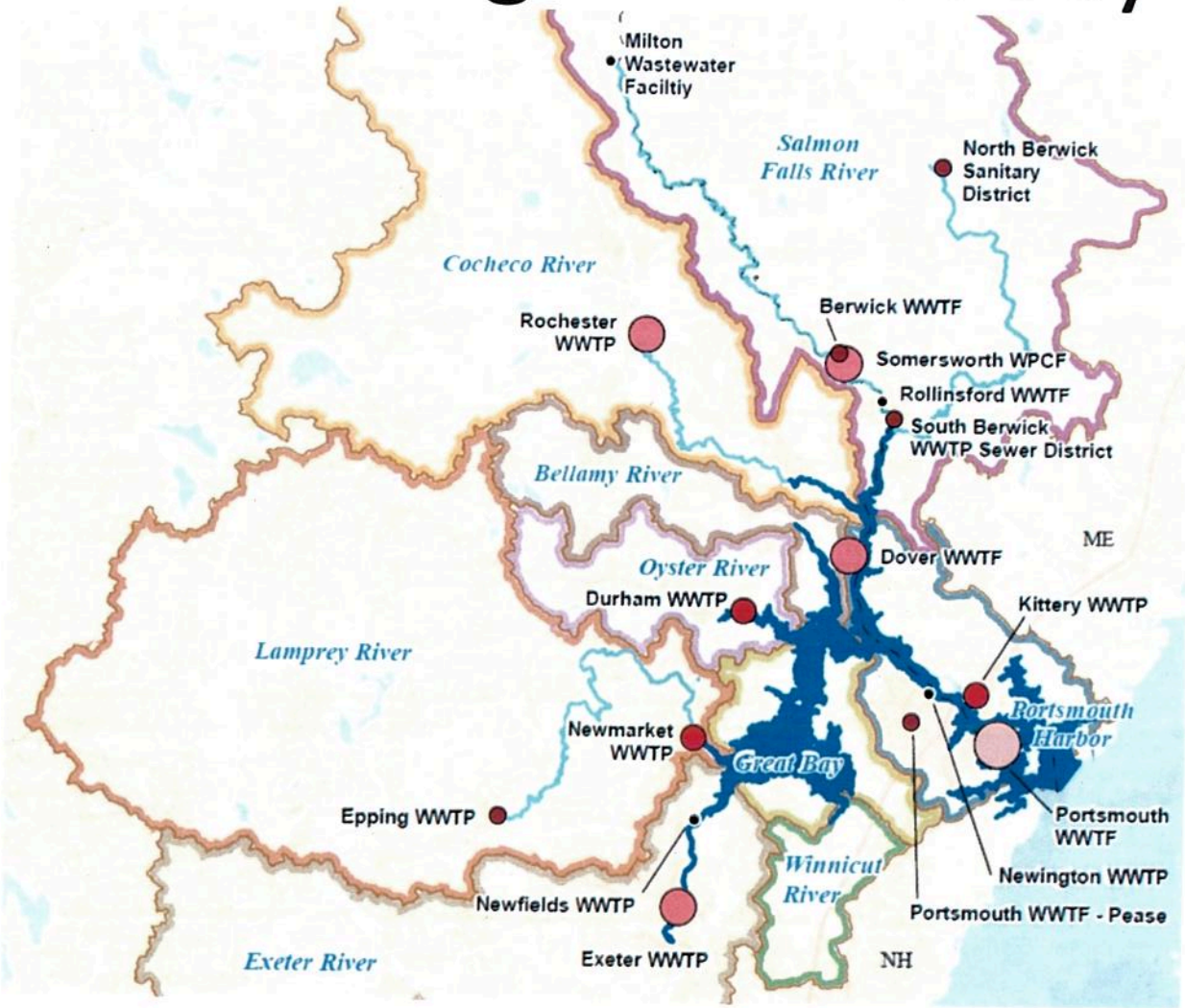
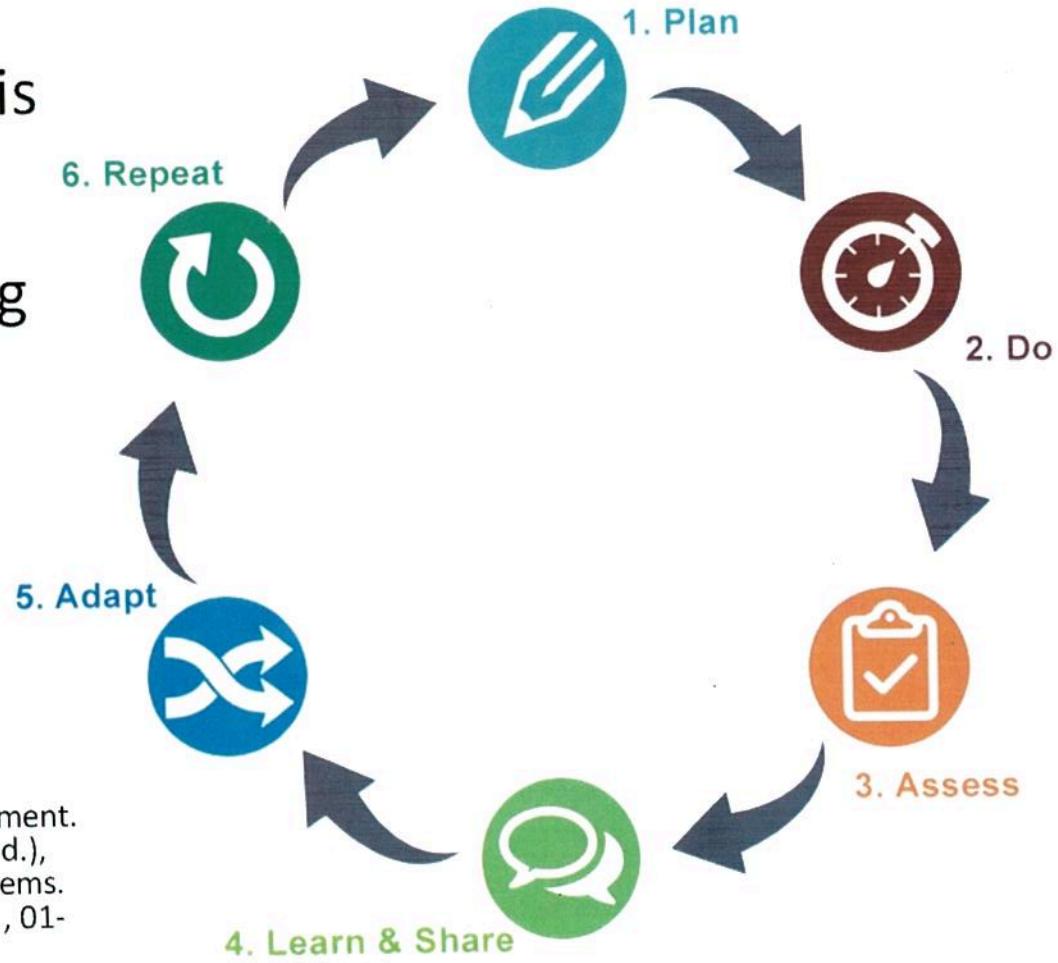
Adaptive Management Permitting for Great Bay



March 8, 2019

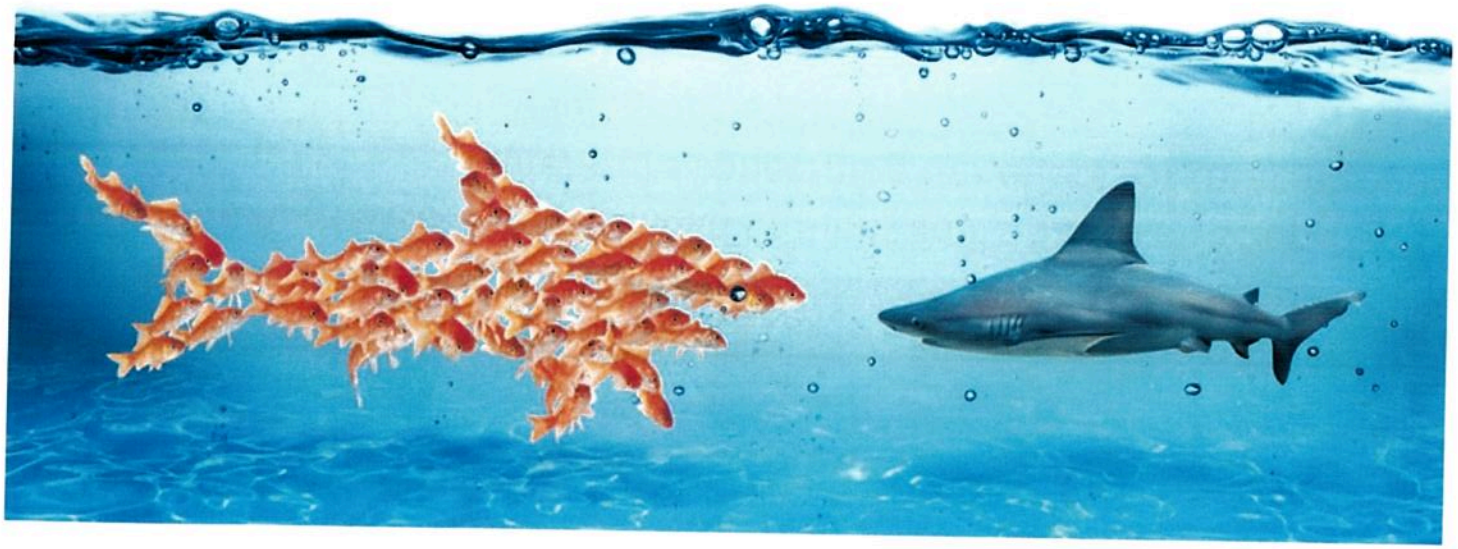
Adaptive management is an approach to natural resource management that emphasizes learning through management where knowledge is incomplete, and when, despite inherent uncertainty, managers and policymakers must act.

(Allen, C. and A. Garmestani. Adaptive Management. Chapter 1, Craig R. Allen, Ahjond Garmestani (ed.), Adaptive Management of Social-Ecological Systems. Springer Netherlands, Dordrecht, Netherlands, , 01-10, (2015)



Great Bay TN General Permit

- All 13 NH WWTFs covered at the same time
- Watershed approach to meet WQS
- Get initial TN reductions sooner
- Greater long-term TN reductions
- Greater opportunity for collaboration

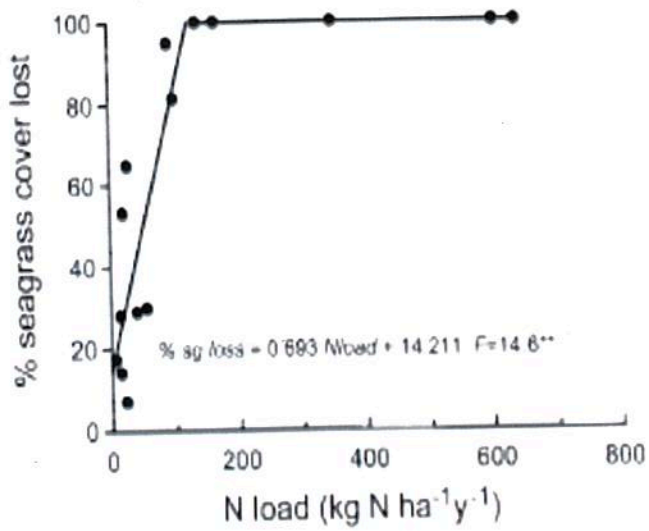


Proposed TN General Permit (GP) Approach	
New Scientific Approach	Annual load effluent limits based on scientific literature concerning the effects of total nitrogen loading on estuaries
Point Source Allocations	Hold load reductions already achieved or already in progress.
NPS Load Reductions	Plan and implement practices that will reduce TN loading from NPS inputs (NH WQ Certification requirement)
Track Loads	Quantify and track point source and non-point source loads via effluent monitoring and NPS tracking (PTAPP)
Ambient Monitoring	Participate in Adaptive Management Monitoring Program to assess system response

General Permit - Science

- 2018 State of Our Estuary report
  - 14 of 24 indicators "cautionary" or "negative"
  - "Nutrient loading is a critical stressor"
  - "nutrients remain of high concern"
- Eelgrass loss
  - 1996 to 2017 loss of 1300 acres (almost 50%)

General Permit - Science



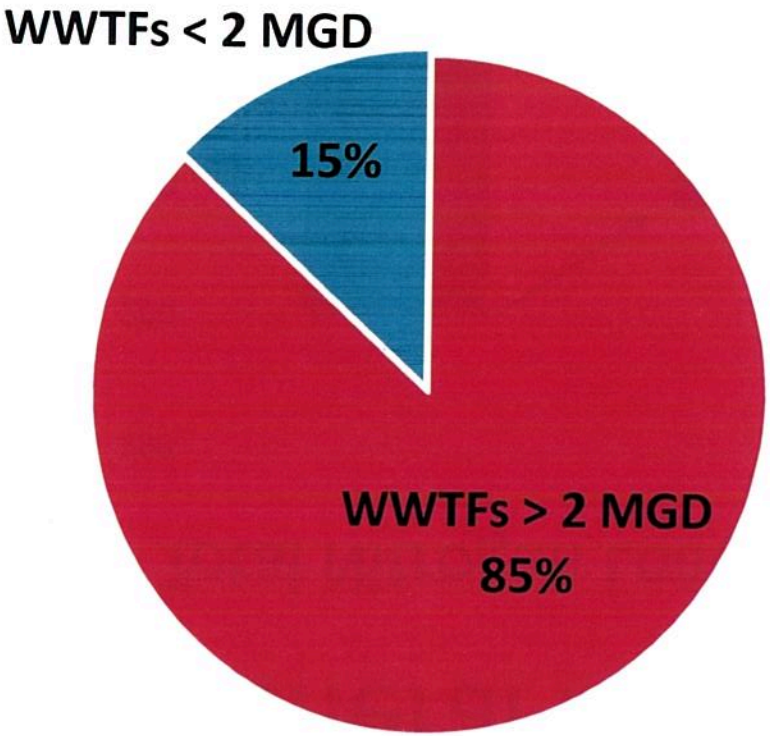
- Literature-based total nitrogen loading threshold to protect eelgrass ranging from 20 – 100 kg/ha-yr

- Narragansett Bay Comparison:
  - From 2000 to 2015 TN loading reduced from 158 to 80 kg/ha-yr
  - Resulted in 37% increase in eelgrass
  - However, DO still in an issue in the upper portions of the estuary

- Initial "Adaptive Management" Target: **100 kg/ha-yr**

General Permit – Point Source

2012-2016 Average Point Source Nitrogen Loading

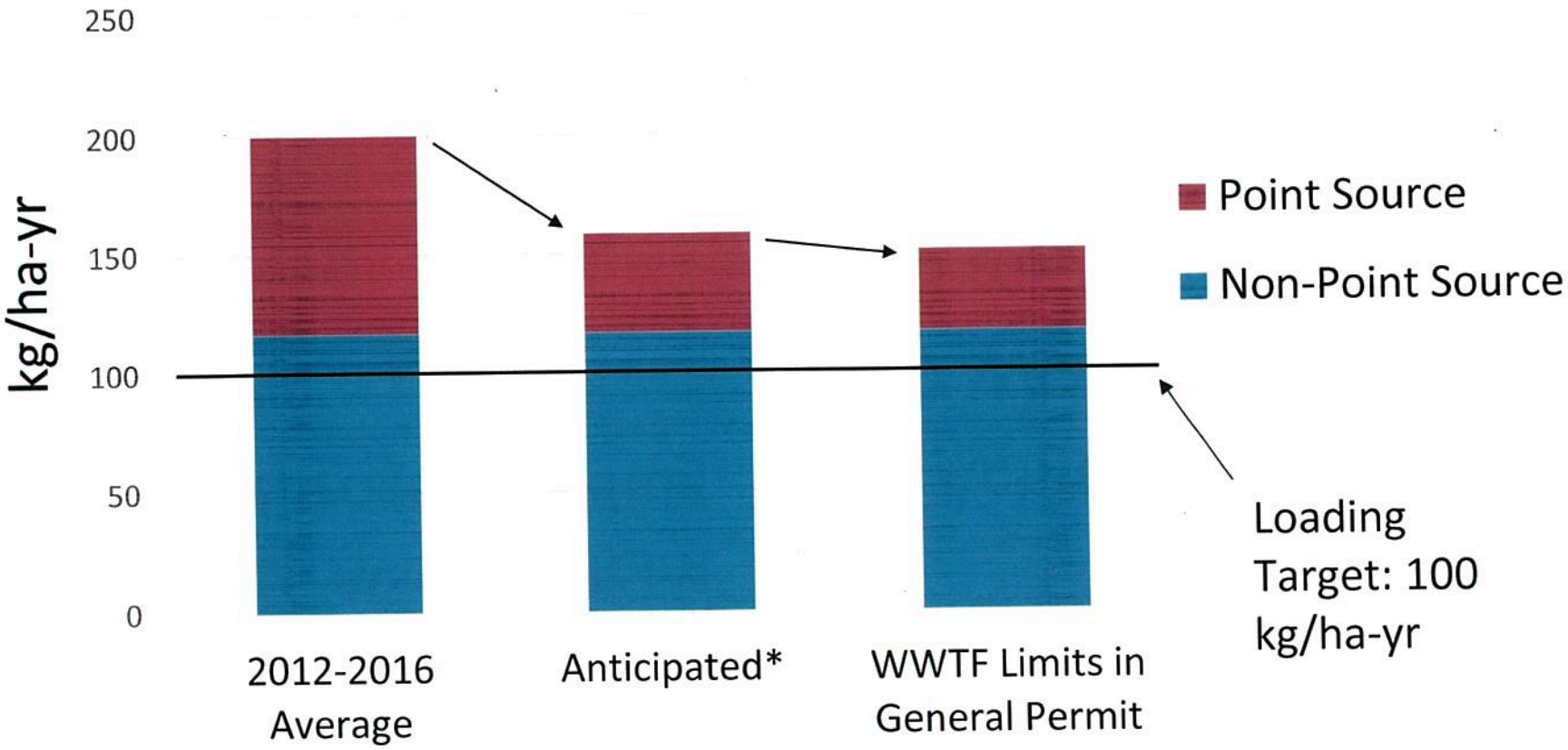


Achievable limits

- 7 WWTFs > 2 MGD: 8 mg/L @ ave. flows
- 10 WWTFs < 2 MGD: "hold load" & optimize

General Permit – Point Source

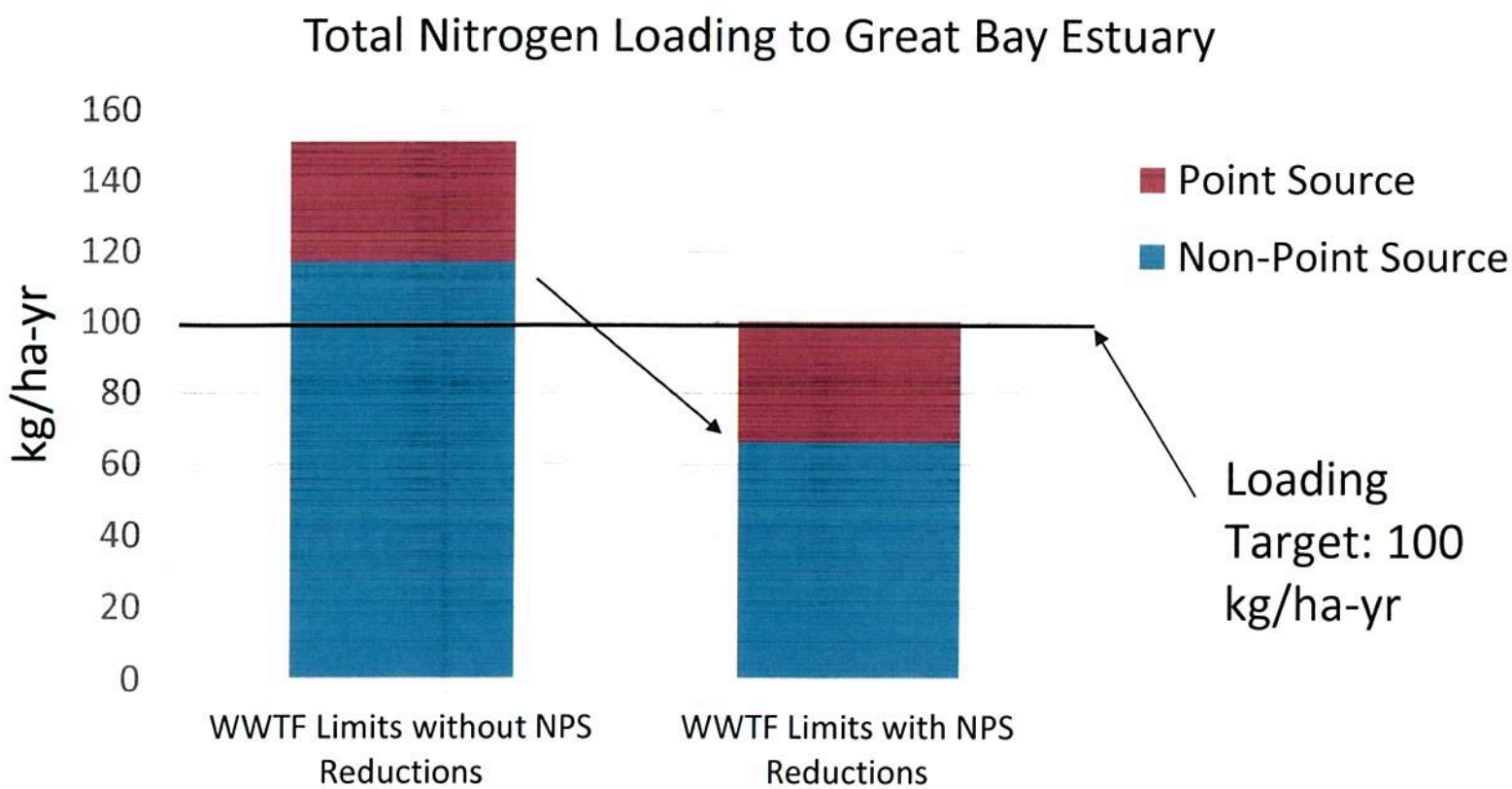
Total Nitrogen Loading to Great Bay Estuary



*Anticipated load given recent and ongoing upgrades and optimization efforts

General Permit – Non-Point Source

44% reduction target to meet 100 kg/ha-yr

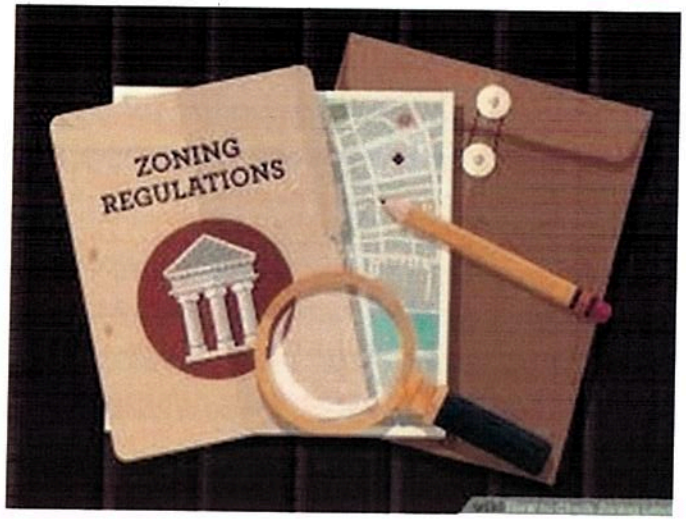


General Permit – Non-Point Source

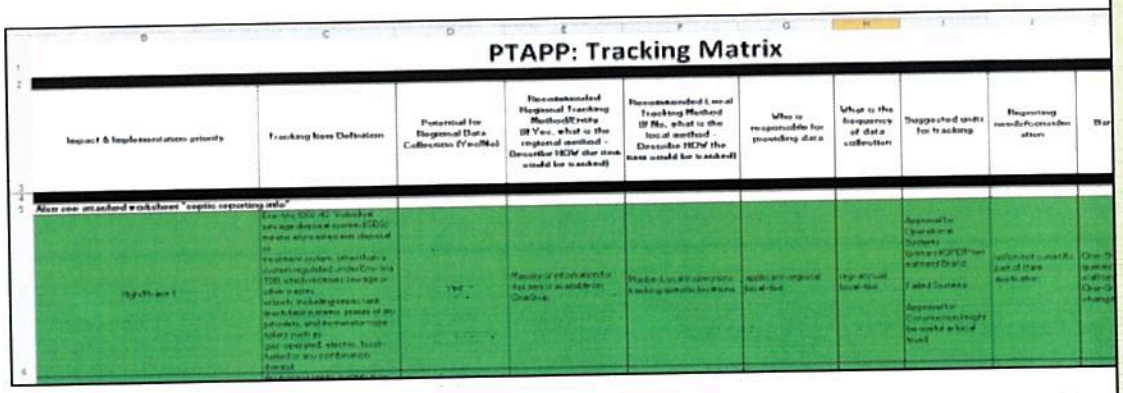
- NPS requirements based on 401 State Cert
  - Tracking and Accounting through PTAPP
  - Year 1
    - Continuation of current NPS activities
    - Develop a near-term (3 years) Total Nitrogen NPS and Stormwater Control Plan
  - Year 3
    - Establish NPS and Stormwater baseline (e.g., GBNPSS)
    - Develop long-term Total Nitrogen NPS and Stormwater Control Plan to achieve 11% reduction from baseline
  - Years 8, 13, 18
    - Develop new long-term Total Nitrogen NPS and Stormwater Control Plans each 5 years to achieve additional 11% reduction from baseline (44% total by year 23)

General Permit – Non-Point Source

- PTAPP
- Nitrogen control plan
- Implementation



What is PTAPP?

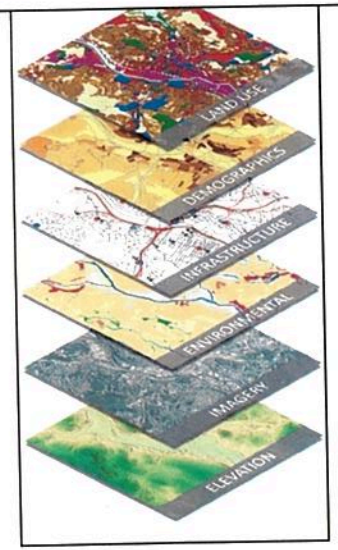


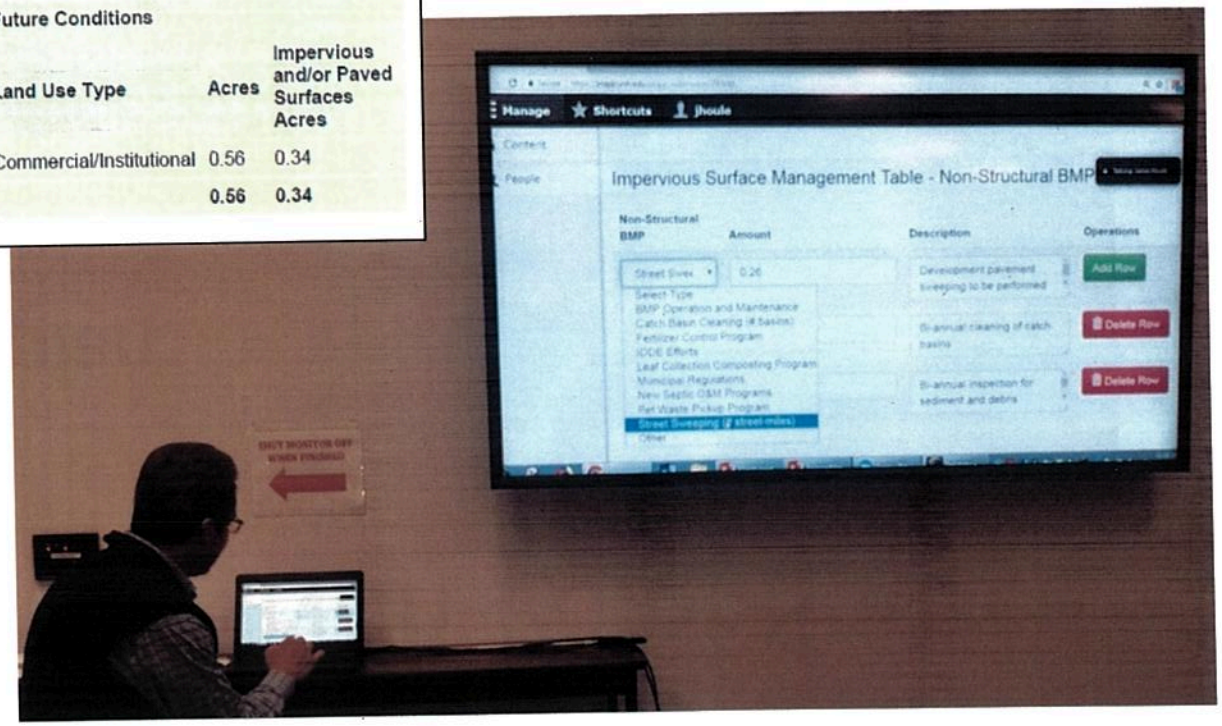
TRACKING—Information about activities that may contribute to increases or decreases in pollutant loading

ACCOUNTING—A quantitative method for inventorying and tabulating planning, management, and conservation practices that affect hydrology and water quality

Land Use Conversion Table

Soils		Existing Conditions			Future Conditions		
Hydrologic Group	Acres	Land Use Type	Acres	Impervious and/or Paved Surfaces Acres	Land Use Type	Acres	Impervious and/or Paved Surfaces Acres
B	0.56	Commercial/Institutional	0.56	0.26	Commercial/Institutional	0.56	0.34
Totals	**0.56**		**0.56**	**0.26**		**0.56**	**0.34**





PTAPP: Implementation Framework

Regional Pollution Tracking and Accounting

Phase 1

Planning

(completed - 2015)

- Developed shared definition of tracking and accounting
- Identified categories of activities for tracking
- Established regional dialogue and process
- Identified key program drivers, needs, and barriers
- Developed conceptual framework & costs for implementation

Phase 2

Pilot tracking program, conduct planning for accounting

- Develop Memorandum of Understanding
- Develop and test "beta" tracking database
- Work with partners (Municipalities, GRANIT, RPCs, UNHSC, DES, PREP, GBNERR, etc.) to input data and refine tracking methods
- Identify process to establish accounting methods to quantify load reductions for tracked activities
- Continue work group meetings

Phase 3

Evaluate pilot tracking, develop accounting methods

- Refine database based on partner input - what worked and what didn't
- Identify technical and financial resources needed to implement tracking beyond pilot communities
- Implement process to develop accounting methods
- Develop framework for broader implementation and identify funding and key roles/providers
- Continue work group meetings

Implementation

Implement wider program

- Implement tracking with additional communities
- Continue process to develop accounting methods to quantify load reductions for tracked activities
- Identify and implement additional tools and financial resources as program evolves
- Convene advisory committee to aid in program assessment and development
- Provide progress reports to partners

Plan → Test → Check → Implement

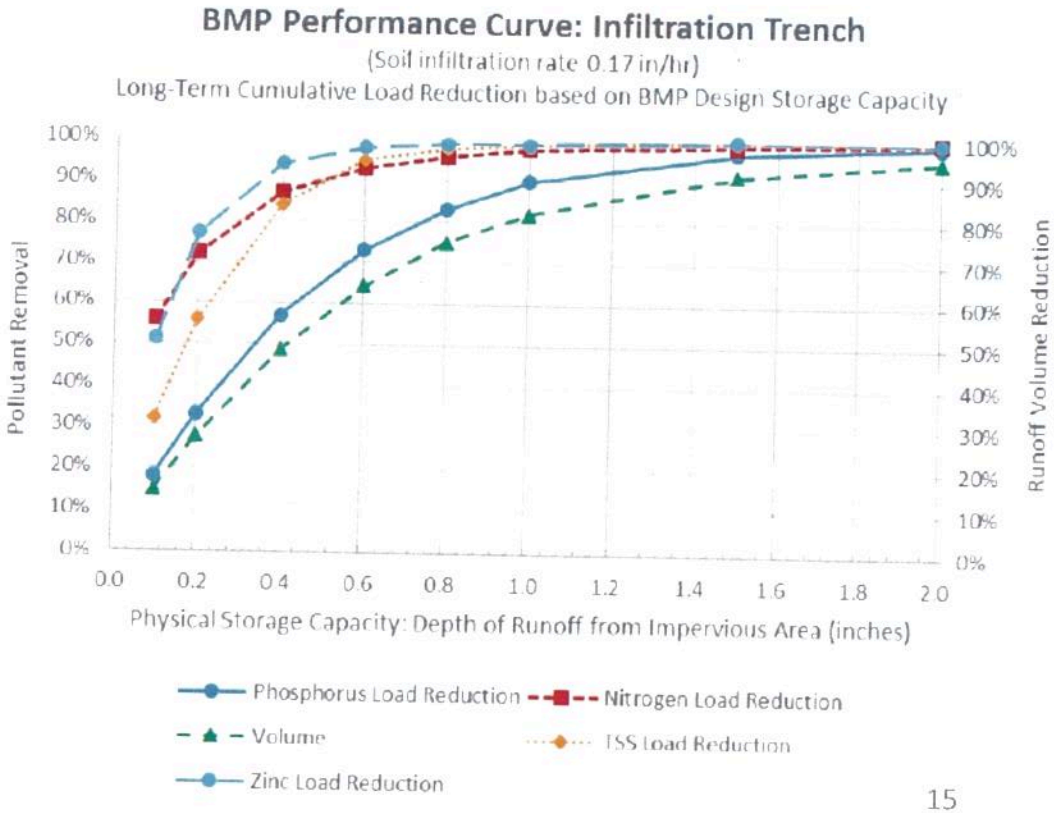
We are here

Nitrogen control plan

- How much do I need to reduce?
- Where is the nitrogen coming from?
- What are the methods I can use?
- Short-term actions and longer–term actions.

Multiple benefits of stormwater treatment

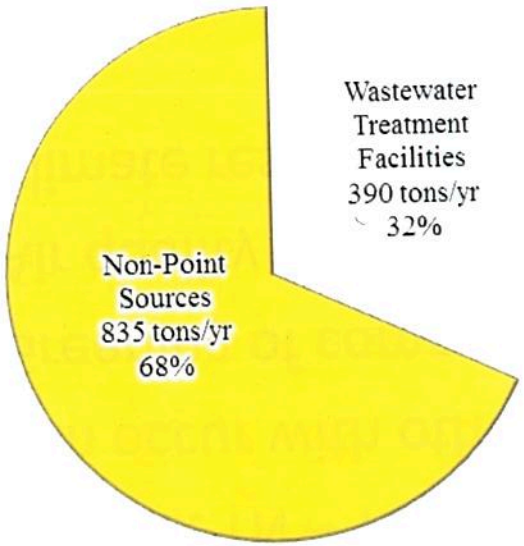
- Not just TN – TSS, bacteria, TP, flooding
- Can occur with other infrastructure improvements
- Greening of communities – quality of life
- Air quality improvements
- Climate resiliency



General Permit – Non-Point Source

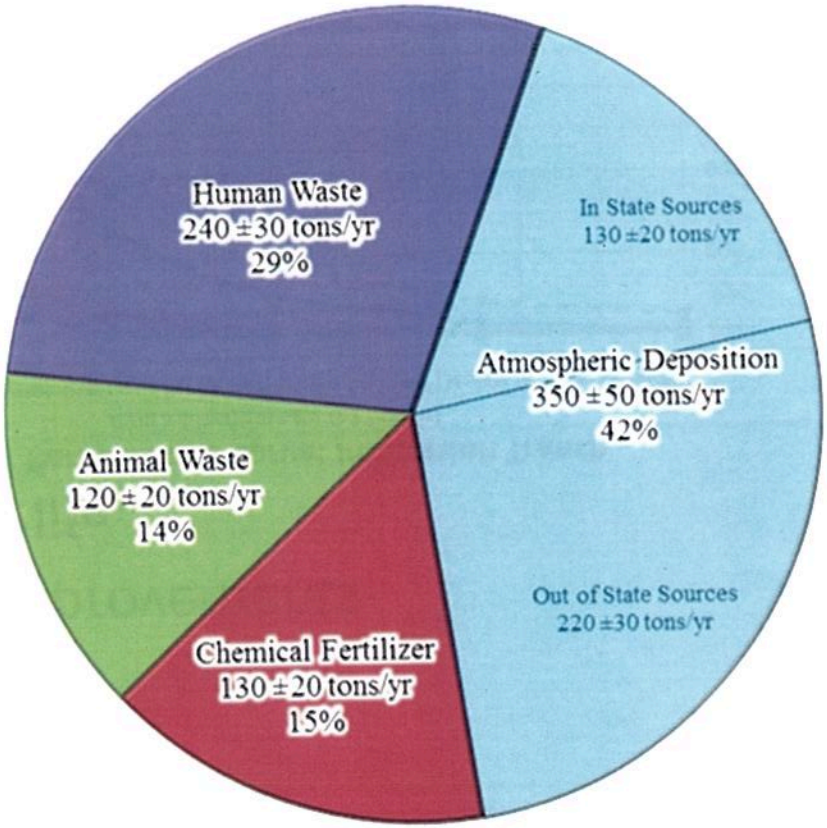
From PREP (2013)

DES Great Bay Nitrogen Non-Point Source Study



Total Load 1,225 Tons/yr

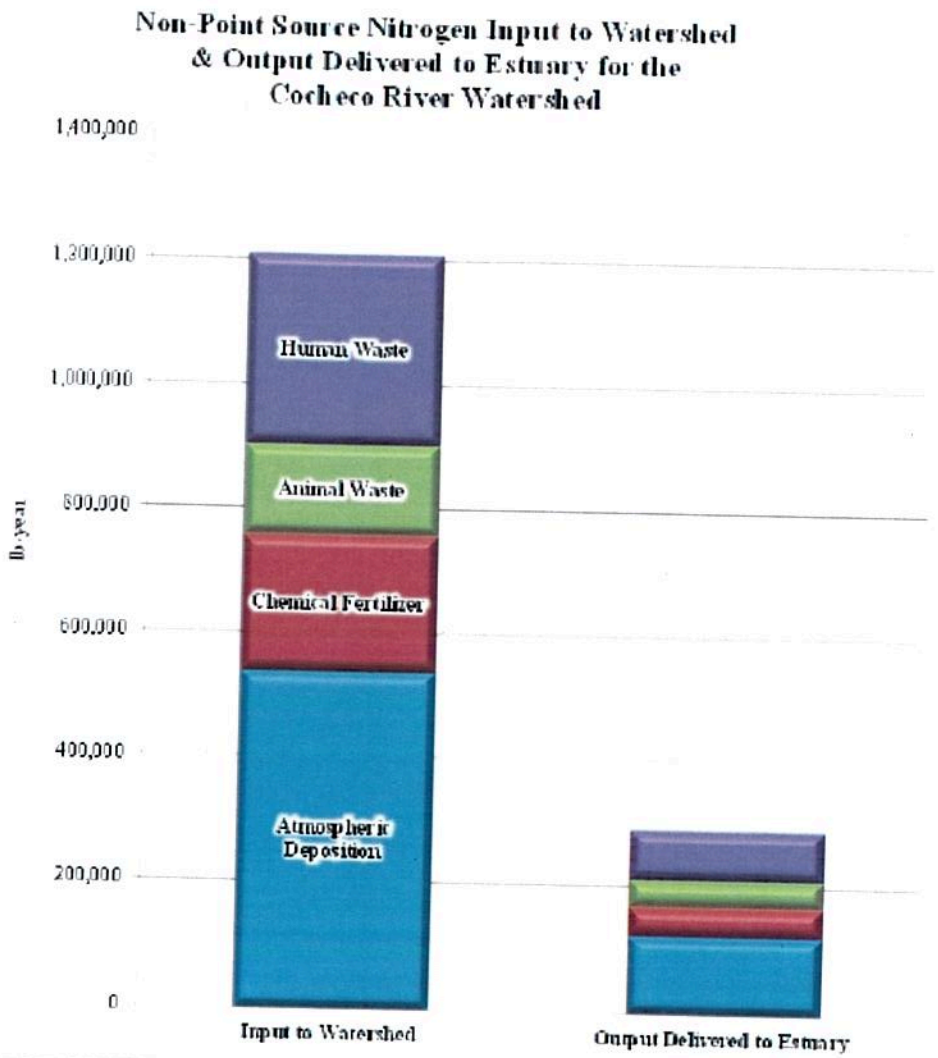
Nitrogen Loading Model



Non-Point Source Load 800 ±100 tons/yr

Non-Point Source Load Delivered by Stormwater = 34%

Figure 17: Inputs and Outputs of Non-Point Source Nitrogen by Source Type for the Cocheco River Watershed



Source	Input to Watershed TN (lb/yr)		Output Delivered to Estuary TN (lb/yr)		TN Lost During Transport
Human Waste	306,144	25%	79,768	27%	74%
Animal Waste	146,410	12%	43,005	15%	71%
Chemical Fertilizer	220,021	18%	47,442	16%	78%
Atmospheric Deposition	538,186	44%	120,857	42%	78%
Total =	1,210,761		291,073		76%

Nitrogen Reduction plan

- Low hanging fruit
- Areas with multiple benefits
- Align with longer term stormwater strategies
- Target highest load areas

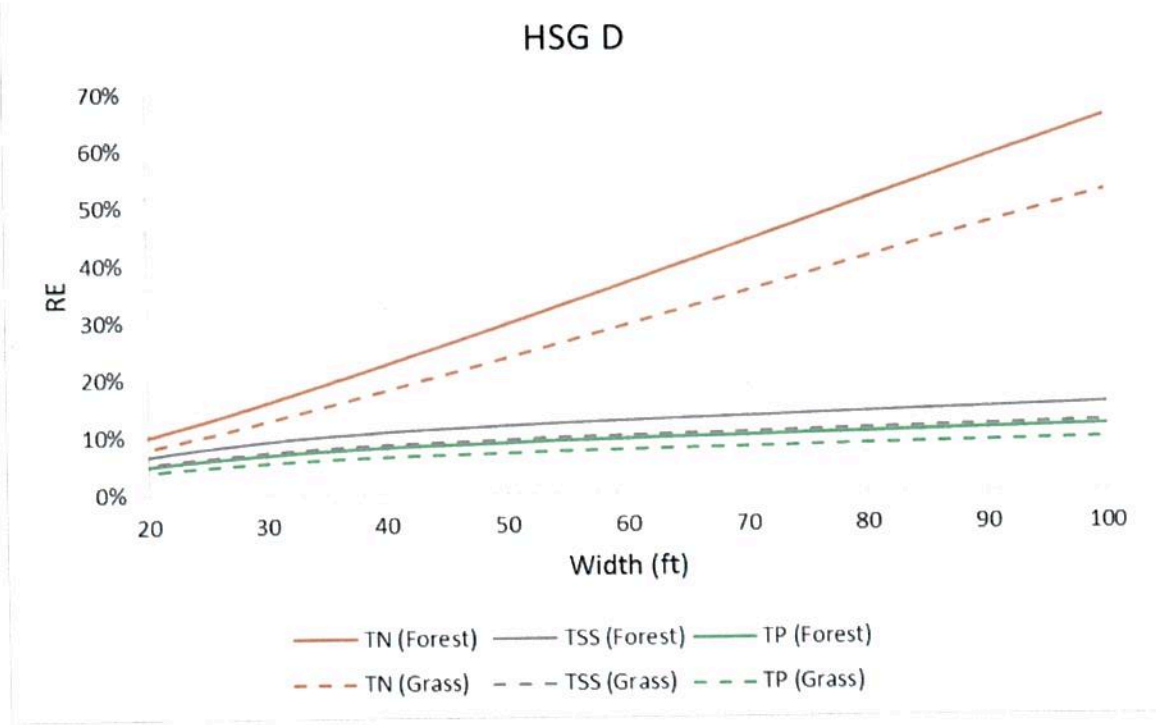
Implementation

Non-structural BMPs

- Leaf pickup
- Dog waste ordinances and outreach
- Fertilizer laws and restrictions

Structural BMPs

- Redevelopment projects
- Road projects
- New development – SWA model ordinance



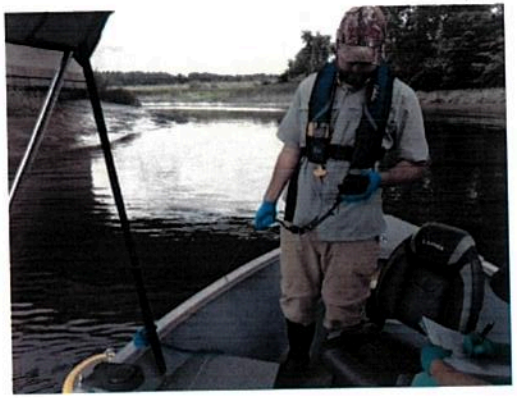
General Permit – Ambient Monitoring

- Purpose – Track response of the estuary to reduced nitrogen loading
- Expands upon monitoring already being performed
- Annual monitoring contains four parts:
  1. Head of tide monitoring
  2. Estuarine chemistry
  3. Eelgrass
  4. Sediment

General Permit – Ambient Monitoring

Head of tide monitoring:

- 2/month for:
  - total dissolved nitrogen
  - ammonia
  - nitrate/nitrite
  - total particulate nitrogen



Estuarine monitoring:

- 16 monitoring sites (up from 11 in 2018)
- Include datasondes at each new location
- 1/month for:
  - total dissolved nitrogen
  - ammonia
  - nitrate/nitrite
  - total particulate nitrogen
  - dissolved oxygen
  - chlorophyll 'a'
  - light attenuation

General Permit – Ambient Monitoring

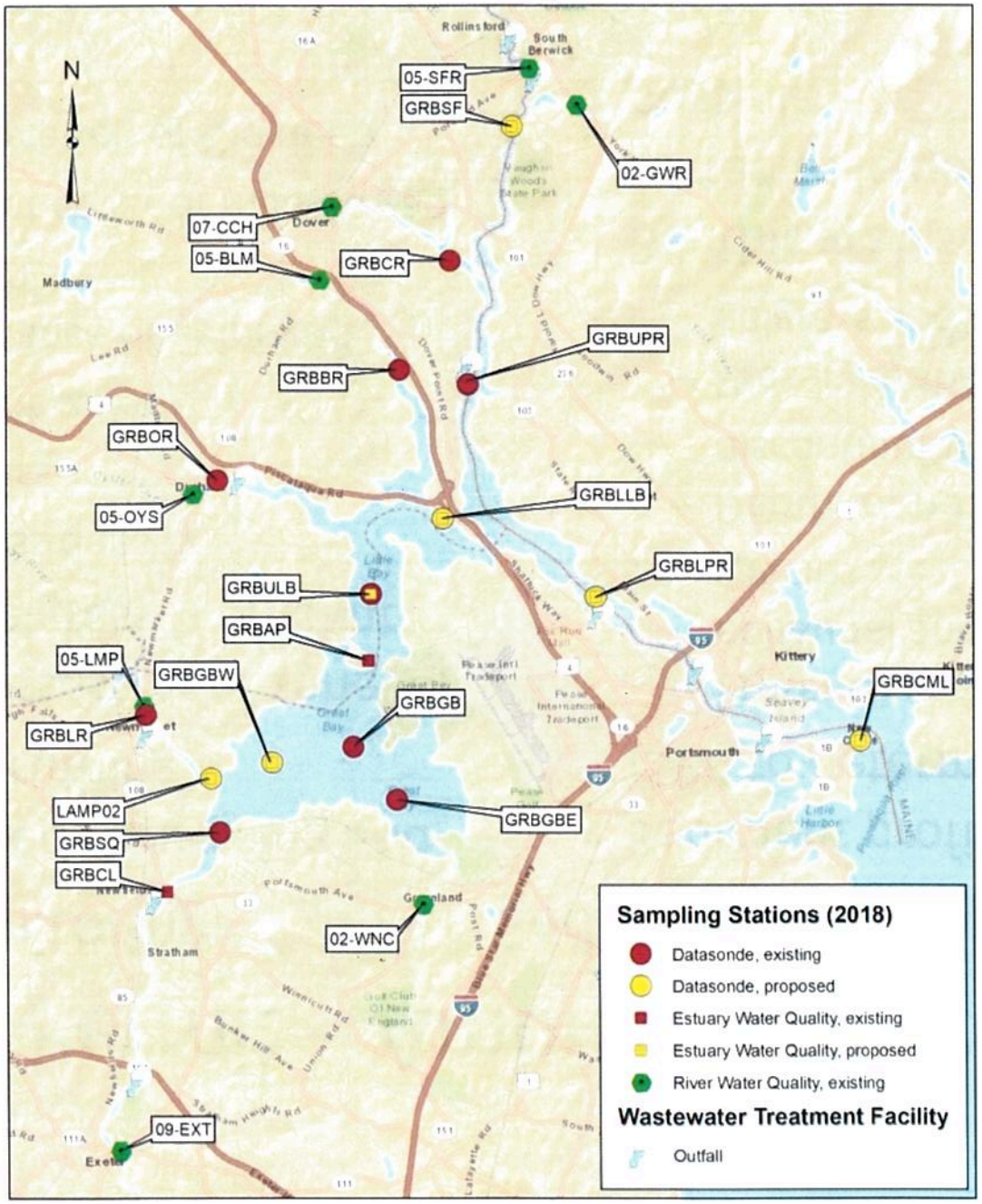
Eelgrass monitoring:

- Annual aerial mapping and ground-truthing
- In each assessment zone where eelgrass is present
  - Eelgrass density
  - Biomass
  - percent cover
  - abundance of epiphytic growth
  - percent cover of macroalgae
  - demarcation of the deep edge

Sediment monitoring:

- Sediment profile imaging (SPI) to determine
  - Presence and type of epifaunal and infaunal species
  - Depth to the redox discontinuity layer
  - Presence/absence of eelgrass and macroalgae
- Benthic grab samples sorted to lowest taxon possible

Annual Sampling for Adaptive Management in the Great Bay Estuary



General Permit – Ambient Monitoring

- Annual report – Includes summary of all monitoring results and trends
- Cost allocated among all communities
- Able to be adjusted as necessary

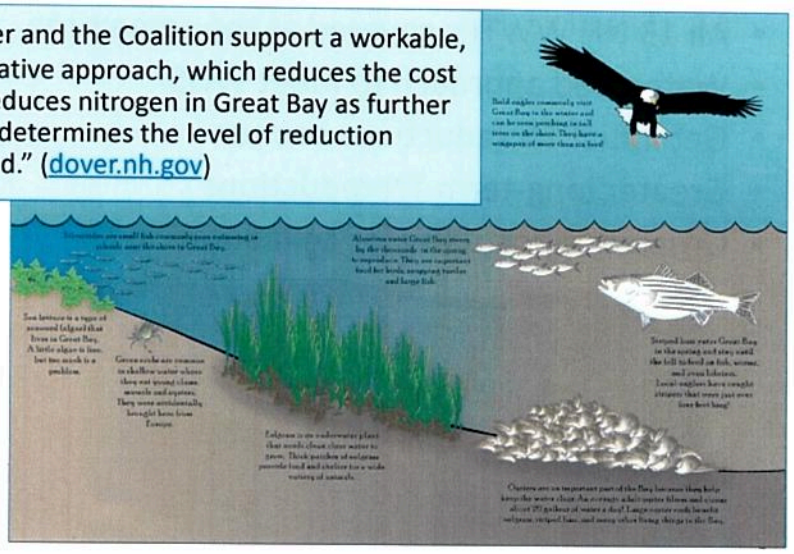
Questions?

Adaptive Management Permitting for Great Bay

October 4, 2018

Community Feedback

"Dover and the Coalition support a workable, alternative approach, which reduces the cost and reduces nitrogen in Great Bay as further study determines the level of reduction needed." (dover.nh.gov)



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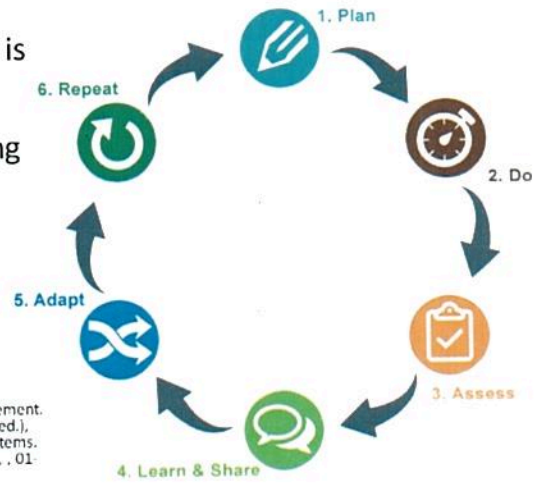
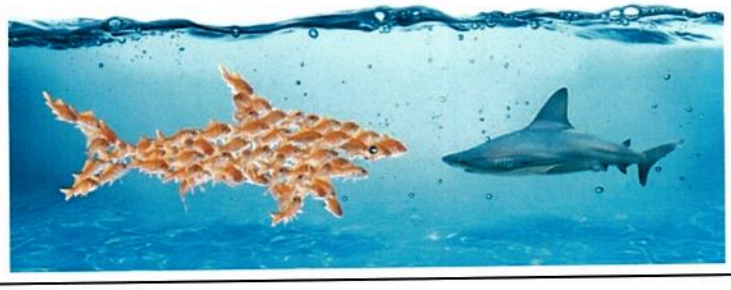


3

Great Bay TN General Permit

- All 13 NH WWTPs covered at the same time
- Watershed approach to meet WQS
- Get initial TN reductions sooner
- Greater long-term TN reductions
- Greater opportunity for collaboration



4

Coalition Adaptive Management Plan (p. 1)	Element	Proposed TN General Permit (GP) Approach
Reduce municipal DIN levels to pre-1990 conditions;	**Point Source Allocations**	GP: hold load reductions already achieved or already in progress.
Quantify overall DIN loadings to the system since 1990;	**Track Loads**	GP: quantify and track point source and non-point source loads via effluent monitoring and NPS tracking
Create a monitoring program capable of tracking macroalgae and DIN levels in select areas of the Bay;	**Ambient Monitoring**	GP: participate in Adaptive Management Monitoring Program
Complete additional literature research on facts and nutrient levels affecting macroalgae growth; and	**New scientific approach**	GP annual load effluent limits based on using accumulation of research on the effects of total nitrogen loading on estuaries in literature
Reduce non-point source (NPS) inputs through land use planning changes and implementation of bioremediation projects, such as oyster replenishment	**NPS load reduction**	GP: plan and implement practices that will reduce TN loading from NPS inputs (NH WQ Certification requirement)

Adaptive Management - Implementation

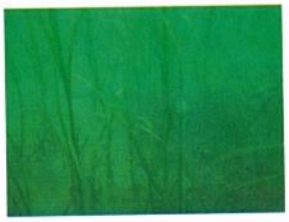
General Permit for Nitrogen

1. **Science** based on nitrogen load to entire estuary
2. **Point source** allocations
3. **Non-point source** target
4. **Ambient Monitoring** to assess system response

6

General Permit - Science

- 2018 State of Our Estuary report
  - 14 of 24 indicators "cautionary" or "negative"
  - "Nutrient loading is a critical stressor"
  - "nutrients remain of high concern"
- Eelgrass loss
  - 1996 to 2017 loss of 1300 acres (almost 50%)



7

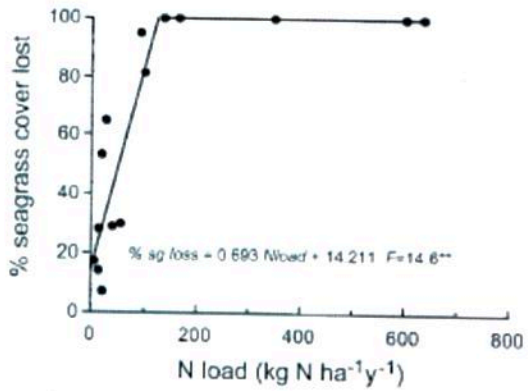
General Permit - Science

- Literature-based loading threshold to protect eelgrass
- Valiela & Cole, 2002
  - 30+ diverse estuaries worldwide, including Great Bay
  - Threshold "critical range": 20 – **100** kg/ha-yr
- Hauxwell et al., 2003
  - Same estuaries as Valiela & Cole
  - Threshold "critical range": < 30 – **100** kg/ha-yr
- Latimer & Rego, 2010
  - 62 estuarine embayments in New England
  - Threshold "critical range": 50 – **100** kg/ha-yr

- Initial "Adaptive Management" Target: **100 kg/ha-yr**

8

General Permit - Science



Valiela & Cole, 2002

- 30+ diverse estuaries worldwide
- Threshold "critical range": 20 – 100 kg/ha-yr

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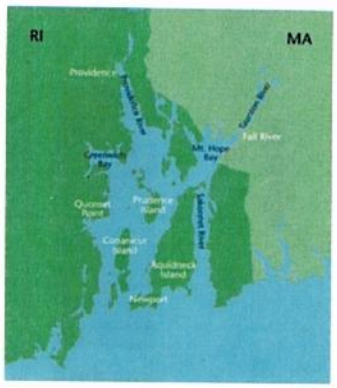
General Permit - Science

Compare to Narragansett Bay

- Significant tidal and riverine inputs; complex flow patterns and mixing dynamics
- 2000-2004 TN loading: 158 kg/ha-yr
- 2013-2015 TN loading: 80 kg/ha-yr
- 2006 to 2012 seagrass acreage increased 37%
  - Eelgrass rebound associated with loading less than 100 kg/ha-yr
  - However, further reductions needed due to remaining excess nutrients and depleted DO in portions of Bay



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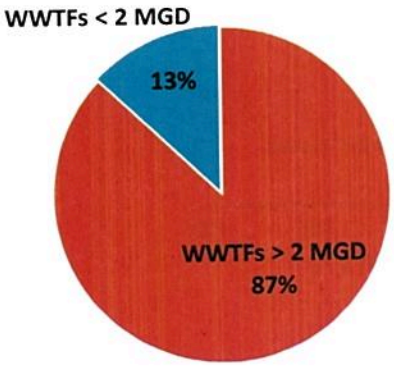
General Permit – Point Source

2012-2016 Average Point Source Nitrogen Loading



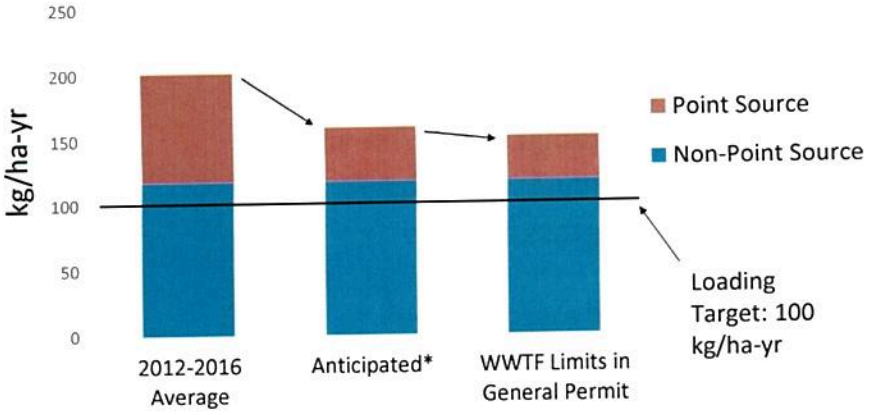
Achievable limits

- 7 WWTFs > 2 MGD: 8 mg/L @ ave. flows
- 10 WWTFs < 2 MGD: "hold load" & optimize

11

General Permit – Point Source

Total Nitrogen Loading to Great Bay Estuary

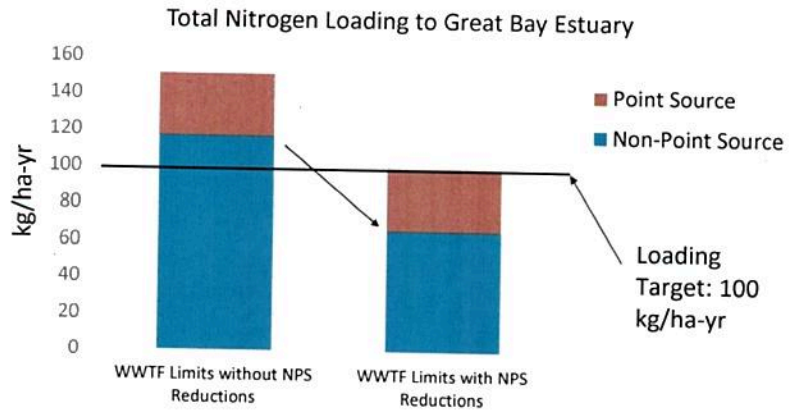


*Anticipated load given recent and ongoing upgrades and optimization efforts

12

General Permit – Non-Point Source

44% reduction target to meet 100 kg/ha-yr



13

General Permit – Non-Point Source

- NPS requirements based on 401 State Cert
  - Tracking and Accounting through PTAPP
  - Year 1
    - Continuation of current NPS activities
    - Develop a near-term (3 years) Total Nitrogen NPS and Stormwater control plan
  - Year 3
    - Develop NPS and Stormwater baseline
    - Develop a long-term (20 years) Total Nitrogen NPS and Stormwater control plan to achieve 44% reduction from baseline

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General Permit – Non-Point Source

- PTAPP
- Nitrogen control plan
- Implementation

PTAPP: Implementation Framework

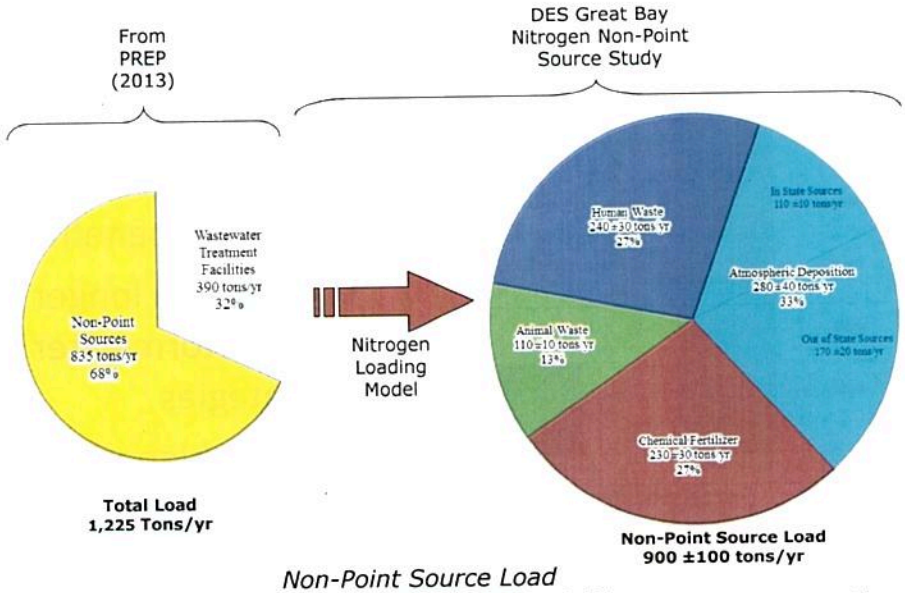
Regional Pollution Tracking and Accounting

Phase 1	Phase 2	Phase 3	Implementation
Planning *(completed - 2015)*	Pilot tracking program, conduct planning for accounting	Evaluate pilot tracking, develop accounting methods	Implement wider program
• Developed shared definition of tracking and accounting • Identified categories of activities for tracking • Established regional dialogue and process • Identified key program drivers, needs, and barriers • Developed conceptual framework & costs for implementation	• Develop Memorandum of Understanding • Develop and test "beta" tracking database • Work with partners (Municipalities, GRANIT, RPCs, UNHSC, DES, PREP, GBNERR, etc.) to input data and refine tracking methods • Identify process to establish accounting methods to quantify load reductions for tracked activities • Continue work group meetings	• Refine database based on partner input - what worked and what didn't • Identify technical and financial resources needed to implement tracking beyond pilot communities • Implement process to develop accounting methods • Develop framework for broader implementation and identify funding and key roles/providers • Continue work group meetings	• Implement tracking with additional communities • Continue process to develop accounting methods to quantify load reductions for tracked activities • Identify and implement additional tools and financial resources as program evolves • Convene advisory committee to aid in program assessment and development • Provide progress reports to partners

Plan → Test → Check → Implement

We are here

General Permit – Non-Point Source



Non-Point Source Load Delivered by Stormwater = 26%

17

Multiple benefits of stormwater treatment

- Not just TN – TSS, bacteria, TP, flooding
- Can occur with other infrastructure improvements
- Greening of communities – quality of life
- Air quality improvements
- Climate resiliency

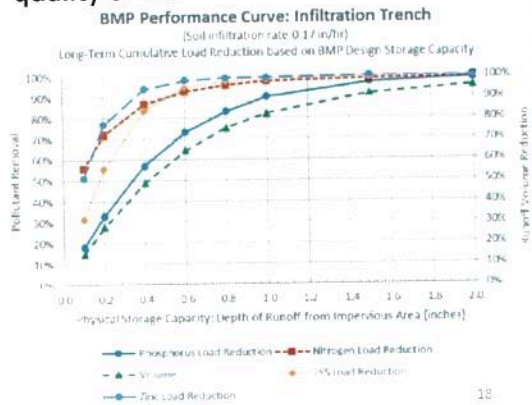


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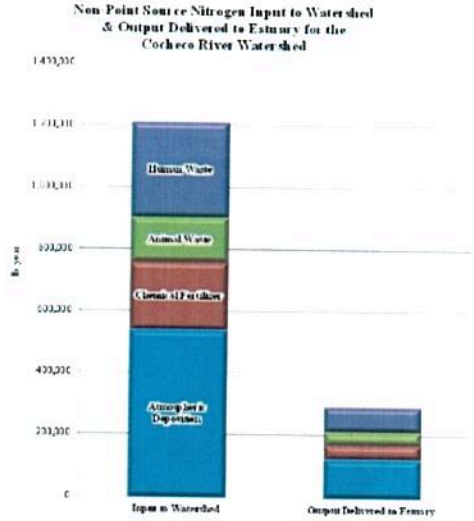
Figure 17: Inputs and Outputs of Non-Point Source Nitrogen by Source Type for the Cocheco River Watershed



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Nitrogen Reduction plan

- Low hanging fruit
- Areas with multiple benefits
- Align with longer term stormwater strategies
- Target highest load areas

19

Implementation

General Permit – Ambient Monitoring

- Purpose – Track response of the estuary to reduced nitrogen loading for adaptive management
- Expands upon monitoring already being performed
- Annual monitoring contains four parts:
  1. Head of tide monitoring
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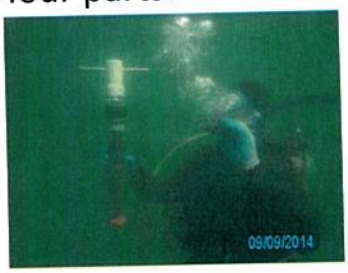
  3. Eelgrass
  4. Sediment



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General Permit – Ambient Monitoring

Head of tide monitoring:

- 2/month for:
  - total dissolved nitrogen
  - ammonia
  - nitrate/nitrite
  - total particulate nitrogen

Estuarine monitoring:

- 16 monitoring sites (up from 11 in 2018)
- Include datasondes at each new location
- 1/month for:
  - total dissolved nitrogen
  - ammonia
  - nitrate/nitrite
  - total particulate nitrogen
  - dissolved oxygen
  - chlorophyll 'a'
  - light attenuation

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General Permit – Ambient Monitoring

Eelgrass monitoring:

- Annual aerial mapping and ground-truthing
- In each assessment zone where eelgrass is present
  - Eelgrass density
  - Biomass
  - percent cover
  - abundance of epiphytic growth
  - percent cover of macroalgae
  - demarcation of the deep edge

Sediment monitoring:

- Sediment profile imaging (SPI) to determine
  - Presence and type of epifaunal and infaunal species
  - Depth to the redox discontinuity layer
  - Presence/absence of eelgrass and macroalgae
- Benthic grab samples sorted to lowest taxon possible

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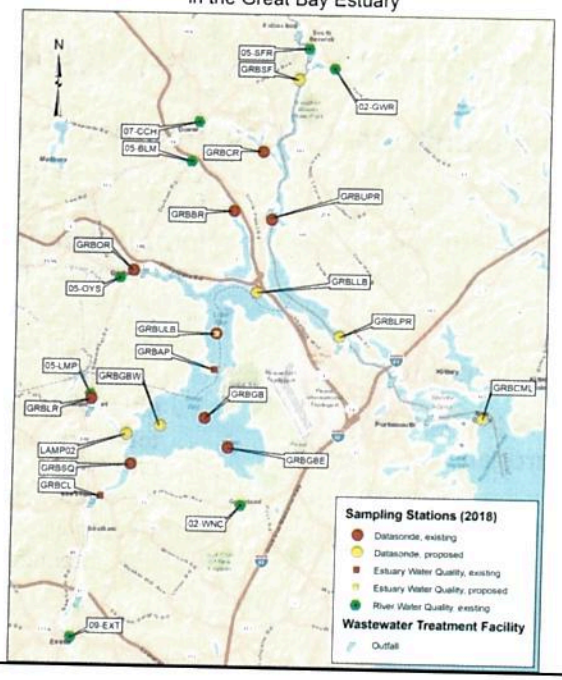
Annual Sampling for Adaptive Management in the Great Bay Estuary



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General Permit – Ambient Monitoring

- Annual report – Includes summary of all monitoring results and trends
- Cost allocated among all communities
- Able to be adjusted as necessary

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Working lunch

- Break in separate rooms
- Discuss approach to provide feedback this afternoon
- Brainstorm areas for near-term (1-3 year) progress
- Back together in 1 hour

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