About Me (Tim Rodgers)

- Postdoctoral Fellow with Prof. Amanda Giang in IRES
- Undergrad - University of Waterloo Environmental Engineering (2016)
- Graduate – UofT Chemical Engineering
  - Began my MASc. in 2016
  - Switched to a PhD, graduated in 2021
- Research – chemicals transport & fate
  - Particular interest in contaminant transport through stormwater
  - Publications under: Timothy F. M. Rodgers

Carbon Neutral Infrastructure Biodiversity and Infrastructure (Healthy Environments)

Tim Rodgers

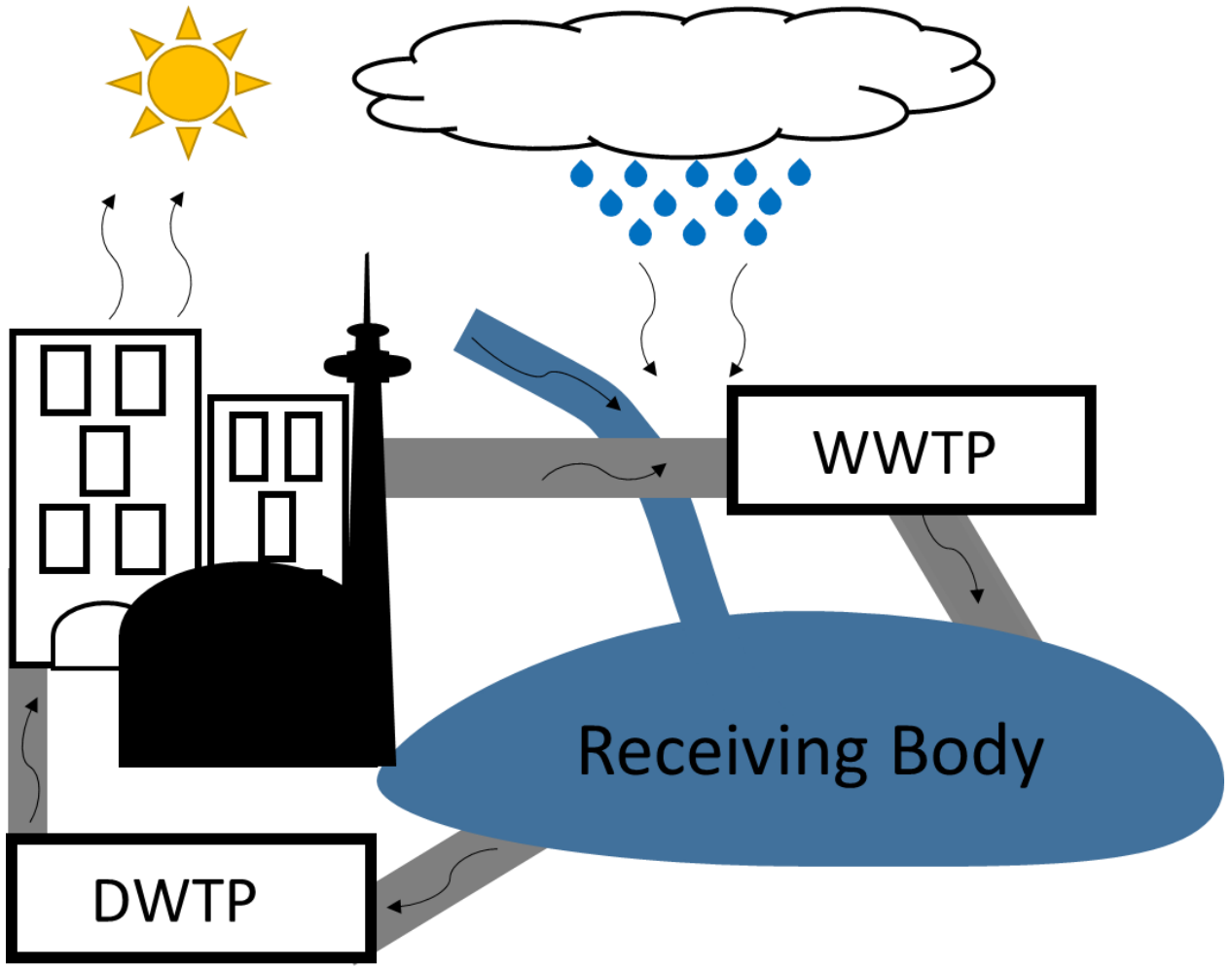
Postdoctoral Fellow, IRES

Outline

- Urban Water Cycles
- Traditional Approach
- Green Infrastructure (GI) /Low Impact Development (LID)
- Activity: Traditionalists vs LIDers
- Recap & Discussion

Urban Water Cycles

- Wastewater
  - People & industry produce a lot of waste
    - Cholera, E.Coli (Walkerton)
- Stormwater Runoff
  - Quantity & Quality



Traditional Approach: Urban Water as a Nuisance

Iona Island Treatment Plant

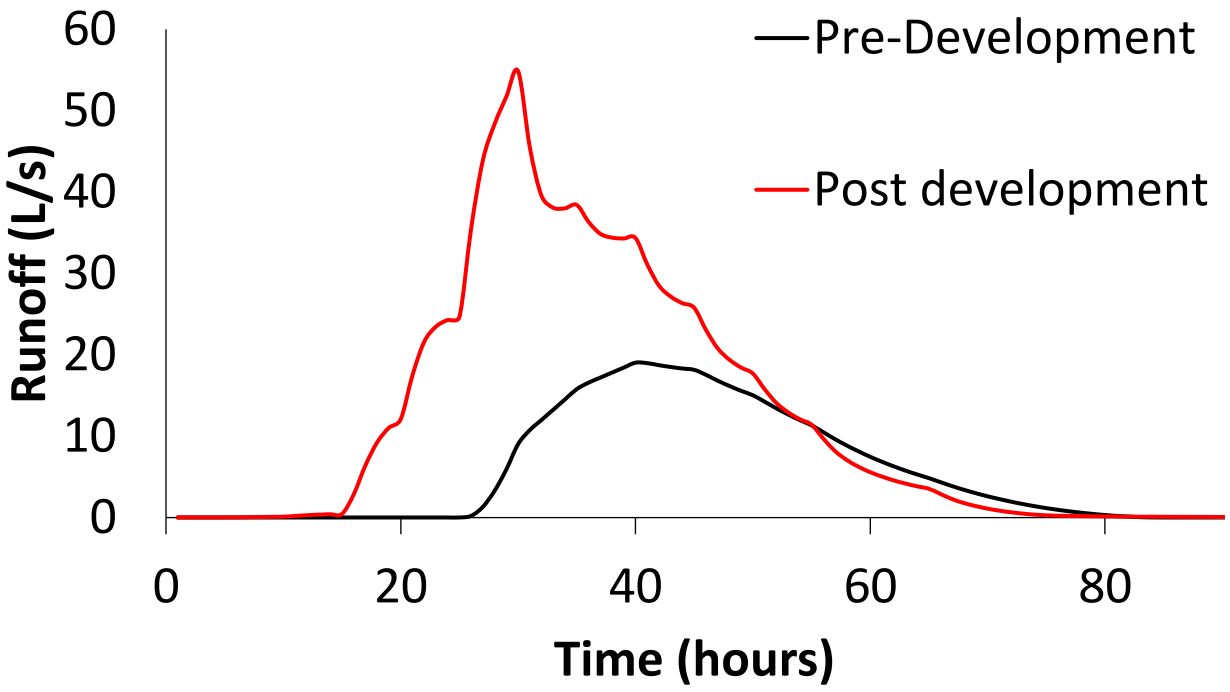
https://thetyee.ca/News/2020/08/20/Metro-Vancouver-Sewage-Plant-Upgrade/

https://2nct6h8fx1w308av73hxfvhl-wpengine.netdna-ssl.com/wp-content/uploads/2019/09/d-F-storm-drains.jpg

https://upload.wikimedia.org/wikipedia/commons/thumb/1/10/False_Creek_2018.jpg/1200px-False_Creek_2018.jpg

Problems with the Traditional Approach

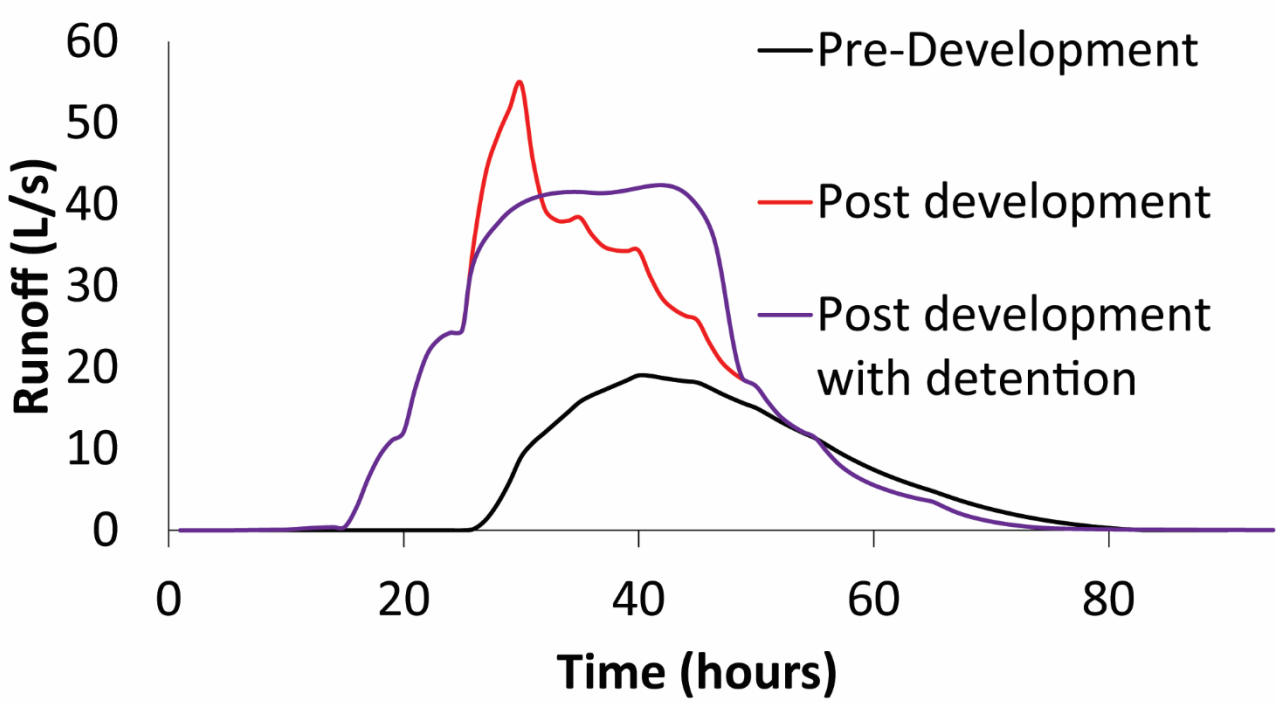
- Wastewater:
  - Carbon emissions
  - Expensive, high energy intensity
  - Continuing water quality issues
    - Difficult to remove pharmaceuticals, increased temperature, BOD, etc.
- Stormwater
  - Urbanization increases runoff
  - Combined Sewer Overflows (CSOs)
  - Water quality issues (e.g. road salt)
  - “Urban stream syndrome”



Urban Stream Syndrome

Traditional Approach (Redux)

- Stormwater Detention:
  - Reduce peak flow rate
  - Delay time to peak
  - Allow suspended particles to settle
  - Reduce Combined Sewer Overflows
- Examples:
  - “Dry” stormwater management ponds
  - “Wet” stormwater management ponds
  - Storage tanks/facilities



Traditional Approach (Redux)

Stormwater Detention Pond

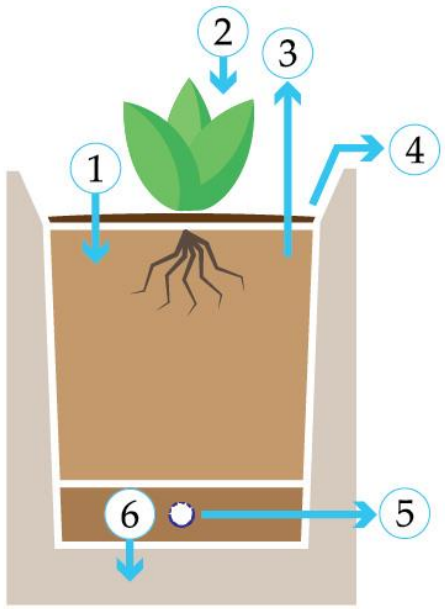
https://www.surrey.ca/sites/default/files/styles/21x9_1100w/public/2020-06/ENG-Detention%20Ponds.jpg?h=208bb47f&itok=S1rV-Tod

Thames Tideway Tunnel

https://londonist.com/2015/08/what-is-the-thames-tideway-tunnel

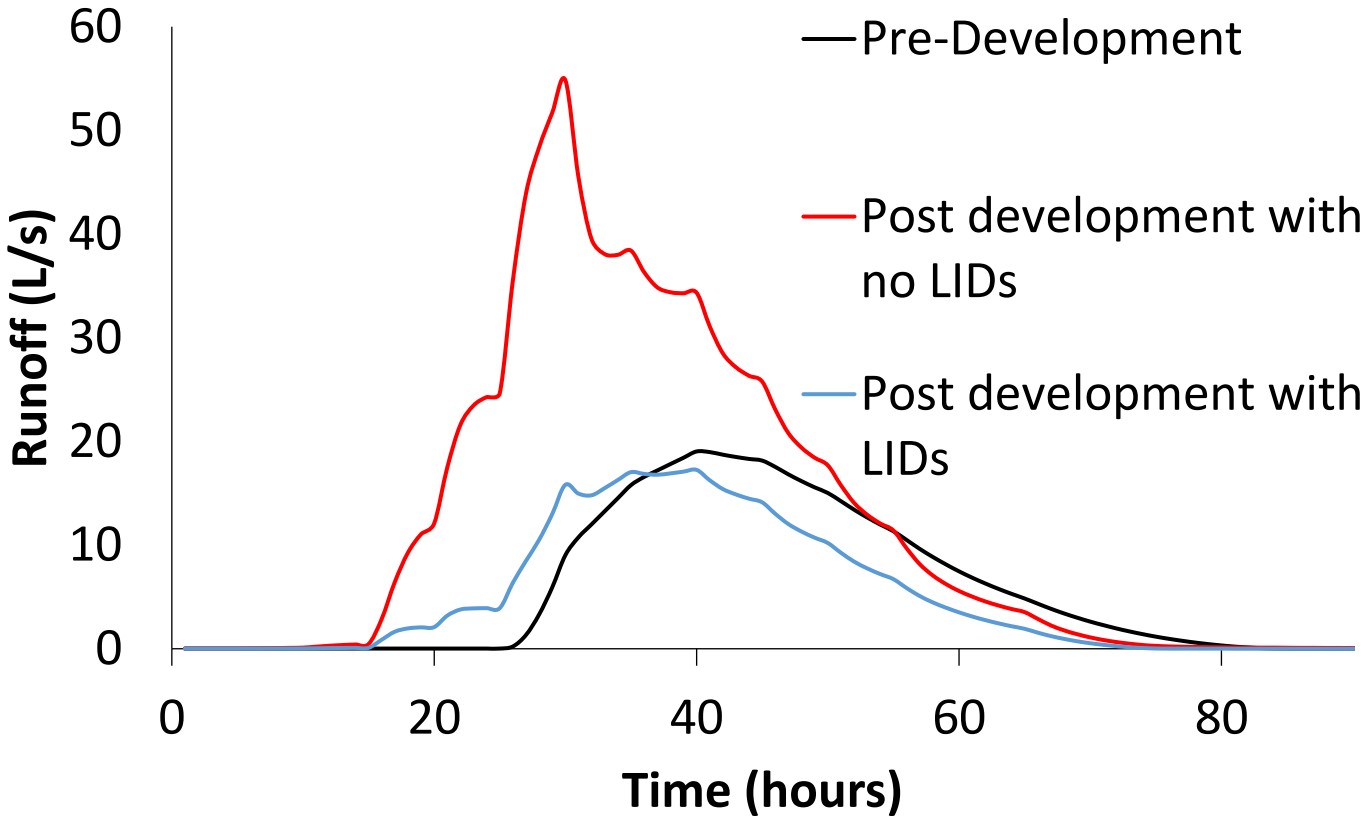
Green Infrastructure/Low-Impact Development

- Distributed systems to treat stormwater at-source
- Two goals:
  - Restore pre-development hydrology
  - Improve water quality



1. Infiltration
2. Interception
3. Evapo-transpiration
4. Overflow
5. Drainage
6. Exfiltration

Spraakman & Rodgers et al., 2021



The Promise:

Rain Garden or Bioretention Cell

https://upload.wikimedia.org/wikipedia/commons/5/5c/Rain_Garden_%2815455930908%29.jpg

Green Roof

https://upload.wikimedia.org/wikipedia/commons/4/41/British_Horse_Society_Head_Quarters_and_Green_Roof.jpg

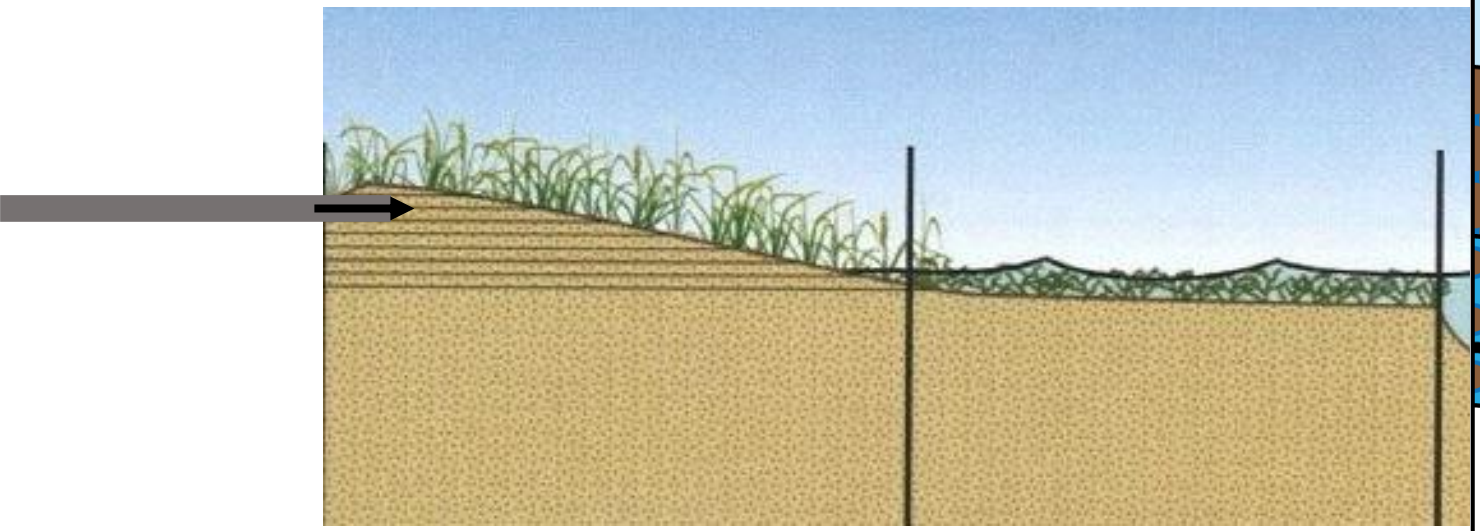
The Problems:

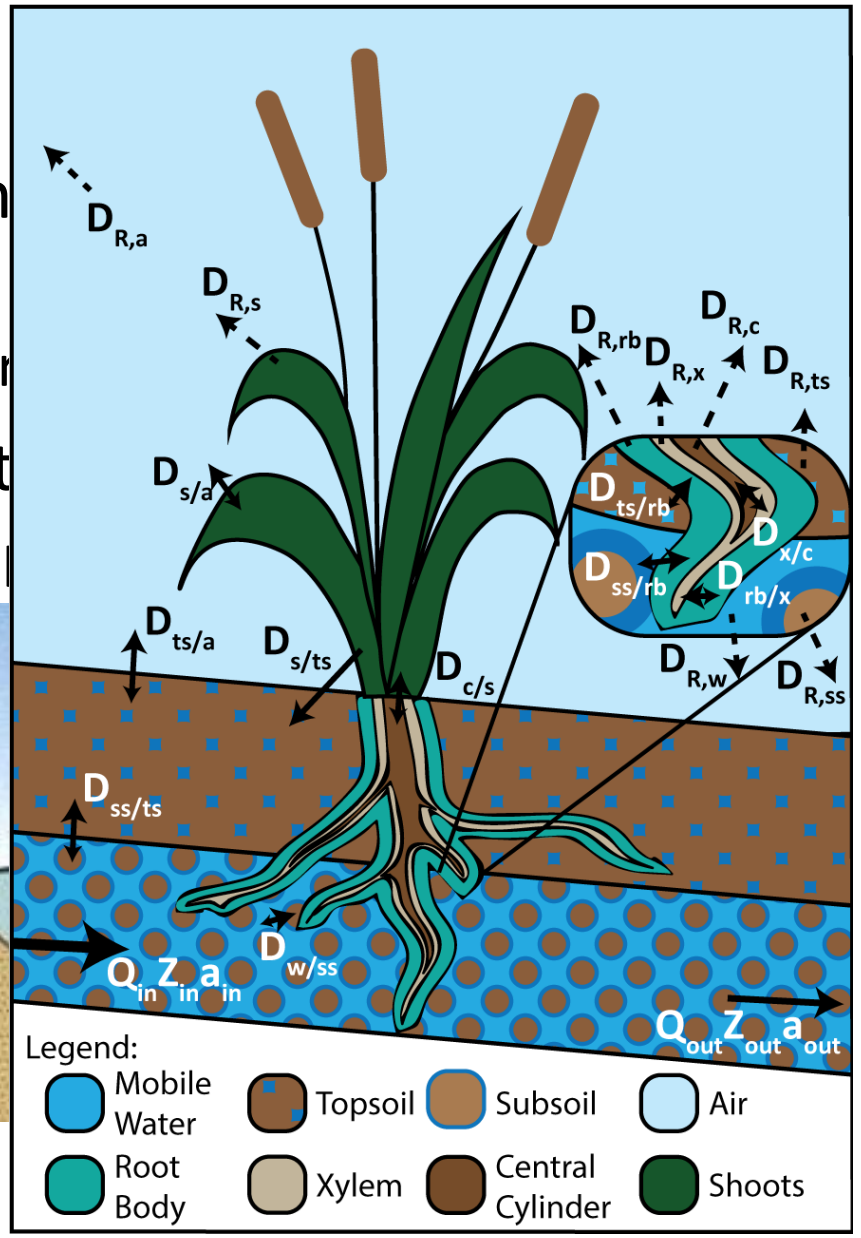
- Maintenance:
  - Lots of distributed systems = Lots to keep track of!
- Many systems designed for “First Flush”
  - Still need traditional infrastructure for large events
- Doesn’t effectively treat hydrophilic compounds
  - Potential for groundwater contamination
- Slow Adoption
  - Municipalities can be slow-moving and risk averse

https://www.conteches.com/DesktopModules/DigArticle/MediaHandler.ashx?portalid=0&moduleid=635&mediaid=279&width=800&height=600

Promising Developments:

- Policy tools to encourage better stormwater m
  - “Runoff Volume Control Targets”
  - Stormwater fees – tax paid based on impervious ar
- Combining ecosystem services – e.g. “Horizont
  - Horizontal Levee –Water treatment + storm surge





Activity: Traditionalists vs LID-ers

- Two hypothetical developments in the Lower Mainland need a Stormwater & Flood Management Plan
  - City of Vancouver National Yard
  - Langley Pagoda Ridge Golf Course

- 2 groups for each development:
  - Traditional/Hard Infrastructure
  - LID/Green Infrastructure

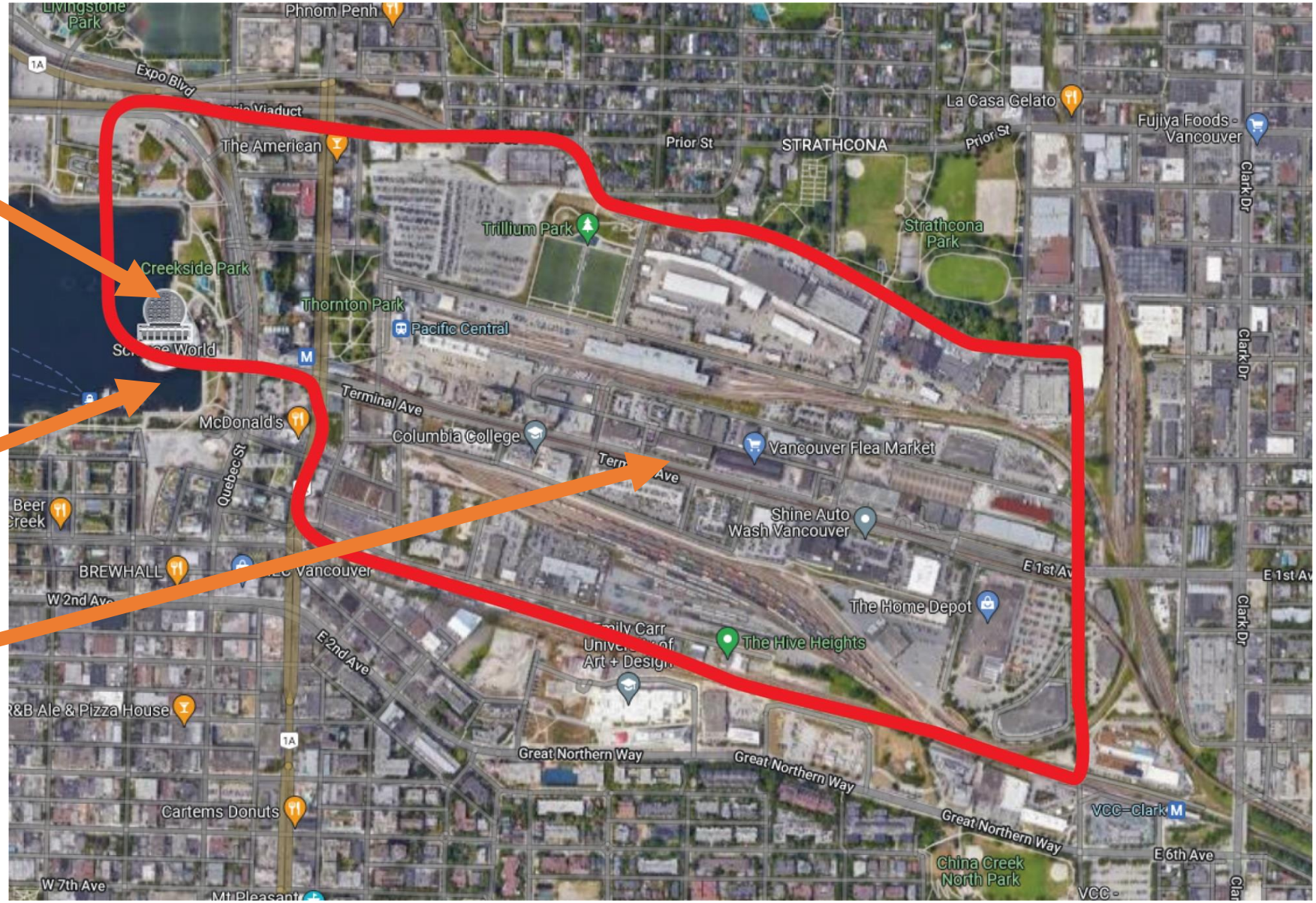
- First – in your groups fill in the front-side of the handout
- Second – meet with another group on the same development & decide on an overall plan
- Third – Regroup, discuss final plans

Vancouver National Yard

1. Storm Surge

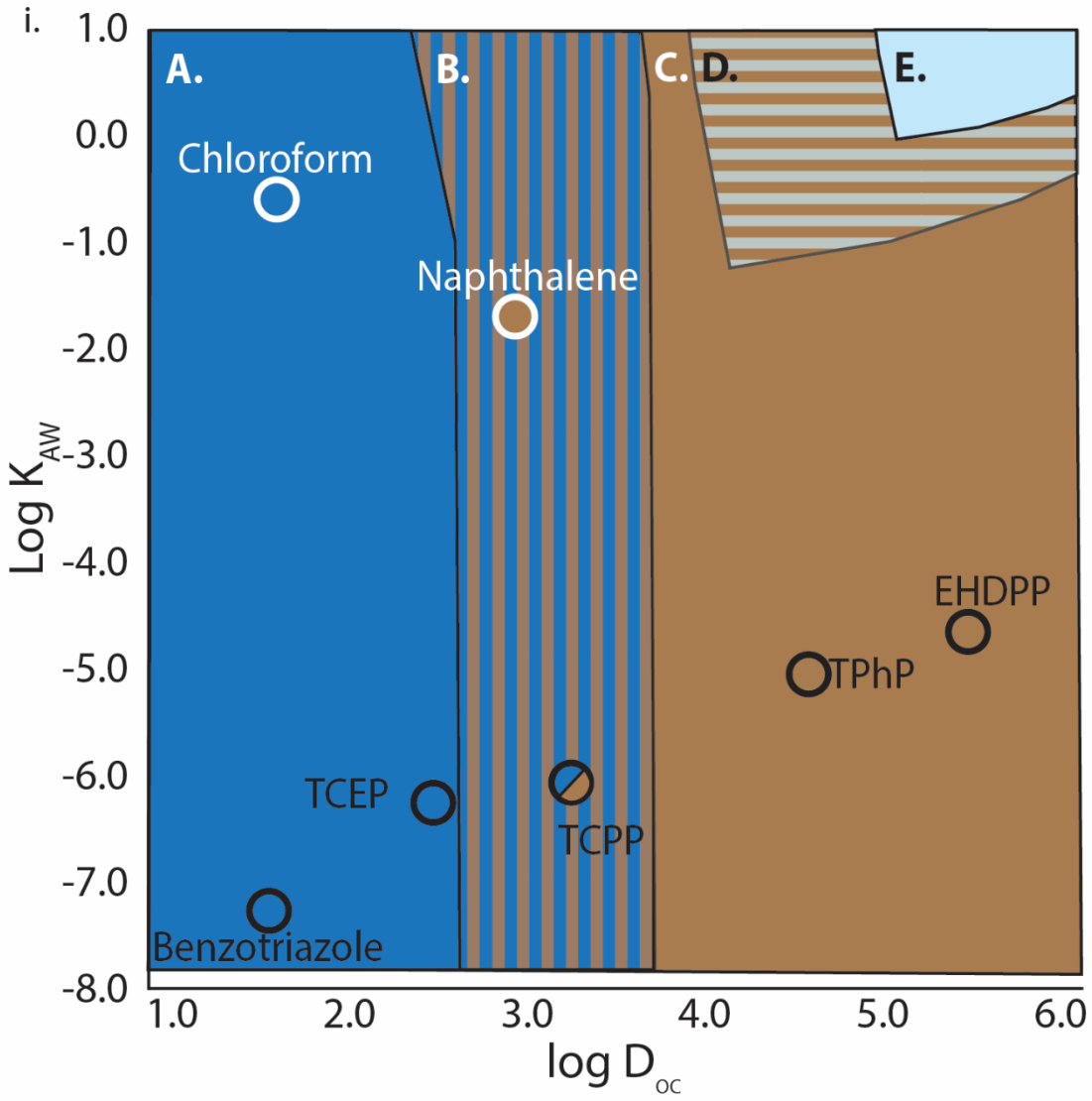
2. Combined Sewer Overflow

3. Brownlands Contamination



Pagoda Ridge Golf Course

Chemical Applicability of LIDs:



- Log D_{OC} < 2.75
  - Not captured, very mobile
- 2.75 ≤ Log D_{OC} ≤ 3.75
  - Fate is sensitive to hydrology, diffusion
- Log D_{OC} > 3.75
  - Mostly captured, not mobile

Legend
- Volatilization
- Water Advection
- Sorption

Rodgers et al. (2022, currently finishing revisions)