



# Bioretention Hydrologic Performance Study III

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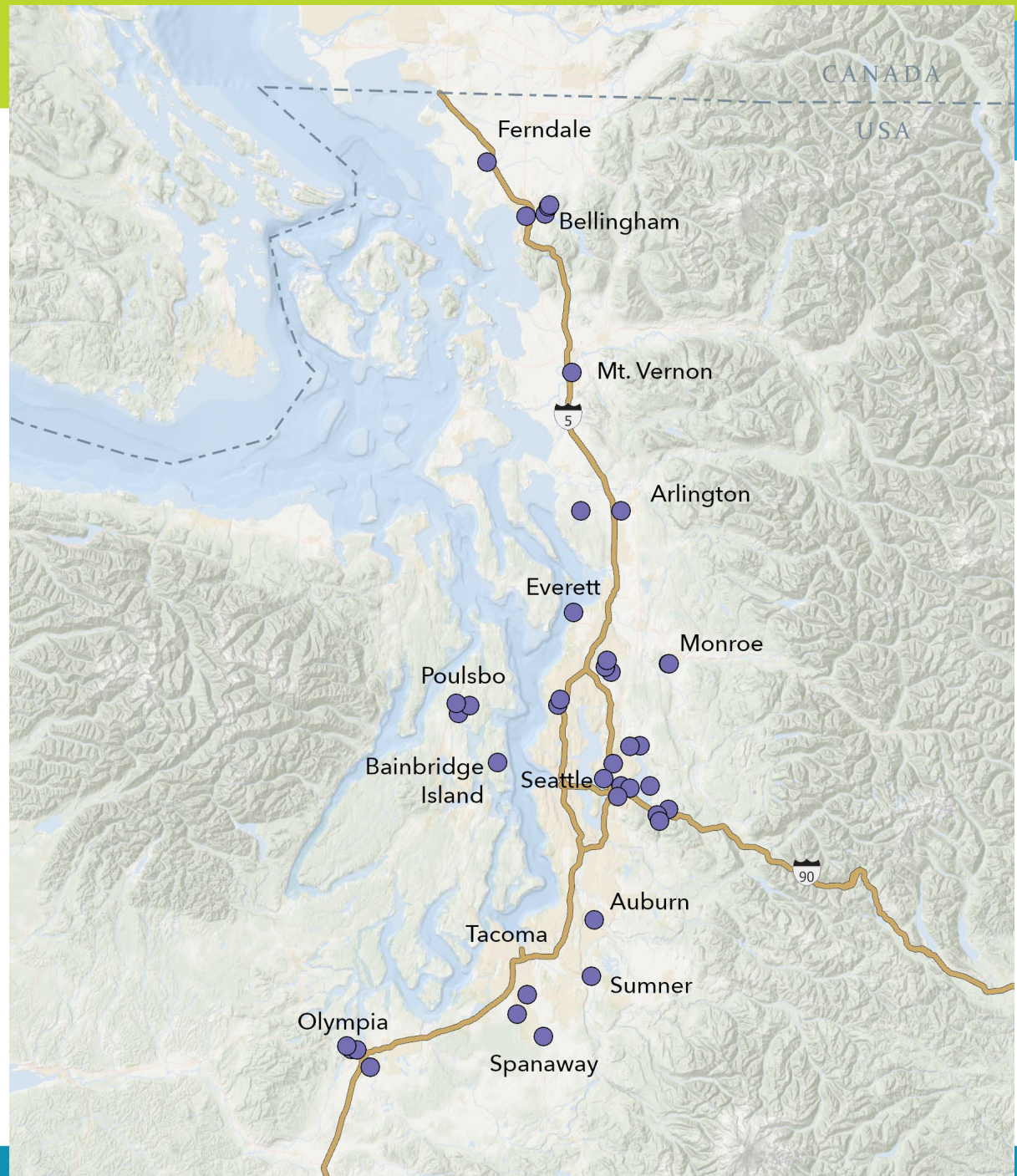
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# Purpose of the BHP III Study – How are they aging?

- Look at 50 (!) bioretention cells ten years old or older – 2013 or earlier
  - We characterized the plant community, measured the cell infiltration rate and soil composition, and the owners' O&M
- now ask:
- How does the current infiltration rate and plant community compare to initial design and plant community?
  - What does it mean for design recommendations?

Fifty bioretention study cells across approximately 25 jurisdictions, with a few individual residential/commercial properties



# Soils/ Infiltration Evaluation

# FIELD INVESTIGATION

- Plan review
- Drone imagery, utility locate
- Site access, hydrant permission
- Multiple shallow hand borings
- Shallow well point
- Controlled field infiltration test
- Geotechnical T-probe
- Laboratory testing
  - grain size, organic matter



# CELL CONDITION RELATIVE TO PLAN

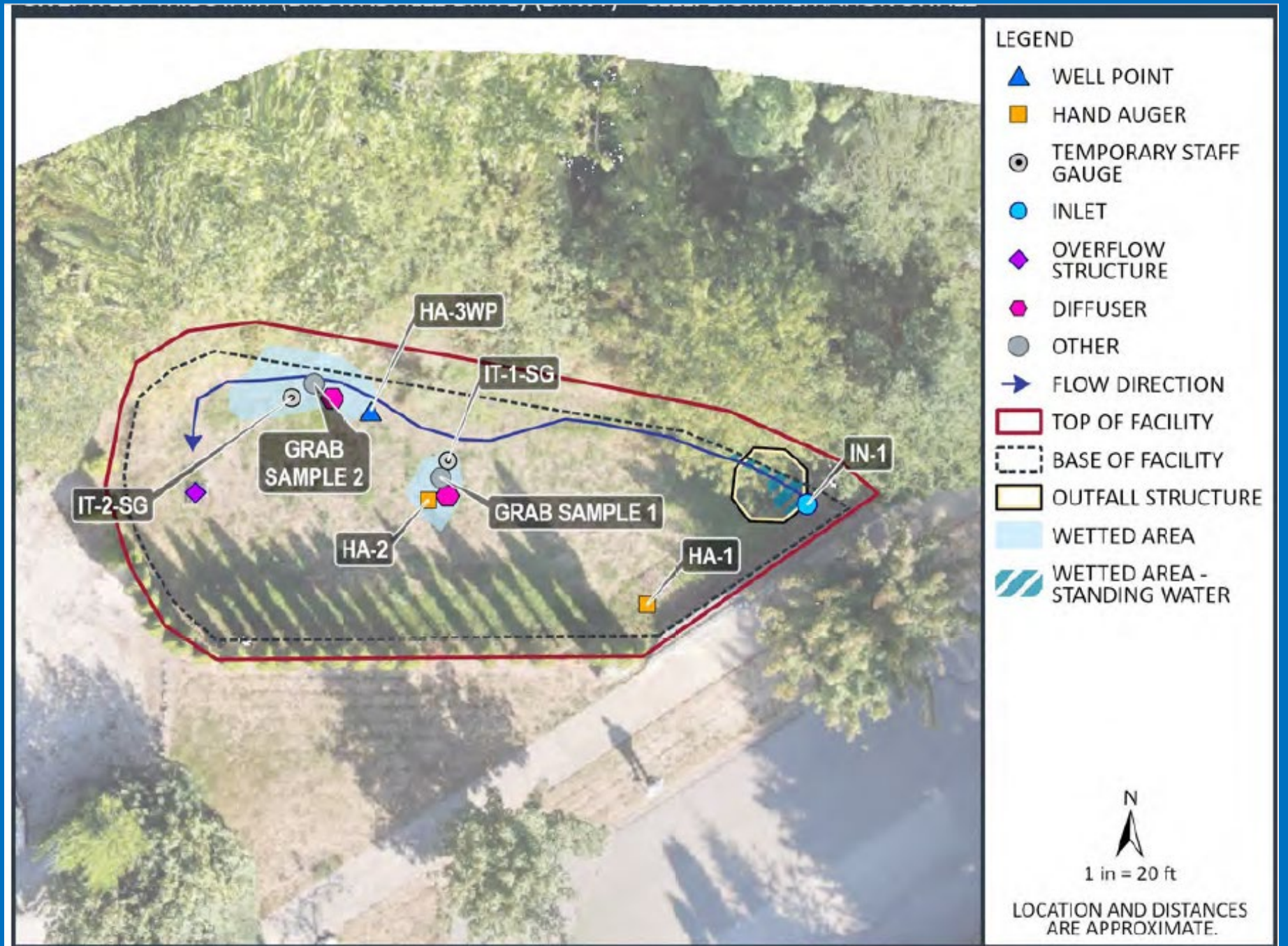
- 38 cells consistent with as-builts
- 9 cells varied –
  - Non-engineered overflows
  - Bypass
  - Landscaping modifications
- 3 cells did not have as-builts
- Inlets:
  - 17 cells -> 1+ inlet with erosion;
  - 32 cells -> 1+ inlet with blockage
- Outlets:
  - 41 cells -> engineered overflows
  - 11 cells -> debris buildup at overflow



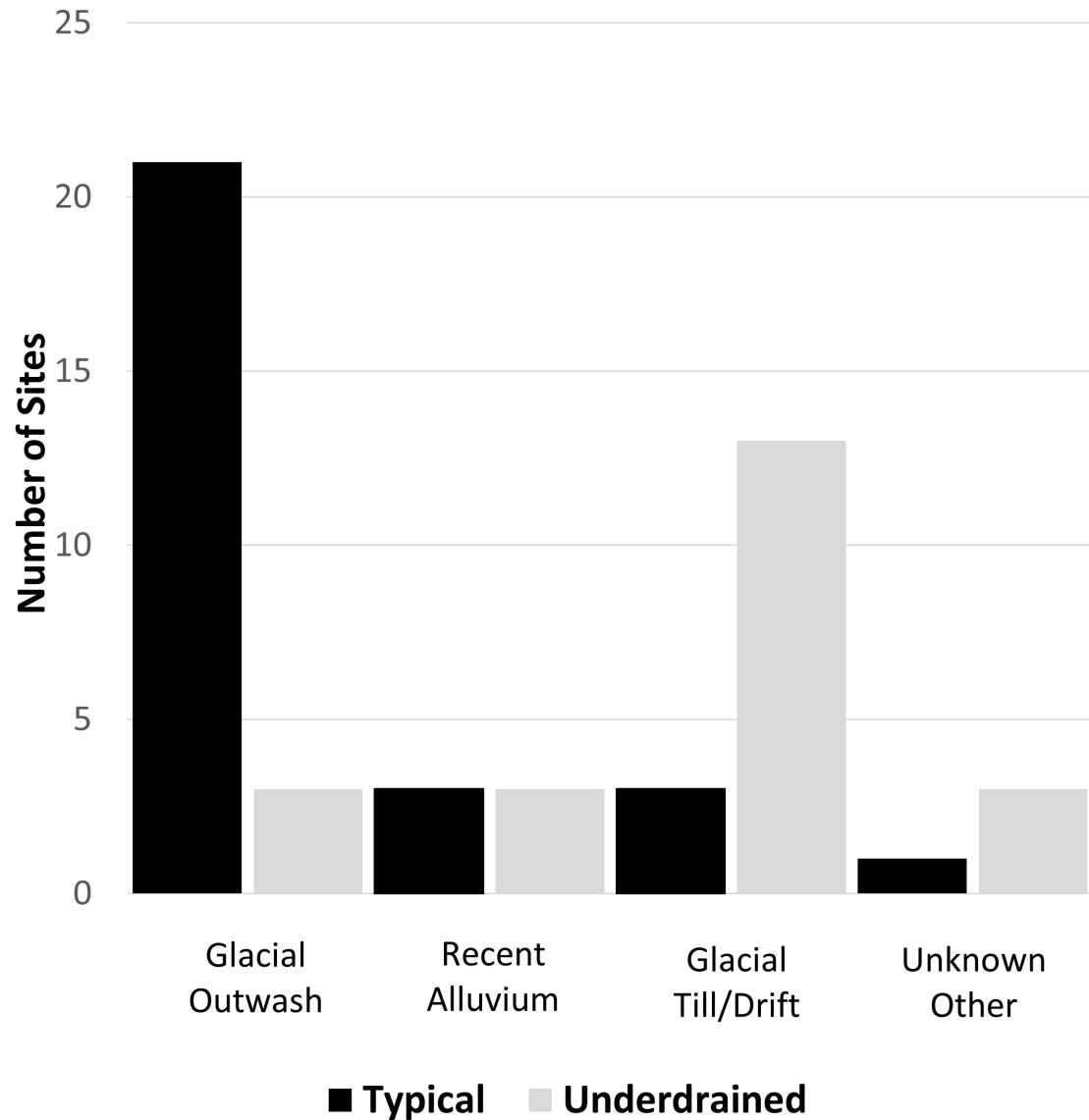
# Site BHWT

-Micro Topography

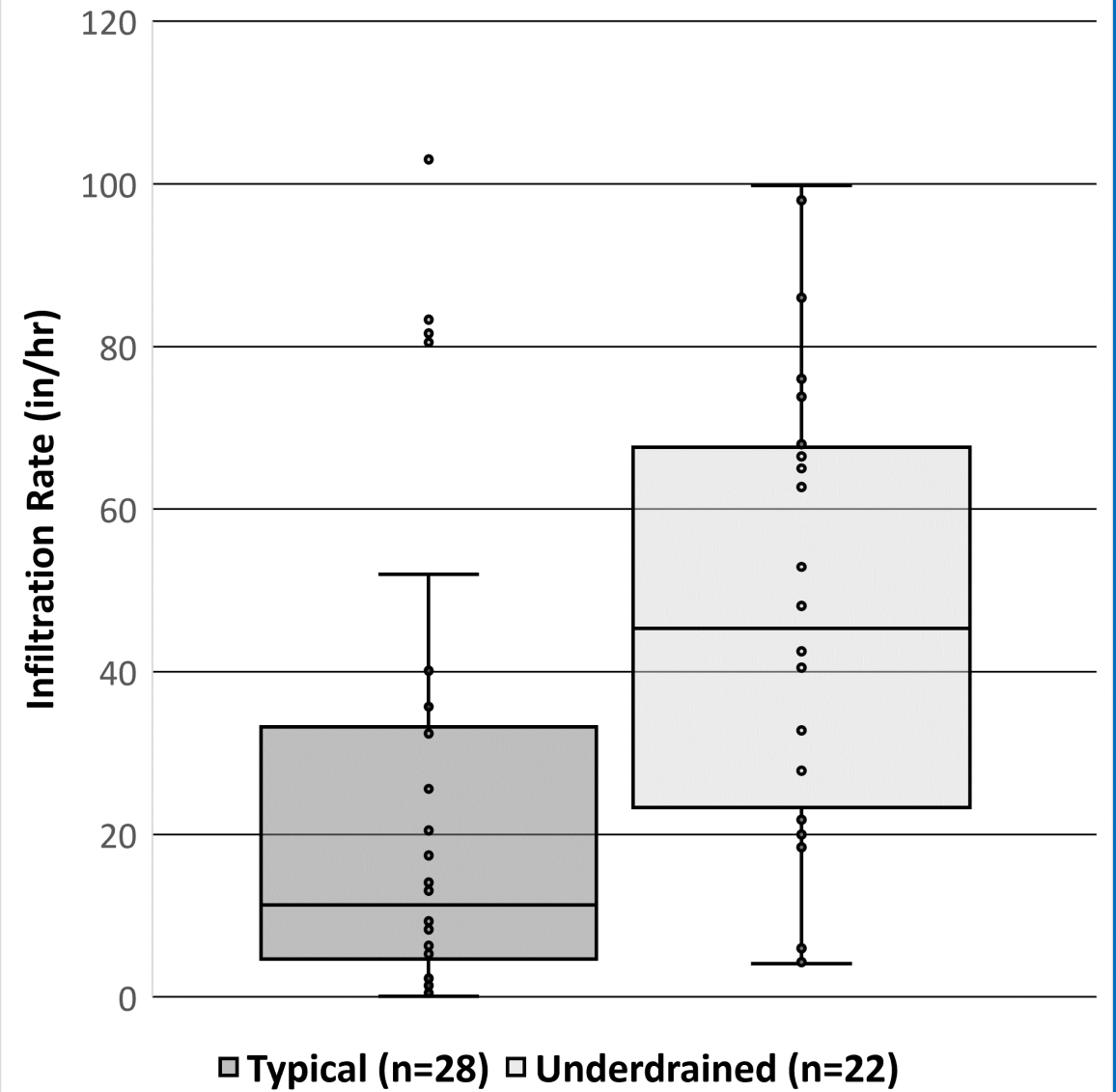
-Variable Rate



## Geologic Setting for Typical and Underdrained Bioretention Cells

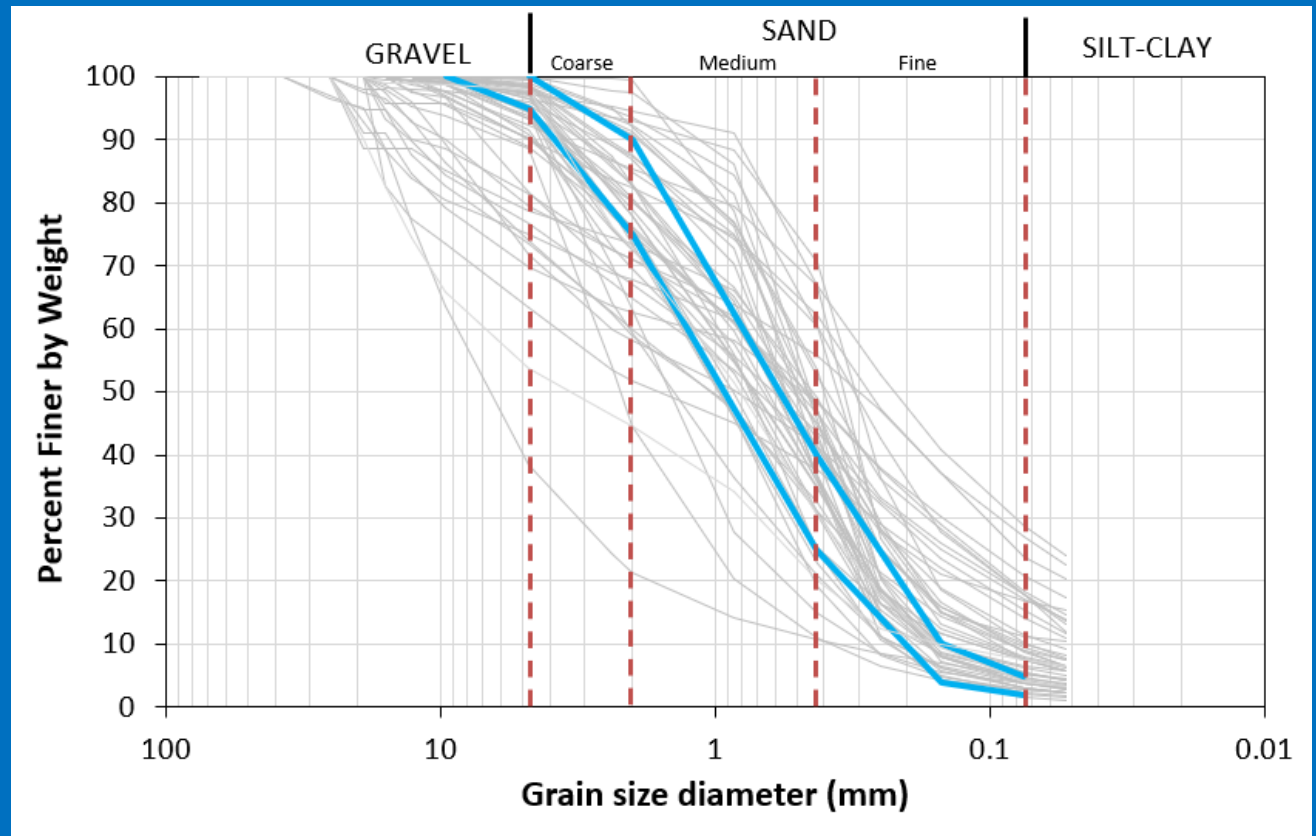
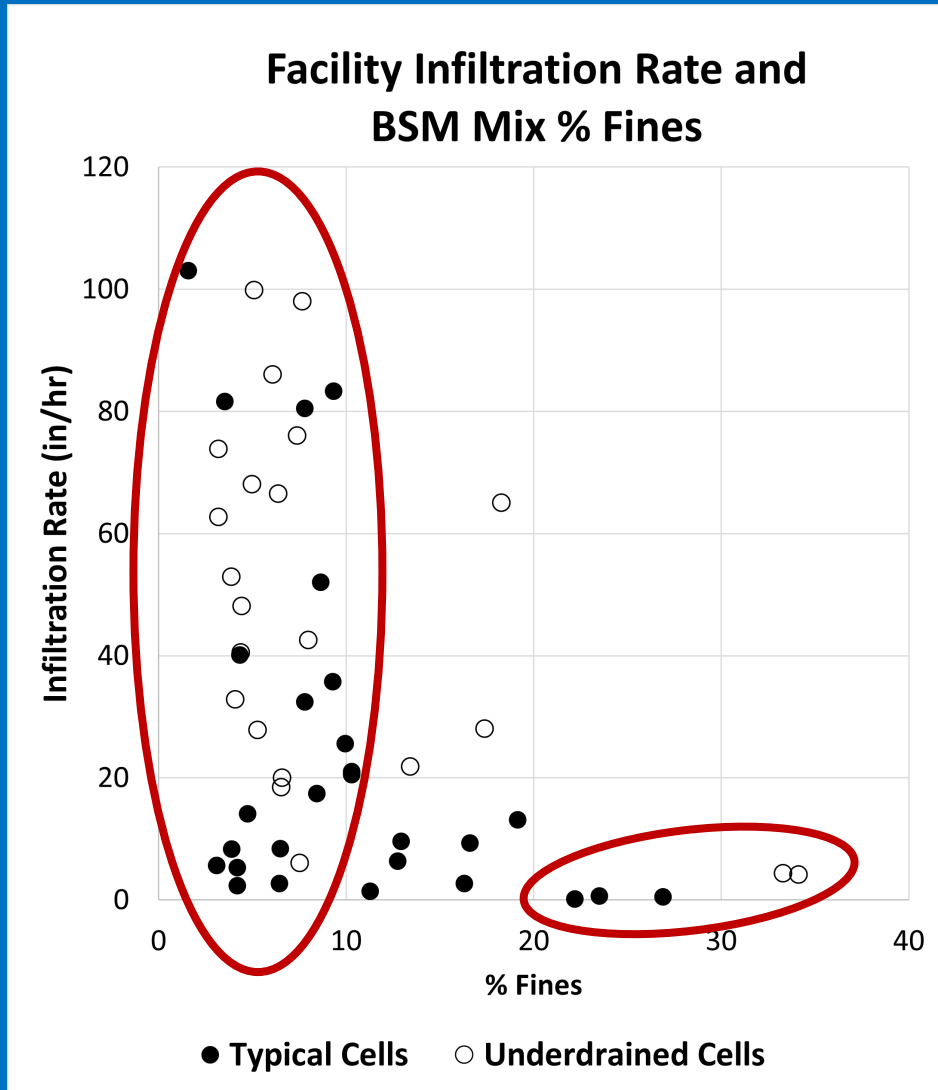


## Facility Infiltration Rates: Typical and Underdrained





# Bioretention Soil



60:40 BSM Guide Grain Size, %Passing	Sites Within Spec	Finer	Coarser
#200, 2 to 5%	11	38	1
#40, 25 to 40%	16	27	7
Organic Matter	Within Spec	Less than	More than
5-8%, by weight	20	20	10

# KEY FINDINGS

## As-built/Design:

- Physically mostly resembled plans
- Some key differences
  - Non-engineered overflows(2), Lateral Flow(3)
  - Leaky structures (10 of 31)
  - Incorporated into lawn (1-2), Filled in (1)

## Infiltration and BSM soils:

- High rates persist, Typical < Underdrained
- No facility clogging
- Some inlet compaction, siltation
- BSM – Most finer, esp. #200 fraction
- Wide range of organic matter content



# Vegetation Results

# Wetland Indicator Status (WIS)

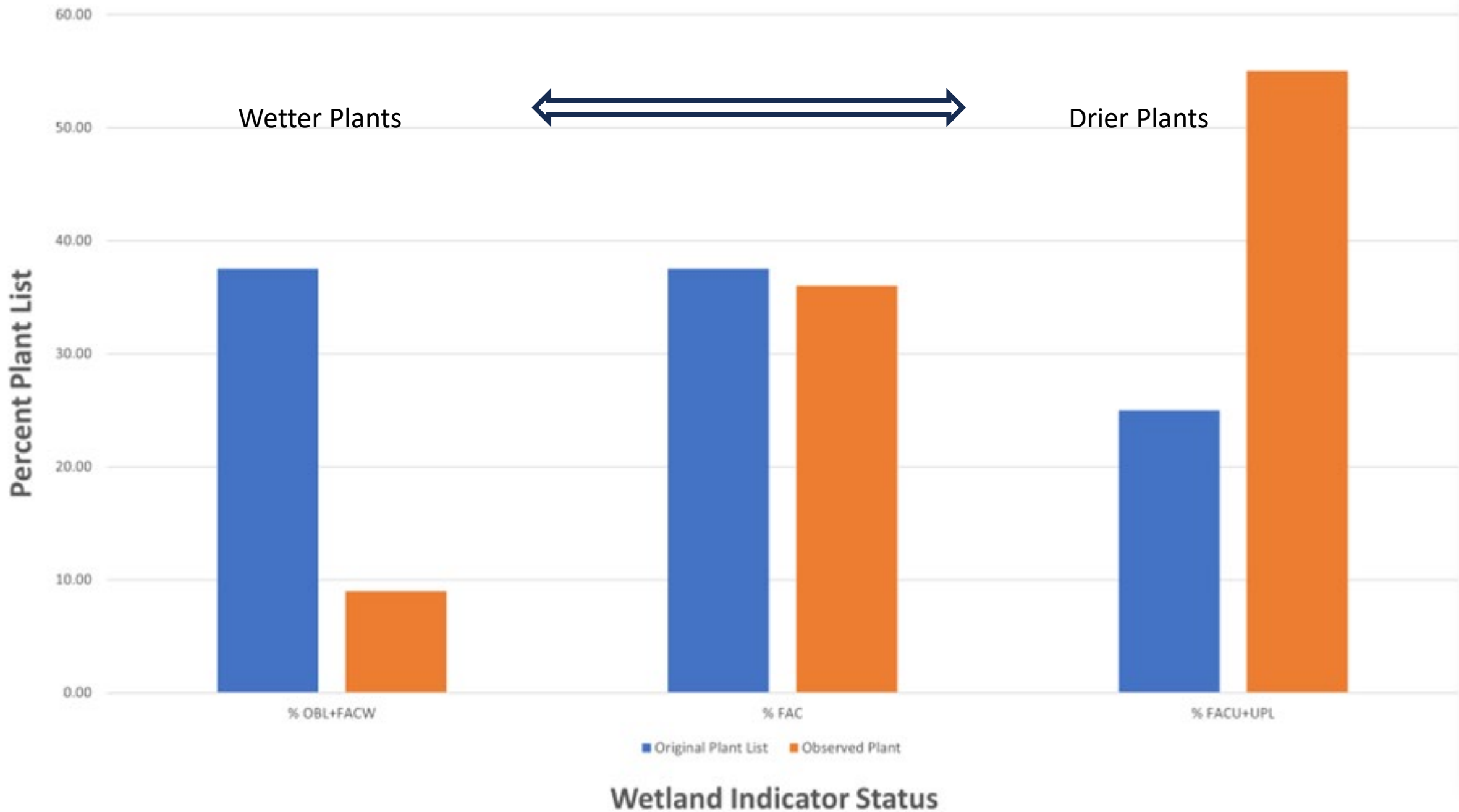
How likely a PLANT species is to occur in wet  
versus dry soils

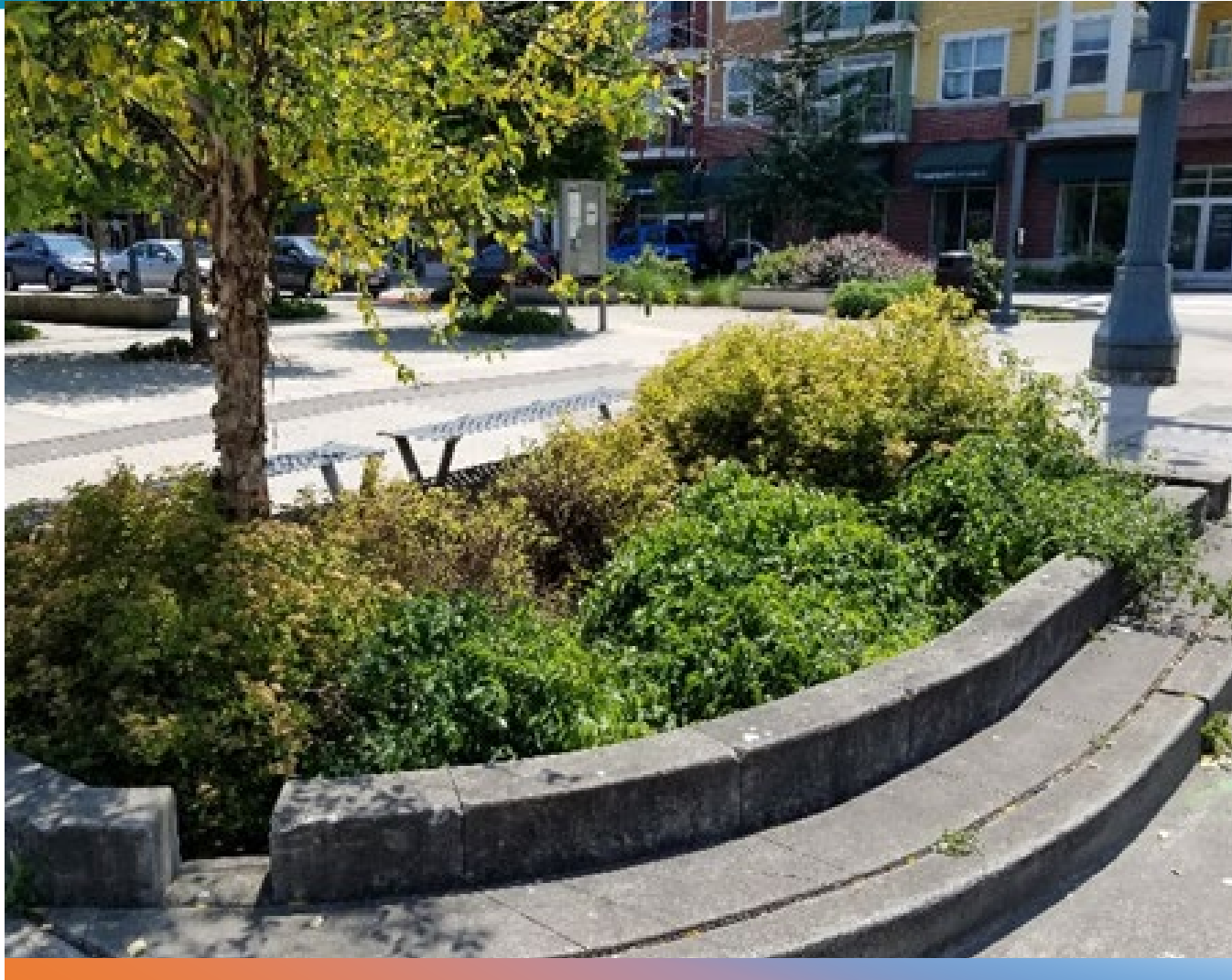
- But remember: Bioretention facilities are not wetlands! They are really dry!



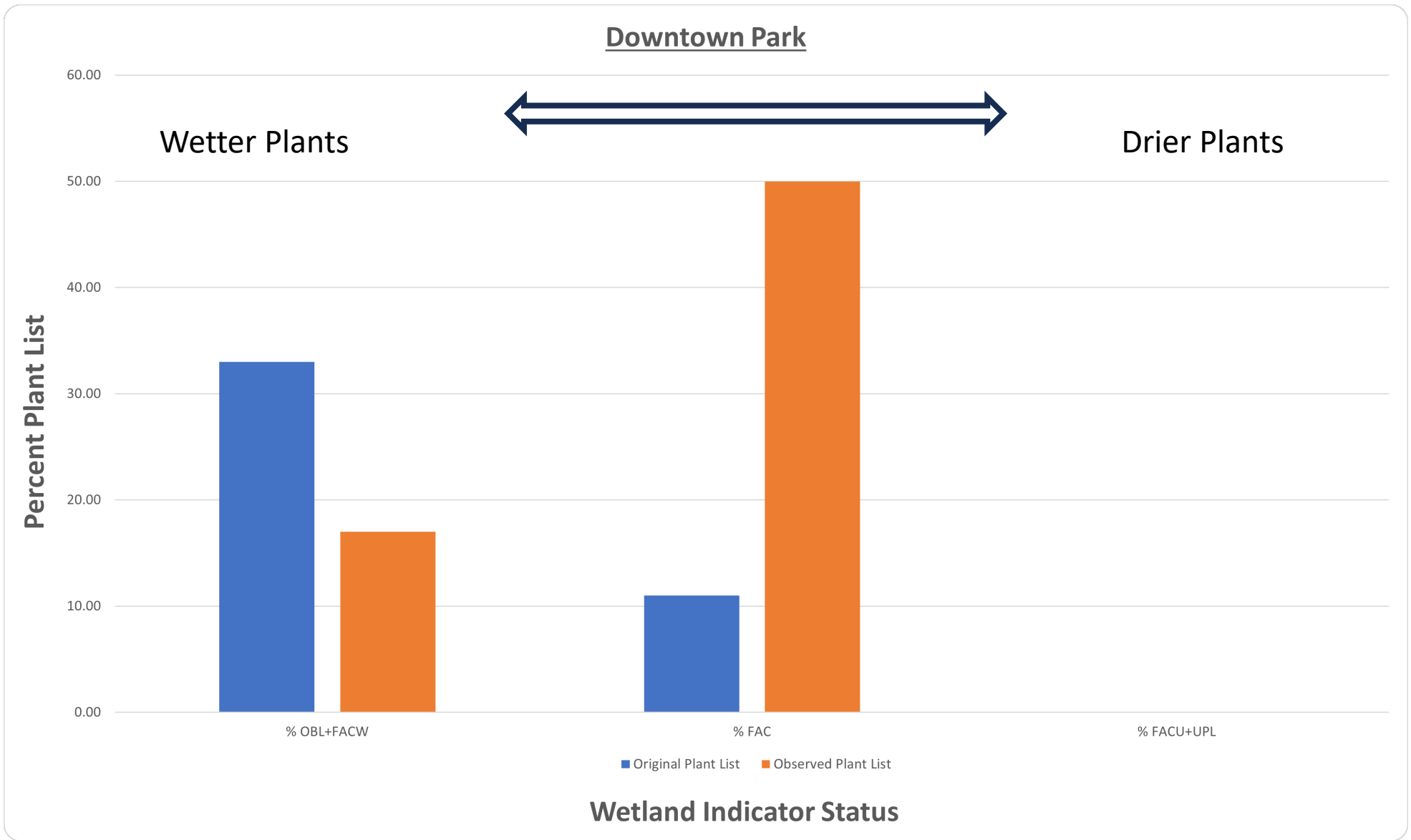
Arlington Blvd.  
Cell 1

# Arlington Boulevard Cell 1





# Downtown Park

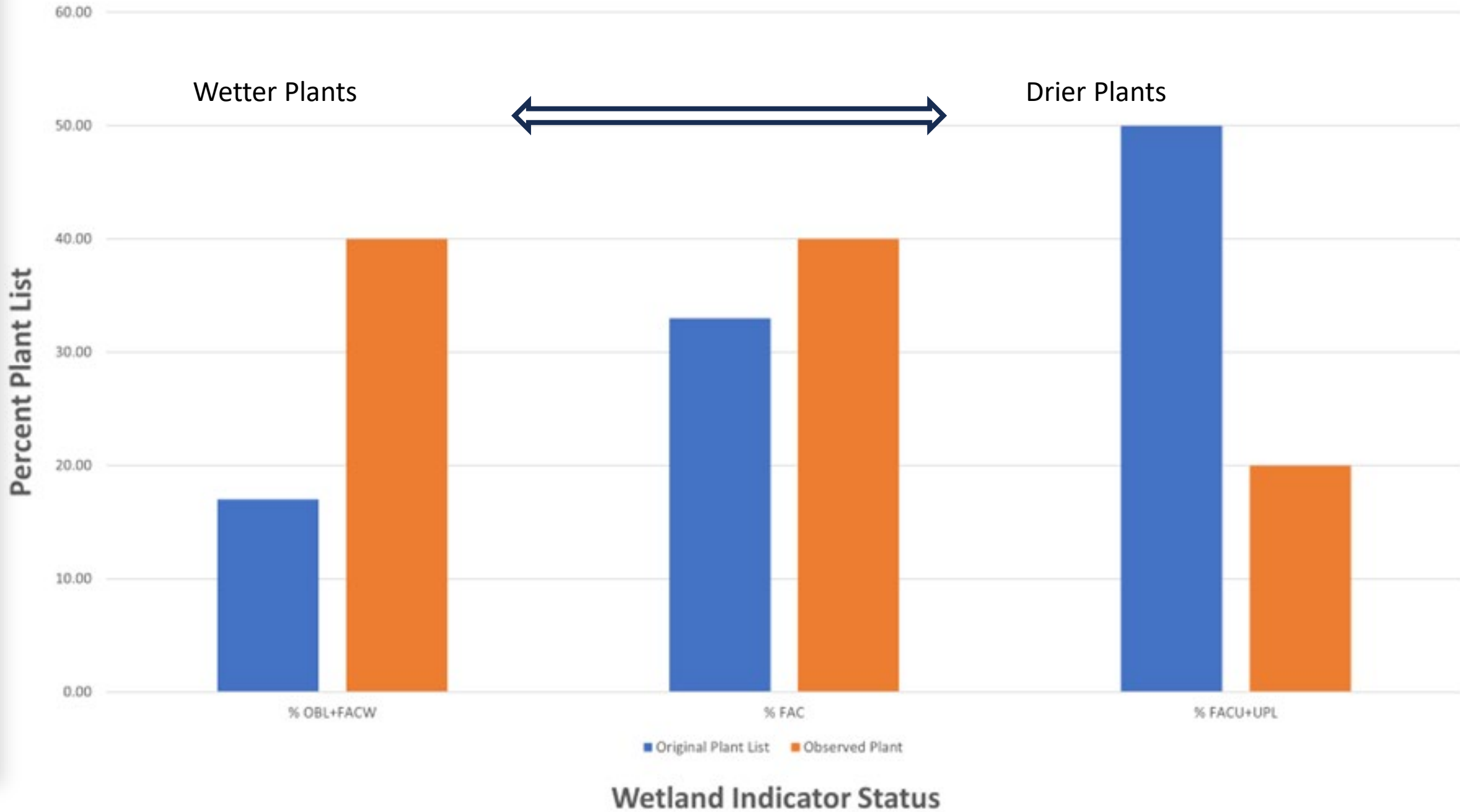




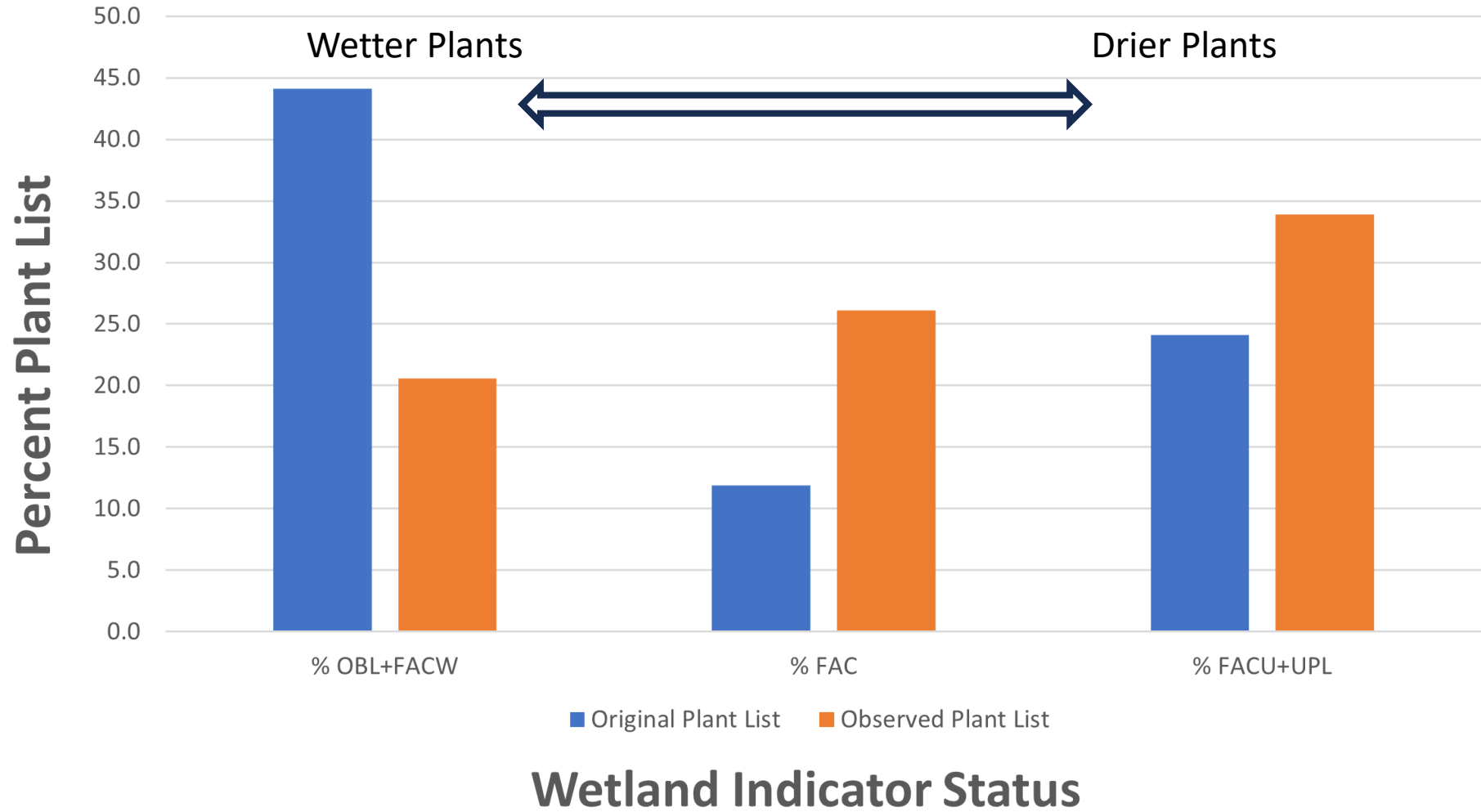


Bloedel  
Donovan Park

# Bloedel Donovan Park



### Summary Across Sites

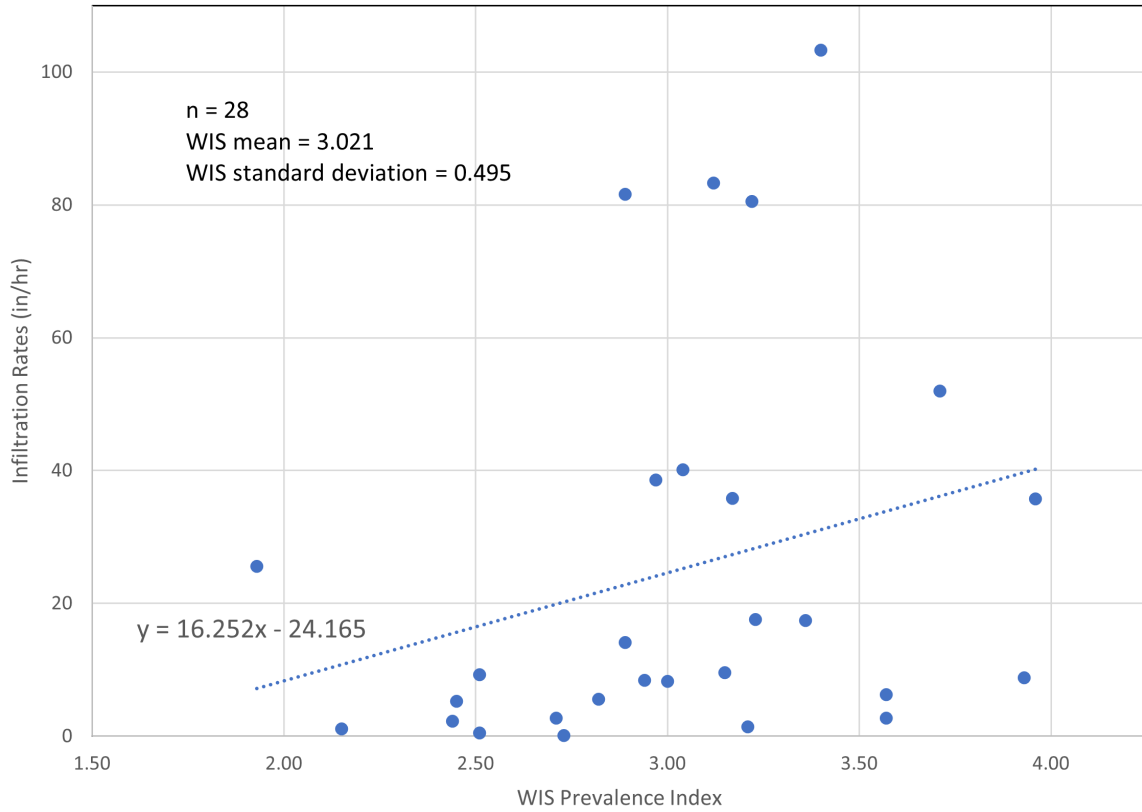


# Summary of Vegetation Change

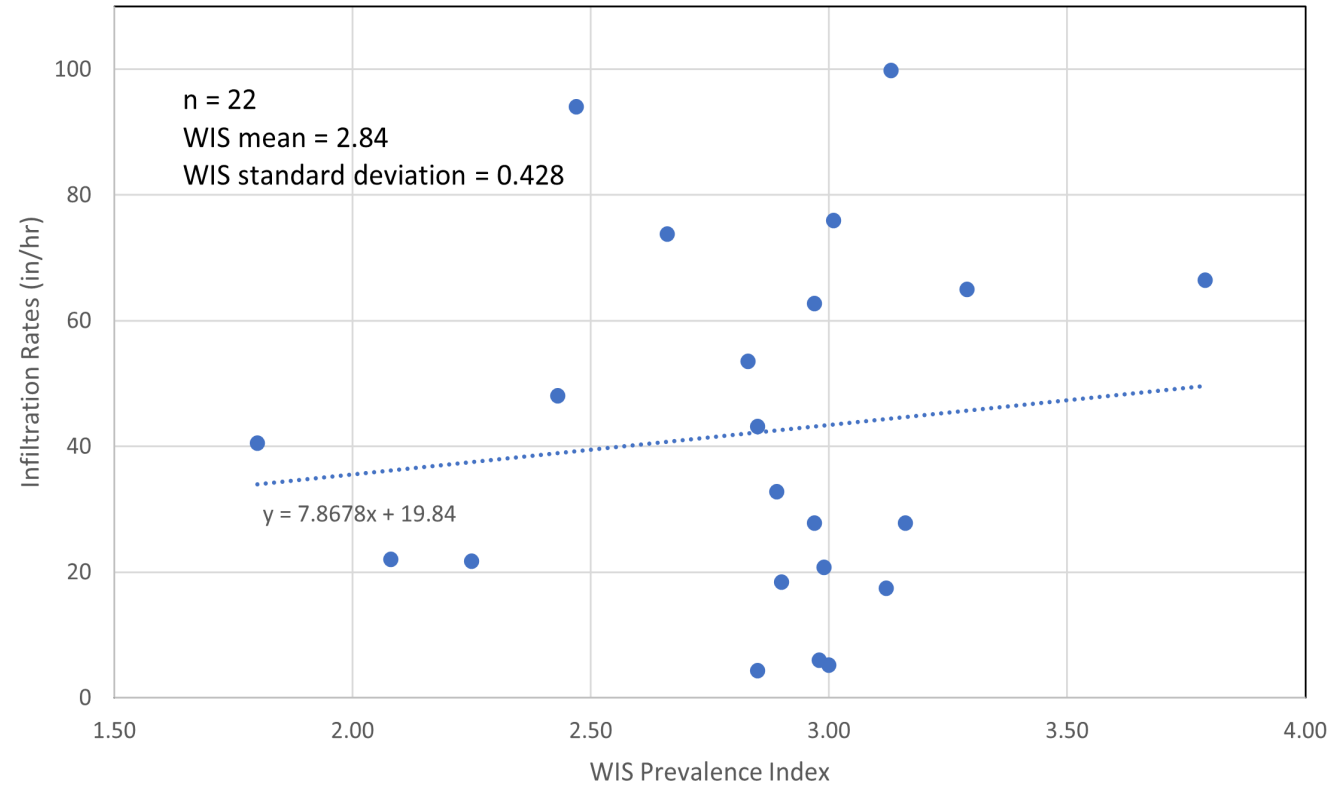
- Approximately 75% of original plant lists shifted to drier plants
- The number of herbaceous plants increased over time
- Not many originally planted herbs survived to present

Original Plant List		Observed Plant List		Percent of Original List Remaining	
Avg. # Herbs	Avg. # Woody	Avg. # Herbs	Avg. # Woody	Avg. # Herbs (%)	Avg. # Woody (%)
3.1	3.9	11.9	3.9	13.4	56.0

Scatterplot - Typical



Scatterplot - Underdrained



# Frequency of Maintenance

Frequency of Maintenance	Number of Respondents
0	1
1 - 2x / mo.	6
1 - 4x/ yr.	15
1/5 years.	1

# Vegetation Take Home Points

Be aware of unique site conditions:

- a. Moisture regime (solar exposure, dry, ground water, irrigation, inflow location?)
- b. Expected maintenance (irrigation? Frequency? Public display?)
- c. Contributing area ratio?
- d. Adjacent volunteers/ habitat?
- e. Expect spatial variability
- f. Woody veg. more persistent than herbaceous

# Modeling Evaluation



# Bioretention Stormwater Modeling Evaluation

Table 1. Ratio of Cell Area to Drainage Area for Cell Ratios of Less than 5 Percent

<b>Bioretention Cell</b>	<b>Base Area to Drainage Area Ratio</b>	<b>Measured Infiltration Rate (in/hr)</b>
145th PI RG#2 U	2.3%	40.5
Tyee Middle School Bioretention Pond A U	3.3%	62.7
Rainier Boulevard T	1.4%	35.8
Rosehill Community Center North Rain Garden UNK	4.7%	5.3
Decatur Raingarden U	3.2%	65.0

# Questions / Discussion