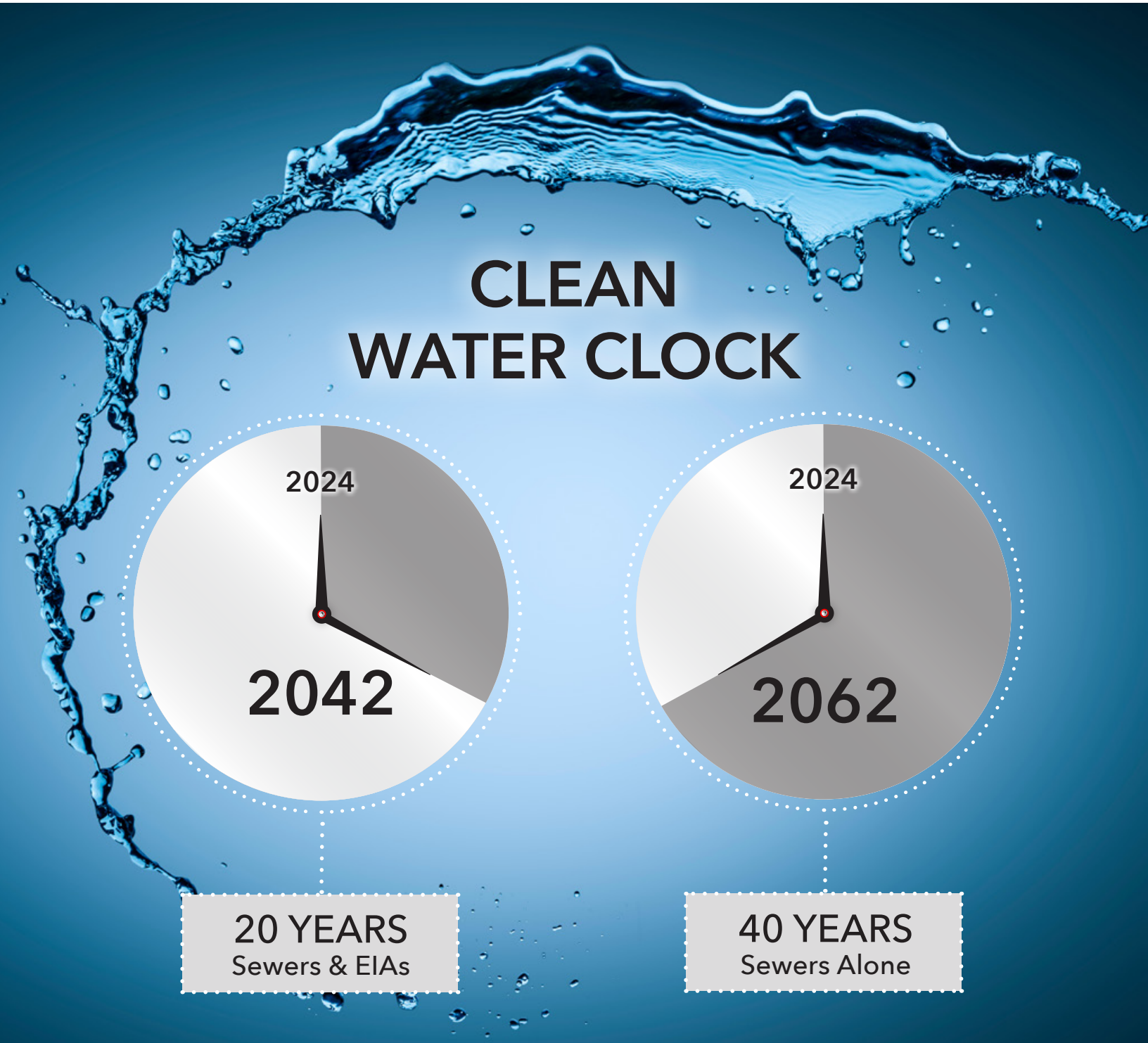
Double Issue 28 Fall/Winter 2025

Barnstable Clean Water Coalition

COALITION Quarterly



Modeling *the* Future

A Note From The Helm

MODELS MATTER

The complexity of our world comes into focus almost every day. We experience or read about some weather event or condition, and we ask, "Is it natural or is it climate change?" Is this something "we" made happen?

When it comes to the waters in and around Cape Cod, we know the answer. Thousands of us have gradually changed the ground and surface waters through our wastewater disposal. Water chemistry is now significantly different with increasing levels of nitrogen, phosphorus, other elements and contaminants. We have algal blooms in our estuary that turn the water brown. Our ponds and lakes are no longer pristine, and many are periodically closed due to cyanobacteria outbreaks.

As a society, and throughout history, we have relied on models, "math" to help us understand and hopefully predict something. The best day to day example of this is weather forecasting. Models to predict the weather are good examples of a well-known aphorism in the 1970's, "all models are wrong, but some are useful". Forecasters never seem to get the weather exactly right!

In 2001, the late Dr. Brian Howes and his team developed the Massachusetts Estuary Project (MEP) model to determine nitrogen inputs in estuaries. At the time, this model was groundbreaking and cutting edge. We believe it is still directionally correct. However, like the world in general, new data and changing inputs call into question this model's long-term usefulness.

Why?

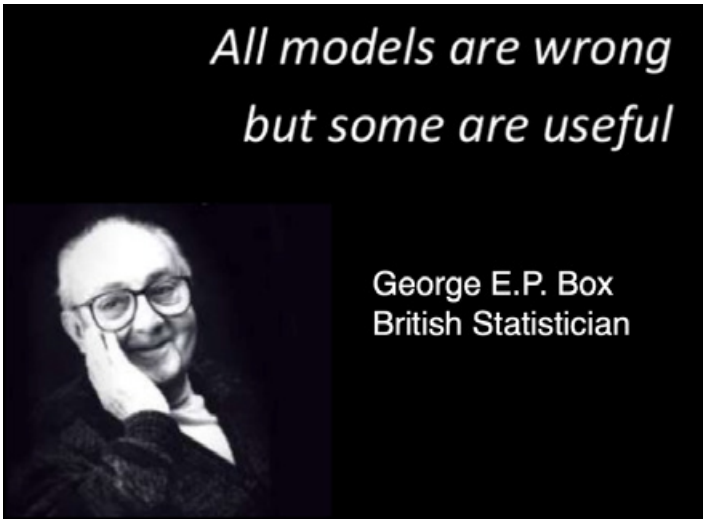
The MEP model is a "black box", not "open source". It is a "static" model. Yet new information is now available which is critical to our modeling approach and thus, our planning. The MEP model is used for some watersheds but not others. Currently, many watersheds have no models, while others use models developed independently. Cape Cod, the Islands, and the entire southeastern Massachusetts region need and deserve ongoing, adaptable modeling that includes the entire area. A federal agency, the U.S. Geological Survey (USGS) which does all the modeling for Long Island Sound, could do modeling for the entire region. (see box on page 3)

"AI" and data processing have taken enormous steps, data inputs that heretofore took weeks or months to process can now be done in seconds. With billions of dollars of wastewater-related spending at stake we need an up-to-date and adaptive approach.

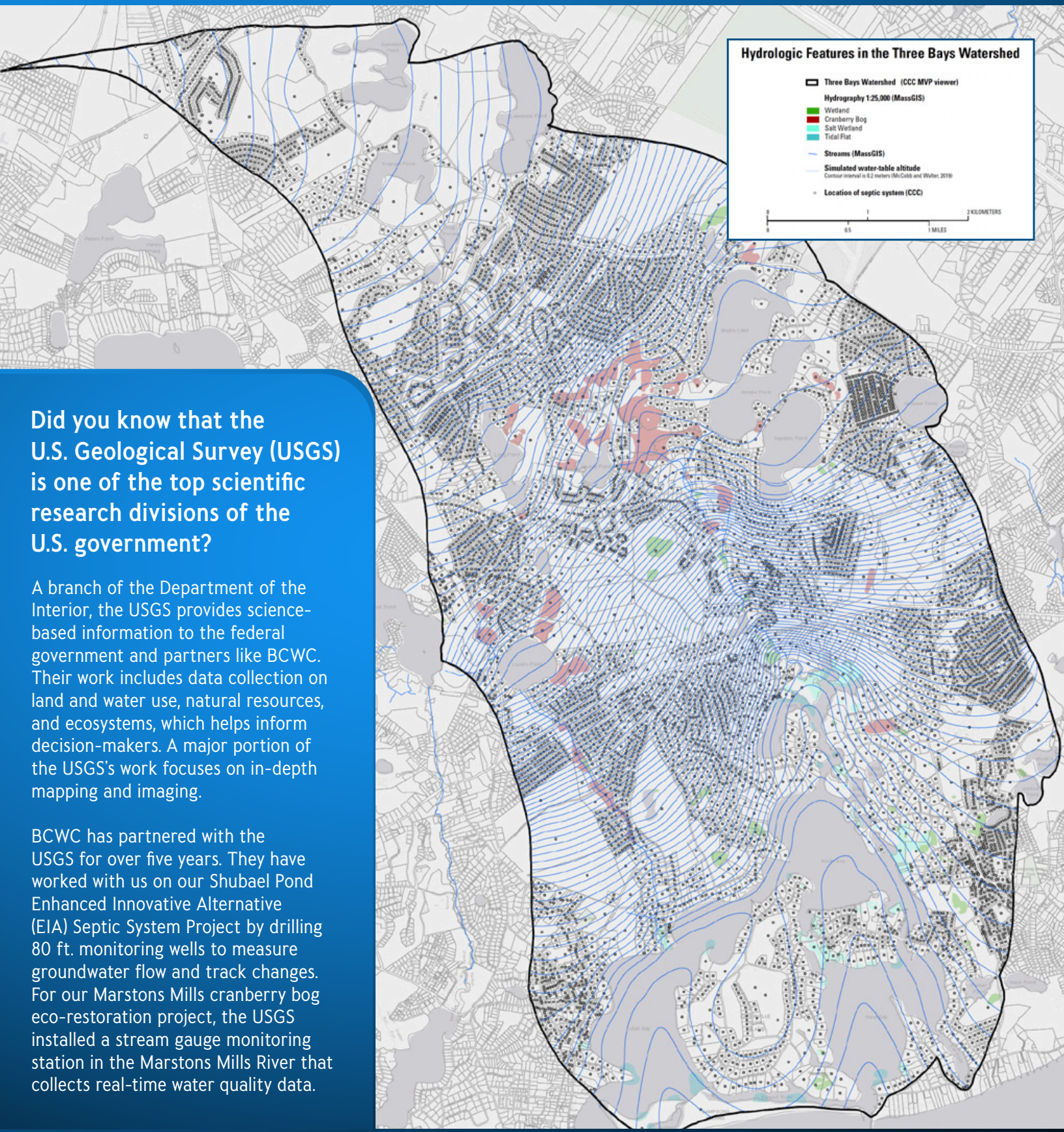
No matter the cause, climate change and warmer conditions are having an impact. Water usage trends and water saving devices have led to a near doubling of the assumed nitrogen concentrations in our septic systems. On the flip side, atmospheric nitrogen has declined as coal plants have closed.

Change is not easy, but we are convinced that an adaptable, open-source modeling approach is what the Cape, the Islands and the entire southeastern Massachusetts coast need. No doubt, the "devil will be in the details", and we DO NOT advocate going back to "square one". Existing legal and environmental goals can be incorporated, and a new model can be adopted to allow us to achieve the goal: Clean Water! We will know we have achieved success when eel grass returns to our coastal waters.

Why does a 30-year plan take 40 years to clean water?
Time-to-travel!



USGS Geological Survey



Did you know that the U.S. Geological Survey (USGS) is one of the top scientific research divisions of the U.S. government?

A branch of the Department of the Interior, the USGS provides science-based information to the federal government and partners like BCWC. Their work includes data collection on land and water use, natural resources, and ecosystems, which helps inform decision-makers. A major portion of the USGS's work focuses on in-depth mapping and imaging.

BCWC has partnered with the USGS for over five years. They have worked with us on our Shubael Pond Enhanced Innovative Alternative (EIA) Septic System Project by drilling 80 ft. monitoring wells to measure groundwater flow and track changes. For our Marstons Mills cranberry bog eco-restoration project, the USGS installed a stream gauge monitoring station in the Marstons Mills River that collects real-time water quality data.

How Models Matter in the Three Bays Estuary and Watershed

The map to the right shows a portion of the Town's three phase, 30-year sewer plan which is designed to address the state mandate to lower the nitrogen load in our watershed to improve the health of the Three Bays estuary. The Massachusetts Estuary Project (MEP) model has been the critical arbiter of the forecast success of the sewer expansion plan.

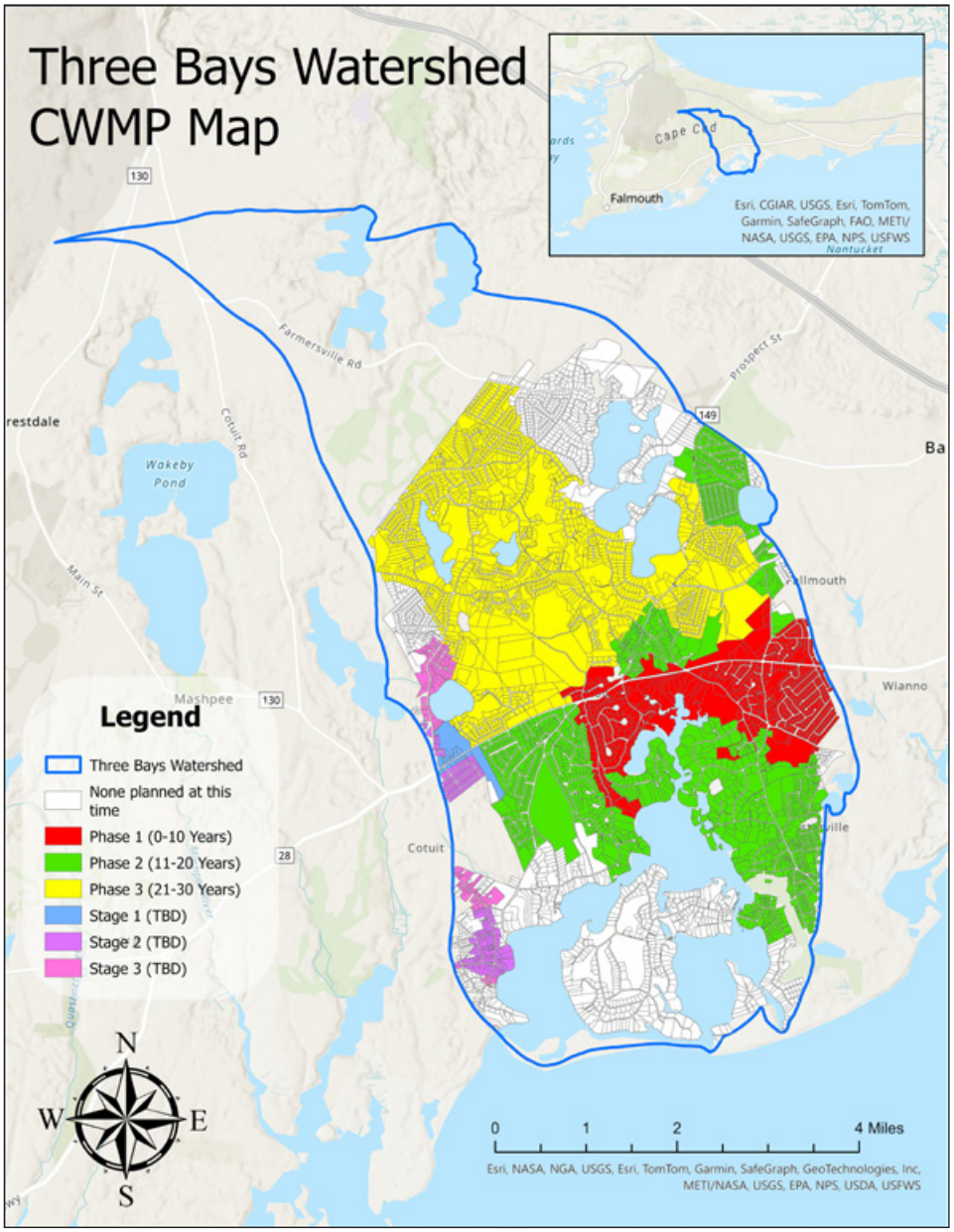
While we applaud the sewer plan and all the work our town has put into the effort, we question some of the "absolutist" conclusions of the MEP model.

We are told that the area in yellow, Phase 3, which is not scheduled to be completed for over two decades, must be 100% sewered for the model to indicate successful nitrogen load reduction.

We have several real-world problems with this conclusion. Are we looking at the problem myopically? A new approach or new model may help us solve the problem differently.

If other interventions including stormwater management and fertilizer reductions are implemented, this would reduce the required wastewater reductions.

One of our main issues with the MEP model is that incorporating new Enhanced Innovative Alternative (EIA) technology appears to fall short of solving the problem when compared to sewer expansion.



How can that be? Some of these new technologies remove 95% or more of the nitrogen load from individual homes. Wouldn't an expanded treatment area accomplish the same thing as 100% in a smaller area? Additionally, the EIA approach treats wastewater in situ, whereas municipal treatment simply moves the treated effluent to another location with all the associated pumping costs and long-term energy commitments. This removal also creates recharge considerations for the aquifer.

It is important to remember that the watershed ignores town boundaries, so some treatment should include Sandwich.

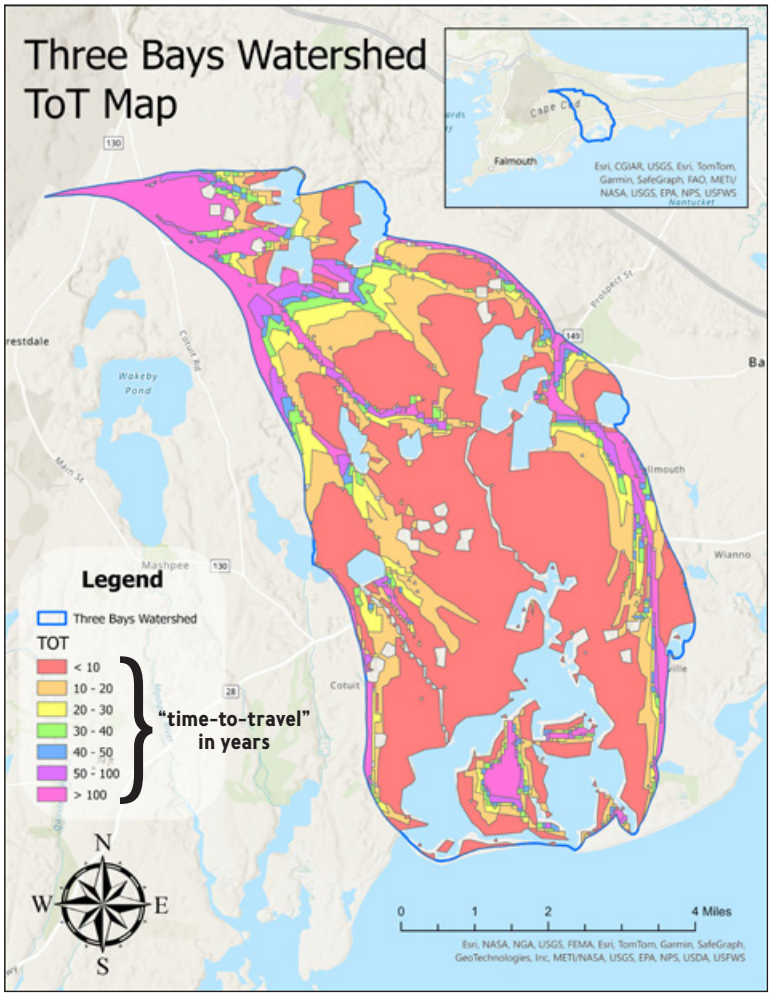
NEW MODELING SHOULD INCORPORATE TIME-TO-TRAVEL

The map to the right shows groundwater "time-to-travel" in years. Nitrogen travels with the groundwater on Cape Cod until it reaches surface waters (bay, estuary, lake, pond or river).

Approximately 1,991 homes are present in the Phase 3 area, with 1,737 of these located in the Three Bays watershed. The average age of homes in this area is over 40 years (median year built is 1977).

With a Title 5 system or cesspool's limited life, we could expect to see most of these households replace their systems over the 25-year period before the planned sewer reaches their property.

If these homes upgraded to new EIA systems over this timeframe, the need for sewer might be mitigated or even eliminated! More importantly, the **"clean water clock"** will start running decades earlier making it more likely that our estuary will survive!



MONEY ALSO MATTERS

The MEP model wasn't designed to address the importance of time to travel nor the practicality of how communities pay to fix the problem. But these are major considerations.

The clean-up clock is ticking, but it is hard to place a societal value on returning an estuary to a healthy status in 10 years rather than 40 years. Property values, tourism, and our overall lifestyle will all be impacted if our water quality continues to decline!

Once again, a model and math may help provide the answer. Actuarial tables help us determine how long we may live and what kind of insurance we may need to provide for income in our later years. Modeling could help us determine the value of a healthy estuary now and in the future.

Another important part of the equation to model is the overall cost. We tackled some of this in our last newsletter *Subsidize to Equalize*. Our work has shown that today a new EIA system may cost just one-third the cost of sewer. Less than a third if we incorporate the state credit of $18,000 and other potential incentives.

Modeling for Wastewater Treatment in Phase 3

FASTER, CHEAPER, FAIRER.

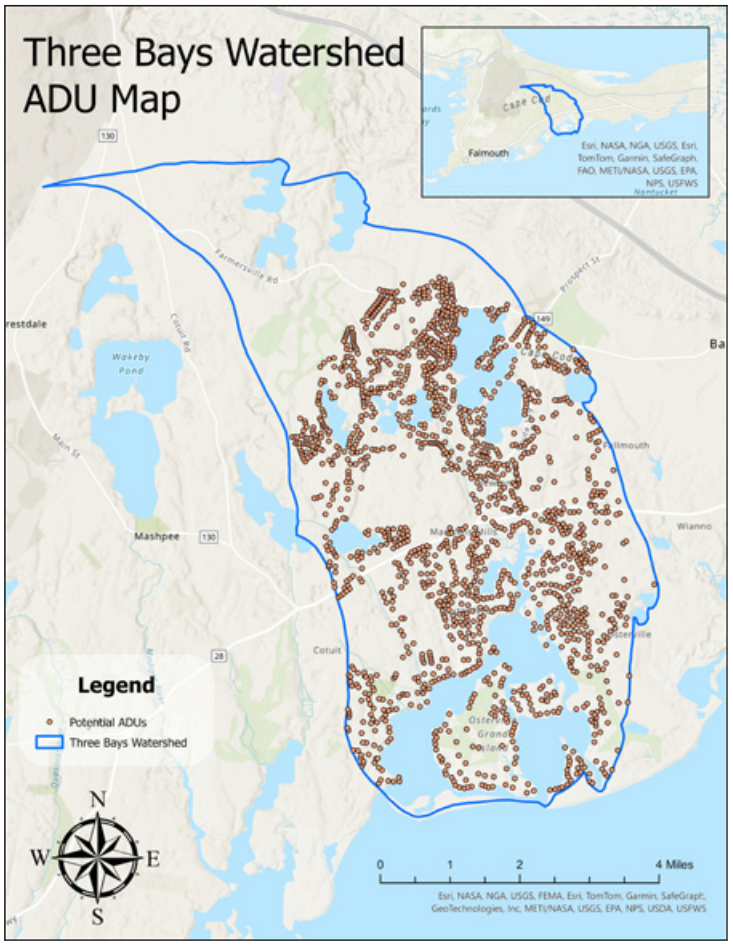
We have estimated the number of households in the Phase 3 area within the Three Bays watershed. The latest Phase 3 area includes some parcels outside of the watershed itself. Here are some of the baseline numbers:

- Phase 3 encompasses 1,991 parcels.
- Phase 3, Three Bays Watershed: 1,737 parcels.
- The average year a house was built in the area is 1977.
- For a large portion of the homes in this area, the time to travel is 10 years or less.
- Connecting 1,737 homes to sewer at current prices would cost approximately $243 million.
- Phase 3 starting date is likely to be in the 2040's.

The Cape's housing crisis, a warming climate, and our wastewater clean-up mandate suggest looking at our overall problem with new urgency. Here are a few things to consider:

- EIA technology can achieve a better than 95% reduction in nitrogen.
- EIA technology may be 1/3 the cost of sewer expansion.
- New state tax incentives of up to $18,000 enhance EIA affordability for some homeowners.
- Data suggests that existing septic systems (cesspools and Title 5s) in the Phase 3 area will require replacement prior to sewer arrival given the age of the properties.

A simplistic analysis of sewer expansion alone to treat household wastewater in the Phase 3 area would indicate that the total cost in today's dollars would be $243 million. This is using a cost $140,000 per parcel as the baseline for the 1,737 parcels in question. Individual homeowners would be responsible for paying $20,000 of the $140,000 to connect to the sewer. Therefore, about $35 million would be shouldered by homeowners and $208 million by all the town's taxpayers.



A different approach is to use EIA systems for wastewater treatment while modeling potential financial incentives to lower the cost and accelerate adoption.

One approach could incorporate the need for more housing with the ability to add an Accessory Dwelling Unit (ADU) to a property. We posit that in the Phase 3 area, 509 of the 1,737 properties could add an Accessory Dwelling Unit (ADU see glossary, page 10) based on lot size and number of bedrooms. We show these locations on the map above.

Based on existing water and wastewater data we can conclude that the best EIA technology can reduce nitrogen by 95% or more and adding an ADU would still lead to a net reduction of 80% or more.

Four-Part EIA Approach to Phase 3 Could Save $175 million

ADU's are desirable because they both add a badly needed housing unit (1-2 bedroom) and provide a potential source of income and lifestyle flexibility for today's families. For the town, they add to assessed value, and thus the tax roll. We suggest incentivizing adoption by providing a 10 year "tax holiday" on the increase in assessed value in exchange for switching the main house and the ADU over to a new EIA at the homeowner's expense. For the sake of our model, let's assume that half of the potential property owners take advantage of this incentive (and possibly the state tax credit).

The "cost" to the town in this case is the deferral of tax revenue based on an increase in assessed value. We model a ten-year program during which time 254 households are upgraded. We assume an ADU will add $250,000 to assessed value, which equates to a "tax holiday" of $2,200/year.

Based on an average EIA cost of $46,000, here are four separate approaches to EIA rollout that when taken together, the savings equals $175 million.

Four Steps to Save $175 million

PART 1

Install 254 EIAs on parcels that can build an ADU at a "cost" to the town of $58,000/year or $558,000 over 10 years.

($46,000 per household. Homeowners pay full $46,000, Town Tax Credit of approximately $2,200 per household per year for 10 years, plus potential state grant of $18,000 = Net homeowner cost of $6,000.)

PART 2

1,483 parcels are now left to be treated in our model. Our research indicates that more that 60% of these qualify for a residential exemption and earn enough money to take advantage of the new $18,000 state tax credit for upgrading septic systems. We next assume that each of these property owners will be asked to shoulder the same percentage for an EIA as they would for a sewer connection (14.3% or $6,578).

$46,000 minus $18,000 minus $6,578 = $21,422 to be town financed. With 890 parcels costing $19.06 million.

Install 890 EIAs at a cost to Town of **$19,065,580**

($46,000 per household. Homeowners pays $6,578, State Tax Credit of $18,000, Town subsidy of $21,422)

*** To receive the full State Tax Credit, one's income must be $91,000/year and one must be a resident. Median household income in Phase 3 area = $111,754 (61.4% of residents make above 91,000), and residential exemptions in Phase 3 area = 1,069 (61.54% of residents have a residential exemption)*

PART 3

Of the 593 parcels left to treat with EIAs, approximately 308 could fall into the low-income category if we use the Barnstable County metrics of family's earning below $75,000 annually. For this cohort we will assume the town pays the entire $46,000 per household with the understanding that this is an oversimplification. Assume funding comes via SRF funds or other borrowing mechanisms. $46,000 X 308 = **$14,168,000**

PART 4

Our math indicates that 285 households remain to be addressed with EIA treatment, and these are all non-residents. For this cohort we posit a direct payment of $16,000 (roughly the cost of a new title 5 system) and a SRF or other borrowing mechanism for the homeowner to borrow the balance of the costs at a low interest rate for an extended term of 20 years.

CONCLUSION

Town Sewering Phase 3 Projected Costs	**Total EIA Direct Town Responsibility**
$243,180,000	$19,065,580
($140,000 x 1,737 total phase 3 sewering costs - $34,740,000	($21,422 x 890 Town partial subsidy) + $14,168,000
($20,000 x 1,737 Homeowner costs)	($46,000 x 593 Town fully subsidized)
$208,440,000 Town responsibility	$33,233,580 Town responsibility

$208,440,000 Town Phase 3 Sewer Costs
-$33,233,580 Town EIA Subsidy Costs

$175,206,420 TOTAL ESTIMATED SAVINGS TO THE TOWN

See Illustration page 10

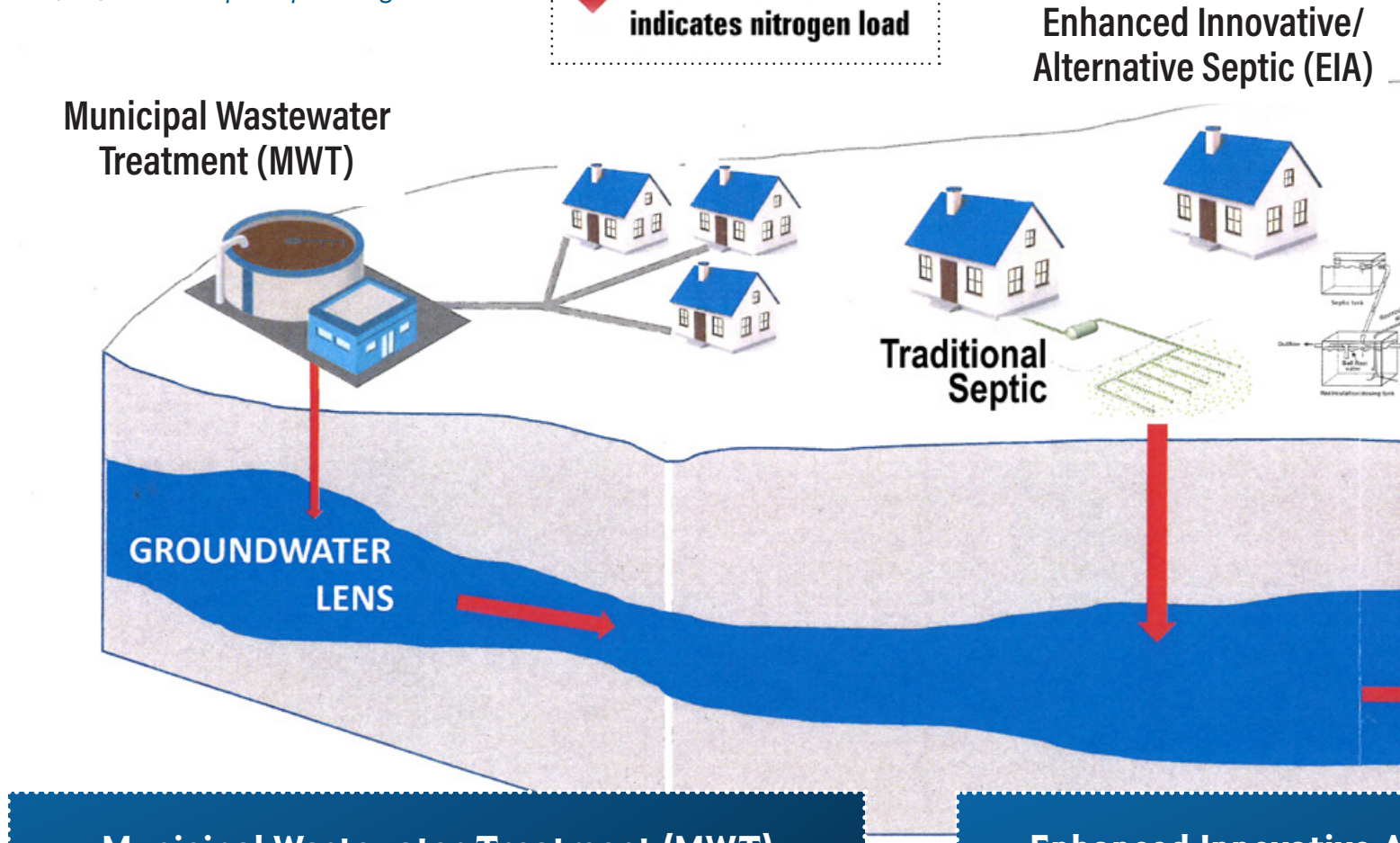
Developing an Adaptive Plan for Wastewater Treatment in Town

Highly permeable
Recent regulatory chan
protection, but do not include
to municipal wastewater

The graphic below shows some of the components worth considering for future adaptive planning.

Symbol Key

Thickness of arrow indicates nitrogen load



Municipal Wastewater Treatment (MWT)

Cost/Benefit Analysis

- Proven technology and plan.
- Can be modified to treat Contaminants of Emerging Concern (CECs).
- High and rising costs to build and operate.
- Cost per kg of Nitrogen removed = +/- $900.
- Parcel cost $140,000, range of $100,000-$200,000.
- Operation and Maintenance (O&M) considerations.

Challenges

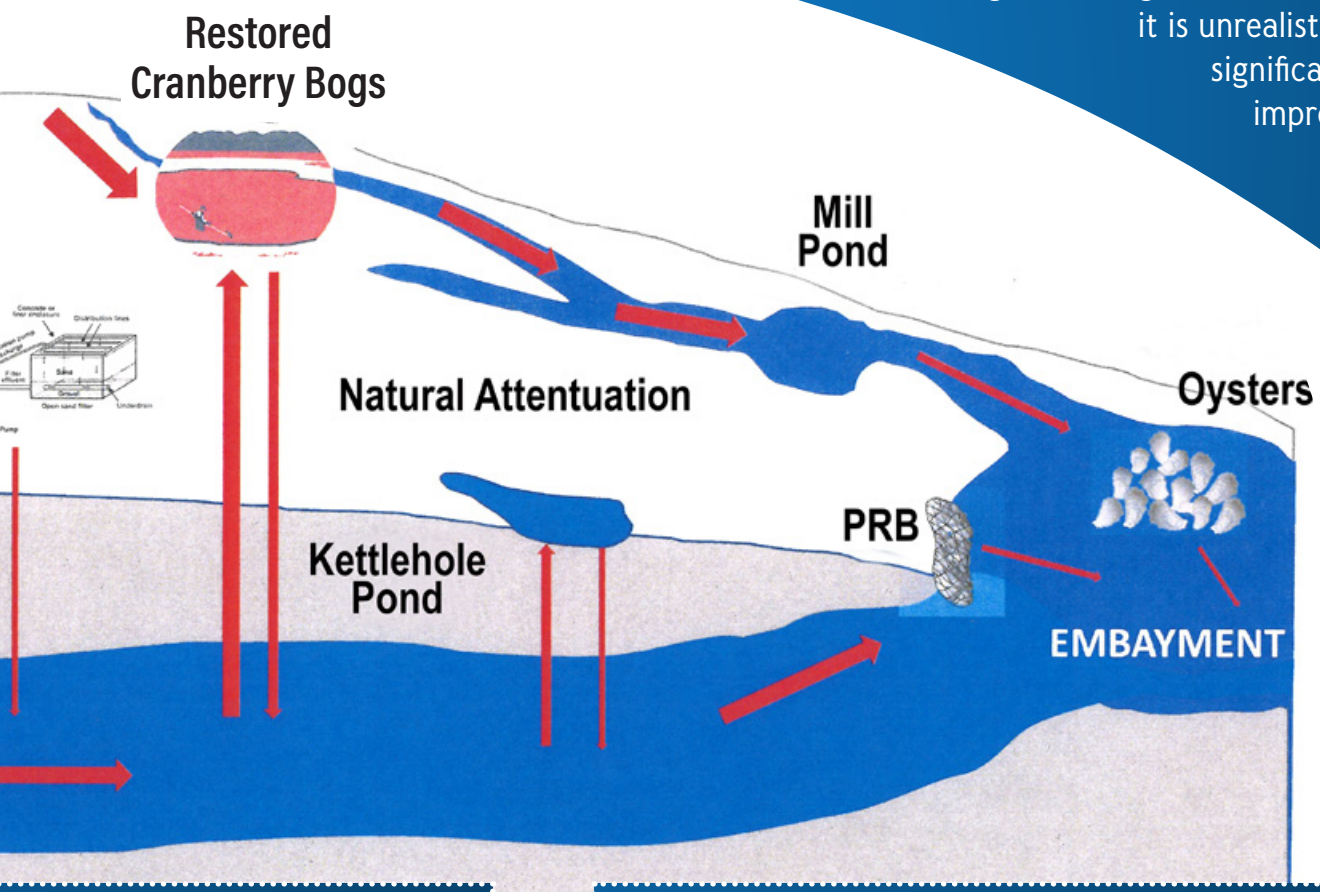
- Effluent disposal challenge rises with increased volume and system expansion.
- Distance from MWT raises overall and ongoing costs.
- Recharge may be a consideration for water departments.
- "Time-to-travel" results in slow improvement in groundwater.
- Costs preclude ability to address town-wide wastewater.
- Will community be willing and able to fund costs?

Enhanced Innovative A

Cost/Benefit Analysis

- Costs at 1/3 of MWT on a unit basis.
- Potential to target "at risk" areas quickly.
- Potential for town-wide adoption.
- More balanced recharge.
- Cost per kg of Nitrogen removed = +/- $300.
- Unit cost of $46,000 for full new replacement, estimated $38,000 for partial replacement (keep tank and/or leach field).
- O&M considerations.
- Betterment opportunity to lower town-wide costs and address housing needs.

e, sandy soil conditions on Cape Cod lead to wastewater-compromised groundwater throughout the peninsula. ges to Title 5 by the Massachusetts Department of Environmental Protection this past year addresses estuary e our freshwater ponds. Currently, the town has about 27,000 households with approximately 3,500 connected r treatment. The current three phase, 30-year wastewater collection and treatment expansion plan expects to connect an additional 12,000 households. In 2018, the cost estimate was about $1.45 billion. Costs have risen substantially since then. Due to the timing and location of the sewer plan, along with the groundwater "time to travel", it is unrealistic to expect any significant water quality improvements in our bays for several decades.



lternative Septic (EIA)

Challenges
- New technology.
- CEC reduction?
- Regulatory recognition..
- Scale production and installation.
- Workforce training and need for workers (job creation).
- Responsible Management Entity (RME) need.
- Lack of high-performing technology choices.

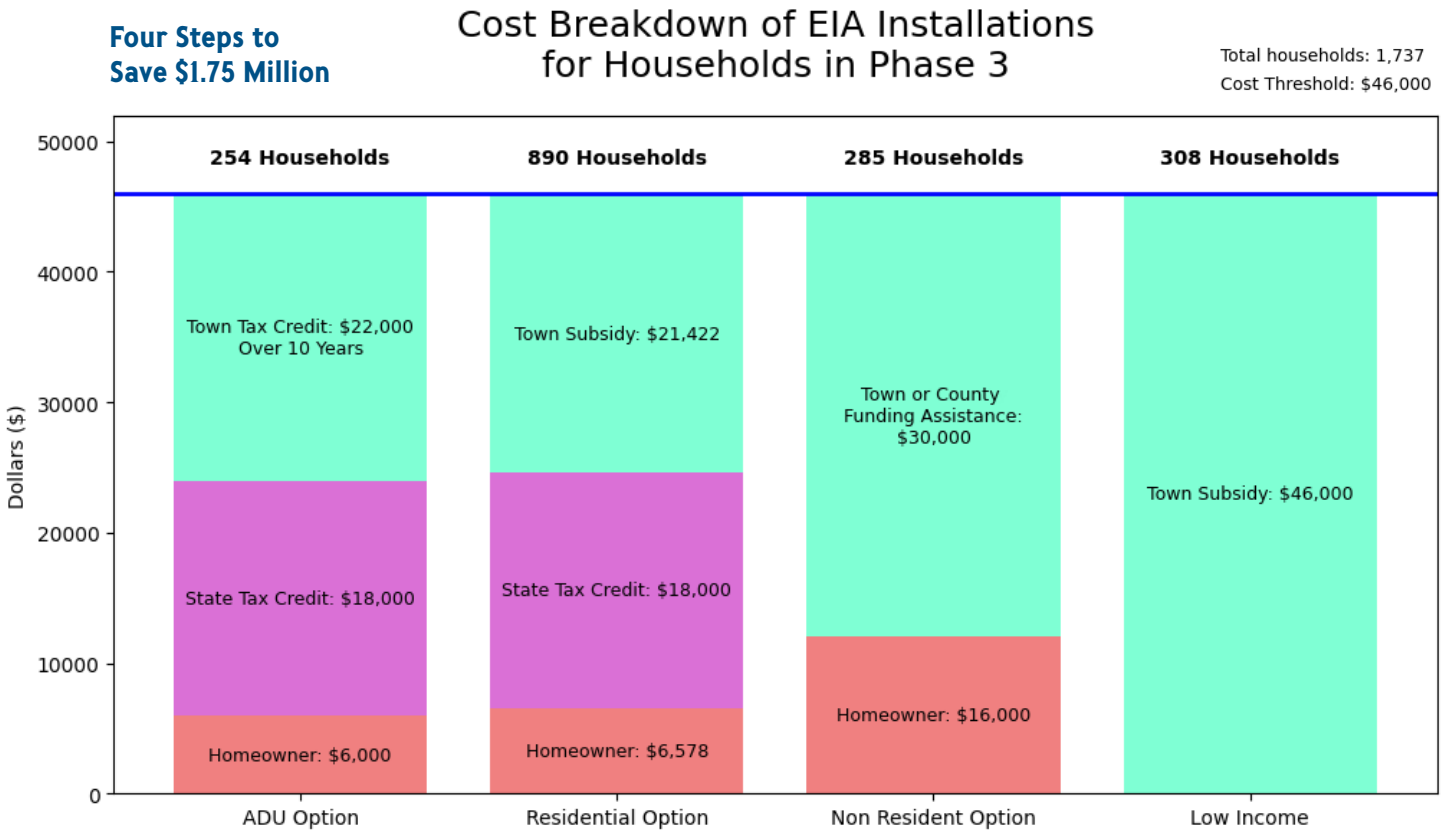
Restored Cranberry Bogs

Cost/Benefit Analysis
- Low cost to build and operate.
- Rapid impact given to "time-to-travel".
- Cost per kg of Nitrogen removed = +/- $50.
- Ancillary benefits as community asset (open space, recreation, etc.).
- Cranberry bogs restored to natural wetland habitat.

Challenges
- Limited scope due to limited locations.
- New "nature-based" technology.
- Need for permits, approvals, and funding.
- Ability to purchase bogs.

Phase 3 Cost Breakdown Illustration

Four Steps to Save $1.75 Million



GLOSSARY

Contaminants of Emerging Concern (CEC): CECs are chemicals and toxins that have been shown to have human health and ecological impacts.

Operation and Maintenance (O&M): Manage and maintain large facilities, including municipal wastewater treatment plant.

Recharge: The process of water inflow into groundwater or an aquifer.

Responsible Management Entity (RME): Agency or organization tasked with managing decentralized wastewater infrastructure.

Accessory Dwelling Unit (ADU): A smaller, self-contained housing unit that can be attached or detached from a single-family home with its own separate entrance.

Municipal Wastewater Treatment (MWT): Sewage and wastewater from homes and businesses are collected and transported via sewers to a municipal wastewater treatment plant where it is treated before it is discharged back into the environment.

Enhanced Innovative Alternative Septic (EIA): EIAs are onsite systems that treat wastewater and remove most of the nitrogen before leaching into groundwater and other water bodies.

HELPFUL RESOURCES

Check out the Town of Barnstable's Water Resources page, **https://BarnstableWaterResources.com** for information on water quality issues, the Comprehensive Wastewater Management Plan, and the answers to questions like:

Am I Eligible for New Sewer Service?
How Do I Hook-Up?
What are the Anticipated Costs?

Visit the Massachusetts Alternative Septic System Test Center (MASSTC) website **https://masstc.org** for information on EIAs, their Septic Utility Program (SUP!) and more.

Update on the Marstons Mills Cranberry Bog Eco-Restoration Project

Photo by Rachel Jones

BCWC is excited to announce recent grant awards for our Marstons Mills Cranberry Bog Eco-Restoration Project. BCWC is restoring 64-acres of retired cranberry bog property along the Marstons Mills River. Our goal is to reduce nitrogen loading to the Three Bays estuary by restoring this site to healthy, self-sustaining, and dynamic wetlands that will naturally remove excess nitrogen and improve water quality. This innovative eco-restoration project is now at the "90% design and permitting" phase, which means we hope to begin construction within the next 12 months.

Along with receiving a $200,000 grant from the US EPA Southeast New England Program this summer (see back cover for more details), BCWC has also received several other grants:

- An anonymous foundation has given BCWC a generous challenge grant of $800,000 to help fund construction costs for the 64-acre restoration.

- The Massachusetts Division of Ecological Restoration awarded $540,000 to fund construction costs for 10-acres of a comprehensive study area within the 64-acre restoration site.

- The Horizon Foundation is helping to fund an outdoor environmental education amphitheater overlooking the comprehensive study area with a $15,000 grant.

STAY TUNED FOR MORE BOG RESTORATION UPDATES IN THE NEXT NEWSLETTER!

The Water Column *by Luke Cadrin*

If you live on Cape Cod, you probably know about Nitrogen and the state and towns' efforts (and price tag) to reduce nitrogen pollution in our environment. You may also have heard about the negative effects of nitrogen pollution on our local waters and the strategies to combat this nutrient overload. However, if you're like me and struggled through chemistry class, then you may still be wondering what exactly is Nitrogen and what's the big deal? Here are some of the basics:

Nitrogen (N) cycles through our atmospheric, terrestrial, aquatic, and marine ecosystems and is a necessary building block for life. Most of the N cycle is facilitated by bacteria and cyanobacteria, converting N into biologically available forms and back again. This process consists of 5 steps:

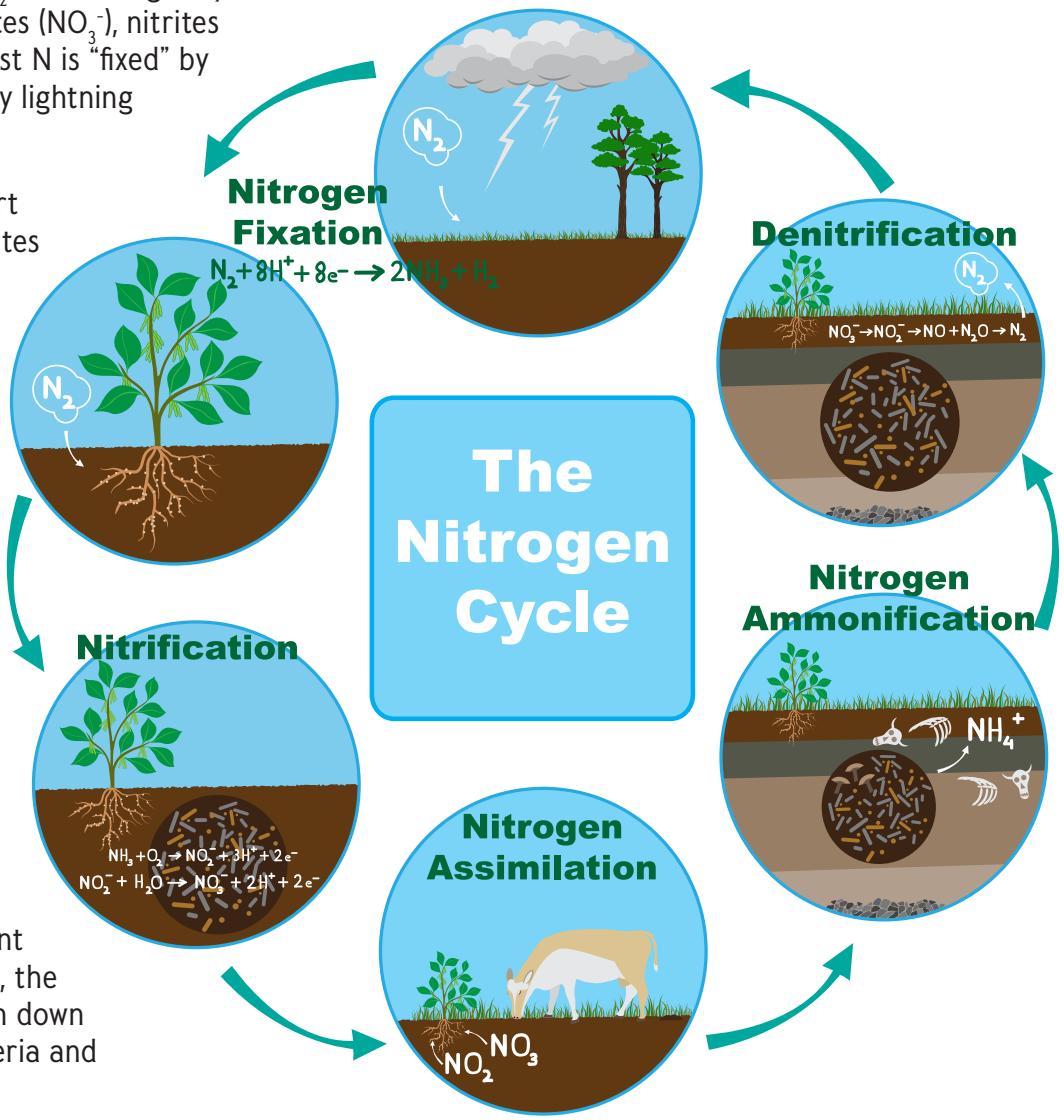
1. **Fixation:** Converting N gas (N_2) into biologically available types of N like nitrates (NO_3^-), nitrites (NO_2^-) and ammonia (NH_3). Most N is "fixed" by bacteria, but some is "fixed" by lightning strikes.

2. **Nitrification:** Bacteria convert ammonium to nitrates or nitrites (the process happening in your Title-5 septic system). Due to their high solubility, much of this leaves the soil and dissolves in the groundwater.

3. **Assimilation:** Plants can then absorb N as ammonium (NH_4^+) or nitrate through their roots and create organic forms of N such as amino acids. Animals then consume plants and N cycles through the organisms in an ecosystem.

4. **Ammonification:** When a plant or animal dies or expels waste, the organic forms of N are broken down back into ammonium by bacteria and fungi in the soil.

5. **Denitrification:** In anaerobic (lack of oxygen) conditions, like waterlogged soil, certain bacteria convert nitrates BACK to N gas, allowing the cycle to begin again. *(This is the process happening in your Enhanced Innovative Alternative septic systems)*




Luke Cadrin

Most N occurs naturally as a harmless gas that makes up around 78% of our atmosphere. However, this gas is not available to most living things. This leads to a scarcity of available N in most ecosystems making it a "limiting nutrient". Basically, of all the building blocks for life in an ecosystem, like carbon and oxygen, the least available is N, which dictates how productive an ecosystem can be.

For example, with an abundance of sunlight, water, carbon dioxide, and other minerals, plants could grow exponentially. However, the amount of N in the system creates a threshold for growth. While there are some exceptions (in freshwater ecosystems, the limiting nutrient is usually phosphorus, but that's a conversation for another day), N is typically the "limiting nutrient" for most of the earth's ecosystems.

What's the problem here, you might ask?

N is a crucial element that cycles through our ecosystems. Why all the time, effort, and money to get rid of it?

Well, humans have globally and locally altered the N cycle. Through industrial production and use of fertilizers, we have increased the amount of "fixed" or bioavailable N ten-fold. Since 1970, the global population has increased by 78% and reactive N creation has increased by 120%.[1] The denitrification process does not have the capacity to keep up with the rate we are adding N.

Most food we eat on Cape Cod doesn't originate here or use the locally available N. It was most likely farmed using industrial fertilizer containing N and then shipped here. We consume the excess N, and it goes straight into our waste. This waste ends up in our septic systems and flows into the groundwater.

Our septic tanks leach wastewater relatively deep into the aquifer, where many of the denitrifying bacteria do not live, effectively bypassing part of the cycle and sending nitrate-loaded groundwater directly to our forests, ponds, wetlands, and bays. When this happens, the limiting factor for growth is no longer so limiting.

Unencumbered growth of algae and plants occurs, they compete with one another, then die off and decompose. These effects are drastically changing our ecosystems: resulting in loss of diversity and resiliency, increasing harmful algal blooms, and more.

This is why the shallow waters and near shore beaches of our estuary are now "muck" instead of sand!

1 James N. Galloway, Alan R. Townsend, Jan Willem Erisman, Mateete Bekunda, Zucong Cai, John R. Freney, Luiz A. Martinelli, Sybil P. Seitzinger, Mark A. Sutton. 16 May 2008. Transformation of the Nitrogen Cycle: Recent Trends, Questions, and Potential Solutions. Vol 320 SCIENCE.

BCWC Welcomes New AmeriCorps Service Member and Barnstable High School Intern

AmeriCorps Member Spotlight: Tom Bedard

Tom is a 26-year-old AmeriCorps member who will be spending the next 10 months serving with Barnstable Clean Water Coalition. He is from nearby Fairhaven and recently graduated from the University of Massachusetts Dartmouth with a bachelor's degree in biology and concentration in marine sciences. Tom wanted to serve with BCWC given his academic background and life experiences around water that inspired him to take a step further and put all that knowledge to use to help the community. He looks forward to serving with BCWC to improve local waters and help keep those waters clean for future generations to come. Tom hopes to use the experience he gains from BCWC and AmeriCorps to work on conserving habitats ranging from marshlands to forests. In his free time, Tom enjoys spending time with his family and three dogs.

Barnstable High School Intern Spotlight: Lucas Tadim

A senior in Barnstable High School's Environmental Science & Technology pathway program, Lucas grew up and lives in Hyannis with his mom. He is always trying to find a way to get involved and give back to the community. This includes Lucas's work with Best Buddies and the Community Empowerment and Leadership Club, which involves helping people with special needs, along with raising money for the homeless community and local food banks. He was interested in interning at BCWC as another way to help the local community and environment. Lucas plans on attending Florida Atlantic University next fall where he will major in computer science. When not working at a local restaurant to save money for college, he enjoys playing video games in his free time.

Golfing and Shucking for Clean Water

It was a great day on the links at the Hyannisport Club on October 21st for BCWC's 4th Annual Clean Water Challenge golf tournament. The weather was perfect, the view was stunning, and the golfers enjoyed the spirited competition and fun. Thank you to the golfers, sponsors and donors who raised funds to ensure BCWC has the resources needed to continue our work for clean water for all.

After two years of torrential rain, the sun made an appearance again at the 7th Annual Shuck! Oyster Festival at Cape Cod Beer on October 5th. It was a fun day with a great crowd who enjoyed freshly shucked oysters and pints of delicious Cape Cod Beer, music and more. Thanks to everyone who made this an amazing day, especially the hardworking BCWC volunteers and Cape Cod Beer Brew Crew. A special thank you to Beth and Todd Marcus for their continued generosity and support of BCWC.

Barnstable Clean Water Coalition

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Mission Statement

Barnstable Clean Water Coalition works to restore and preserve clean water in Barnstable. BCWC utilizes science as its foundation to educate, monitor, mitigate and advocate for clean water.

US EPA Southeast New England Program (SNEP) Announces the Massachusetts Recipients of SNEP Watershed Implementation Grants (SWIG) for 2024

On Oct. 4th, the Town of Yarmouth hosted an event to announce the 2024 SWIG grant funding in Massachusetts. BCWC is one of the five MA SWIG grant awardees for our Marstons Mills Experimental Cranberry Bog Restoration Project. This project will restore a former bog to wetlands to test and analyze which restoration methods will remove the most nitrogen from surface waters in the most cost-effective way.

Left to Right: Caleb White of the Office of Sen. Elizabeth Warren, U.S. Representative Bill Keating, and BCWC Executive Director Zee Crocker

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