Below the Surface

Nutrient Pollution in the Biscayne Bay

The Elisabeth Haub School of Law
Environmental Law and Policy Hack 2021 Submission

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Image Attribution and Description: Photo of Biscayne Bay taken by Samantha Cristol

Acknowledgements

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Land Acknowledgement

We acknowledge that this brief was drafted on, and discusses pollution on stolen Seminole and Miccosukee lands. Any discussion of pollution, land use, and mitigation should include the original people of the land we currently occupy. Although N and P pollution has been especially damaging to plant life and aquatic ecosystems, the EPA and state governments are not monitoring several other pollutants that have widespread devastating impacts on the traditional ways of life of sovereign tribal communities. We thank tribal communities for contributing knowledge to this brief.

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About the Authors

Samantha Cristol is a 1L student at the University of Miami School of Law. She received her undergraduate degree in Civil Engineering from the University of California, Berkeley, and has spent the past three years working in the construction management industry in the San Francisco Bay Area. In 2018, she was part of the team that built the bioswale on the corner of First and Fremont street in downtown San Francisco.

Jordan Maun is a 2L student at the University of Miami School of Law also pursuing a Master's of Professional Science in Marine Conservation. She received a B.S. in Marine Science along with minors in International Studies and Studio Art at the University of Florida in May 2020, and has spent the last few years volunteering at an environmental research lab and interning at various law firms. She has studied marine invertebrates, the effect of tourism hotspots on herbivorous foraging fish, and other marine subjects throughout the Caribbean and hopes to use her degrees to promote the conservation of the Florida Reef Tract surrounding her home island, Key West, Florida.

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Executive Summary

This policy proposal offers interventions to mitigate nutrient pollution from Nitrogen (N) and Phosphorus (P) in the Biscayne Bay, a lagoon off the Atlantic coast of South Florida that provides countless resources to residents and visitors each year. Agricultural fertilizer overuse, wastewater system deficiencies, and stormwater runoff are identified as major local sources of contamination. A successful mitigation plan must reduce the amount of nutrients entering the water system and manage nutrients existing in the water system. Possible nutrient reduction interventions include fertilizer reduction and wastewater system improvements. Possible nutrient management interventions include the installation of filtration infrastructure including rain gardens and bioswales; permeable pavement systems; next generation sea walls; along with the enforcement of stormwater pollution prevention plans. The jurisdictional breakdown of the South Florida region is currently hindering nutrient reduction and management solutions. This proposal aims to overcome these challenges by suggesting policy and enforcement changes on both regional and municipal levels, and by creating community education programs.

Part I: The Biscayne Bay

A. Introduction to the Bay

1. Geographic Positioning of the Bay

Located off the southeastern tip of the Floridian Peninsula north of the Florida Keys, Biscayne Bay is centered within the vast urban area of Miami and extends approximately fifty miles from northern Dumfoundling Bay to southern Barnes Sound and Manatee Bay.[1] (Figure 1)

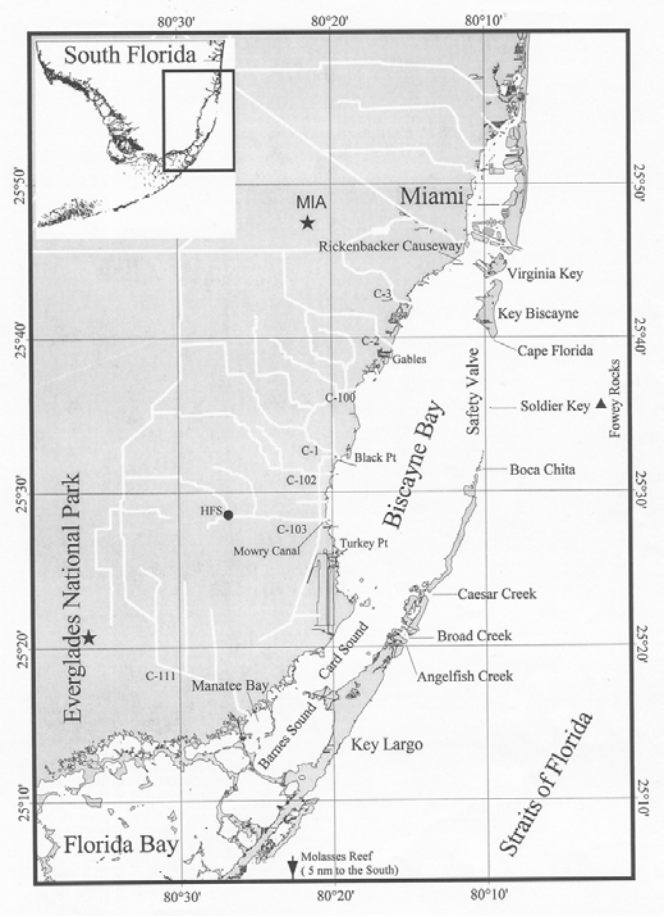


Figure 1: Map of the Biscayne Bay, *in* Wang et al, *Flows, salinity, and some implications for larval transport in South Biscayne Bay, Florida*, Bulletin of Marine Science 72 (2003).

Biscayne Bay is a large inner-shelf lagoon, consisting of shallow water separated from the ocean by sandbars and coral reefs. The Bay spans 150,000 acres and is divided into three regions (Appendix A).[2] The north region spans 12,000 acres and hosts urbanized areas with relatively high nutrient outputs.[3] The central region spans 110,000 acres, made up of canals varying in salinity along the shoreline due to receipt of nutrients from Mount Trashmore.[4] The 26,000 acre southern region is less developed, but contains Turkey Point and C111.[5]

2. Ecosystem Services and the Importance of Biscayne Bay

The Biscayne Bay provides numerous valuable ecosystem services to both humans and the environment. The Bay consists of seagrasses and hardbottom surfaces, acting as a nursery for many species of juvenile birds, reptiles, fish, invertebrates, and plants. The Bay also provides coastal protection; sediment stabilization; water purification; commercial and recreational fishing opportunities; tourism attractions; unique research subjects; and blue carbon storage for humans.[6,7,8] The keystone species that support adolescent aquatic organisms and provide benefits to people are highly susceptible to discharges of nutrients and other pollutants from land-based sources.[9]

3. Water Flow Pathways: Connections and Movement

The water in the Bay comes from a combination of canal systems and ocean currents moving southward along the Atlantic Coast (Appendix B). As the City of Miami's residential and tourist populations have increased exponentially since the early twentieth century, the demand for homes and other necessities has driven a sharp increase in construction as well.[10] Man-made canals have altered the flow of water within coastal ecosystems and continued re-engineering significantly alters freshwater flow into the Bay.[11] Wetland communities used to absorb nutrients as the freshwater slowly flowed south, but due to negative impact on water flow from rapid commercialization, nutrients applied to agricultural lands now quickly reach the east and west coasts, entering marine ecosystems that are harmed by elevated nutrients.[12]

4. Causes of Concern

Eutrophication caused by excess nutrients results in macroalgae outcompeting keystone species such as seagrasses. Between 2006 and 2016, three notable algae related seagrass

mortality events occurred in the South, North, and Northern Central areas of the Bay. Studies revealed that the bloom was triggered by wastewater containing excess N, especially near the Snapper Creek and Coral Gables canals.[13,14,15] Studies show that these mass mortality events have been recorded as vast, but localized, emphasizing the need for more stringent local regulations. This need was further emphasized by large-scale fish kills that occurred in the Bay in 2020 and 2021, with nutrient pollution identified as the primary cause.[16] In order to maintain habitat and nursery areas for various aquatic species, it is vital that Miami-Dade County implements laws and regulations reducing nutrient output in an attempt to improve water quality.[17]

B. Local Sources of Nitrogen and Phosphorus Pollution

1. Agricultural Fertilizer

Runoff from fertilizers containing N and P applied to agricultural areas near Homestead and to the south of Lake Okeechobee reaches the Bay through a series of man-made canals.[18] Fertilizer runoff from these planting operations disrupts marine ecosystems on both Florida coasts, resulting in irreversible harm to local marine life.[19] Although agricultural runoff is a well-known contributor to the nutrient pollution problem in many of Florida's watersheds, the state Water Quality Status Dashboard does not have accurate tracking data for the agricultural areas to the North and West of the Biscayne Bay (Appendix C).[20] Despite the lack of information, water quality testing after Hurricane Katrina showed evidence of increased agricultural runoff in the Bay, highlighting the exaggerated impacts of extreme weather events on nutrient transfer from cultivation effluence.[21]

2. Wastewater

N and P from wastewater reaches the Bay through wastewater treatment plant discharges, leaking sewer lines, and septic tank systems.

Miami-Dade County manages three wastewater treatment plants, each bordering the Biscayne Bay. The North District plant is located in North Miami, the Central District Plant is located in Virginia Key, and the South District Plant is located in Blackpoint Marina (Figure 2).[22,23,24] Wastewater treatment plants release large amounts of N and P, and these specific plants have been using a marine outfall that discharges into the Biscayne Bay.[25]

Miami-Dade County's 2018 Sanitary Sewer Overflow Status Report[26] revealed that forty-seven different sewer overflows released approximately 649,491 gallons of sewage into the environment over the course of a year.[27] Leaked sewage material containing large amounts of N and P is carried to the Bay through the man-made canal systems discussed above.[28]

In addition to the sanitary sewer system, a significant portion of County wastewater is accounted for in septic tank systems. There are roughly 2.6 million septic tank systems in operation in the State of Florida, accounting for around one-third of all homes in the State.[29] When the drain fields of septic systems are saturated, N and P leach into the surrounding groundwater, contributing to nutrient loading in runoff that flows into the local water system.[30]

3. Stormwater Runoff

Miami-Dade County includes many suburban areas, industrial parks, golf courses, and urban areas. Stormwater combined with routine land maintenance contributes to fertilizer runoff, pet excrement, and leaf litter washing into storm drains that empty into the Bay.[31]

Stormwater running over construction sites has also been identified as particularly problematic in the release of harmful pollutants into the Bay.[32] Although construction stormwater

runoff requirements are monitored and enforced by municipal public works departments[33], the high volume of in-progress construction projects in the Miami area[34] results in insufficient monitoring and enforcement.

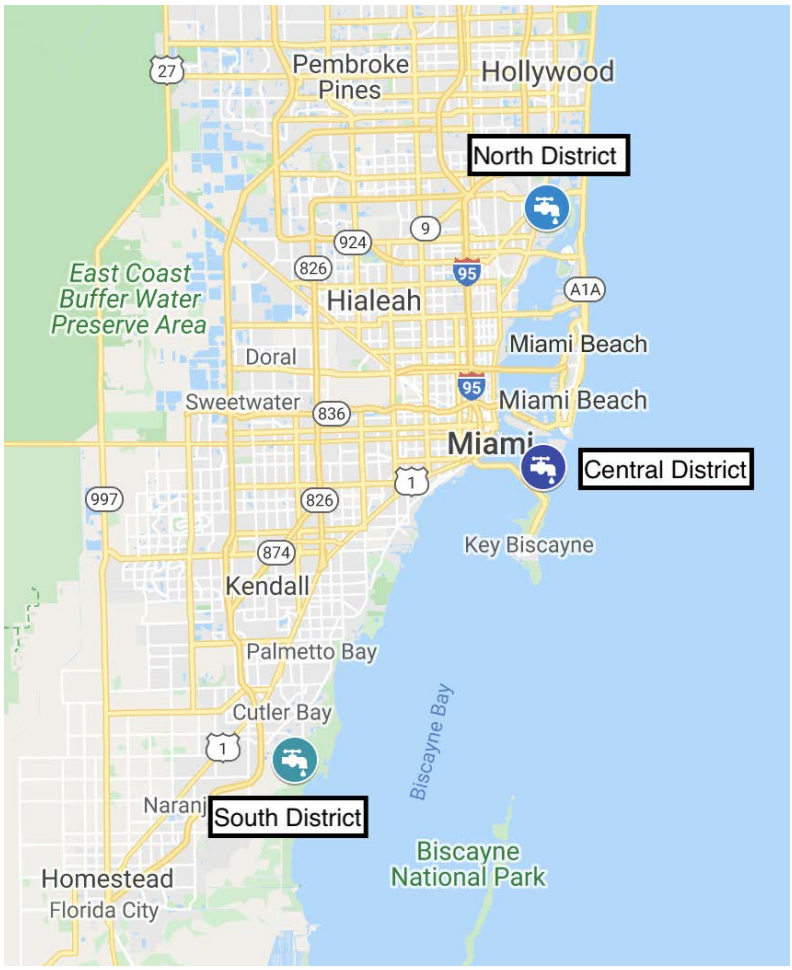


Figure 2: Samantha Cristol, Map of Biscayne Bay Wastewater Treatment Plants

Part II: Mitigation Strategies

Just as N and P pollution stems from a combination of sources, a combination of mitigation strategies will be necessary to reduce nutrient loading in the Biscayne Bay. It is imperative that local governing forces take a wide, collaborative approach that seeks to reduce both the overall amount of nutrients being released into the environment and the contamination level of the water reaching the Bay. The following section discusses a selection of potential strategies and actions for the reduction of nutrients entering the system, and management of contaminated water in the system.

A. Reducing Nutrients

1. Fertilizer Reduction

Fertilizer is the most well-known culprit when it comes to nutrient pollution. The County has already restricted residential and commercial fertilizer use during the rainy seasons and near waterways, and go as far as to require soil testing to justify the use of phosphorus fertilizer.[35] Even still, the 2021 fish kill in the Bay indicates that these measures are not enough. The county ban includes numerous exceptions for farm operations, research areas, vegetable gardens, athletic fields, certain sports stadiums, and parks. As banning N and P fertilizer outright is not possible under state law, a further solution for fertilizer reduction may be to remove these exclusions for sports stadiums, athletic fields, and golf courses. However, as a large portion of Florida's economy is driven by the golf and tourism industries[36], it is unlikely that the County will readily implement or enforce bans that would restrict those activities, especially in the face of recent pushback from major sports leagues on the use of artificial turf.[37]

Another option would be to extend the scope of marine protected areas. The current "fertilizer free zone" is deemed to be within twenty feet of bodies of water. Extending this distance will help to further reduce residential fertilizer runoff. All measures taken to reduce fertilizer runoff must be accompanied by enforcement and public awareness campaigns, to ensure that residential and commercial fertilizer usage is actually meeting the standards imposed.

Instead of expanding the fertilizer ban, another viable option to reduce fertilizer use would be to reduce the need for fertilizer itself. According to the U.S. Forest Service, "Native plants do not require fertilizers and require fewer pesticides than lawns."[38] The University of Florida and the Department of Environmental Protection established a Florida Friendly Landscaping Program[39] in coordination with the five Florida Water Management Districts, with the goal of conserving and protecting state water resources. The plan includes numerous suggestions for native ground cover alternatives[40] to non-native lawn grasses, which typically require fertilization to thrive.[41] A county-wide incentive program for homeowners and commercial operators to switch to native ground covers may help to reduce the overall usage of fertilizers. The City of Miami could also implement groundcover changes in public parks and landscaped areas, in addition to imposing native plant requirements on new developments.

2. Wastewater and Sewage System Updates

Improving wastewater treatment will play a vital role in keeping N and P out of the Bay. This can be accomplished by reducing nutrient levels in wastewater treatment plant discharges, upgrading and maintaining sewer lines, and decommissioning septic tank systems.

B. Managing Nutrients in the System; Stormwater Infrastructure

Stormwater intervention is a necessary second-line of defense in the fight against nutrient pollution. A combination of the following intervention methods can be used to create a multi-tier filtration system, increasing the likelihood of nutrients being captured before reaching the Bay.

1. Rain Gardens and Bioswales

According to the National Association of City Transportation Officials, "Bioswales are vegetated, shallow, landscaped depressions designed to capture, treat, and infiltrate stormwater runoff as it moves downstream."[42] To the average passerby, a bioswale looks similar to any other landscaped area of sidewalk, and serves the dual purpose of providing greenery amidst urban landscapes (Appendix D). Similarly, rain gardens are "a garden of native shrubs, perennials, and flowers planted in a small depression, which is generally formed on a natural slope."[43] As bioswales and rain gardens contain bioretention systems, they are more effective in nutrient uptake than purely aggregate-based filtration systems.[44] A 2019 study found that bioswales in New York City reduced overall nitrogen pollution in their respective watersheds[45], and rain gardens have been found to be up to 90% effective at removing nutrients from rainwater runoff.[46] Installing more bioswales and rain gardens in the hardscaped areas would allow for stormwater to be trapped and filtered before reaching the Bay.

2. Permeable Pavement Systems

Permeable pavement systems are an alternative to impermeable hardscape, which allows for water catchment and filtration. They are multi-layered paving systems that typically have a porous top material, such as pervious concrete or pavers, sitting on top of layers of coarse

aggregate that rests on the soil subgrade (Appendix E).[47] Permeable paver systems are best suited for low-traffic areas[48], while pervious concrete retains the strength profile suitable for non-infrastructure hardscape areas.[49,50] Although these systems are designed to reduce pollutant discharge from rainfall and stormwater runoff, they are not bioactive and "are less effective at removing dissolved nutrients and metals before they reach subsoils or underdrains."[51] Even so, the use of permeable pavement systems reduces reliance on "gray" infrastructure, like piping and catch basins.[52]

3. Next Generation Sea Walls

The University of Miami Next Generation Coastal Structures[53] U-Link Team is developing multi-functional sea wall structures. In addition to the traditional retainment and protection purposes of sea walls, these "Next Generation Coastal Structures" would also control environmental pollution, add natural beauty, and contribute to animal and marine biodiversity.[54] By incorporating planted vegetation areas on the land side of the wall, and buckets for mangrove growth on the water side of the wall, the team believes that sea walls can act as an additional filtration system for runoff before it reaches the Bay (Appendix F).[55]

4. SWPPP Enforcement

Strict enforcement of stormwater pollution prevention plans (SWPPP) is another necessary measure to ensure that runoff from construction does not infiltrate and contaminate the Bay. Further enforcement could include raising the fines for violations and increasing inspection frequency for new and existing construction projects.

Part III: The Legal Framework

The Biscayne Bay is protected by a collection of federal, state, county, and municipal regulations that often overlap. For purposes of simplicity, this paper focuses on Miami-Dade County and the City of Miami. The City of Miami is one of thirty-four municipalities in the County, and sits directly next to the Bay.[56]

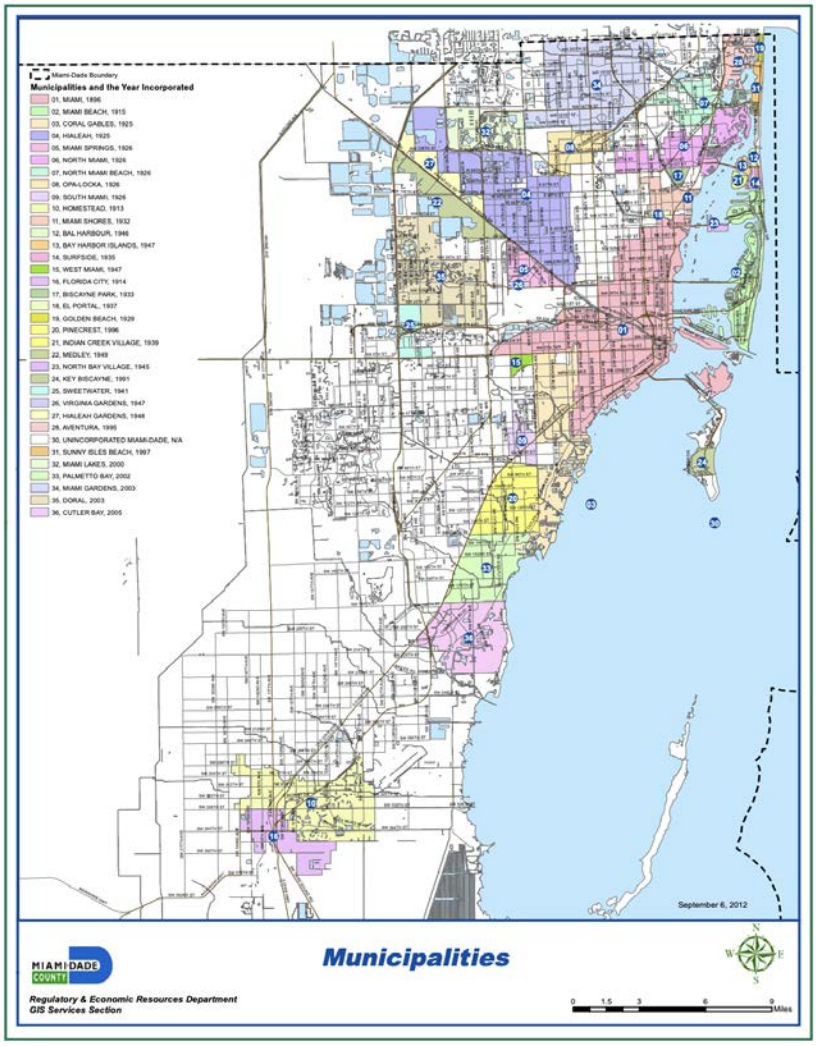


Figure 3: Miami-Dade County, Map of Miami-Dade County Municipalities

A. Regulation Surrounding Nutrient Reduction

1. Agricultural Fertilizer

The Florida Clean Waterways Act of 2020 increased agricultural inspections and required the establishment of real-time water quality monitoring.[57] Although the statute created a real-time water quality monitoring program,[58] many Florida counties have yet to incorporate sufficient monitoring (Appendix C). Additionally, it is important to note that although the water quality monitoring requirements include N and P pollutants, the EPA and other regulatory bodies fail to monitor other pollutants that are also harming tribal communities and ecosystems across the state.[59]

2. Wastewater

The Florida Clean Waterways Act of 2020 transferred management of the onsite sewage program to the Florida Department of Environmental Protection (FDEP); imposed strict wastewater treatment requirements; imposed strict biosolids standards; doubled wastewater violation fines; and increased the administrative penalties cap.[60] The 2021 Sewage Disposal Facilities Statute then imposed more stringent regulations surrounding the discharge of domestic wastewater through ocean outfalls by requiring the installation of a reuse system in Miami-Dade County by December 31, 2025.[61]

The County aims to eliminate the normal use of the ocean outfall by 2025 in order to comply with the ocean outfall legislation imposed by the Sewage Disposal Facilities Statute.[62] To do so, the County has allocated $2 billion to major construction projects for implementation.[63] At the North and Central plants, the projects will "reduc[e] nutrient discharge by providing effluent disposal via municipal injection wells."[64,65] At the South Plant, there is planned expansion work to implement a feasible reuse system (Figure 2).[66,67]

In regards to sewer line maintenance, the County received $5.6 million in the form of two federal Federal Emergency Management Agency (FEMA) Hazard Mitigation Grants following Hurricane Irma.[68] These grants are being used to upgrade and maintain sewer lines, and to retrofit pump stations.[69]

Septic system permitting and compliance is managed by the Miami-Dade County Department of Health, in compliance with the FDEP regulations.[70] The County also regulates septage haulers for homes using septic tank systems.[71]

3. Stormwater

Miami-Dade County adopted a Rainy Season Fertilizer Ban[72] following the Biscayne Bay 2020 fish kill. The ban took effect on May 15, 2021[73] and prohibits the use of N and P fertilizers during the South Florida rainy season, which spans from May 15 to October 31.[74] The ban also institutes year-round measures, including the installation of "fertilizer free zones" within twenty feet of bodies of water including canals, lakes, storm drains, the tops of sea walls, and the Bay.[75] Other year-round measures include N fertilizer limits, soil testing requirements to allow for use of P fertilizer, and certification requirements for commercial applications of fertilizer.[76] The regulation includes exceptions for farm operations, research areas, vegetable gardens, athletic fields, and certain sports stadiums and parks.[77]

The City of Miami also passed a year-round fertilizer ordinance that regulates the type of fertilizer that can be applied within city limits and establishes prohibited application periods.[78]

B. Regulation Surrounding Nutrient Management

1. Stormwater

The Federal Clean Water Act created the National Pollution Discharge Elimination System (NPDES) permit program to regulate point sources that discharge pollutants into waterways.[79] On a State level, the FDEP administers the NPDES permitting program for construction activities, industrial activities, and municipal sewer systems.[80] In 2020, the FDEP was required to update this stormwater permitting program to comply with The Florida Clean Waterways Act.[81] The state-regulated NPDES permits are then issued and enforced by the City of Miami Department of Resilience and Public Works for all construction and demolition projects within the city bounds that disturb over a half acre of land, in compliance with Florida Statutes,

the City of Miami's MS4 Municipal Separate Storm Sewer System (MS4), and City Ordinance 13081.[82] NPDES permits require a stormwater pollution prevention plan (SWPPP) that complies with both public works standards[83] and state regulations found in the Florida Stormwater, Erosion, and Sedimentation Control Inspector's Manual[84] and/or the FDEP/FDOT Erosion and Sediment Control Designer and Reviewer Manual.[85] The City of Miami passed a 2020 ordinance amending the City Building Code to allow for stricter enforcement in regards to discharge, wastewater, and oils from construction sites.[86]

Miami-Dade County enforces residential watering restrictions that help reduce the amount of runoff into local waterways. The watering restrictions assign watering days based on house address number, and provide residents with watering time windows on assigned days.[87] Residents are restricted from watering more than once a day, with exceptions provided for pressure cleaning, car and boat washing, fountains, and water recreation purposes.[88] The regulation provides exemptions for (1) users of reclaimed water and low-volume irrigation methods and (2) for the first 90-days of newly planted landscaping.[89] An incentive rebate program is also in place to encourage single-family households and large properties to upgrade their watering systems.[90]

Part IV: Recommendations

A comprehensive plan to fight nutrient pollution must account for the jurisdictional tension between the County and the City. As the County has a larger overall footprint and controls wastewater treatment, it will have a farther reach in regards to nutrient reduction. Additionally, the County has a Biscayne Bay Watershed Management Board that may aid in the implementation of proposed recommendations.[91, 92] The City of Miami, on the other hand, will be an essential actor in the fight to redirect runoff, as it controls NPDES permitting and local infrastructure installations. The City does not have a Bay task force, which may pose problems in regards to policy implementation. The suggestions in this section aim to provide concrete recommendations that work within this jurisdictional structure.

A. Nutrient Reduction

1. Enforce the Fertilizer Ban for Commercial Applicators

Miami-Dade County must prioritize enforcement of the fertilizer ban by increasing the frequency of inspections. To do so, the County could hire two additional inspectors to focus solely on soil testing, water quality testing, and physical inspections. It is important this work is undertaken in an equitable manner, and focuses on commercial applicators like golf courses and tourism development, rather than low-income neighborhoods and predominantly Black and Latinx neighborhoods.

2. Decommission Septic Systems

Decommissioning septic systems should be the next major focus, as Miami-Dade County has numerous projects underway to fix the crumbling sewage lines and update the wastewater treatment plants. The County could apply for a Environmental Protection Agency (EPA) Nonpoint Source Section 319 grant,[93] as the state funding for the septic system upgrades has been exhausted.[94] Although the County recently applied for COVID relief grants, some of which will be directed to septic system decommissioning, the issue is pertinent and large enough to warrant additional grant applications.

3. Provide Community Education

Community education is extremely important for ensuring the success of local fertilizer and watering regulations. Many community members remain unaware of the new regulations, and the legislation is not as effective as was hoped.[95] As county-led enforcement capabilities are limited, community education is necessary to ensure compliance from residents in the Miami area. Community education could be undertaken in the following three parts: educational material for schools, a social media campaign, and a tabling campaign at farmers markets, street fairs, and sporting events. Each of these measures will aim to reach residents of the County.

Primary and secondary public schools in Miami-Dade County celebrate Earth Day every year.[96] The County could implement a mandatory Earth Day curriculum addition for public schools with a focus on N and P pollution in the Bay. Not only would this increase the general public's understanding of the impacts of fertilizers seeping into the Bay, but would cultivate a sense of collective responsibility to the Bay across the County, not just in the coastal municipalities. In addition to teaching children in public schools about the importance of the Bay, both the Miami-Dade Watershed Management Board and city-level task force could work

together to build formal relationships with Miami area colleges and universities to partner in field trips and other hands-on learning opportunities; long-term nutrient pollution research; and community service days to clean the Bay and the canals connected to it. These opportunities should not be limited to Science, Technology, Engineering, and Mathematics (STEM) students--there are connections worth building across different schools within universities such as public policy, law, business, and marketing schools.

Increasing general public awareness is key right now as the 2020 fish kill is still fresh in the public's mind. A mass social media awareness campaign is vital to raise awareness to the County's little-known Biscayne Bay Watershed Management Board (WMB) and the actions it has taken. As the County's WMB and its work are not well-known, a mass social media awareness campaign is important to shift public opinion and community practices like encouraging residents and industry to reduce fertilizer use. Thus, the WMB and a city-level task force should include communications experts with expertise in strategic digital communication and public outreach. This strategy can work in tandem with efforts to raise public awareness and action in schools across the County as students can be encouraged to use their own social media platforms educating their peers on nutrient pollution and protecting the Bay. Educational institutions can also work with students and the local and regional governing bodies to educate the public about the impact of the 2020 fish kill on the Bay and the fertilizer ban more generally. In addition to working with youth and educational institutions on a mass social media awareness campaign, the County and City should work with local stakeholders and non-profit community organizations to reach a wider breadth of audiences.

Lastly, as COVID testing and vaccines are more readily accessible to County residents, in-person activities present an opportunity to ensure the public not only understands the fertilizer

ban and impacts of nutrient pollution on the Bay, but are able to ask questions and interface directly with fellow community members and government officials. Furthermore, the County could collect names and contact information from residents interested in nutrient pollution reduction while tabling to build a strong volunteer force for future Bay service projects.

B. Nutrient Management

1. Pass a New City Ordinance for Stormwater Infrastructure

The Miami City Commission should pass a new ordinance that will both amend the building code and impose a gasoline tax, as allowed under Florida Statute 166.23.[97]

The amendments to the building code should include that a certain percentage of the plants in new and existing construction projects are native; empower the public works department to require the installment of bioswales, rain gardens, and/or permeable pavement systems in developments that touch the public right of way; and further increase amount per fine for the discharge of contaminated water from construction sites. The frequency of SWPPP inspections per construction site should also be increased, in coordination with the fine increase.

These infrastructure solutions would contribute to the multi-tier filtration system discussed above, while also further reducing illegal dumping. The levy of a local gasoline tax will serve to fund this measure, while also encouraging the use of carpooling and public transit to further decrease the amount of N released into the Bay.

1.1 Feasibility Analysis

This ordinance would aim to spread the costs of pollution between the developers and the public. The costs involved in enforcing the ordinance would be (1) increased site work costs on

the part of developers and (2) increased inspection and approval work on the part of the Public Works Department.

The additional workload on the Department of Public Works would likely require at least two inspectors to the Department of Public Works. The City Senior Code Compliance Inspector role makes an average annual salary of $87,502, with the low end being around $58,000 and high around $116,000.[98]

In July 2021, the State of Florida sold on average 20,000,000 gallons of gasoline per day.[99] If examined through the lens of population, the City of Miami would account for roughly 2%, or 400,000 gallons, sold per day. This amounts to roughly 146 million gallons of gasoline sold in the City per year. The Florida conventional gasoline price as of July 2021 was $3.006.[100] Holding these numbers constant, a quarter of a cent gasoline tax would amount to roughly $365,000 in revenue. This would be sufficient to employ somewhere between two and four additional inspectors. Additionally, a quarter of a cent tax would likely not impose an undue burden on residents to the point where the commission would be wary of passage of the ordinance.

2. Establish a City Task Force

The City should establish a governing body whose sole mandate is to monitor and reduce nutrient pollution in the Bay. A model similar to the County Watershed Management Board (WMB) but tailored to the needs of the City would serve four crucial purposes: (1) make communication between the City and County more efficient, (2) clearly establish a body tasked with ensuring all local nutrient pollution monitoring and reduction projects are completed, (3) formalize stakeholder involvement in addressing N and P pollution in Biscayne Bay, and (4) raise public awareness about nutrient pollution's impact on the Bay.

To ensure efficient coordination with Miami-Dade County, when creating a city task force, one member should be designated to liaise with the County, including with the County's WMB, and other local governments. The task force should include representatives of tribal communities, community-based organizations, earth science and engineering experts, and communications professionals. It should also be representative of various city neighborhoods. The task force should also be empowered to review intervention proposals, support approved projects from start to finish, and even proactively propose projects itself. Lastly, the task force's communications professionals and community leaders should work to increase public awareness of City ordinances related to N and P pollution in the Bay and promote interventions like sea wall construction, rain gardens and bioswales, and vehicle emission reduction efforts.

2.1 Successful Task Force Case Studies

This model has seen success in other municipalities, namely in Gulfport, Mississippi and Boston, Massachusetts. Like in Miami, nutrients from wastewater pollute the Turkey Creek. In 2004, the EPA awarded the Land Trust for the Mississippi Coastal Plain $150,000 to create partnerships across the watershed and form a coalition of local government officials, stakeholders, and environmental organizations to address pollution in Turkey Creek.[101] Residents successfully pushed the Mississippi government to increase its water quality requirements, developed a 400-acre waterway to decrease pollution in the Creek, and continue to monitor the Creek's water quality.[102]

In Boston, a coalition formed to reduce nutrient pollution into the Mystic River.[103] Representing twenty-one communities along the River, the coalition has been successful in nutrient pollution reduction.[104] Not only did the coalition, with the help of the EPA, "put an end to the dumping of more than 10,000 gallons of sewage a day into the river," but also increased

public awareness about pollution, and worked with local partners to implement ongoing water testing.[105] In both cases, the social and cultural significance of the bodies of water was an important motivator for creating these coalitions: "the story of the watershed and the residents' connection to the water has been an essential part of the restoration effort."[106]

In addition to task force models being successful across the country, the sovereign Seminole Tribe of Florida has seen measurable progress locally on the Big Cypress reservation. Moreover, Indigenous communities in the Miami metropolitan should have adequate representation in a task force that makes decisions that impact reservations and sovereign territory. The Seminole Tribe has been one of the most vocal groups pushing for more stringent water quality standards in the state of Florida as a sovereign nation impacted by upstream land use and entered into a Water Rights Compact with the South Florida Water Management District.[107,108,109] The Tribe commenced its own robust water quality testing program in 1994.[110] The program found that much of the P pollution was coming from industrial agriculture around Lake Okeechobee and the Everglades.[111] By designating water bodies near the Big Cypress reservation for cultural and traditional uses and using narrative along with quantitative data to measure water quality, the Tribe noticed a decrease in nutrient pollution in the water after five years.[112]

In all three case studies, coordination with state and local governments and community members, implementing more than one intervention strategy, raising public awareness, and formalizing stakeholder power in decision making led to each groups' success. If the City of Miami were to use these models as guides for creating a Biscayne Bay task force, the efforts would likely be successful in reducing nutrient pollution in the Bay.

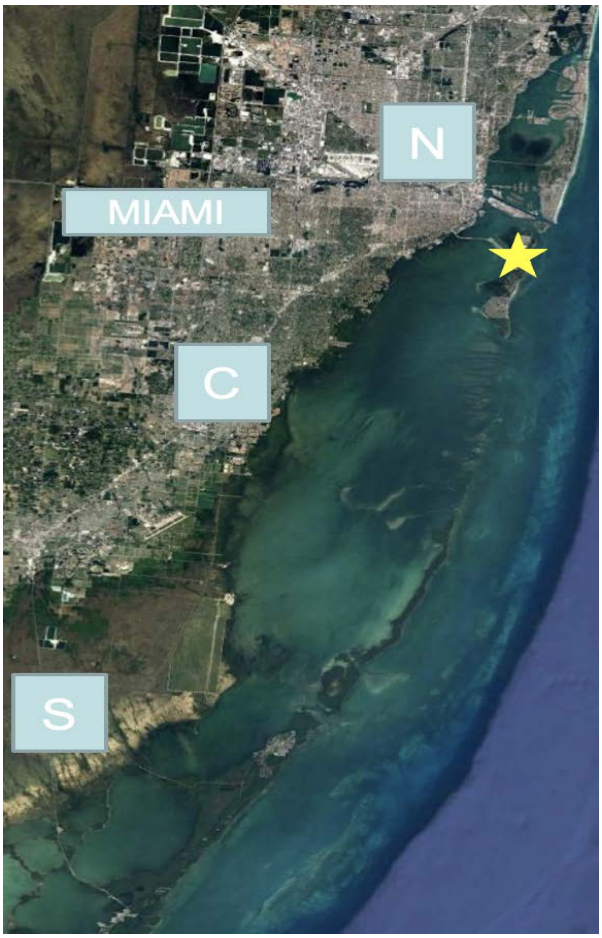
Part V: Next Steps and Conclusion

N and P pollution threatens public health and the health of marine habitats in Biscayne Bay and its surrounding areas. A combination of enforcement measures, infrastructure changes, and public awareness campaigns are necessary to ensure a cleaner future for the Biscayne Bay.

Our team plans to provide our policy recommendations and research to the Biscayne Bay Watershed Management Board, the Miami Waterkeeper team, and the University of Miami Department of Civil, Architectural, and Environmental Engineering. We intend to both work with the Miami Waterkeeper team to help draft Stormwater Infrastructure ordinances to be implemented across the County and create public educational material about the fertilizer and watering regulations. Award money from this competition would go towards associated costs, with the remainder being a split donation between local tribal communities and the Miami Waterkeeper, for the continuation of the vital and necessary work they do to save the Bay.

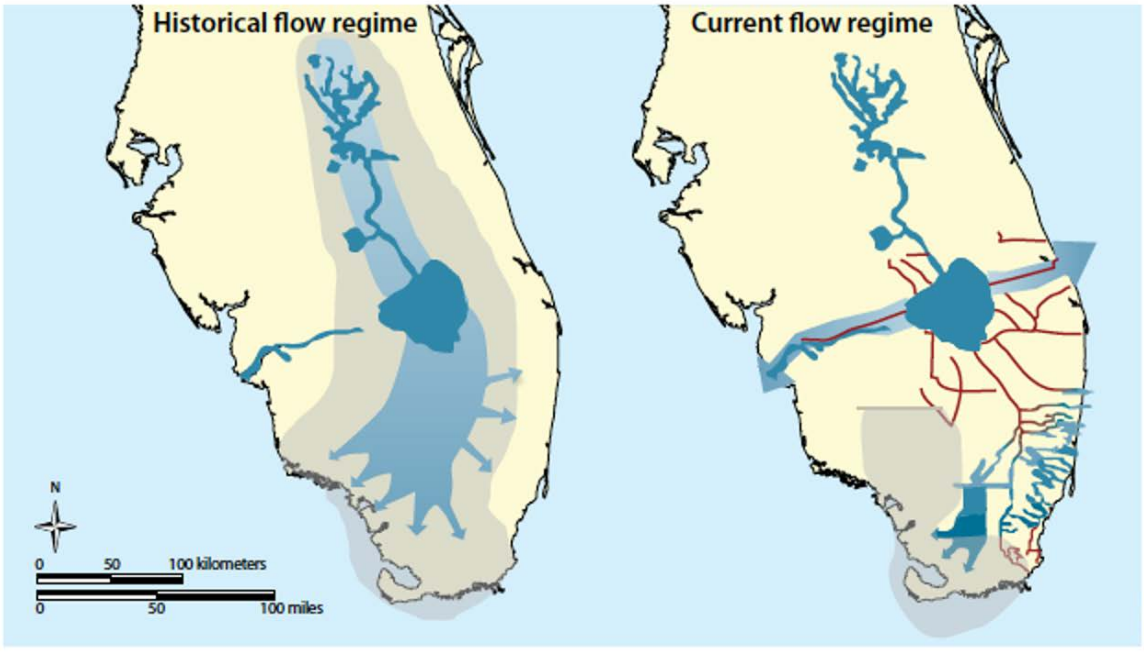
Appendices

Appendix A: The Three Regions of Biscayne Bay



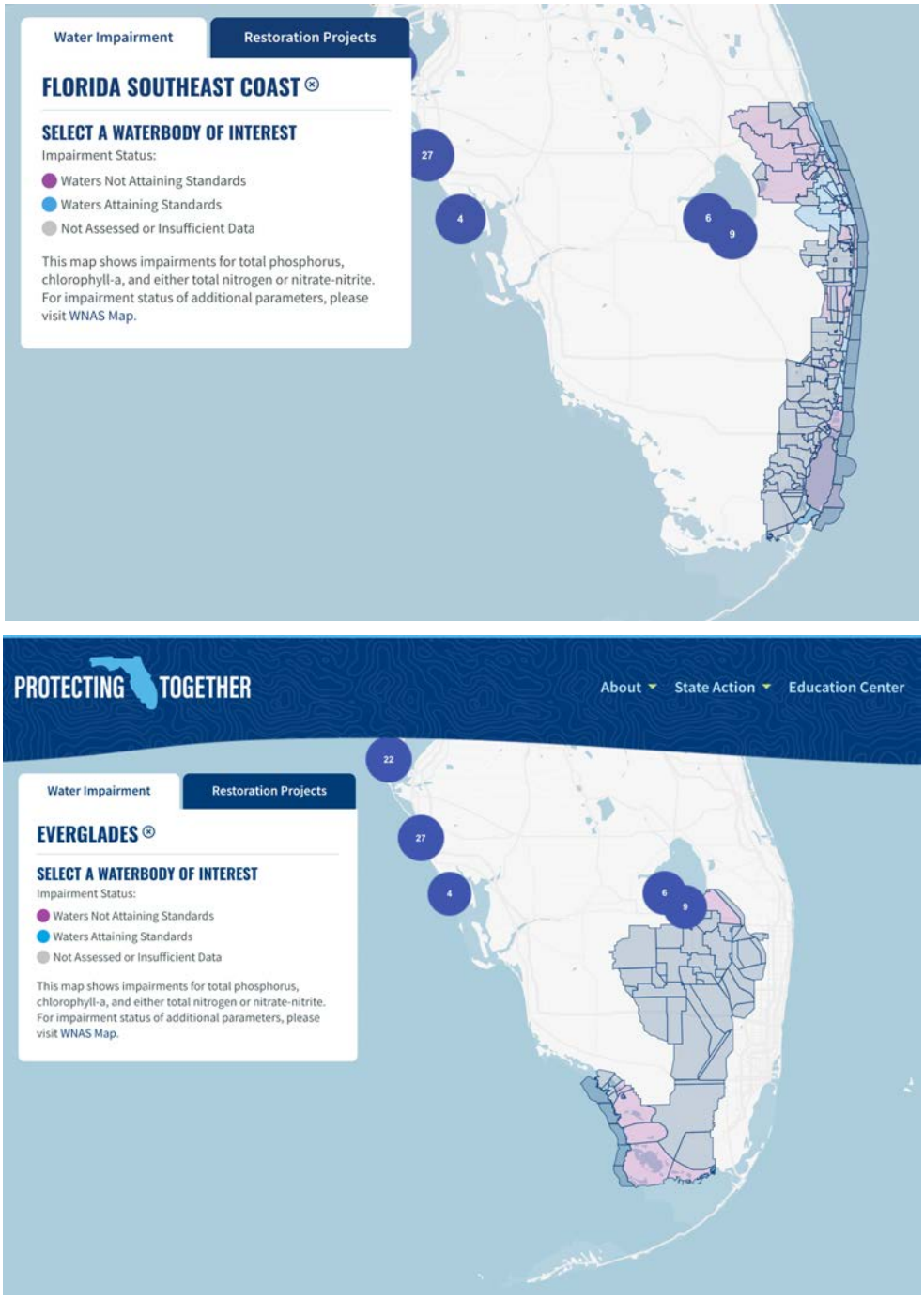
Source: Map of the Three Regions of the Biscayne Bay, *in* Diego Lirman, Seagrasses, Lecture for the Tropical Marine Ecology Course at the University of Miami Rosenstiel School of Marine and Atmospheric Science 30 (Oct. 5, 2021).

Appendix B: Historical and Current Flow Regimes



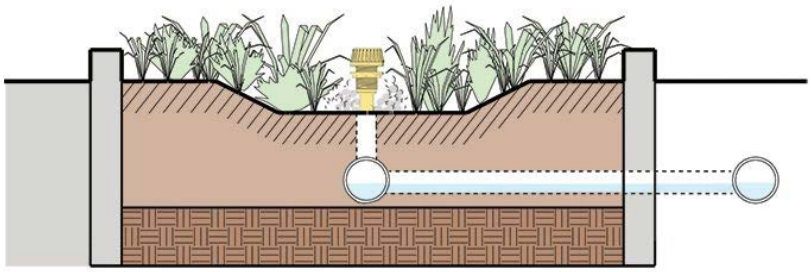
Source: Map of Historical and Current Flow Regimes in Southern Florida, *in* Chris Langdon, Tropical Environment, Lecture for the Tropical Marine Ecology Course at the University of Miami Rosenstiel School of Marine and Atmospheric Science 27 (Aug. 31, 2021).

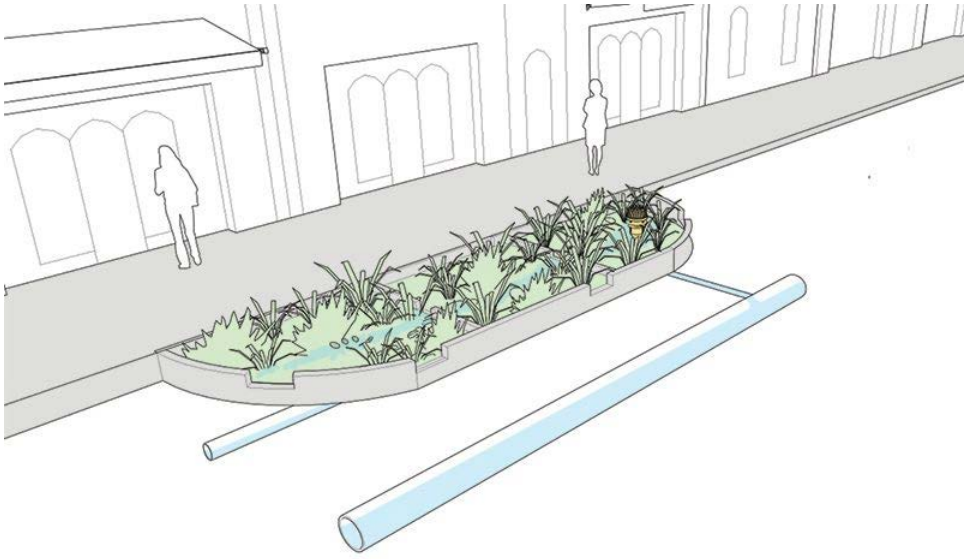
Appendix C: Florida Water Quality Dashboard



Source: *Water Quality Status Map*, Protecting Florida Together, https://protectingfloridatogether.gov/water-quality-status-dashboard (last visited Oct. 13, 2021).

Appendix D: Bioswale Diagrams





Source: Illustration of a Bioswale, *in Bioswales*, National Association of City Transportation Officials, https://nacto.org/publication/urban-street-design-guide/street-design-elements/stormwater-management/bioswales/ (last visited Oct. 13, 2021).

Appendix E: Permeable Pavement System

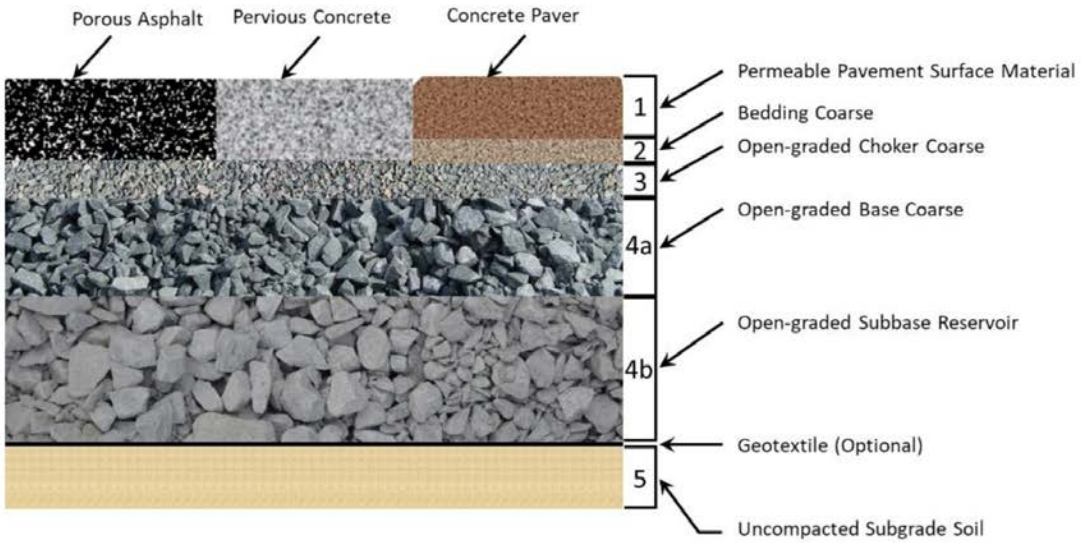
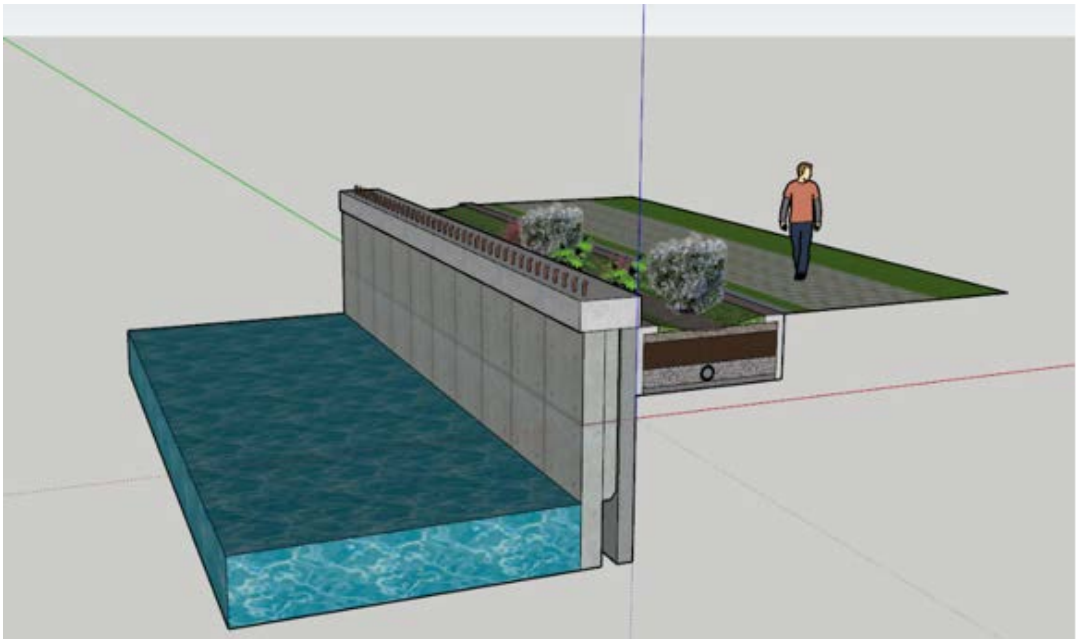
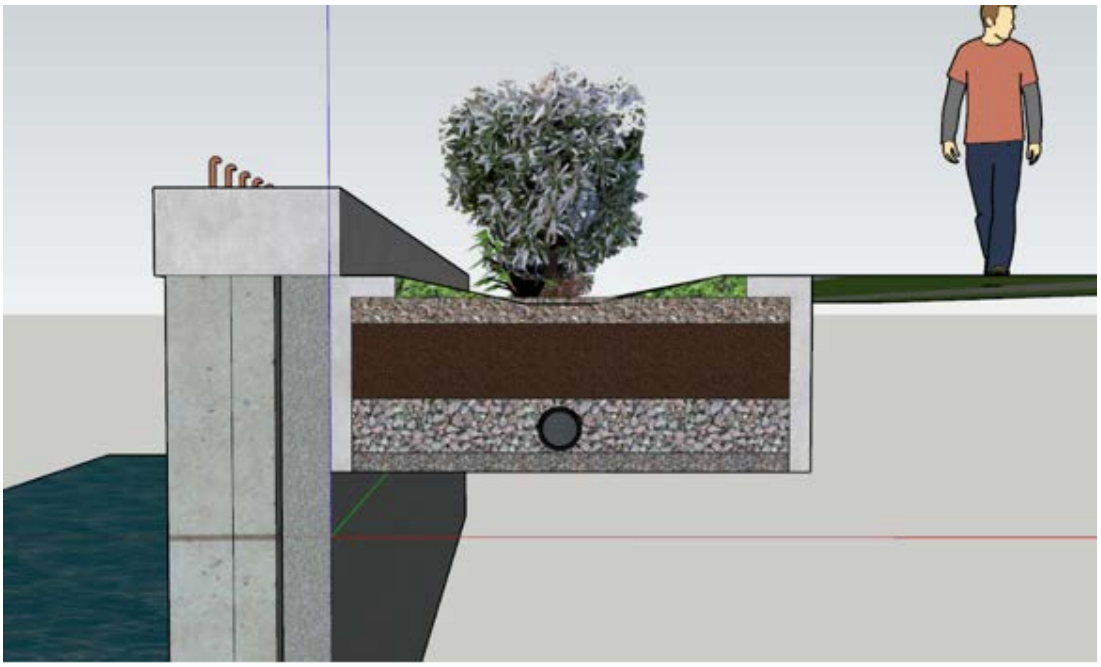


Figure 1. Typical permeable pavement cross-section profile for common pavement materials (not to scale).
Credit: Eban Bean, UF/IFAS

Source: Elban Bean, Permeable Pavement Cross Section (diagram), *in* E. Bean et al, Permeable Pavement Systems: Technical Considerations, University of Florida, (May 21, 2019) https://edis.ifas.ufl.edu/publication/AE530.

Appendix F: Next Generation Coastal Structure





Source: Professor Esber Andiroglu, Rendering of a Next Generation Coastal Structure.

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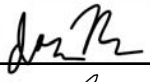
Certification

We hereby certify that the brief for University of Miami School of Law Environmental Policy Hack Team is the product of the undersigned. We further certify that the undersigned have read the Competition Rules and that this brief complies with these Rules.

Date: October 14, 2021

Team Member Samantha Cristol 

Team Member Jordan Maun 

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