Naturalizing Detention Basins…

What's It All About?

Dr. Stephen J. Souza

Part 1

The Need to Tame Stormwater Runoff

Water, Water Everywhere!

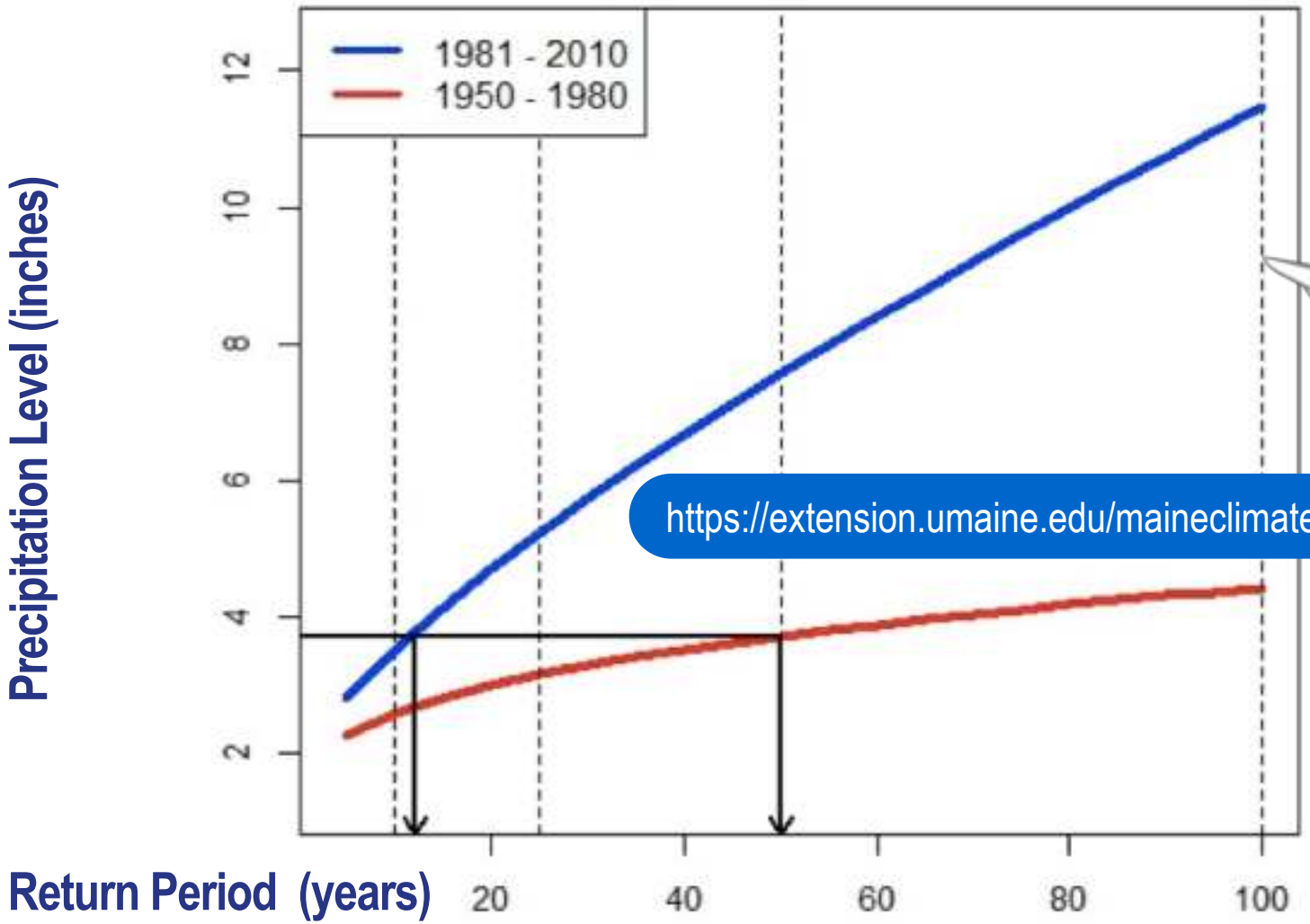
- National Oceanic and Atmospheric Administration calculated the total damages from floods and hurricanes during 2021 eclipsed $100 billion!
- NOAA also estimates that sea level will rise by 10”-12” by 2050.
- This, along with the increasing occurrence and frequency of storm events, puts many of the most populated areas of the nation at increased risk of repeated flood induced damage.

NOAA – February 2022- Sea Level Rise Technical Report
https://oceanservice.noaa.gov/hazards/sealevelrise/sealevelrise-tech-report-sections.html

But Its Not Just The Extreme Events

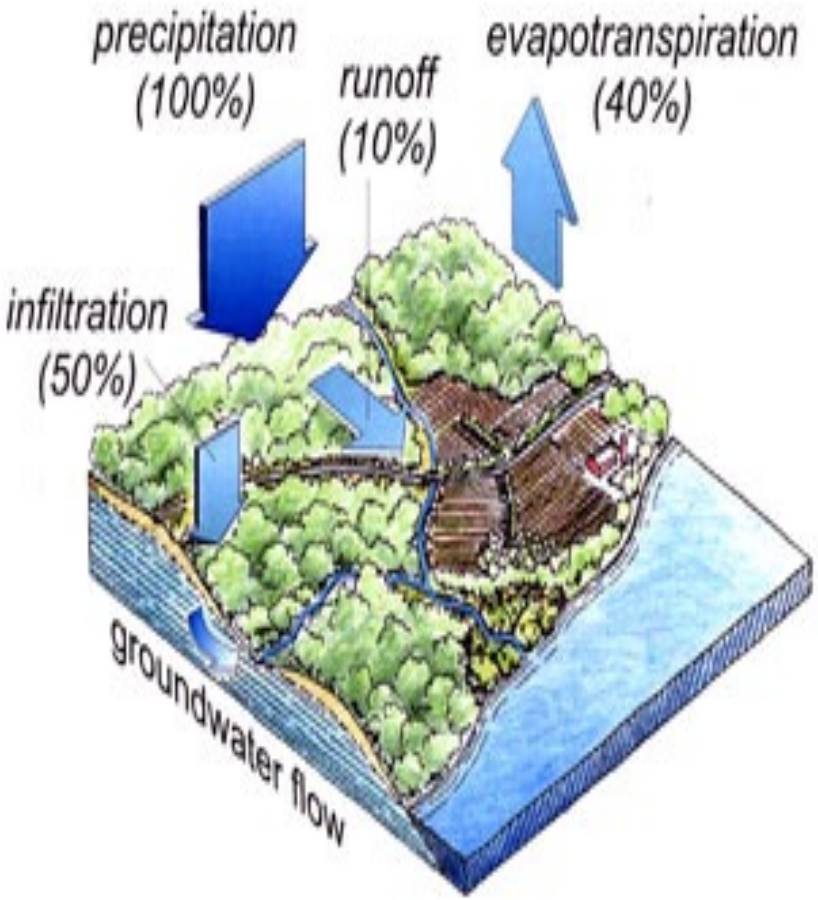
- Proper planning needed to deal with extreme events…but
- Smaller, more frequent events need to be given greater emphasis and priority.
- Greater return frequency storms (0.5-yr, 1-yr and 2-yr events) result in…
  - Increased frequency of localized nuisance flooding.
  - Exacerbated environmental stress.
  - Chronic, repeating ecological impacts.

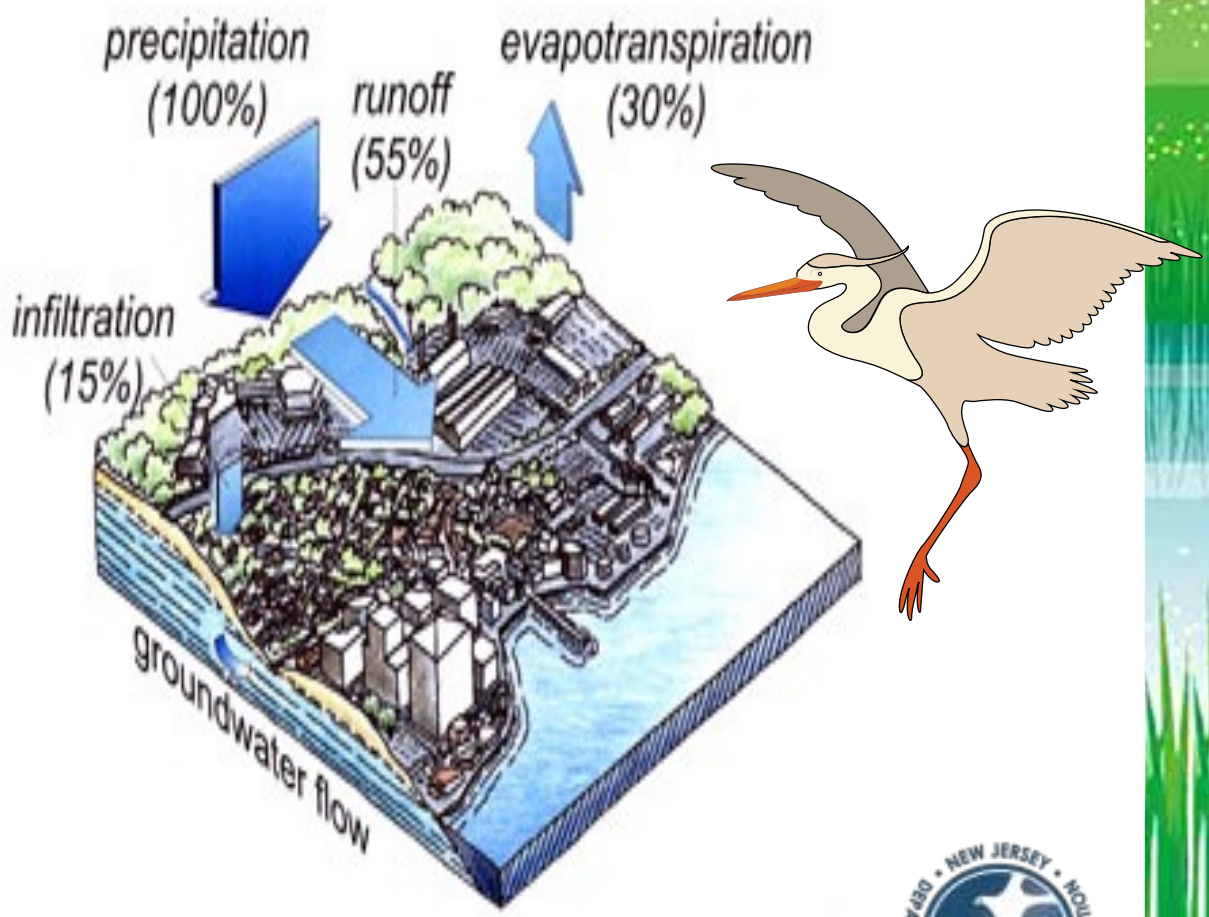
Increasing Storm Frequency



https://extension.umaine.edu/maineclimatenews/home/adapting-to-extreme-rainfall/

Development Driven Hydrologic Changes



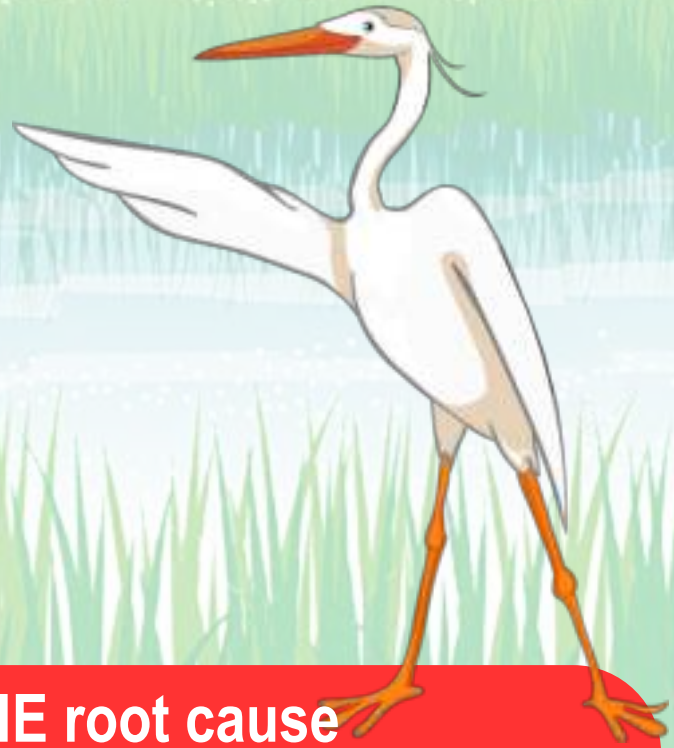


www.mass.gov

The Impacts of Watershed Development

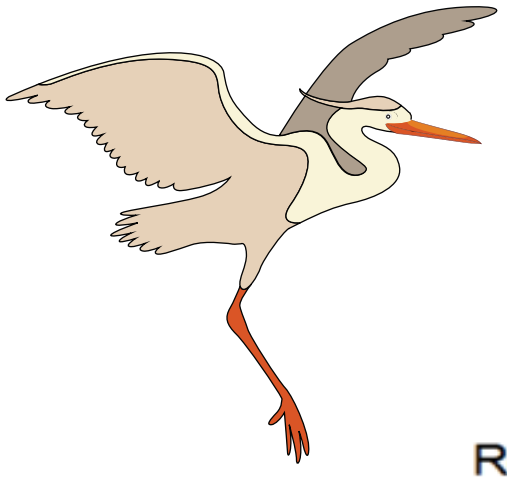
More impervious cover results in:

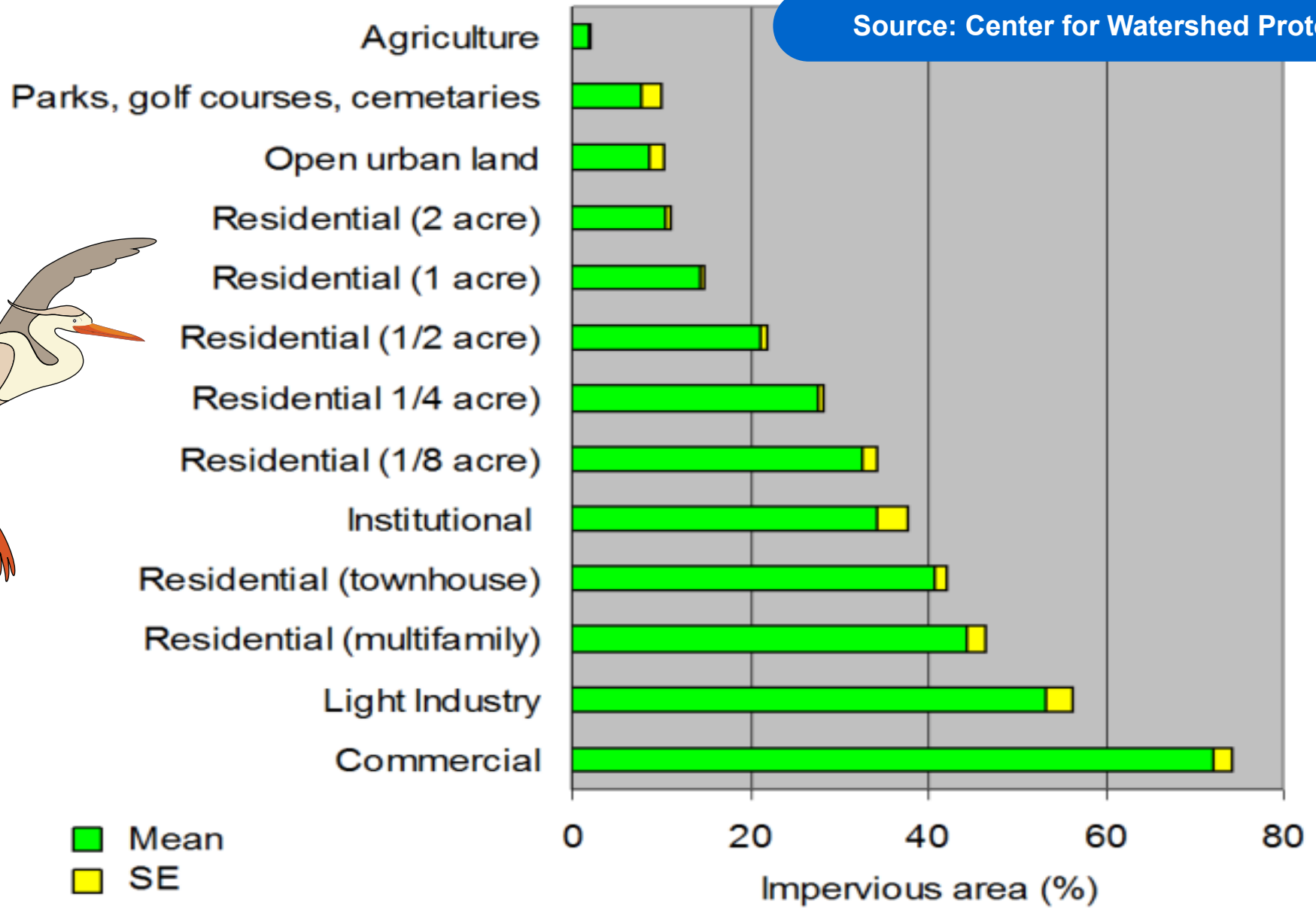
- Increased volume and velocity of runoff.
- Altered stream hydrology and hydraulics.
- More pollutant loading.
- Degraded water quality.
- Loss of ecological services and functions.
- Harmful algae blooms.



USEPA - Stormwater runoff is THE root cause of approximately 70% of the nation's water quality problems.

Source: Center for Watershed Protection 2003





So Yes…
A Little Runoff Can Create a Lot of Problems

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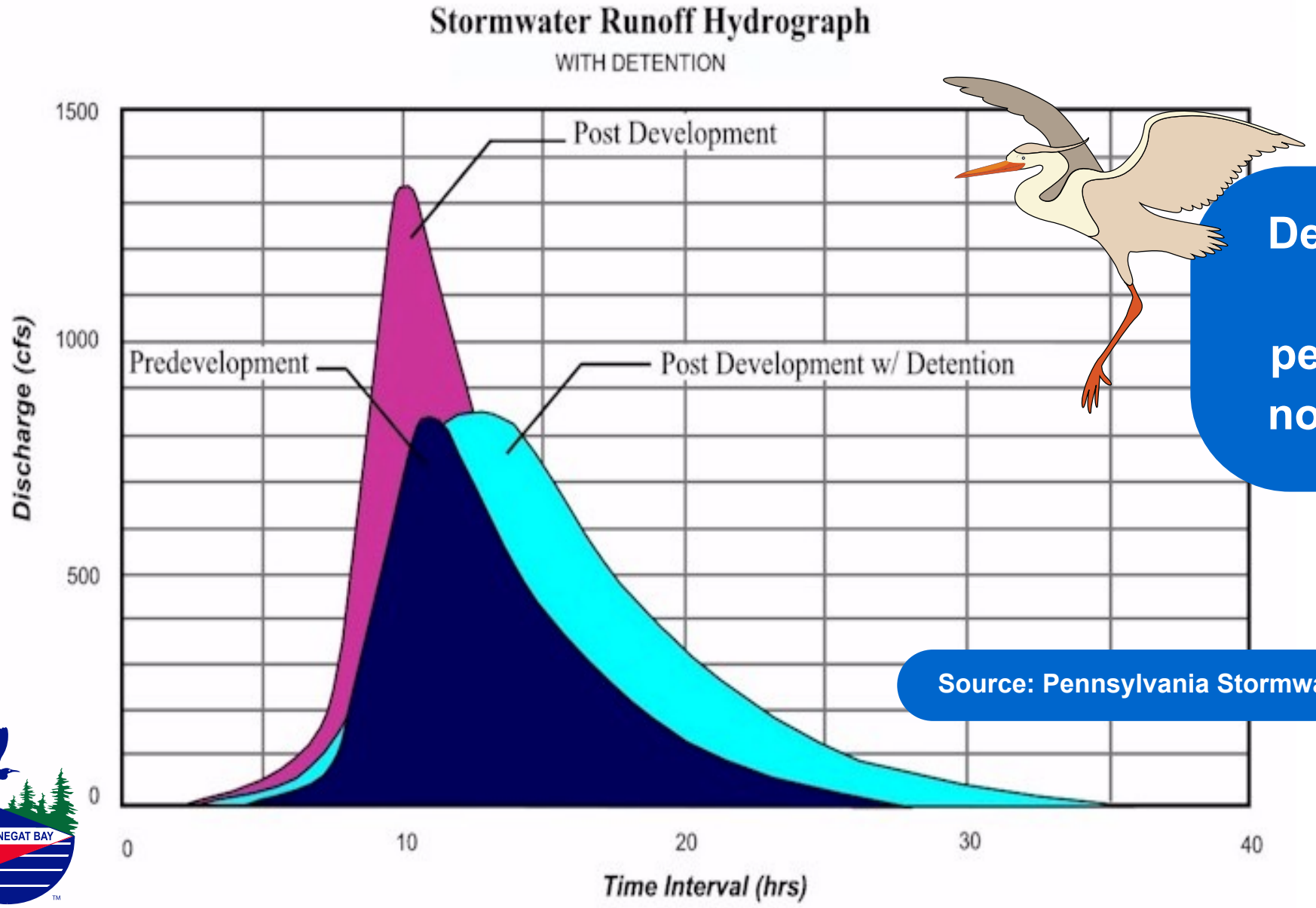
Part 2

The Problem With Detention

Detention Approach to Managing Runoff

- Quickly concentrate and move runoff away from structures.
- Route runoff to centralized detention basin.
- Store runoff for a fixed time and released at controlled rate.
- **Results:**
  - Peak flow decreased.
  - Minimal volume reduction.
  - Only 60% TSS removal.



Detention does reduce peak flow…but not much more

Source: Pennsylvania Stormwater Management Manual

Detention Doesn't Solve All Runoff Problems

We also need to…

- Reduce runoff volume.
- Recharge precipitation.
- Remove or reduce pollutants… including nutrients.

Conventional Detention Basin

- No volume reduction.
- Compacted soils limit groundwater recharge.
- Low pollutant removal efficiency exacerbated by low flow channel.
- Increased regional flooding and channel instability problems.
- Limited ecological benefits.
- Poor aesthetics.

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Beyond Detention

Naturalization

Minimal modification of the existing basin, no reconditioning of basin soils and no re-planting…basin allowed to “go fallow”.

Retrofit

Involves an extensive modification of the existing basin including reconditioning of the soils and re-planting of basin with specific types of plants.

Success of Naturalization Starts With Better Design

- Make stormwater management a priority not an after thought… applies for new development, redevelopment and retrofits.
- Don’t settle for “end of pipe” detention.
- **DO NOT** consider naturalized stormwater facilities **as innovative**, rather make it the routine approach.
- Naturalization and retrofit projects yield better stormwater control and treatment.

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Planning …

The Key To Proper Design and Community Acceptance

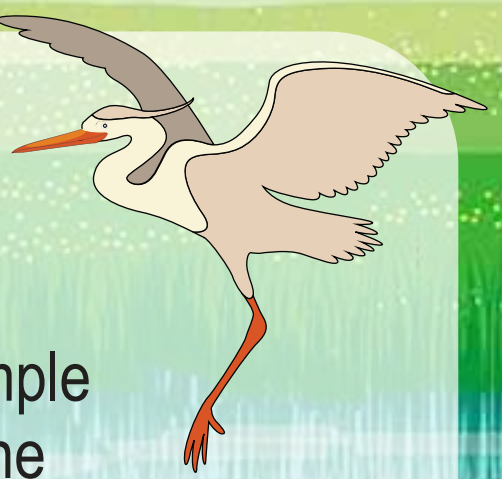
- Naturalization / retrofit often faced with community pushback.
- Fear of change, fear of nature, maintenance concerns.
- Community acceptance must be considered in the design process… start education and outreach early!
- Low maintenance, deep rooted grasses should be the workhorse element of naturalized/retrofitted basins…not as showy but very sustainable.
- Will this philosophical change be easy? Absolutely not, because change is difficult and stormwater design has been inherently conservative for many, many years.

The Bioretention Approach

- Utilize specialized soils and plants to passively treat runoff.
- Keep runoff on site for as long as possible; retain, assimilate and recharge!
- Focus on smaller storm events (0.5, 1, and 2-year storms)

But scalable…works for small and large catchment areas.

Functionality of Bioretention



- Vegetation - Filters (sediment) and assimilates pollutants (nutrients).
- Vegetation – via both photosynthetic transpiration and simple evaporation reduces the volume runoff discharged from the basin.
- Vegetation – deep rooting vegetation promotes and enhances infiltration of runoff. Maintains soil porosity.
- Soil medium - filters pollutants and soil voids facilitate storage and infiltration of runoff.

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Let's Not Forget About the Soil

- **Soils effectively…**
  - Store runoff (soil pores/voids)
  - Attenuate runoff (via recharge)
  - Process pollutants (physically and biologically)
- Cannot be compacted or too silty or clayey
- Need high (7-15% by weight) organic content
- Need 2' separation from SHWT… or underdrain

Common Design Specs for Bioretention

- Storage volume above planting bed great enough to fully contain the runoff produced by the water quality storm; 1.25”/2-hr. storm or 2.75”/24 hrs.
- Soil bed having high sand and organic content.
- Minimum 1’ -2’ separation between bottom of soil bed and SHWT.
- Must drain/dewater within 72 hours…no standing water between storm events.

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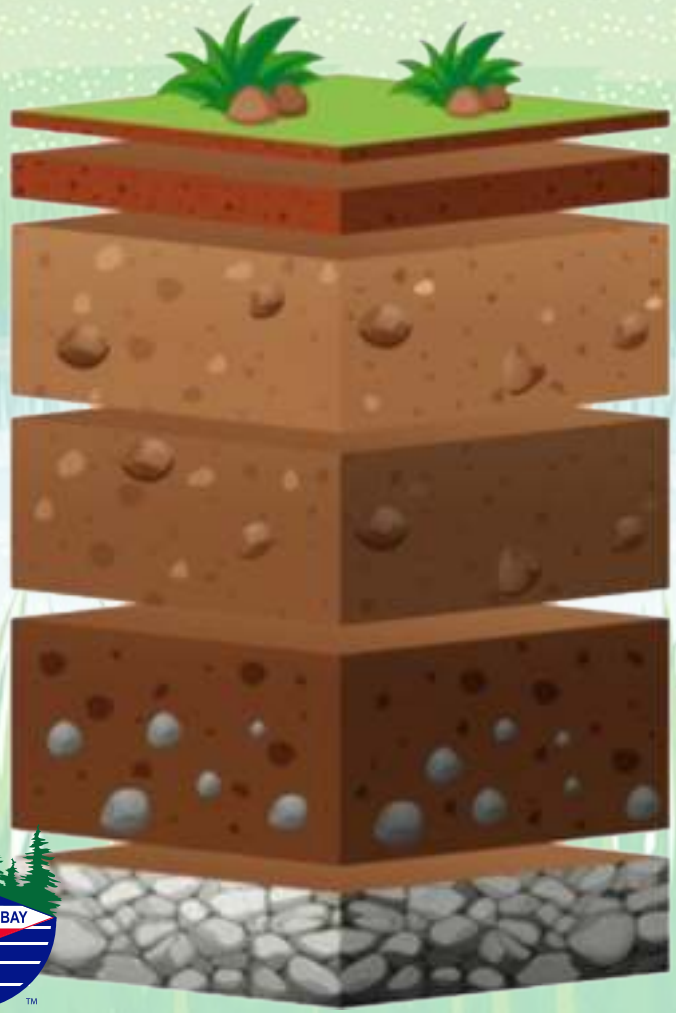
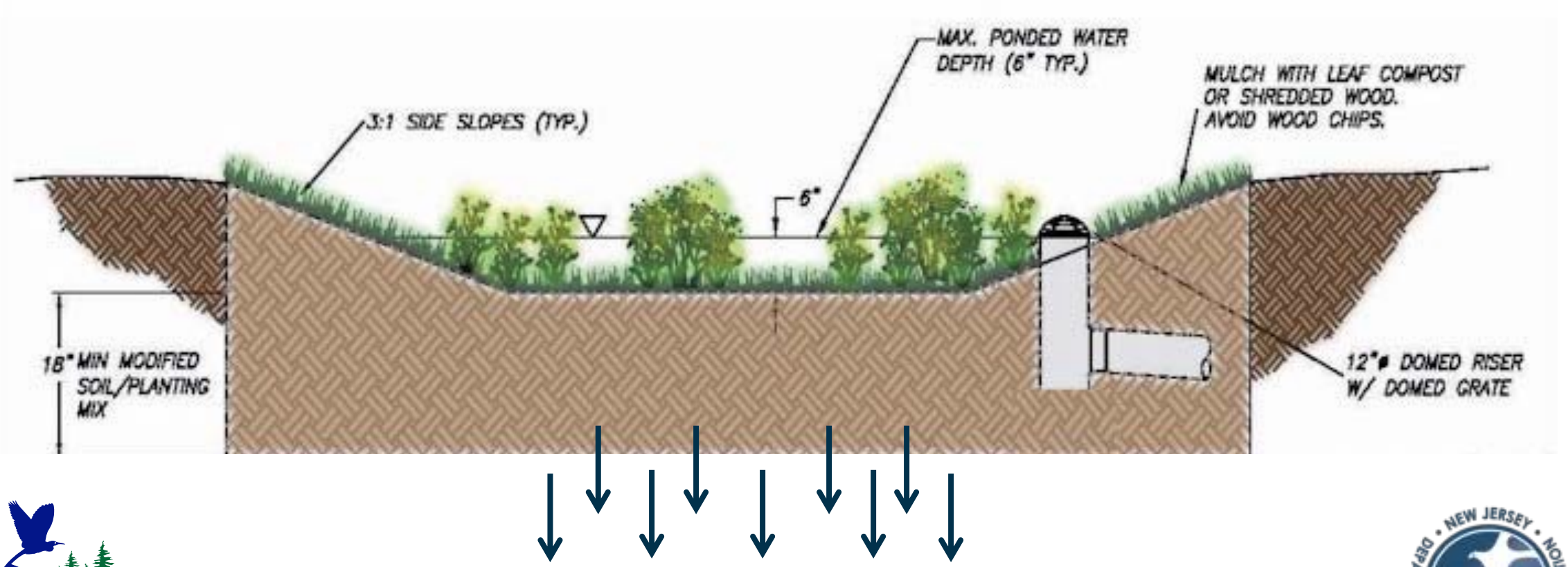
Bioretention Soil Mix



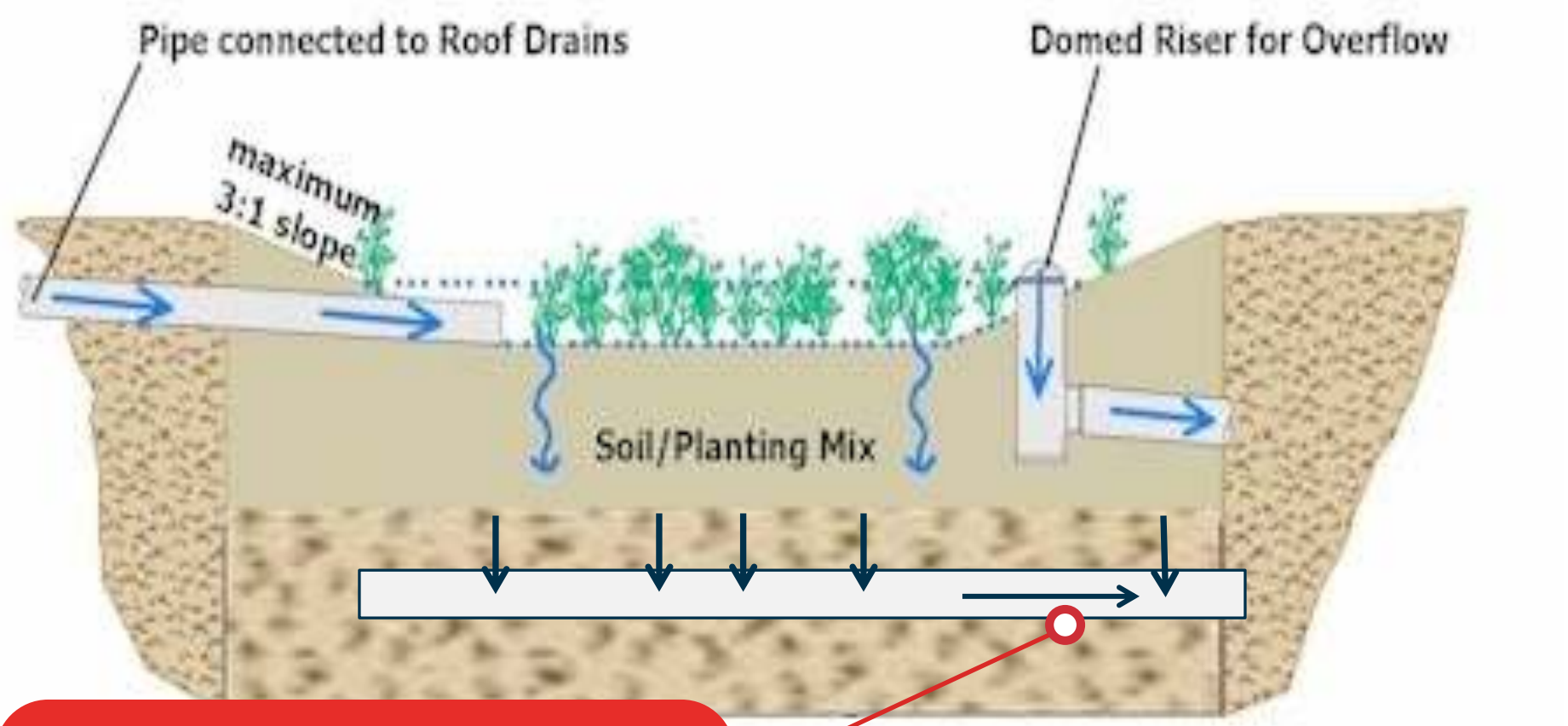
- Soil composition by weight
- Sand: 85 to 95%,
- Mostly course; <25% fine or very fine sands
- Silt: < 15%
- Clay: < 5%
- Organic content: 3 to 7% (prefer 10-12%)
- pH: 5.5 to 6.5

Bioretention Without Underdrain



Chapter 6.4.5 of PADEP Manual

Bioretention With Underdrain



Under drain prevents standing water

Chapter 6.4.5 of PADEP BMP Manual

Plant Selection

- Seed, plugs, plants…all acceptable.
- Closely examine “pre-packaged” seed mixes… often spending money on seeds that will never germinate.
- Use native plant material that is sourced from local nurseries.

Make sure hydrology supports the proposed plant mix…most bioretention systems are relatively dry.

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Match Plants to "Typical" Hydrologic Conditions

Common Name	Scientific Name	Plant Type	Hydrologic Zone	Wetland Indicator	Inundation Tolerance	Commercial Availability
Bulrush, river	Scirpus fluviatilis	Grass-like	[1,2],3	OBL	0-1′	Seed
Bulrush, softstem	Scirpus tabermontanii	Grass-like	[1,2],3	OBL	0-1′	Plants, Seed
Bulrush, three-square	Scirpus pungens	Grass-like	[2,3],4	FACW+	0-6″	Plants, Seed
Burnet, Canada	Sanguisorba canadensis	Perennial	4,[5,6]	FACW+	Yes	Plants
Burreed, American	Sparganium americanum	Emergent Perennial	[1,2],3	OBL	0-1′	Plants, Seed
Burreed, giant	Sparganium eurycarpum	Emergent Perennial	[1,2],3	OBL	Yes	Plants, Seed
Bushclover, roundheaded	Lespedeza capitata	Legume	4,5,6	FACU	No	Seed, Plants
Butter-cup, yellow water	Ranunculus flabellaris	Perennial	[2,3,4]	FACW	Yes	Plants
Butterflyweed	Asclepias tuberosa	Perennial	[5,6]	NI	No	Plants, Seed
Cardinal flower	Lobelia cardinalis	Perennial	1,[2,3],4	FACW+	Yes	Plants, Seed

Source – NJ Stormwater Best Practices Manual – Chapter 7 Landscaping

PLANT DIVERSITY

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Part 4

Case Study Example of Basin “Naturalization”

SITE LOCATION MAP

STORMWATER IMPROVEMENT PROJECT
MARION F. CLAWSON MEMORIAL PARK
TOWNSHIP OF EAST AMWELL
HUNTERDON COUNTY, NEW JERSEY

PRINCETON HYDRO, LLC.
1108 OLD YORK ROAD
P.O. BOX 720
RINGOES, NJ 08551
*with offices in NJ, PA and CT

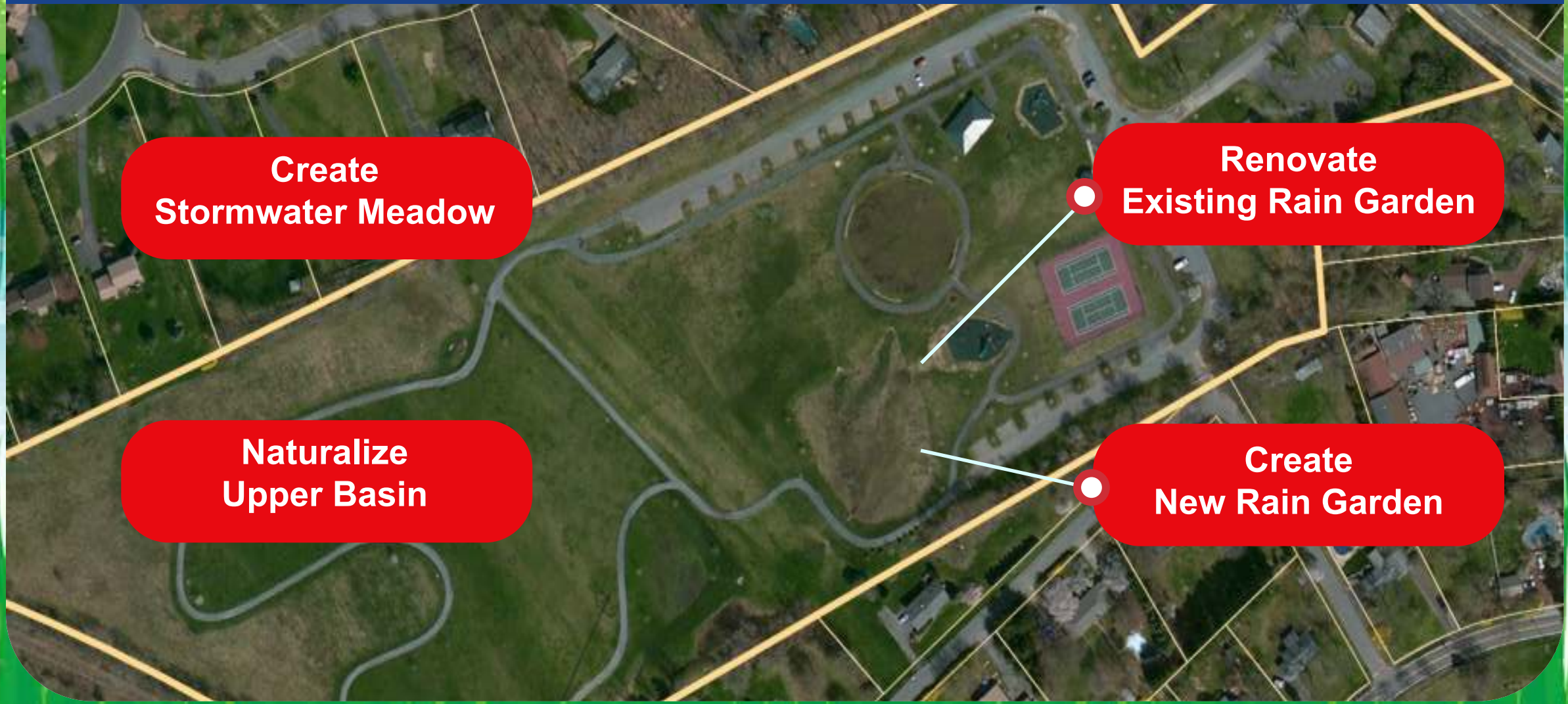
NOTES:
1. Project area is approximate.
2. 2015 orthophotos obtained from state information warehouse website: http://njgin.state.nj.us/NJ_NJGINExplorer/

0 375 750 Feet

Clawson Park

- 319(h) Funded project…total cost $125,000.
- Headwater area of Back Brook (Neshanic and Raritan drainage)…nutrient, sediment and FC impairments.
- History of frequent localized flooding, lack of stormwater quality management.
- Objective retain runoff, decrease nutrient loading, decrease nuisance flooding, improve aesthetics.

Primary Project Elements



Clawson Park | Existing ConditionsUpper Basin

Localized Flooding

Poor Soils | Compacted Clays/Shale

Basin Renovation - Strip Turf and Loosen Compacted Soils

Dig & Drop and Deep Soil Tilling

Incorporating Organic Material

Basin Ready for Planting -2016

Clawson Park

Clawson Park Bioretention Basin – June 2019

Clawson Park

Bioretention Basin – August 2020

Upper Basin Late Winter

Following Major Storm March 2020

Upper Basin

Post- Storm/Pre-Seasonal Mowing – Winter 2021

Upper Renovated Basin

June 2021

Seed Mix for Upper Basin

BOTANICAL NAME:	SPECIES NAME:	APPROXIMATE RATE (LBS PURE LIVE SEED/ACRE)	INDICATOR STATUS:
ECHINACEA PURPUREA	PURPLE CONEFLOWER	1/2	-
ERAGROSTIS SPECTABILIS	PURPLE LOVEGRASS	4	FACU
LOLIUM MULTIFLORUM	ANNUAL RYE	15	-
PERSICARIA PENSYLVANICA	PENNSYLVANIA SMARTWEED	2	FACW
RUDBECKIA HIRTA	BLACK EYED SUSAN	1/4	FACU
SCHIZACHYRIUM SCOPARIUM	LITTLE BLUE STEM	6	FACU
TRIDENS FLACUS	PURPLETOP	2	UPL
SYMPHYOTRICHUM LATERIFLORUM	CALICO ASTER	1/8	FAC
SOLIDAGO JUNECA	EARLY GOLDENROD	1/4	-
CHAMAECRISTA FASCICULATA	PARTRIDGE PEA	1	FACU

LAWN RESTORATION SEED MIX: TO BE SOWN IN ALL AREAS OF DISTURBANCE EXCLUDING DESIGNATED MEADOW PLANTING AREA

BOTANICAL NAME:	SPECIES NAME:	APPROXIMATE RATE (LBS PURE LIVE SEED/ACRE)	INDICATOR STATUS:
FESTUCA BREVIPILA	HARD FESCUE	120	UPL
LOLIUM PERENNE	PERENNIAL RYEGRASS	30	FACU
POA PRATENSIS	KENTUCKY BLUEGRASS	40	FACU

Post 6”-6 hr. Rainfall 19 July 2021

Conventional detention basin

Post 6”-6 hr. Rainfall 19 July 2021

Renovated Basin

Oh Yeah…What About Maintenance?

- Train staff ahead of time…not same as routine mowing… provide detailed O&M Manual.
- Schedule and track maintenance…good record keeping increases success… there are apps for that!
- Need for specialized machinery and manual care...
  - Low pressure equipment prevents soil compaction and rutting.
  - Variable height mowers, don't scalp plants.
  - Weed whacking, hand pulling and spraying of invasive plants.

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Oh, This Is Going To Be Expensive!

- Montgomery Township (PA) Shade Tree Commission1, the first and second year basin maintenance is greater due to possible re-seeding, plant establishment and weed removal….But then drops to $200-300/yr. vs. $2,500-$3,000/yr. for conventional basins.
- NJ data2 shows annual cost saving of $4,000/basin
- Largely a function of mowing 1 or 2 times/yr. as opposed to weekly.
- Also frees up staff to conduct other PW projects.

Sources |
1 - https://www.montgomerytwp.org/egov/documents/1505934972_1622.pdf
2 - https://njaes.rutgers.edu/fs1195/

Another Example…

- In 2003, the Perkiomen Watershed Conservancy and Lower Providence Township naturalized six grassed detention basins.
- Start by educating public…then removed concrete low flow channels, removed turf, planted with native trees, shrubs, and mixture of perennial meadow and wildflower species.
- Naturalizing the six basins saved Lower Providence Township > $9,600 /yr. in maintenance costs.

https://www.montgomeryconservation.org/wp-content/uploads/2013/07/site2.pdf

In Summary

- Improperly managed stormwater causes environmental and ecological impacts.
- Its not just the major storms that cause problems…chronic WQ, environmental and societal impacts linked to smaller, more frequent rain events.
- Standard, “end-of-pipe” detention techniques don’t provide correct solution.

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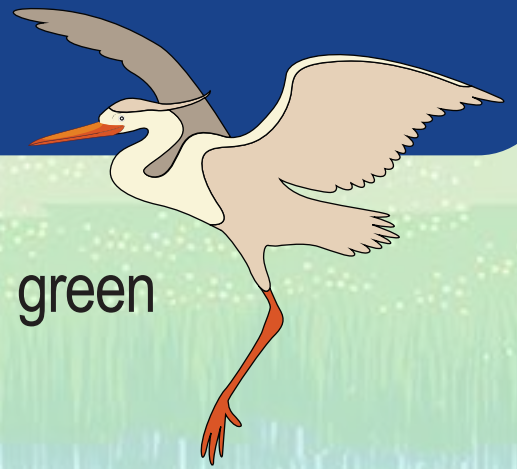
In Summary



- Bioretention is the most commonly implemented green infrastructure technique.
- Bioretention approach especially well suited for comprehensive management of smaller, more frequent rain fall events.
- Bioretention highly scalable and adaptable to wide range of applications, especially urban redevelopment
- Perfect for retrofit of conventional detention basins.

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In Summary

- Naturalized and renovated detention basins, capable of controlling peak flow.
- But more importantly, far more effective at reducing the volume of runoff, increasing recharge and decreasing pollutant loading.
- A function of plants and soil media work in concert to yield the desired results.

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In Summary

- Success of basin naturalization/retrofit projects a function of “homework”… understanding hydrology, hydraulics and environmental attributes of site and of the targeted basin.
- Be careful w/ plant selection...converted basins are often drier than expected.
- Don’t compact soil during renovation.
- Make sure design facilitates maintenance.

In Summary

- Don’t oversell public on post-renovation aesthetics.
- Plant community and basin appearance will change over time… seasonal succession, invasive species and extent of maintenance.
- Best to make deep rooted, low maintenance grasses the “work horse” species and integrate more showy plants along perimeter.

Thank You...

Questions?

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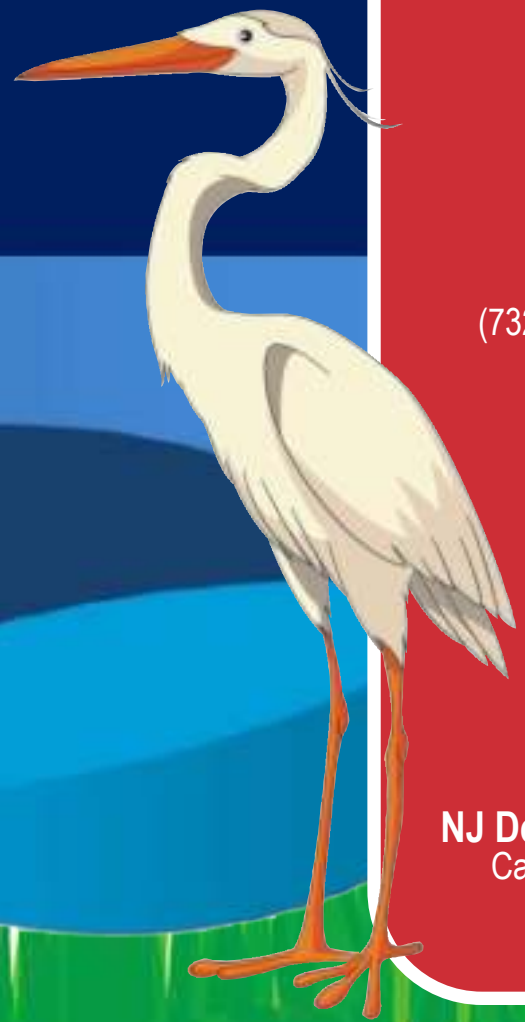
CWC



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