The Miacomet Mission
Nantucket Island

Natural & Geological Sciences Institution
Charles Maxwell Duce
MArch II Thesis 2023
Instructor: Anne Tate
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Nantucket MA, is an island that has failed to refine and regulate the unreasonable uses of freshwater supply, and re-establish the purification processes involved with filtering our wastewater. The validity in claiming re-evaluation for Nantucket’s immoderacies in freshwater consumption and implausibilities in existing wastewater treatments, is seemingly irrefutable. Along with these detriments, Nantucket experiences harsh coastal erosion conditions that are rapidly altering beach profiles and diminishing irreplaceable habitats. Similarly, coastal flooding is causing ecological displacement and in some instances ecological degradation.

The relentlessness and fleetingness sparked by Nantucket’s climatic realities require willing and able action to mitigate impacts, but our fractured response bears no chance. We have spent several years excessively funding the fight against erosion, and countless hours developing preventative coastal flooding measures, but we have yet to face our persistence in over consuming Nantucket’s natural resources. Due to the failure of local officials, there is no other option than to educate the people in my community who blindly partake in this lasting behavior.

As a global citizen, it is my responsibility to face these instances inclusively and diversely, for I have had the opportunity in receiving a contemporary education. Through this education, I have learned new water management techniques that involve biologically complex processes paired with technologically simple operations. A hybridization of living machines and constructed wetlands come together in purifying on site wastewater, and filtering nearby bodies of water.

As the designer, these systems will be my driving force in developing an institution for the researchers and scientists employed at Maria Mitchell Association to educate our community. This non-profit organization has studied Nantucket’s natural sciences for decades, playing a vital role in our understanding of various biological disciplines. Schematically, this thesis will prioritize ecological expansion, allowing built structure to become one with habitat. The landscapes consisting of native plants, biological filtration mechanisms, and various experiential gardens, will come together in defining Nantucket’s newest outdoor classroom.

Welcome to the first natural and geological sciences institution in Nantucket Massachusetts, where local school systems, summer camps, and community members are welcome to learn from respected, highly skilled scientists and researchers. The first assignment entails studying, understanding and resolving Miacomet Ponds toxic algal blooms and its annual reoccurrences.
How can the community play a role in responding to the future of Nantucket’s climate and persistence of its current realities?
Nantucket is a tourist destination and a summer colony. Because of the island population being 15,000 during the off season, the summer residents increase the population to 125,000 during the summer (three to four months out of the year). The National Park Service cities Nantucket, designating it as a National Historic Landmark district in the year of 1966. It is known as one of the “finest surviving architectural and environmental examples of a late 18th century and early 19th century New England Seaport Towns. Nantucket is only accessible via boat, ferry or airplane.

The whaling industry flourished out of Nantucket centuries ago, mainly consisting of the Wampanoags manpower, which was ultimately serviced and sourced from a debt servitude that was established by English Nantucketer’s. If you take a trip down Main Street in the downtown historic District, the buildings transition from storefronts to residents. Many of these homes belonged to old sailors, captains, and whalers. A lot of these houses consist of red bricks like the famous red brick homes that neighbor each other about two blocks up Main Street. These homes, conserved by Nantucket’s HDC have been kept in their original state, similar to most local historical landmarks. Most of these historic homes belong to summer residents, people that have an unfathomable amount of money, willing to spend it on fully embracing the history that Nantucket embodies.

The wastewater in the town sewer district collection system is pumped to the Surfside Wastewater treatment facility via the Sea Street Pump Station, the Surfside Road Pump Station, the South Valley Pump Station, and the new Monomoy South Pump station that was more recently completed. Four years ago, at the very beginning of 2018 Nantucket’s sewer main broke on South Beach Street, discharging over two million gallons of untreated raw sewage in Nantucket Harbor. The decision to discharge was established as a way of avoiding sewage back-up in nearby houses. One of the main contributions in causing this catastrophic failure was the recent cold stint freezing thousands of pipes. However, this belief was more speculative, as the real cause remained unknown for weeks post incident.
Detail from color Bird's Eye View of the Town of Nantucket, State of Massachusetts, Looking Southwest 1881 Nantucket Historical Association
The Client

Maria Mitchell Association
The Maria Mitchell Association (MMA) was founded in 1902 to preserve the legacy of Nantucket native astronomer, naturalist, librarian, and educator, Maria Mitchell. After she discovered a comet in 1847, Mitchell’s international fame led to many achievements and awards, including an appointment as the first American professor of astronomy at Vassar College. Maria Mitchell believed in “learning by doing” and today that philosophy is reflected in the MMA’s mission statement, programs, research projects, and other activities.

The Maria Mitchell Association operates two observatories, a natural science museum, an aquarium, a research center and preserves the historic birthplace of Maria Mitchell. A wide variety of science and history-related programming is offered throughout the year for people of all ages.

This information is directly from the organizations website.

https://www.mariamitchell.org/about-mma
alternatives? immediate action for sustainable operations will continue disregarding the How do we change the way in which these measures; an issue that's irrefutable on to existing structures and appurtenances.

basins.

3.5 MGD Membrane Bioreactor Wastewater "The project consists of construction of million dollars. Hopefully I will get some facility operator

PHASE 1: LOCAL WASTEWATER TREATMENT

I understand that the extracted solids get discharged into the harbor towards the end facility specifically works, and how the facility operator

PHASE 3: LOCAL CONSTRUCTION &

Not a single thing described on the check-sheet. Temporary facilities to maintain existing

PHASE 4: LOCAL LANDSCAPE & NATIVE

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What makes a native plant species hydro-

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aspects of local sciences.

She is incredibly knowledgeable in all

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These aren’t all the questions I’ll

soil conserved for endangered species

which speak to the sensibility involved with

approaching my site.

Walking around my site and different areas

different site experiences, depending on

environmental impact habitats and ecosys-

How can plants be used to produce an

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PHASE 1: LOCAL WASTEWATER TREATMENT

Meeting with Grade 14 water treatment facility operator Mr. Moore. This meeting will be the first stop on my list, getting a tour of Nantucket’s existing wastewater facility and understanding the groundwork during this site visit and interview. I will be focusing on how Nantucket’s facility specifically works, and how the processes take place. This facility is currently undergoing a massive renovation, one that is costing the taxpayers over forty million dollars. Hopefully I will get some insight as to what’s being designed and why.

Questions

What are the phases that break down the wastewater?

How does the separation of solids and liquid occur?

What devices are used throughout the process, and what exactly are they used for?

What percentage of wastewater does this facility account for locally?

What was the real reason behind two million gallons of raw sewage being diverted into the harbor towards the end of 2018?

I understand that the extracted solids get driven to the dump, once they’re at the dump, where does it go?

What machines does this separated sewage get placed into once it reaches the C&D building?

After the wastewater goes through a series of filtration processes, where does it end up and why?

What percentage of this filtered wastewater ends up in our ocean?

How can we minimize the amount of desalted water being discharged?

Is this water used for anything other than discharging?

This Nantucket Wastewater Treatment Facility is currently undergoing a forty-million-dollar renovation that’s being completed by Canin Contracting.

“The project consists of construction of wastewater infrastructure improvements as follows:

- 35 MGD Membrane Bioreactor Wastewater Treatment Facility

- Modifications to ten existing rapid infiltration basins.

- Construction of five new rapid infiltration basins.

- Rehabilitation and modifications to existing structures and appurtenances.

- Selective demolition of existing structures and appurtenances.

- Temporary facilities to maintain existing facility operations.”

Not a single thing described on the checklist above is representative of sustainable measures, an issue that’s irrefutable on Nantucket Town Councils behalf.

How do we change the way in which these operations will continue disregarding the immediate action for sustainable alternatives?

PHASE 2: LOCAL HABITATS & UNDERSTANDING ECOSYSTEMS

Meeting with longtime scientist Sarah Skylar from the Umass Field Station that is located on Nantucket.

This meeting will ideally take place over the course of a few days if the weather permits. Walking around my site and different areas nearby, Sarah can physically show me the breakdown of certain habitats and different ecosystems, specifically what these habitats and ecosystems look like, and what their scientific make-up consists of.

I worked with Sarah several years ago on a science fair project where we had been measuring the change in beach profiles and studying the differences in beach sediment. She is incredibly knowledgeable in all aspects of local sciences.

This interview will essentially be a walk and talk, where she leads the discussion. I will be treating it as a physical lecture series, taking an abundance of notes and asking questions that pertain to the specifics she mentions throughout.

I will take advantage of her knowledge specifically in regards to the toxins that arise in Micmac pond every year.

Questions

What areas on Nantucket carry the same geological and environmental characteristics relative to my site?

How do different habitats and ecosystems exist as one?

How do these things differ, and at what point do certain habitats reject overlap?

How does architecture and the built environment impact habitats and ecosystems once they are newly exposed?

What role can architects play in prioritizing on-site wild life?

How can architecture be used in becoming one with wild-life?

How can I avoid altering surrounding environments, specifically living habitats, throughout my design process?

Through my schematic design process, what are some tips you have on respecting such sensitive adjacencies?

As explained above, I know Sarah will have plenty of her own knowledge to share without the need for me to repeatedly ask questions. However, these are some questions that have came to mind, all of which speak to the sensibility involved with approaching my site.

I’m really hoping that I can catch Sarah on a short visit to the island, but I don’t know if that’s going to be possible since she left her management position at Umass Field Station a few years back.

If in fact she is unable to meet in person, I will carry out a handful of zoom calls from locations that are discussed via email, so that the walking lectures remain possible.

I will also be reaching out to our local Conservation Foundation and the Maria Mitchell Association. Between both of these organizations, I will be exposed to similar amounts of information.

Maria Mitchell Association will have extensive information on local wildlife as this is their expertise.

PHASE 3: LOCAL CONSTRUCTION & BUILDING PROCESS

Meeting with local contracting company Joe Gamborini (Crossing Construction) and their primary architect Jason Crossin.

Both of their companies have several projects, allowing for multiple different site experiences, depending on where exactly each of those projects are located. Ideally, getting walk-throughs of sites that speak to the geology of mine, would be incredibly beneficial in understanding how building and designing works in regards to wetlands.

Over the course of the week, I would be traveling to these different sites, with Mark Cutone and Joe Gamborini (co-owner of Crossing) where they explain the different methods and procedures that take place in constructing local suburban residential structures. This will provide insight as to how the design process translates into the construction phase, and what things take place in-between.

I’ll have access to construction documents, detailed drawings, and physical material samples, to help understand the allowable design strategies granted to both the designers and contractors by the HDC.

Questions

What building typologies define Nantucket’s local historical architecture?

What are the biggest obstacles you face while designing and building on island?

How do these obstacles change, and/or become more strict when dealing with proximity to the ocean / surrounding bodies of water?

What steps need to be taken in understanding how deep things can be dug?

How has contracting become more regulated in the past few years, and why?

What are some differences involved in the application processes taken by the designers and the contractors?

How do these processes relate and overlap in certain circumstances?

When structures are being built near bodies of water, what new steps become part of the procedure that aren’t necessarily considered when building further inland?

How often are surrounding habitats and ecosystems considered and prioritized in specific processes like demolition, or landform modification?

Knowing the presence that the conservation foundation carries, how often does land conserved for endangered species become an unavoidable outcome as the building processes are carried out?

Do they have jurisdiction over property that has been privately purchased?

What is the most disruptive phase in building on Nantucket, whether that may be a residential or commercial project?

Can the organization of on-site processes potentially benefit the amount of disruption that occurs throughout?

How can design reflect a level of organization that is maintained on site?

PHASE 4: LOCAL LANDSCAPE & NATIVE PLANT SPECIES

There are an abundance of landscape designers, architects and plant specialists located in different areas on Nantucket. I am still determining who exactly will be the best people to talk to, as many companies specialize in different areas and utilize very different techniques when approaching certain projects. Growing up on Nantucket, much of my past consisted of being a part-time landscaper during the busy months of five separate summer seasons. This allowed me to understand a fair amount of how local landscapes are re-developed, restored, cared for, and maintained throughout the course of a calendar year.

One of the most renowned landscaping companies on Nantucket is Greg Raith landscaping, who I never had the opportunity to work for, but would love to interview, as a starting point. Their understanding and extensive knowledge in the application of plant species is highly sought after, ultimately providing me with a well versed experience as I dive into this field of my research. They work on hundreds of different sites that are located in different areas of Nantucket. This will provide me with experiences that relate to my chosen site, allowing me to exchange other landscapes relative to wetlands and similar geological make-ups.

Questions

What species generally thrive in climates located in close proximity to wetlands?

How can I plant different species in areas on site that will allow them to thrive, considering that shade and sunlight remain a driving factor?

Do you know of any native plant species that are hydroponic?

What makes a native plant species hydroponic and how does this relate to where an abundance of them are located on island?

What are the most important design strategies used when considering the placement of plant species and allowing them to create both a landscape and architectural experience?

How can plants be used to produce an experiential garden, but also celebrate its relationship to humanity and the buildable structures that make-up a living community?

Are there certain techniques and methods that are considered when designing a landscape as an extension of an existing habitat or existing ecosystems?

How can landscape be designed in a way that diminishes borders from these surrounding habitats that have been there for decades?

Having a brief understanding of specific plants being crucial for certain animals, how do I develop a concise language that naturally forces communication?

Although these aren’t all the questions I’ll be asking, they begin to express the approach I am desiring as I interview multiple different landscape architects, designers, and nursery operators.

Surfing Hydrangea is a nursery that I’m very interested in communicating with. I also happen to know the owner of Surfing Hydrangea, who has been a longtime hockey coach of mine. Between the two of these nurseries and several landscape designers, I will gain a wealth of knowledge.
The Institution
Nantucket, MA
Miacomet Pond

COMPREHENSIVE PLAN

Reminiscent of the traditional Nantucket village (i.e., Siasconset) I pursued a lengthy iterative process to develop the delineation of these structures on site. The delineation of these structures consists of three pods, all of which contain the following structures: greenhouse, classroom and laboratory. Schematically, my institution serves as the very pieces that complete a necklace of existing structures surrounding my site. This necklace became one with the expansion of Miacomet Pond in certain areas. These areas are dedicated to the expansion of floodable landscapes and constructed wetlands, in efforts to rid the pond of toxic algae in the future. This ecosystem cannot afford exposure to the ocean in the coming years, as it will continue to diminish sensitive biological make-ups.
Designing this institution derived from a vision, one that Nantucket has yet to develop. My vision consists of an educational experience that blurs the lines between indoor and outdoor learning. Throughout this process, I continuously engaged with the thoughts of my eighth grade self, partaking in my middle-school senior research project. The reason this played a significant role in my processes, is because this was my first experience studying geological sciences. Allowing this experience to inspire certain decisions, gave reason to the atmosphere that’s present in perspective. The spatial relationships as shown on the right, reveal me tapping into those eighth grade moments and responding to the things I wish I had. A place like this is more necessary now than its ever been.
DETAILED LIVING MACHINE BREAKDOWN

LIVING MACHINE ANALYSIS
WEIGHTED FACTORS

- **TOILETS**
  - 24 GALLONS

- **FAUCETS**
  - 36 GALLONS

- **SHOWERS**
  - 20 GALLONS

- **WASHING MACHINES**
  - 15 GALLONS

- **DRINKING WATER**
  - 4 GALLON

- **DISHWASHERS**
  - 10 GALLONS

10 HOUSEHOLDS

CAPACITY: 3,000 GALLONS/SECTOR

SECTOR BREAKDOWN
FILTRATION PROCESSES
PURIFICATION STAGES

1 SEPTIC TANKS
2 ANAEROBIC REACTOR
3 ANOXIC REACTOR
4 CLOSED AEROBIC REACTOR
5 OPEN AEROBIC REACTOR
6 OPEN AEROBIC REACTORS II-IV
7 CLARIFIER
8 CONSTRUCTED WETLAND
EXPLODED LIVING MACHINE AXON

OPERABLE SKYLIGHT VENTILATION

TENSILE STRUCTURE

GLASS, TIMBER & ALUMINUM FACADE

LIVING MACHINE SECTORS

ROOF ENCLOSURE

BUILDING STRUCTURE

FAÇADE ENCLOSURE

BIOLOGICAL SYSTEM
EXISTING CONDITIONS THAT SHAPED APPROACH
RESPONDING TO EXISTING TOXIC ALGAL BLOOMS

Image pulled from UCLA Researchers.
An emerging system that serves as one of the latest wastewater treatment techniques, utilizes hydroponics to support various types of vegetation. The Living Machine consists of several tanks that are home to various organisms working alongside hydroponics, to fulfill the filtration processes. Originally developed by John Todd, The Living Machine earned its name from the ecological components that it’s comprised of. Some of these components that are heavily involved in the treatment processes include: microorganisms, protozoa, higher animals such as snails, and plants. These advancements in ecological engineering have revealed a significantly more sustainable way in treating and purifying wastewater, as well as remediating existing bodies of water that are prone to increased toxicity levels. Pairing this system with the carved constructed wetlands lining Miacomet Pond in my proposal, will play a huge role in increased biofiltration in necessary areas along the ponds fringe.
DIVERGING ROOFSCAPES FOR RAINWATER
CLASSROOM
The Miacomet Mission

Nantucket Island
Thank you to Anne Tate for an amazing year, and my friends who made this experience unforgettable. To Jiayi, I will forever be grateful for all that you unknowingly taught me both in and outside of studio. To Yuqi, I will miss the daily starbucks and your constant support during stressful times. Lastly, thank you Mom, everything I do and continue to do is for you, and I love you more than words.

Thank You