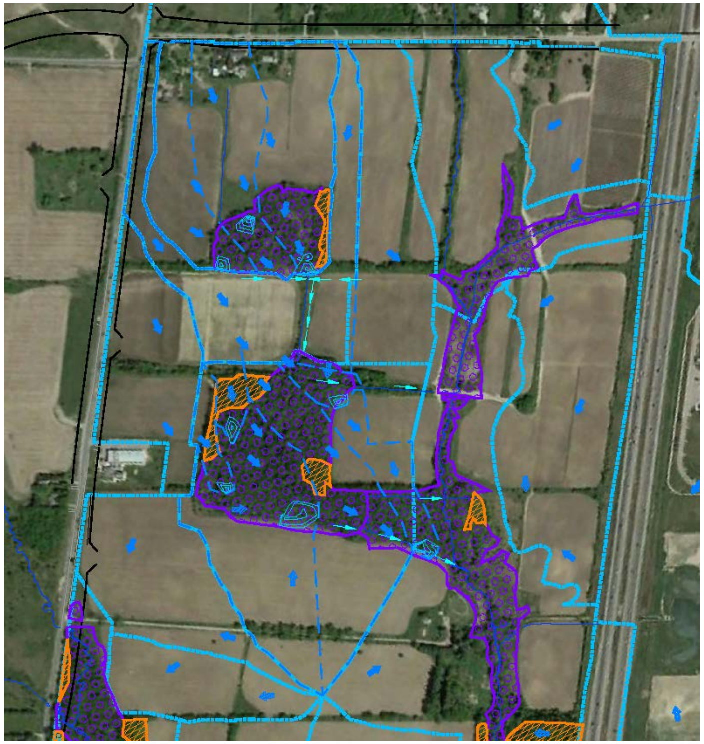
Design

1	HOW?	DIRECT CLEAN RUNOFF COLLECT CLEAN WATER
2	HOW MUCH?	TO SUPPORT WETLAND FUNCTION
3	WHERE?	OUTLET/LID LOCATION
4	WHEN?	DESIGNING LIDS TO MATCH HYDRO-PERIODS

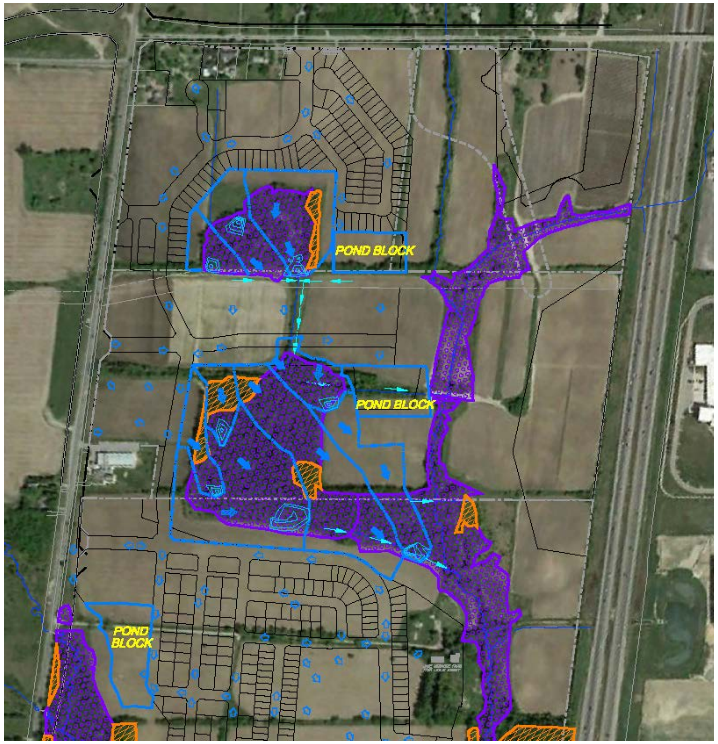
Design Example 1

Richmond Hill Wetland

Existing Conditions



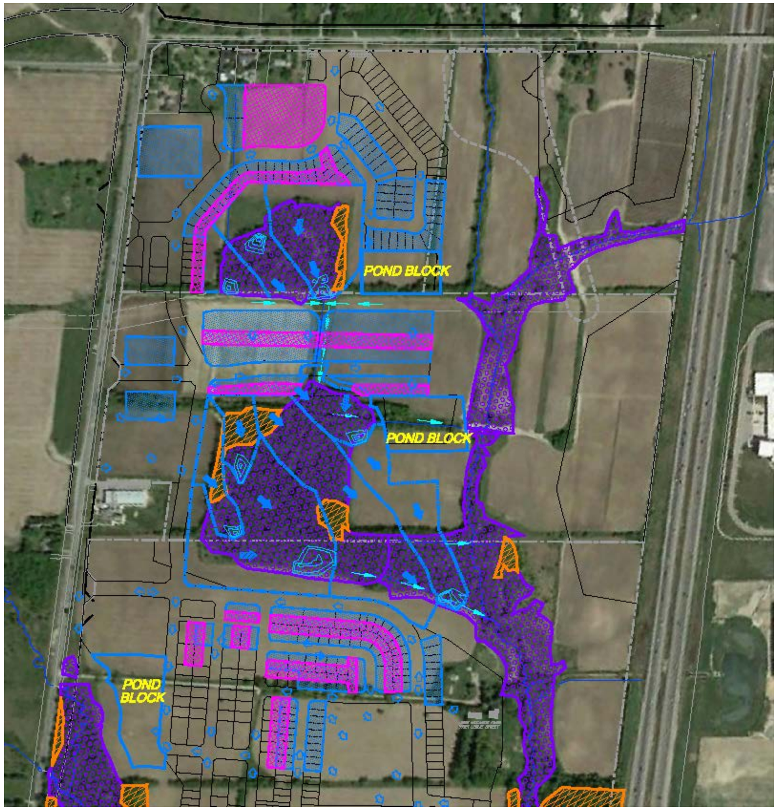
Post – development Conditions



Design Concepts

1 **HOW?**

- Pervious Areas
  - Surface runoff directly to wetland
  - Runoff captured using RLCBs or DICBs to Clean Water Collector (CWC)
- Impervious Area
  - Rooftops connected to CWC



Design Concepts

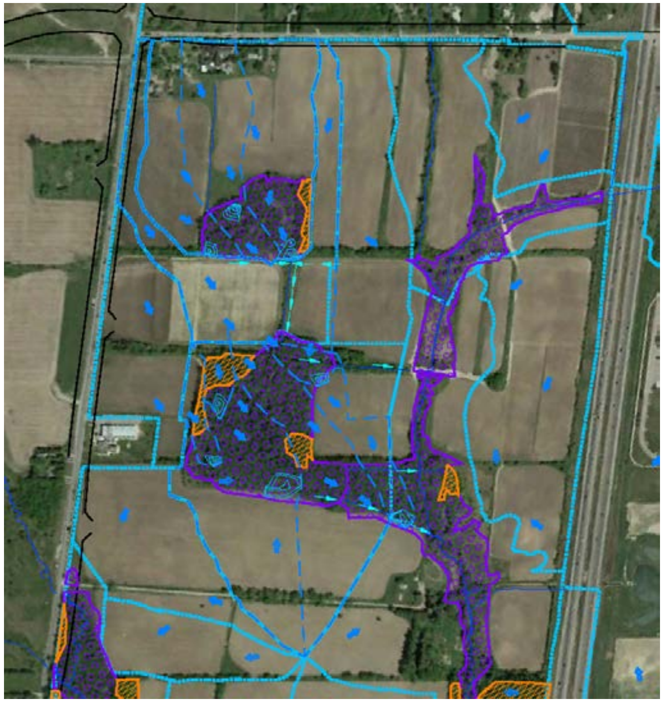
2 HOW MUCH?

- POST-DEVELOPMENT AREA ≠ EXISTING AREA
- TO MUCH WATER MAY BE AS BAD AS TO LITTLE WATER
- MAKE THE DESIGN FLEXIBLE

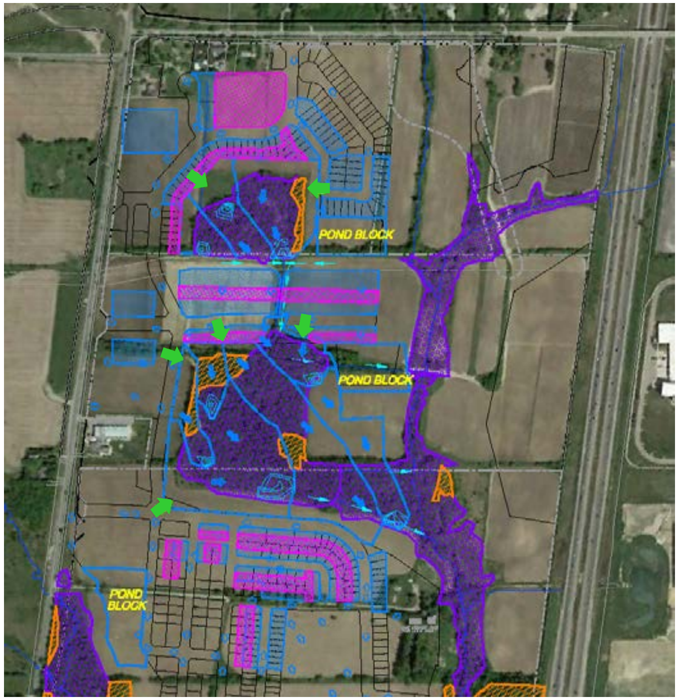
Design Example

3 **WHERE?**

Existing Drainage Area



Post – development Drainage Area



Design Concepts

4 **WHEN?**

Changes in the systems reaction to a rainfall event are due to:

- A reduction of depression storage
- A reduction in infiltration
- A reduction in evapotranspiration

The effects are more pronounced for more impervious contributing areas.

Design Concepts

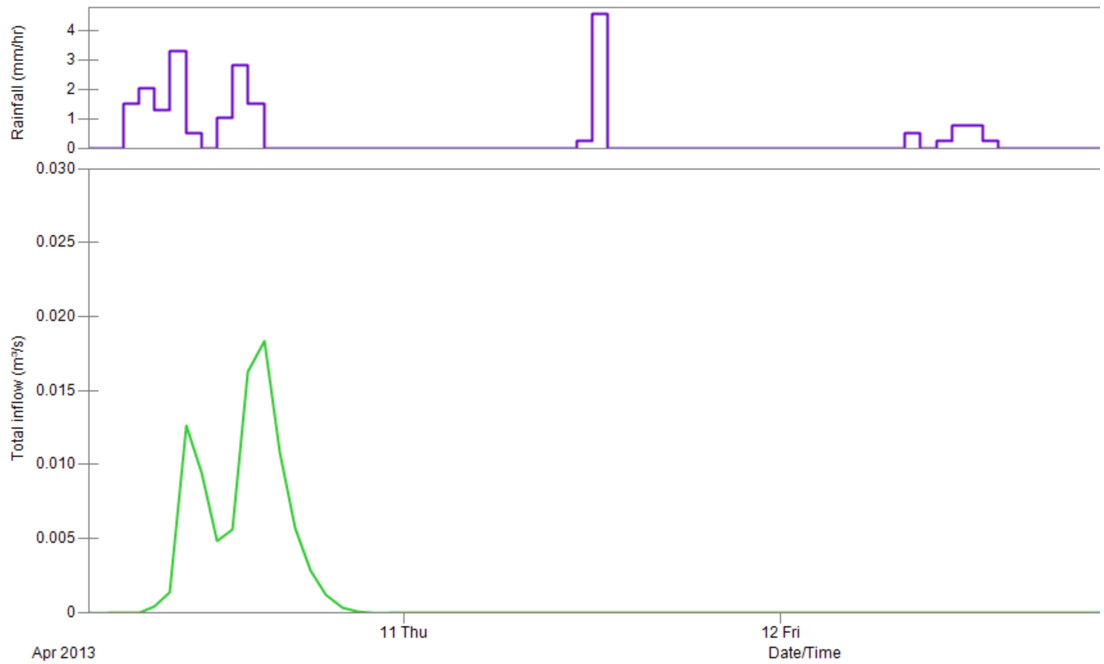
4 **WHEN?**

Existing

Qmax = 20.5 L/s,

Volume = 424 m^3

14 mm rainfall 4.8 mm rainfall 2.5 mm rainfall



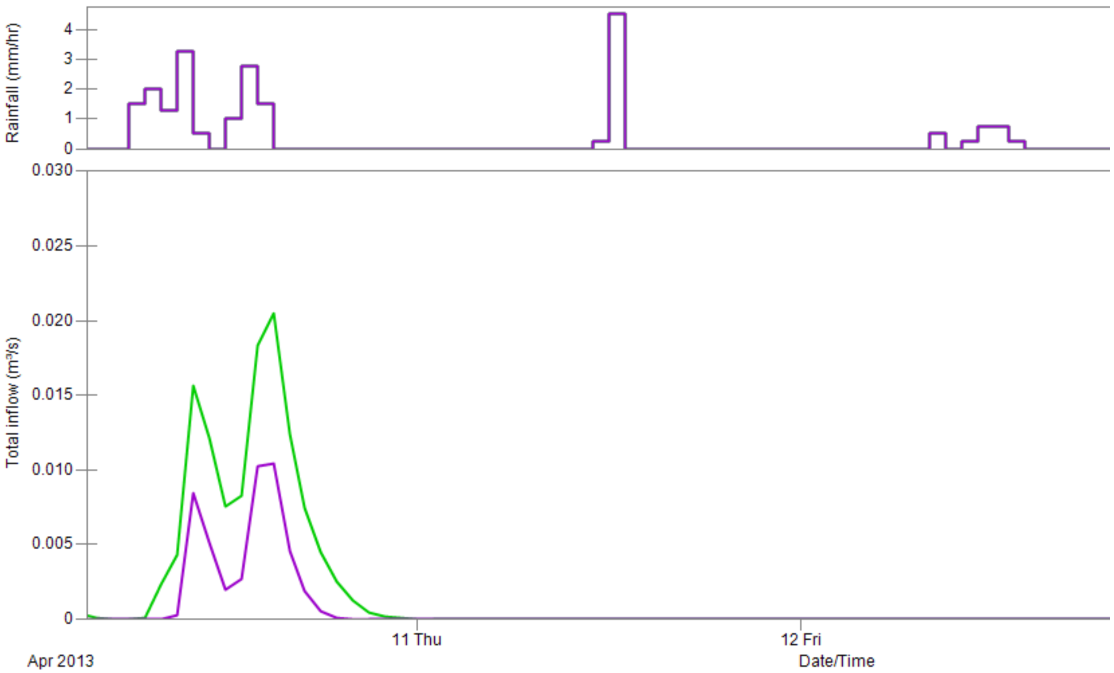
Design Concepts

4 **WHEN?**

Existing
Qmax = 20.5 L/s,
Volume = 424 m^3

Post-dev.
Qmax = 10.4 L/s,
Volume = 165 m^3

14 mm rainfall 4.8 mm rainfall 2.5 mm rainfall



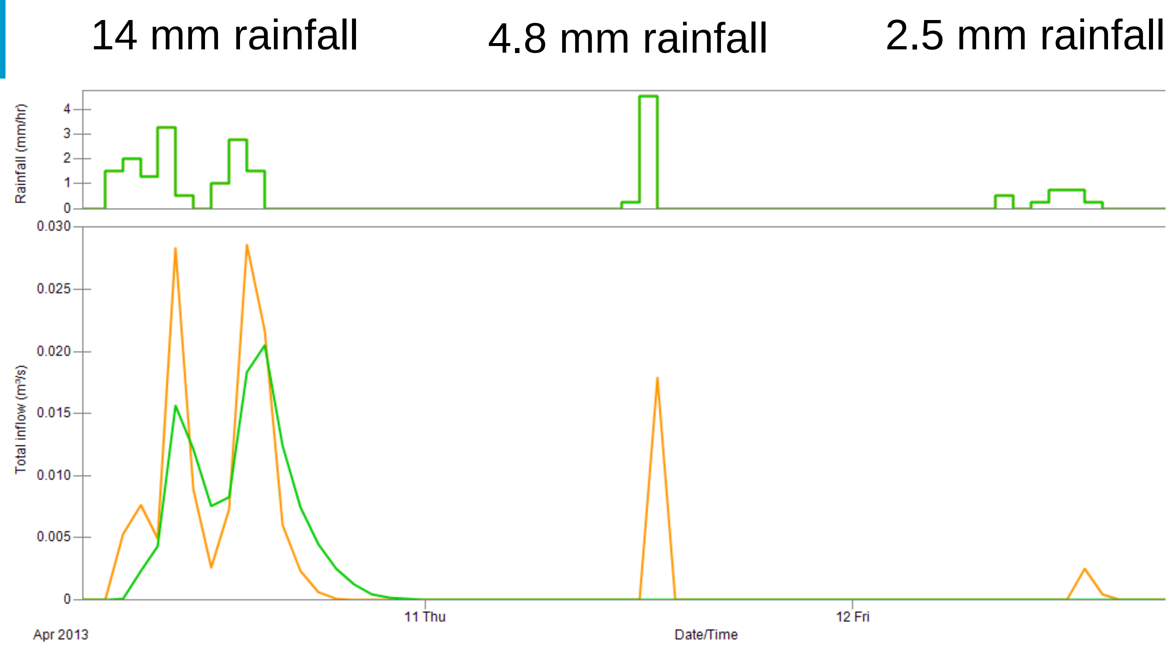
Without mitigation the post development hydrograph shows a reduction in peak flows and runoff volumes

Design Concepts

4 WHEN?

Existing
Qmax = 20.5 L/s,
Volume = 424 m^3

Mitigation
(No LIDs)
Qmax = 28.7 L/s,
Volume = 522 m^3



If water augmentation is provided without LIDs post-development hydrographs show:

- Additional runoff for smaller more frequent rainfall events
- Higher peak flows with shorter duration for larger storm events.

Design Concepts

4 **WHEN?**

Existing

Qmax = 20.5 L/s,

Volume = 424 m^3

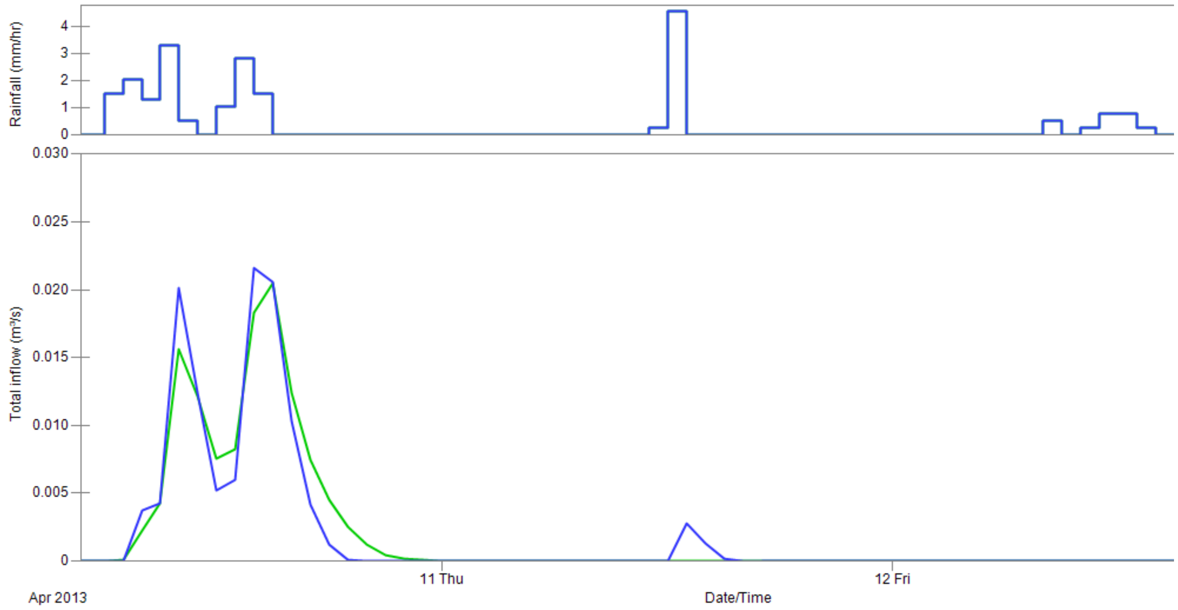
Mitigation

(With LIDs)

Qmax = 21.7 L/s,

Volume = 409 m^3

14 mm rainfall 4.8 mm rainfall 2.5 mm rainfall

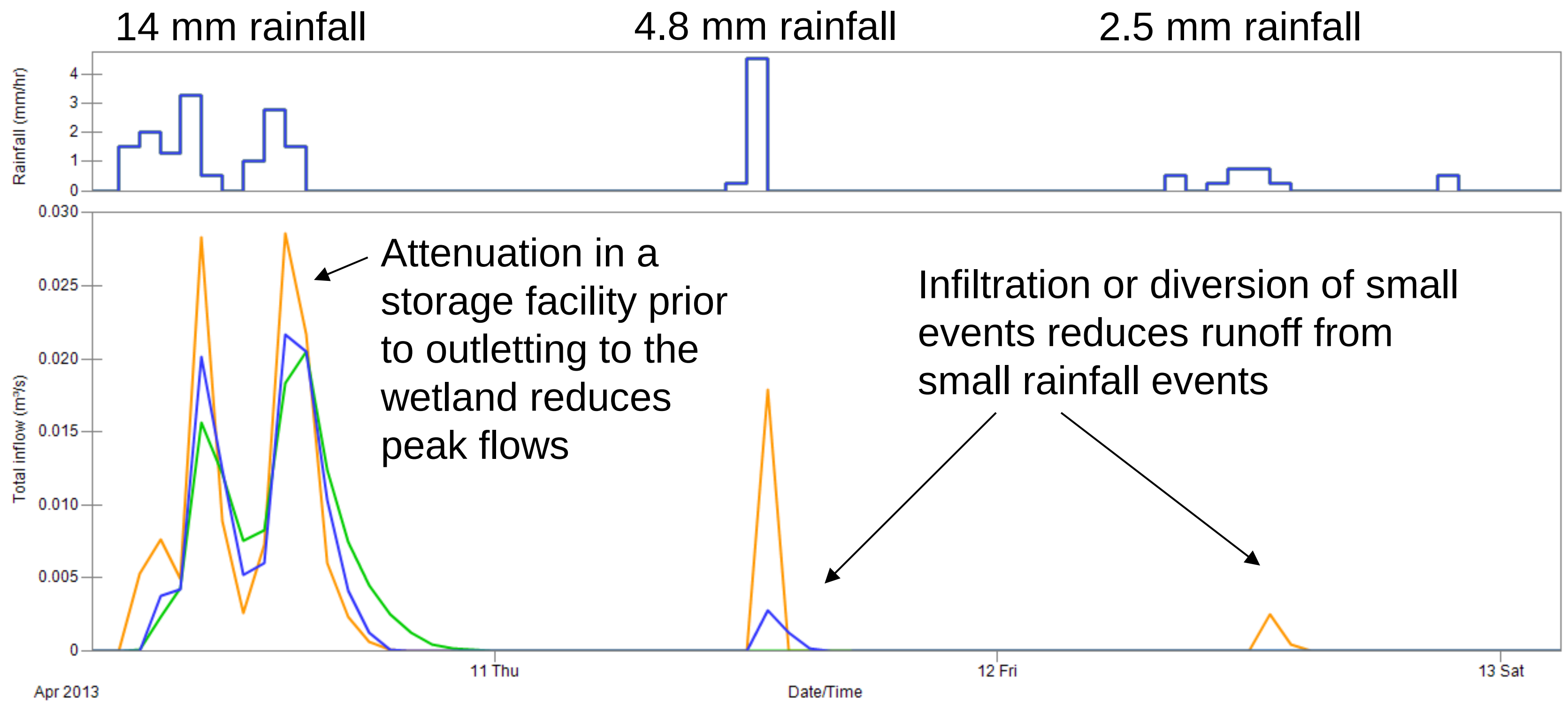


With an LIDs buffering the contributing flows:

- Additional runoff from small storm events is reduced
- Hydrographs for larger events more closely match existing conditions

Design Concepts

4 WHEN?



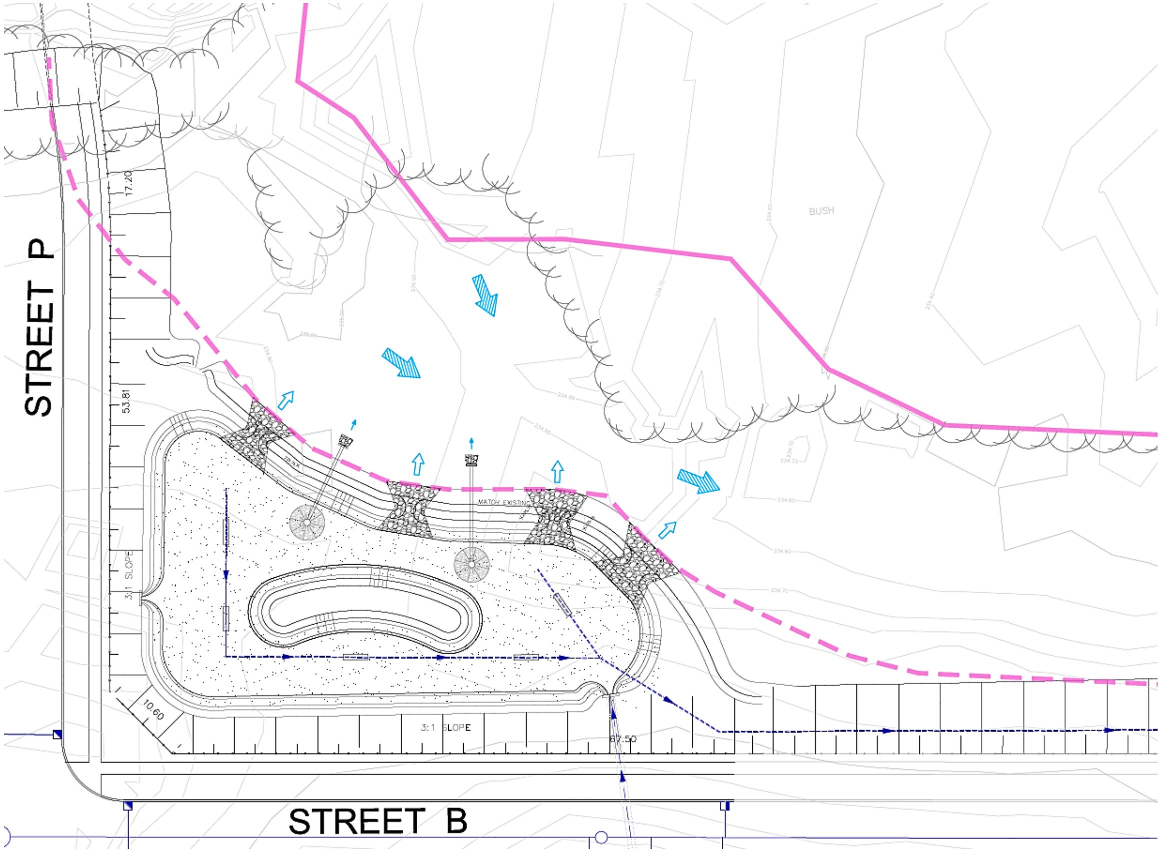
LID Design

Sizing LIDs

- Volume to Infiltrate or re-direct (Typically < 10mm)
- Peak flow control (Focus on 10mm – 25mm events)
- If possible provide an overflow away from the wetland for larger (> 5yr) events.

LID Design

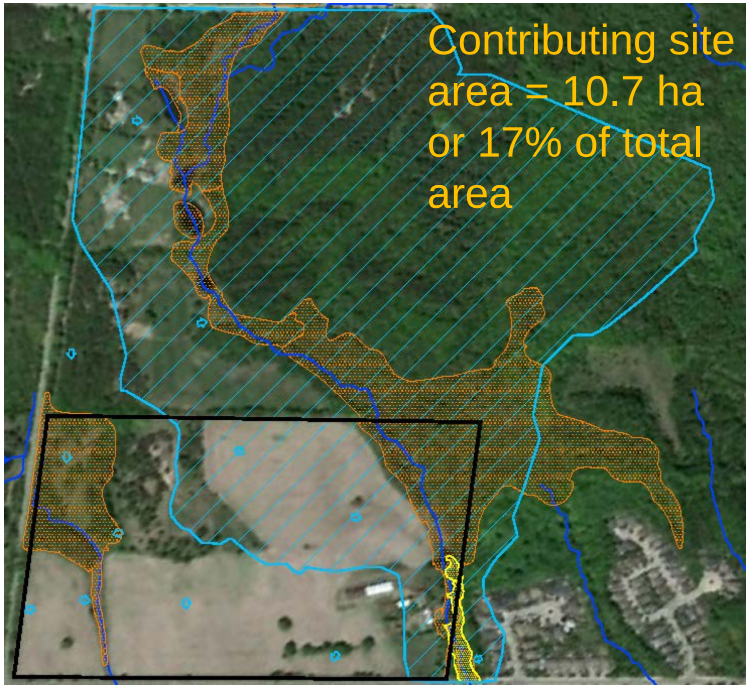
Richmond Hill Wetland

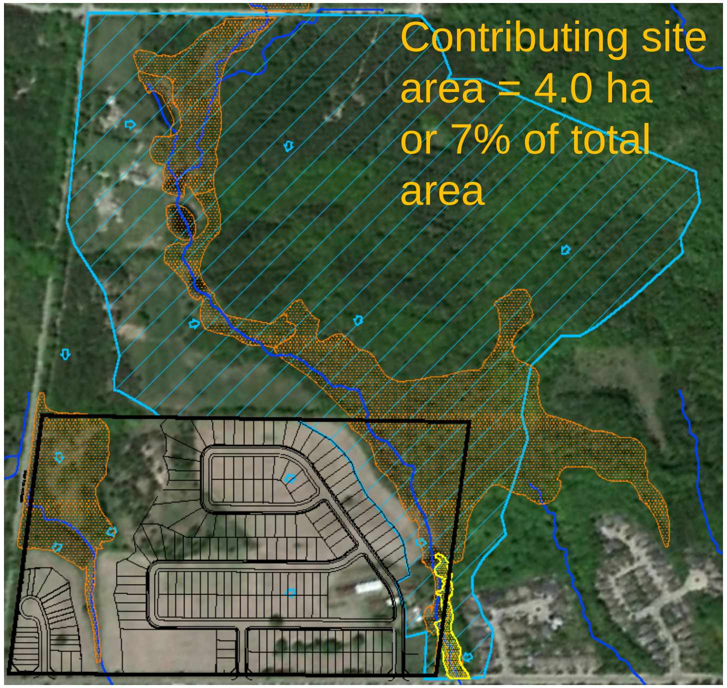


Design Example 2

Caledon Wetland

Existing Drainage Areas





Total area to wetland = 62.7 ha

Total area to wetland = 56.1 ha (10.6% reduction)

Design Example 2

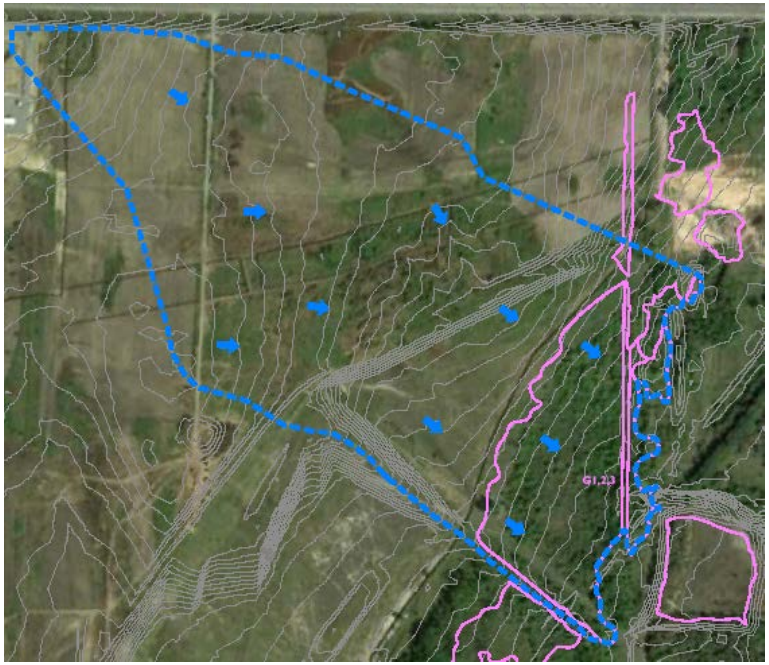
Caledon Wetland

1	HOW?	RIPARIAN WETLAND – WATER FROM THE CREEK FEEDS THE WETLAND
2	HOW MUCH?	CONTRIBUTING DRAINAGE AREA IS REDUCED BY **10.6%**
3	WHERE?	SITE CONTRIBUTES RUNOFF TO THE WETLAND ON THE WEST BANK OF THE CREEK
4	WHEN?	STREAM HAS BASE FLOW - CONTRIBUTIONS ARE CONTINUOUS BUT HIGHER IN THE SPRING AND AFTER A LARGE STORM

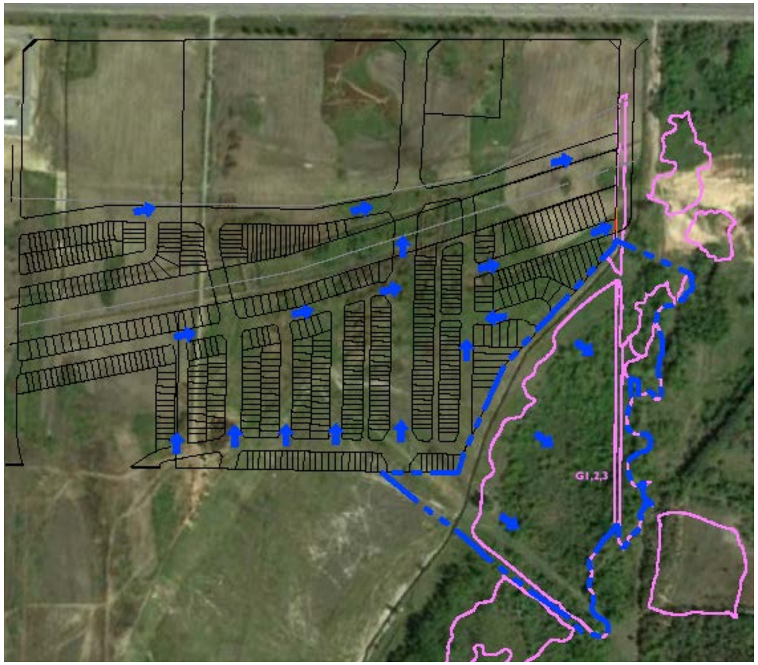
Design Example 3

Pickering Wetland

Existing Drainage Areas



Post – development Drainage Areas



Design Example 3

Pickering Wetland

1. **HOW?** → SURFACE WATER CONTRIBUTIONS ARE SHEET FLOW FROM ADJACENT FARMLAND

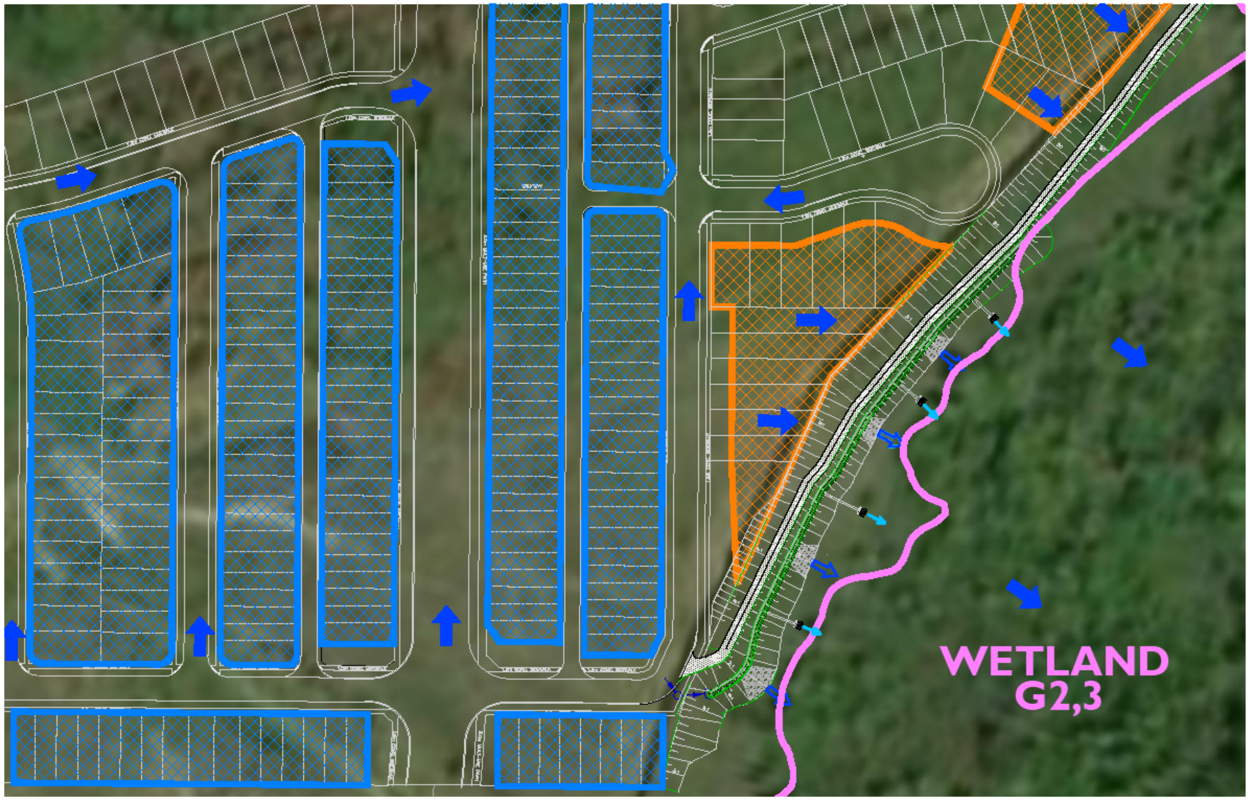
2. **HOW MUCH?** → CONTRIBUTING DRAINAGE AREA IS REDUCED BY 74%

3. **WHERE?** → WATER CONTRIBUTIONS ARE ALONG THE WESTERN BORDER OF THE WETLAND

4. **WHEN?** → MONITORING DATA SHOWS NO RUNOFF FOR EVENTS < 7 MM

LID Design

Pickering Wetland



Lessons learned

- Collaborate EARLY in the process;
- Initiate field work in the early stages of planning;
- Keep the water balance as simple as possible;
- Check your monitoring data frequently;
- Understanding the uniqueness of the wetland
  - HOW?
  - HOW MUCH?
  - WHERE?
  - WHEN?

QUESTIONS?