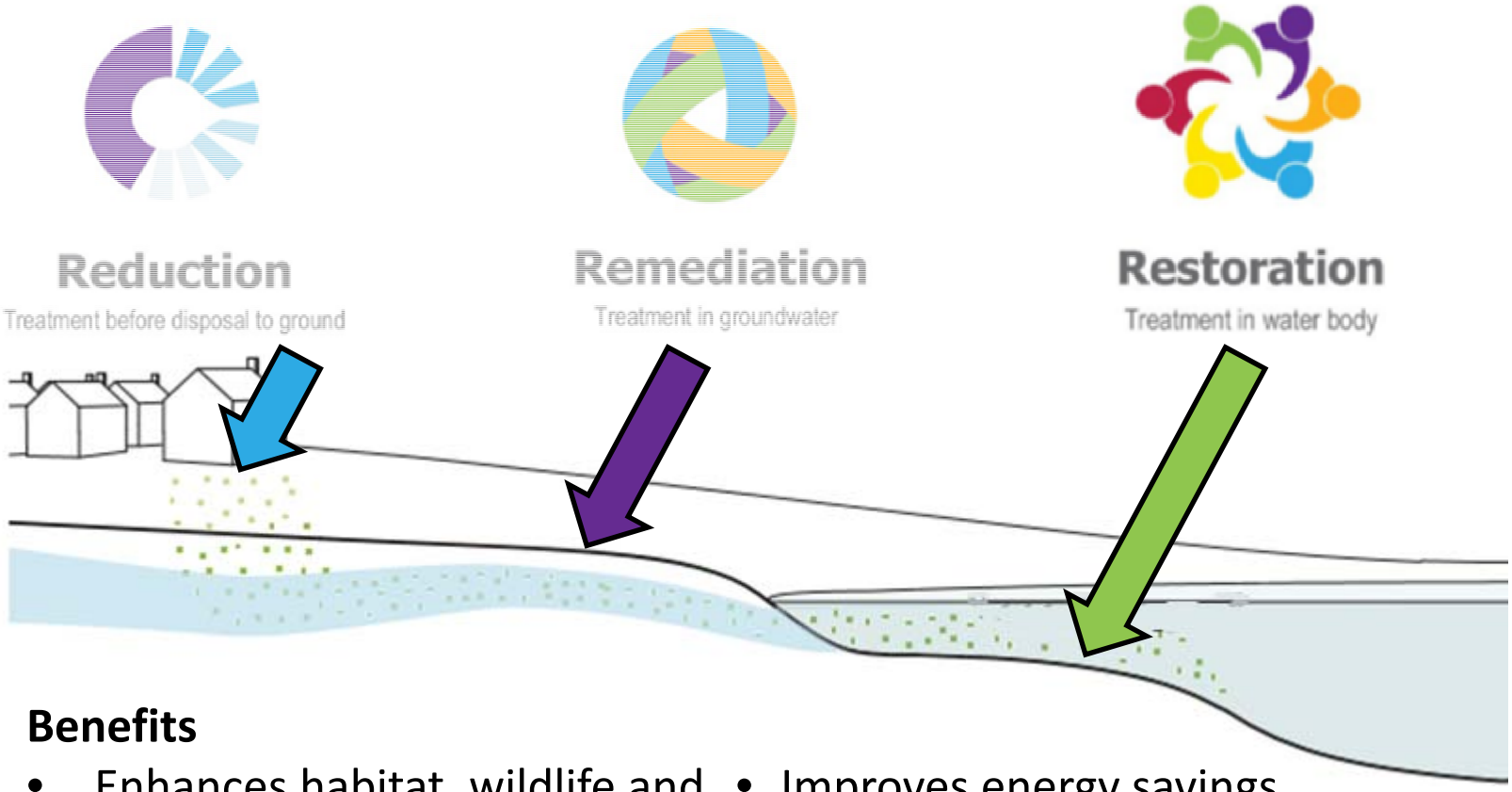
Non-Traditional Technologies for Nutrient Management

Amanda Ruggiero, PE

Town of Barnstable

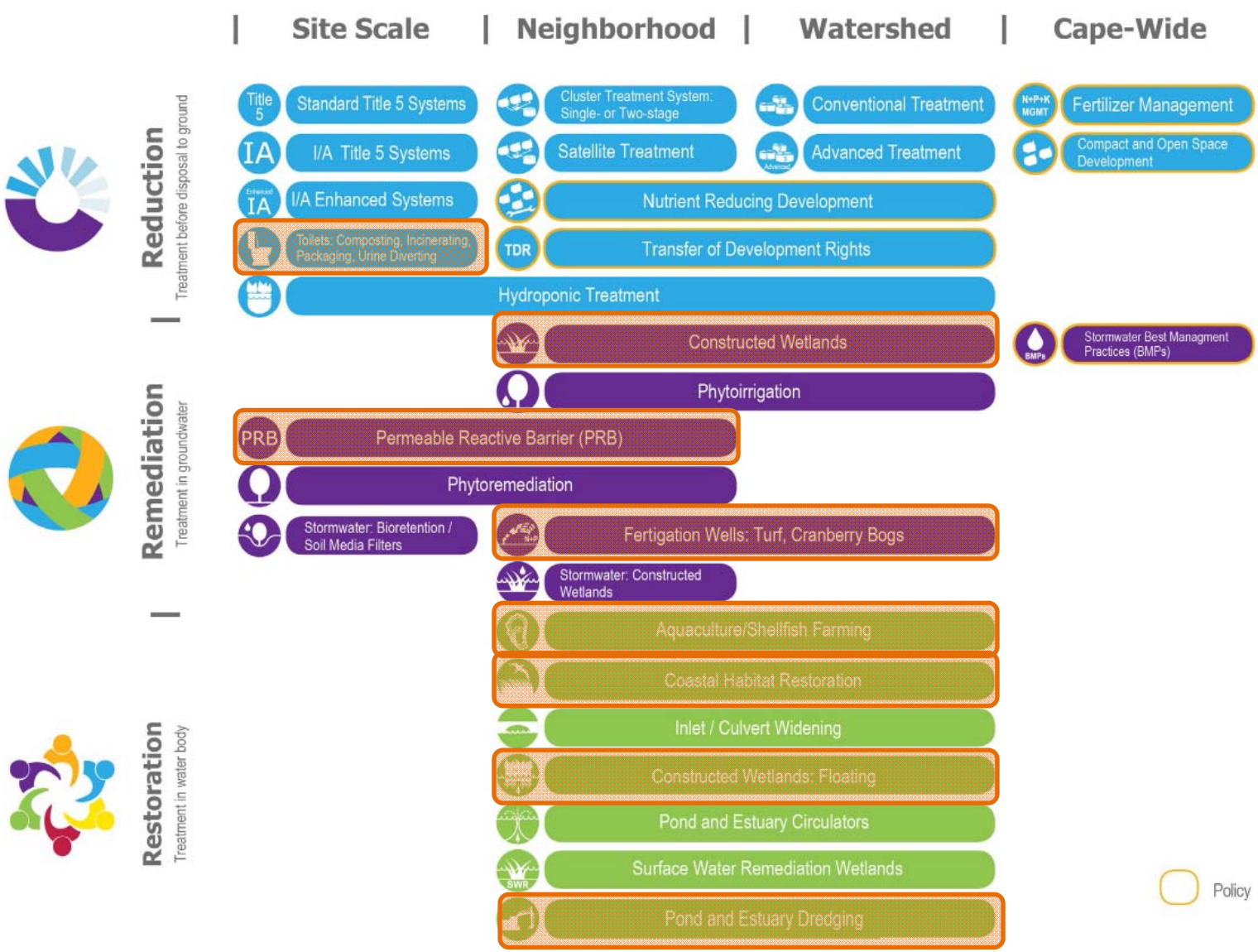
Assistant Town Engineer

208 Plan Solution Categories



Benefits

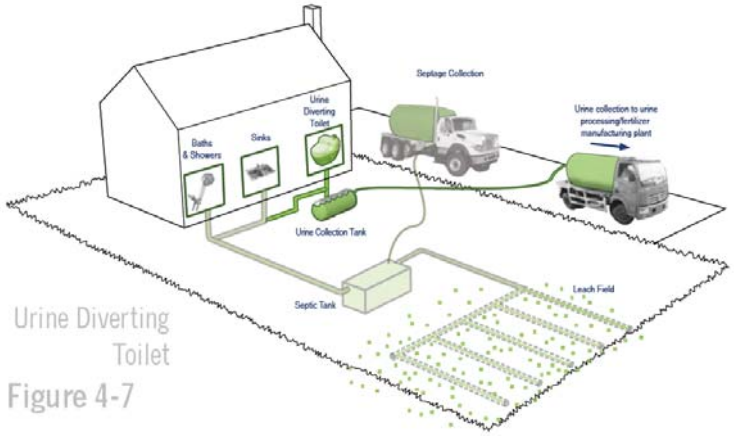
- Enhances habitat, wildlife and biodiversity
- Promotes green space, conservation and recreation
- Improves energy savings, nutrient recovery and recycling
- Improves management of flooding


Site Scale
Neighborhood
Watershed
Cape-Wide
Reduction
Treatment before disposal to ground
Remediation
Treatment in groundwater
Restoration
Treatment in water body
Title 5
Standard Title 5 Systems
IA
I/A Title 5 Systems
Enhanced IA
I/A Enhanced Systems
Toilets: Composting, Incinerating, Packaging, Urine Diverting
Hydroponic Treatment
Cluster Treatment System: Single- or Two-stage
Satellite Treatment
Nutrient Reducing Development
TDR
Transfer of Development Rights
Constructed Wetlands
Phytoirrigation
PRB
Permeable Reactive Barrier (PRB)
Phytoremediation
Stormwater: Bioretention / Soil Media Filters
Stormwater: Constructed Wetlands
Fertigation Wells: Turf, Cranberry Bogs
Aquaculture/Shellfish Farming
Coastal Habitat Restoration
Inlet / Culvert Widening
Constructed Wetlands: Floating
Pond and Estuary Circulators
SWR
Surface Water Remediation Wetlands
Pond and Estuary Dredging
Conventional Treatment
Advanced Treatment
N+P+K MGMT
Fertilizer Management
Compact and Open Space Development
BMPs
Stormwater Best Managment Practices (BMPs)
Policy

Toilets: Urine Diverting & Composting

Reduction

Treatment before disposal to ground



Urine Diverting Toilet

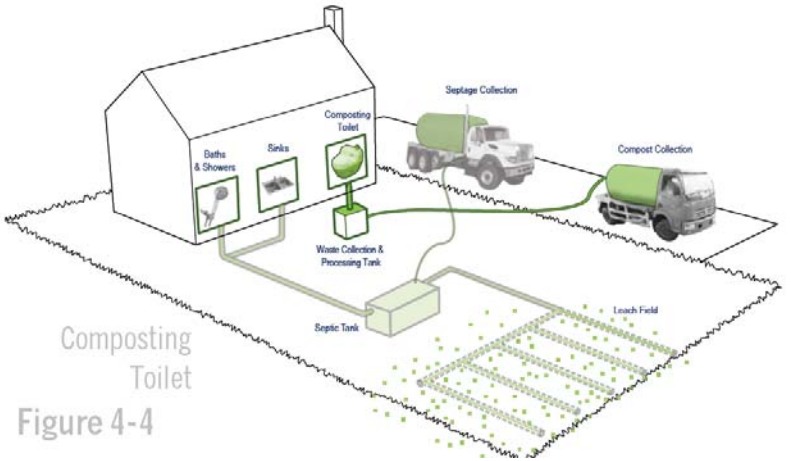
Figure 4-7

Urine Diverting Toilet

- **Diverts urine** into a separate holding tank for fertilizer processing

Composting Toilet

- **Diverts human waste** into a separate holding tank for composting



Composting Toilet

Figure 4-4

Toilets: Urine Diverting & Composting

Reduction

Treatment before disposal to ground

Urine Diverting Toilet

Nitrogen Removal 40% to 60%

Phosphorus Removal 25% to 50%

$333	$2,912
Removal Cost per kg N (avg life cycle)	Removal Cost per kg P (avg life cycle)
20 years	1 to 10 years
Useful Life	Time to See Results

SPECIFIC PERFORMANCE CHALLENGES

- Requires company infrastructure to pick up package
- Tight tank for urine storage required.

SPECIFIC POTENTIAL PERMITTING AUTHORITIES

- Municipality (Local plumbing inspector)
- Municipal Board of Health

Composting Toilet

Nitrogen Removal 70% to 80%

Phosphorus Removal 25% to 50%

$266	$2,323
Removal Cost per kg N (avg life cycle)	Removal Cost per kg P (avg life cycle)
20 years	1 to 10 years
Useful Life	Time to See Results

SPECIFIC PERFORMANCE CHALLENGES

- Requires ongoing maintenance to function correctly
- Requires independent citizens to change systems to be cost effective

Remediation

Treatment in groundwater

Constructed Wetland

- Primary treated wastewater is slowly **filtered** under 3-8 inches of **plant root** zones and **soil media**.
- Reclaimed water is **discharged into the groundwater**

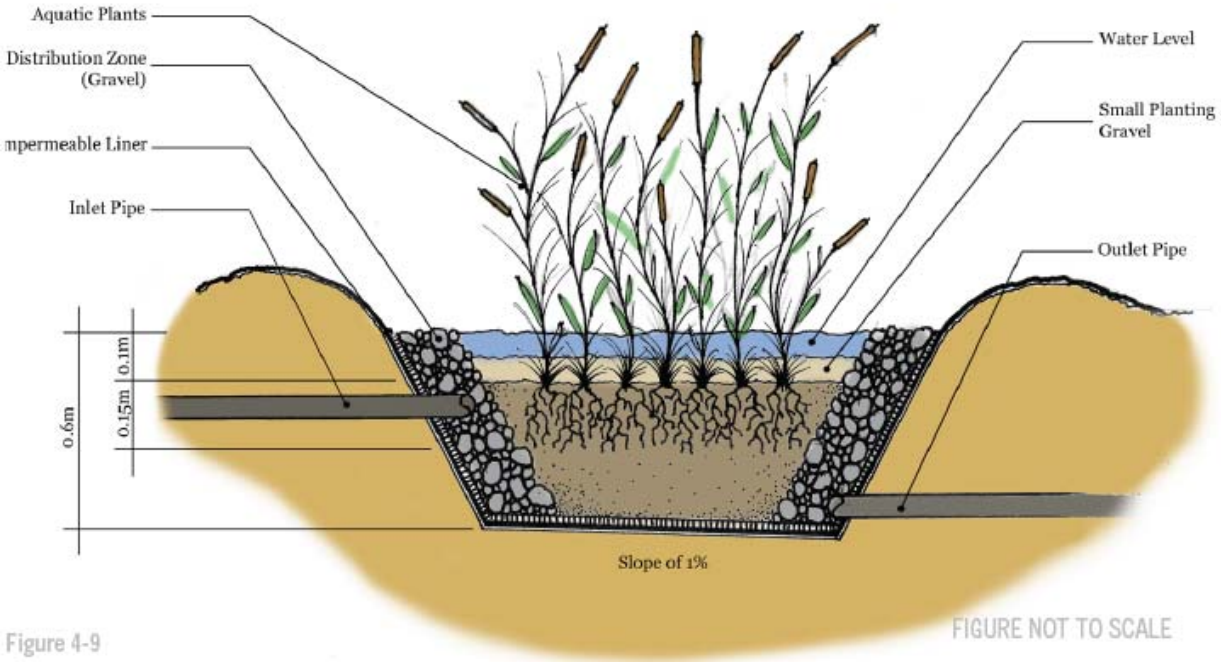
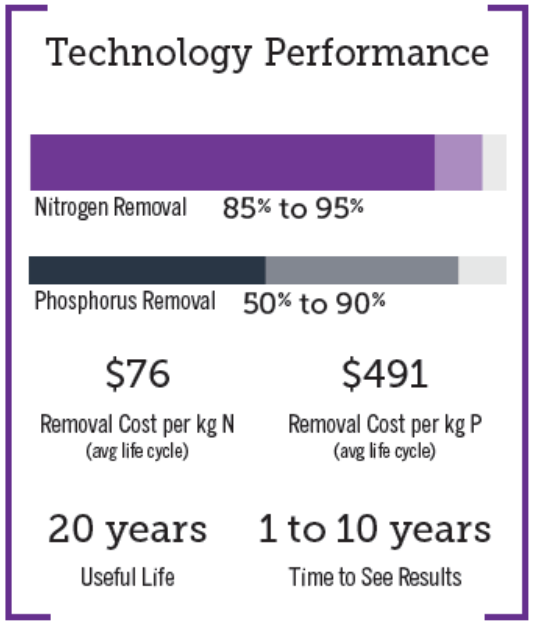


Figure 4-9

Constructed Wetland

Remediation

Treatment in groundwater



Challenges & Risks

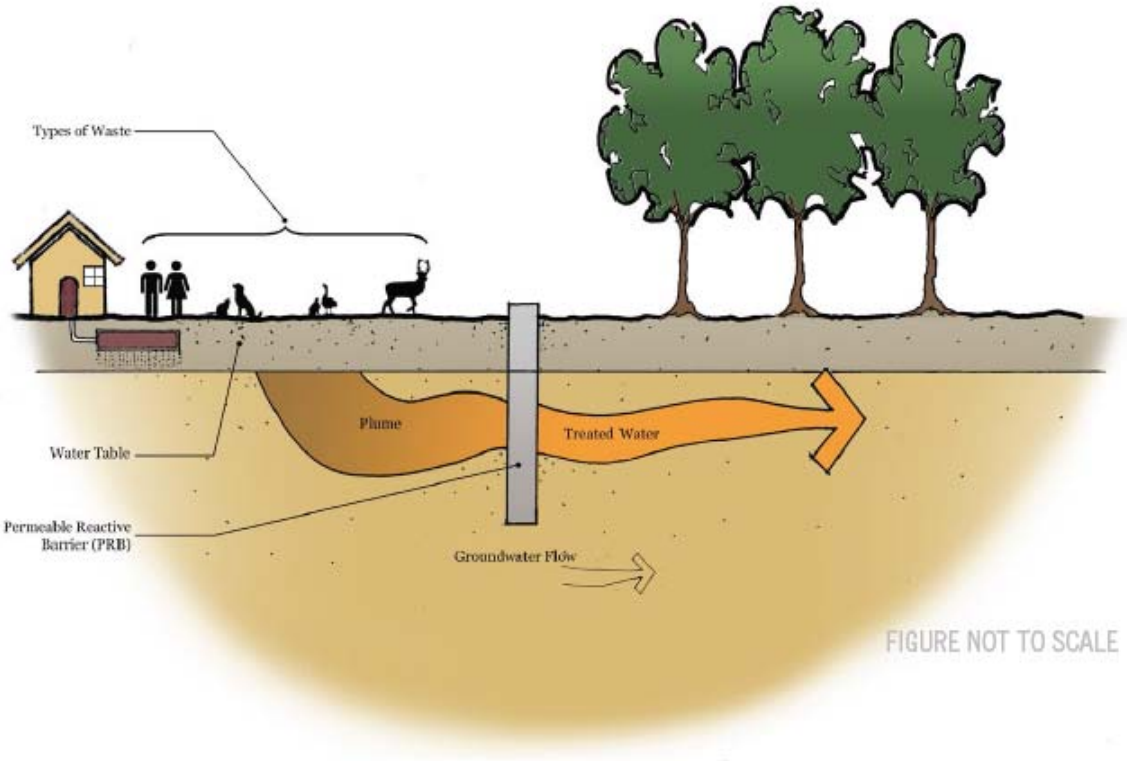
- Site restrictions such as greater than half acre required; outsides all 100 years flood zone and other sensitive areas; greater than 4 feet depth to ground water
- May require carbon source initially
- May become clogged and reduces phosphorus removal over time
- May attract water fowl
- May need to be lined

Remediation

Treatment in groundwater

Permeable Reactive Barrier- Trench

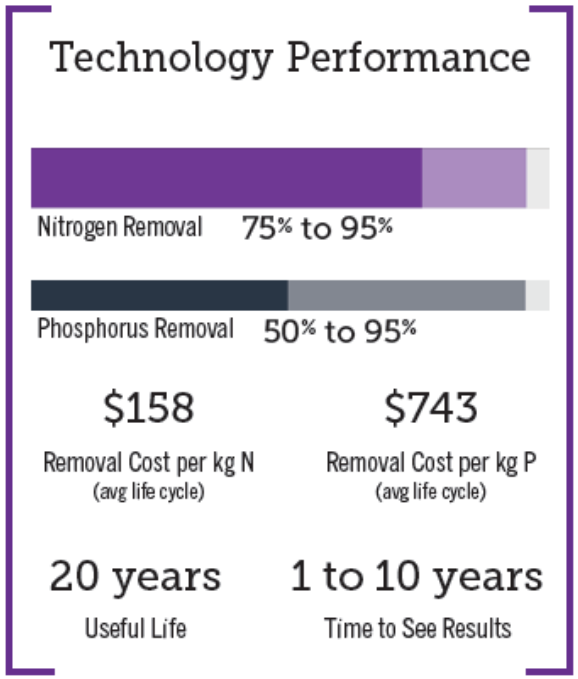
- A **barrier** consisting of coarse sand, wood chips and compost is installed in the aquifer to **intercept nitrogen** enriched groundwater
- Microbes **consume the carbon** source to develop an anaerobic environment **releasing nitrogen**



Permeable Reactive Barrier- Trench

Remediation

Treatment in groundwater



Challenges & Risks

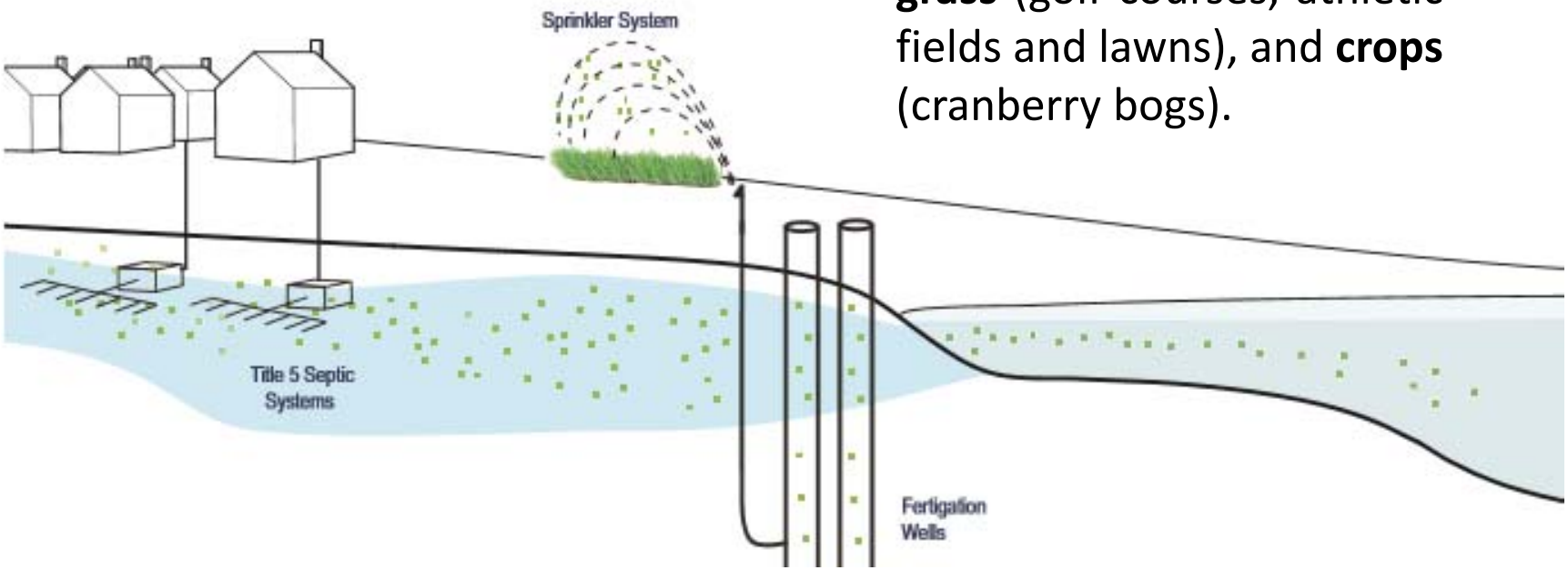
- Site restrictions including requiring a minimum of 20 feet of saturated aquifer
- May require buffering agent to maintain pH
- Requires upstream and downstream groundwater monitoring
- Requires a detail hydrogeological investigation and groundwater modeling to estimate effectiveness

Remediation

Treatment in groundwater

Fertigation

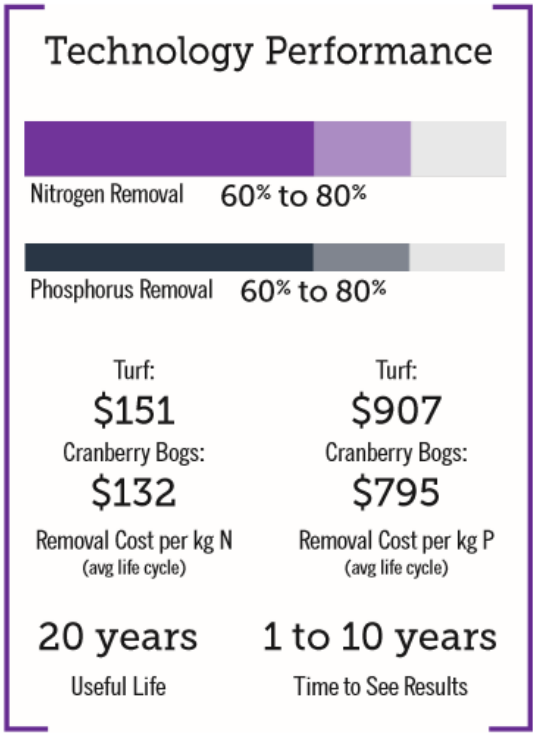
- Installing wells to pump off **nitrogen enriched groundwater**
- Utilizing the water to irrigate and **fertilize turf grass** (golf courses, athletic fields and lawns), and **crops** (cranberry bogs).



Fertigation

Remediation

Treatment in groundwater



Challenges & Risks

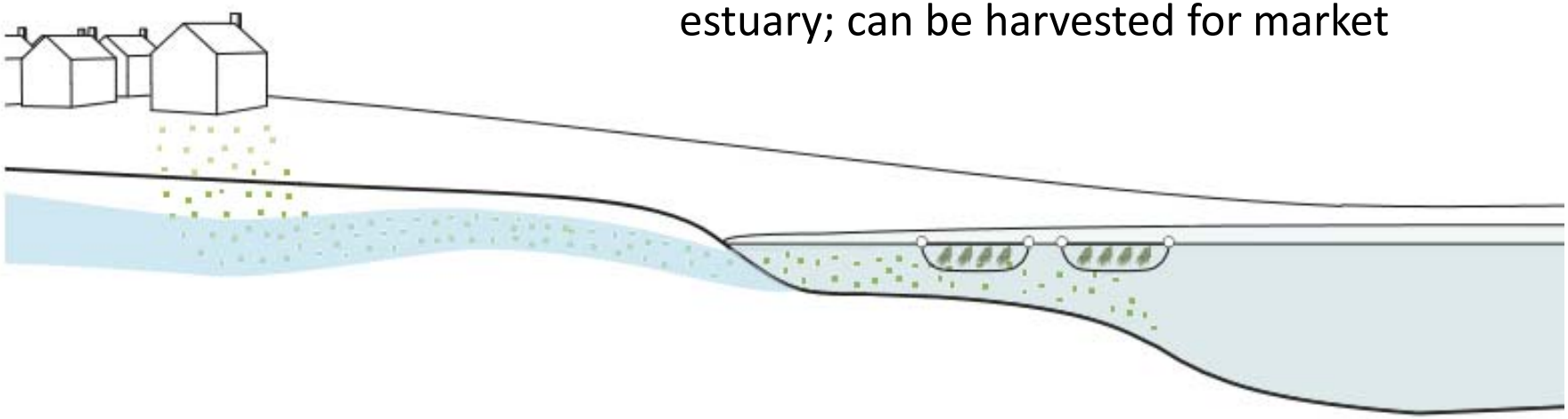
- Seasonal technology
- Location is specific to 'plumes' (i.e. downstream of WPCF)
- Requires monitoring

Restoration

Treatment in water body

Aquaculture Mariculture

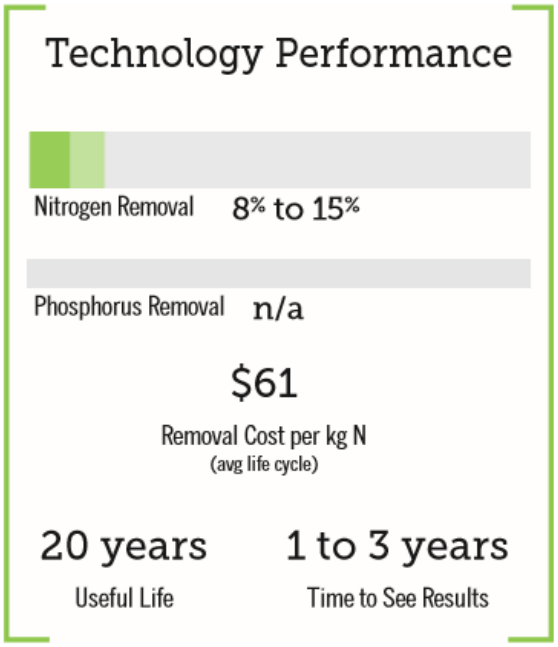
- Planting seaweed and other marine vegetation
- **Seaweed** will **consume** the **nitrogen load**
- Seaweed will need to **cultivated** in order **to remove the nitrogen** from the estuary; can be harvested for market



Aquaculture Mariculture

Restoration

Treatment in water body



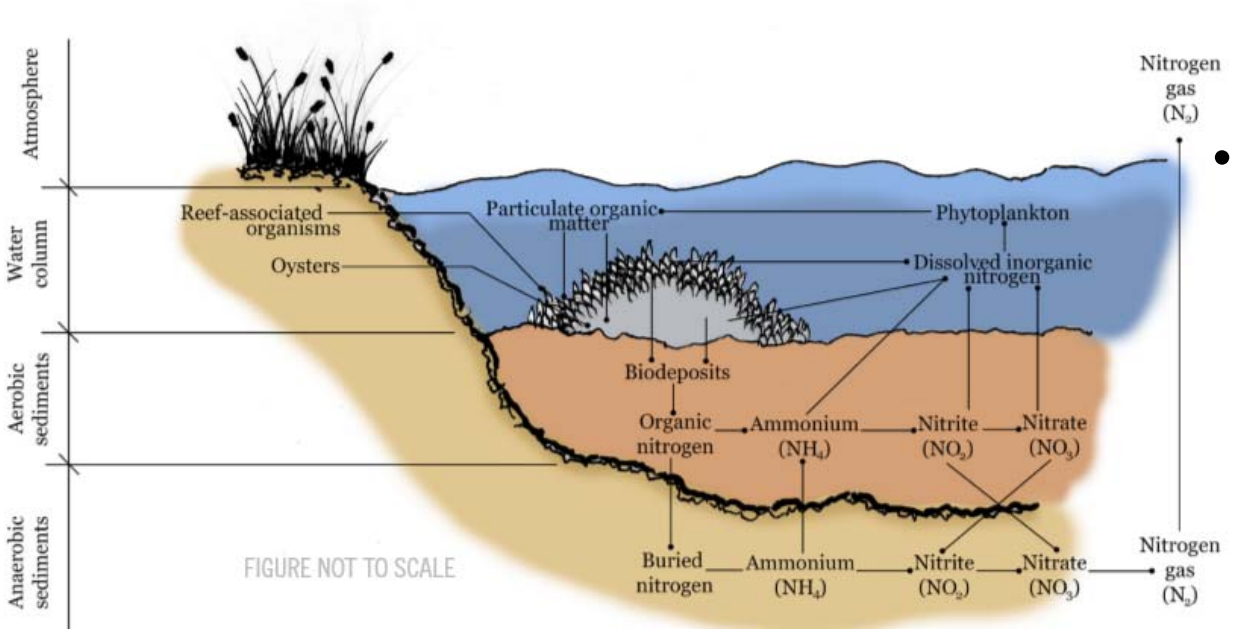
Challenges & Risks

- Growing conditions, aesthetics or navigation may be limited
- Susceptible to disease
- Requires operation and maintenance for the removal of the vegetation

Shellfish Farming

Restoration

Treatment in water body

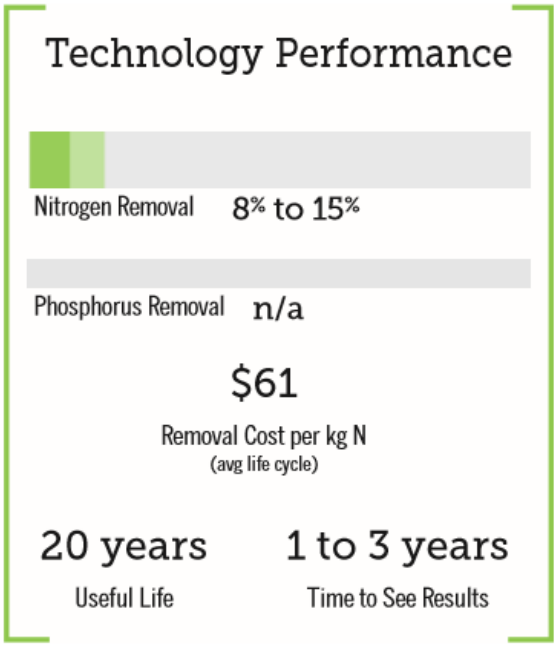


- Encouraging a positive environment for **maturing oysters**
- Growing and removal of **mature oysters** can **remove nitrogen** from an estuary

Shellfish Farming

Restoration

Treatment in water body



Challenges & Risks

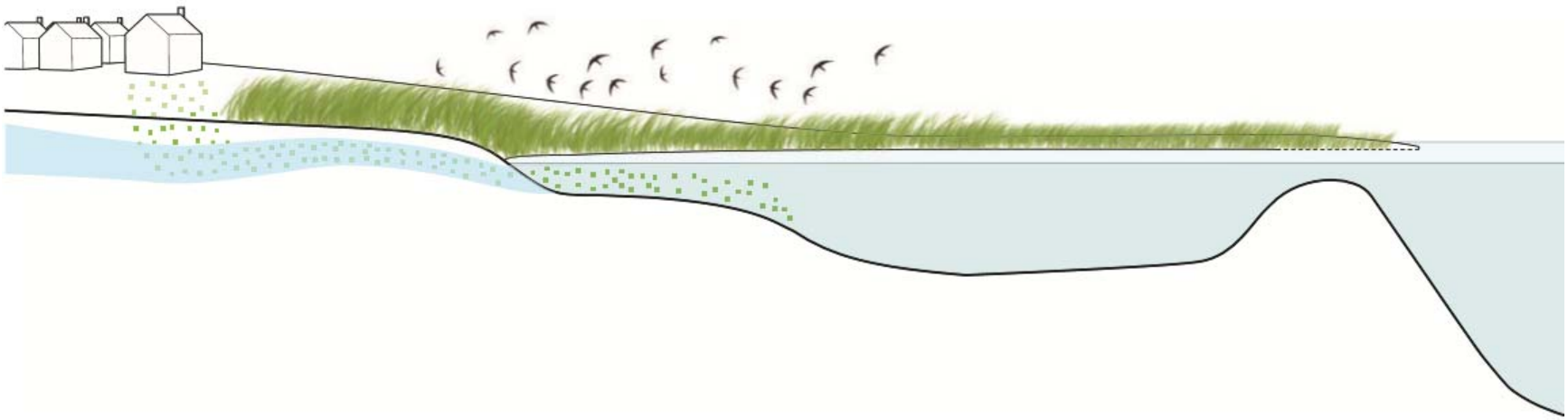
- Growing conditions, aesthetics or navigation may be limited
- Susceptible to disease or population crash
- Requires operation and maintenance for the removal of the oysters
- Large concentrations can generate water products, reduced dissolved oxygen levels and generate ammonia
- Require large, saline areas

Restoration

Treatment in water body

Coastal Habitat Restoration

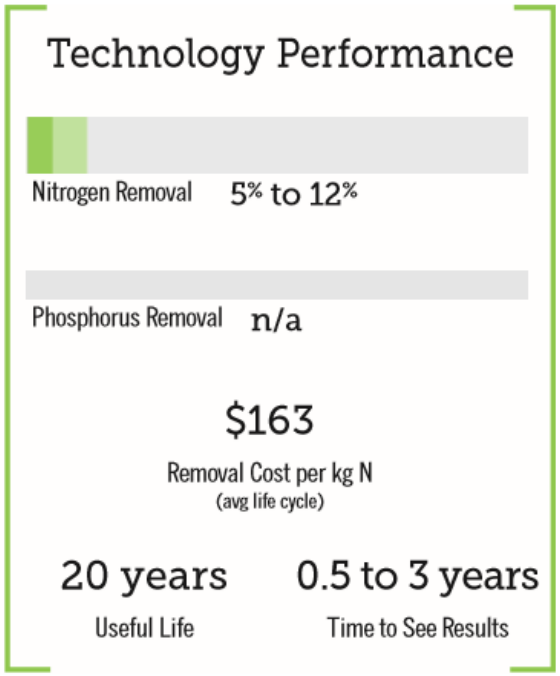
- Establishing and/or enhancing estuary **salt marshes, eel grass beds** will naturally **remove nitrogen** if they are being **optimized**



Coastal Habitat Restoration

Restoration

Treatment in water body



Challenges & Risks

- Reduction in efficiency due to exposure to saline waters

Restoration

Treatment in water body

Constructed Wetlands- Floating

- Manmade **floating islands** made of recycled materials that **reduce nitrogen and phosphorus** by creating an environment in **plant's roots** for fish and microorganisms.

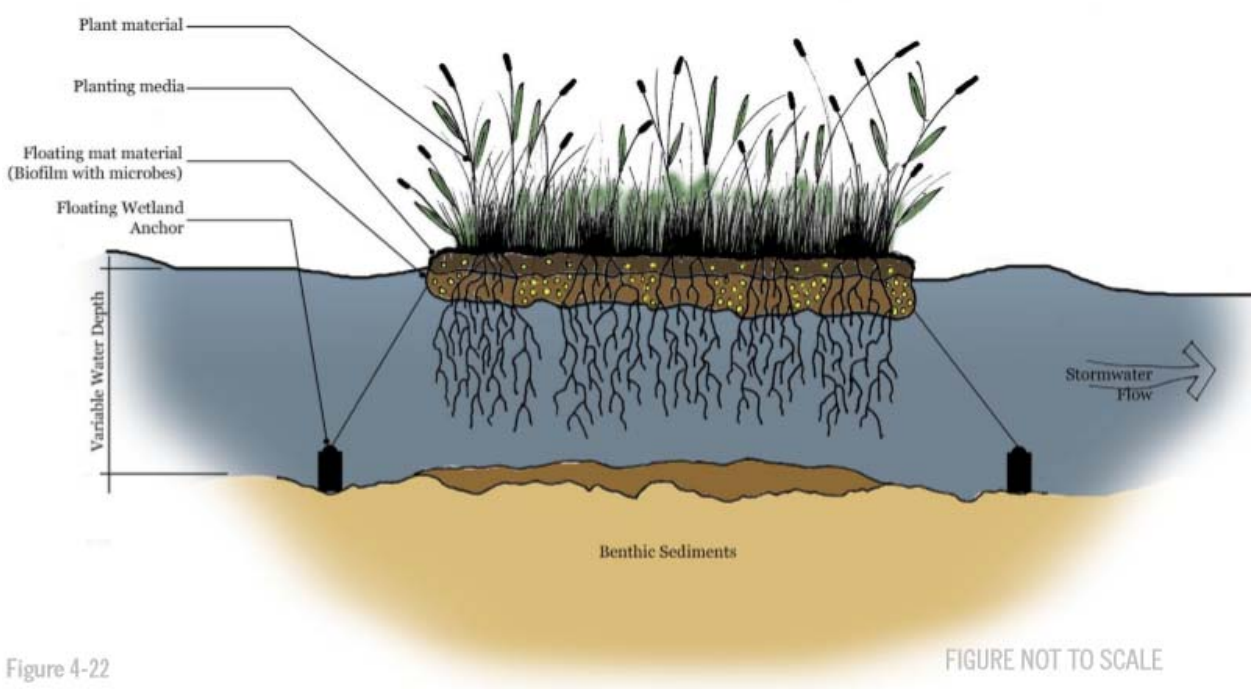


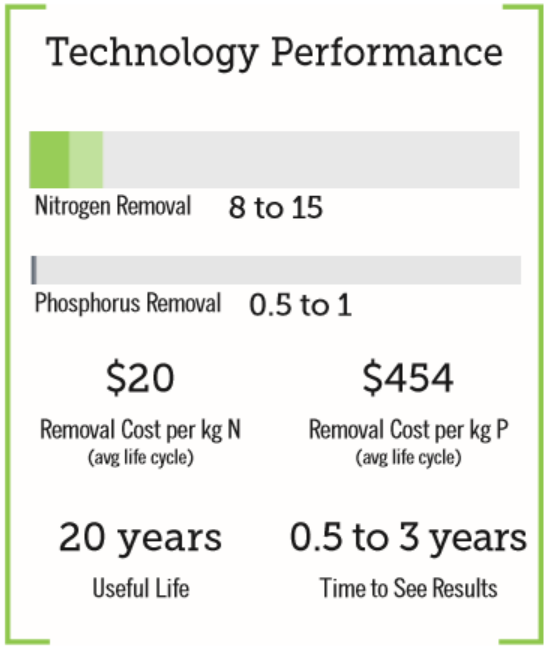
Figure 4-22

FIGURE NOT TO SCALE

Constructed Wetlands- Floating

Restoration

Treatment in water body



Challenges & Risks

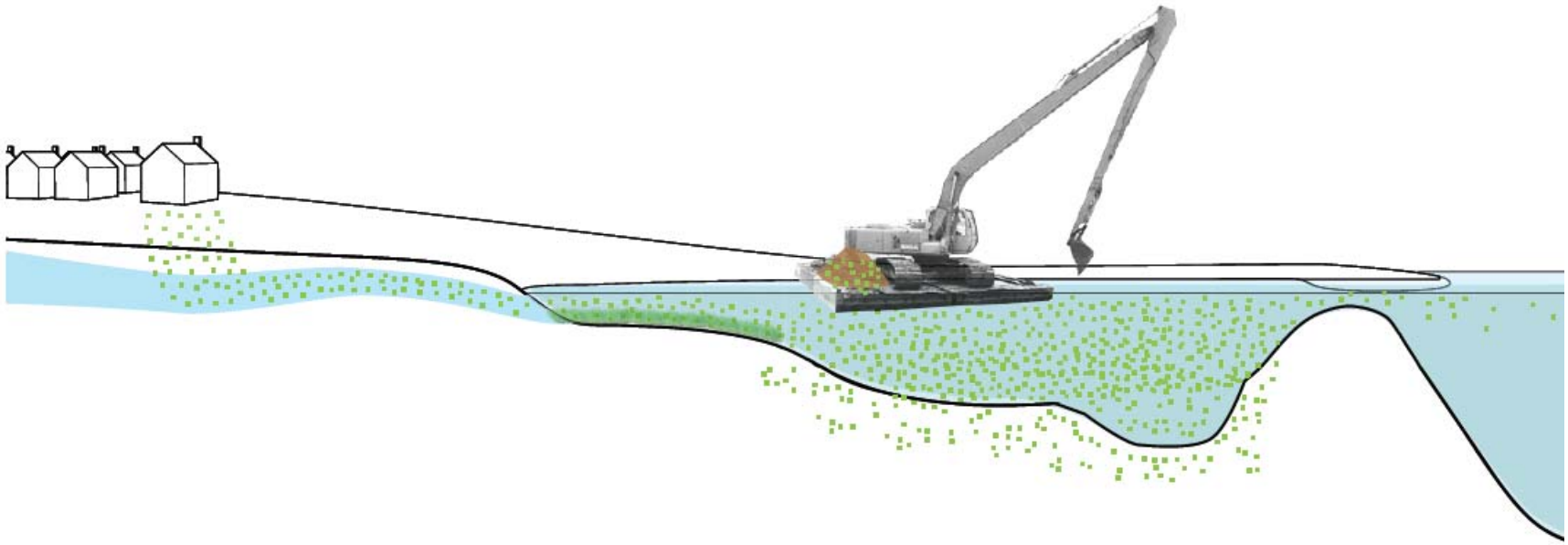
- Damage to structure during storm events

Restoration

Treatment in water body

Pond and Estuary Dredging

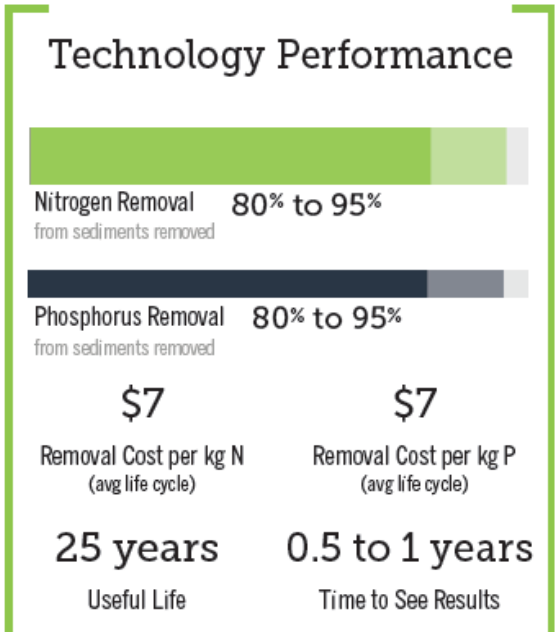
- Utilizing **mechanical means** to physically **remove sediments** from the pond or estuary. These sediments **contain nutrients** that could release into the water column.



Pond and Estuary Dredging

Restoration

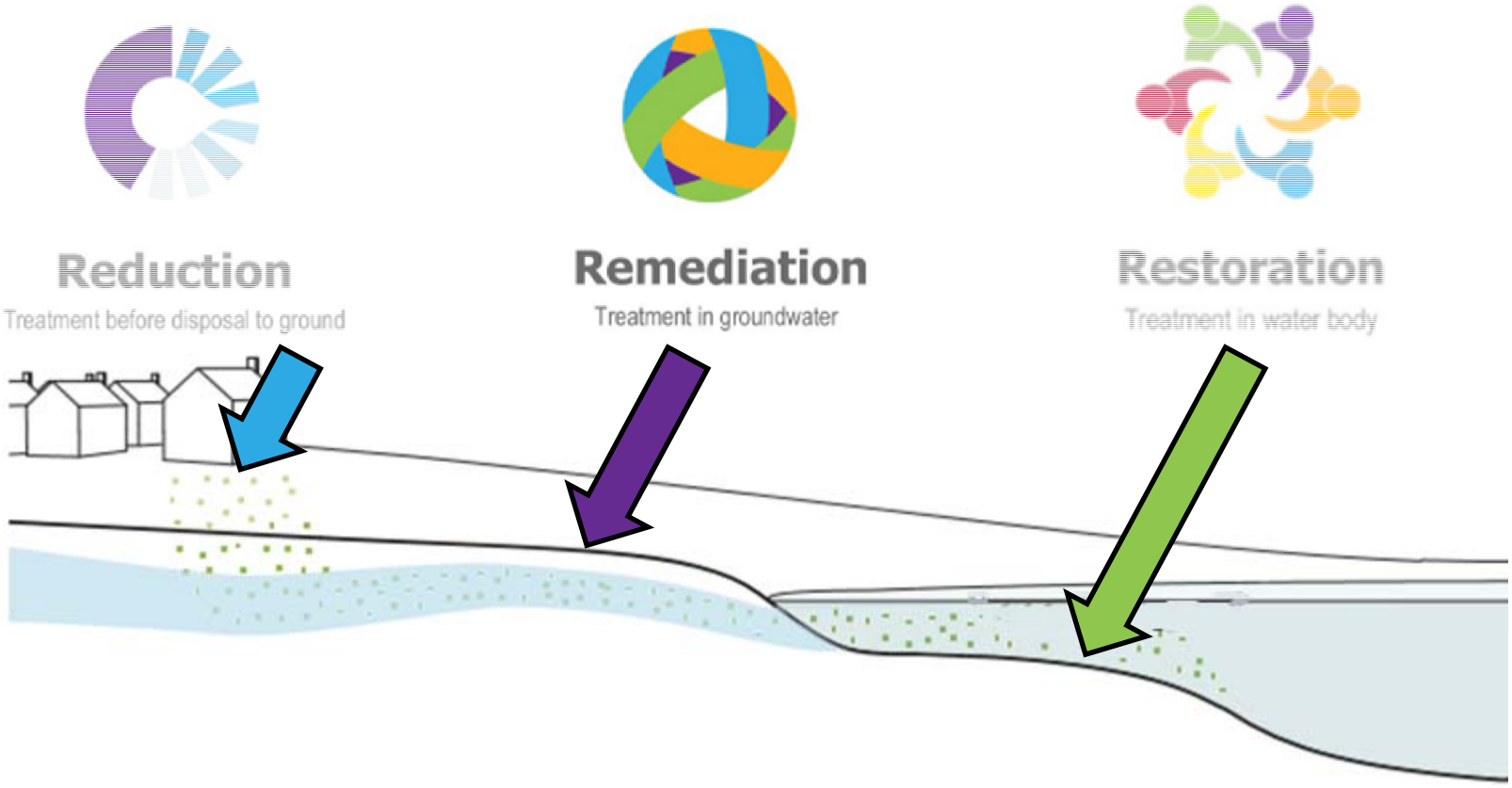
Treatment in water body



Challenges & Risks

- Permitting requirements may be extensive
- Disrupting to biological communities
- Disposal costs of sediments may be costly

Questions?


Reduction
Treatment before disposal to ground
Remediation
Treatment in groundwater
Restoration
Treatment in water body