Ecosystem recovery of Tampa bay following the 2021 release of phosphate mine wastewater from the Piney Point facility

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## Abstract (150-250 words)

Mining activities can support local and global economies, yet also impose significant consequences for the natural environment. Phosphate mining in central Florida has been ongoing for decades and many facilities present risks to freshwater and coastal aquatic environments in the state. In 2021, a breach in the liner of a wastewater holding pond at Piney Point, a legacy phosphate processing facility, resulted in the emergency discharge of ~815 million liters of highly acidic and nutrient-laden (nitrogen, phosphorus) process water into Tampa Bay. A multi-agency, event-response monitoring program resulted, which documented ecosystem impacts within several months. Short-term declines in water quality were observed, with a notable harmful algal bloom and substantial fish kills occurring three months after the initial wastewater release. Acute spills like the 2021 event threaten past successes, while efforts to mitigate and prevent these negative outcomes in the future are ongoing. This chapter will present the historical context and management of Piney Point as a precursor to the events of 2021, while providing quantitative examples of the bay’s response for interpretation relative to the long-term recovery of the bay. The role of the Tampa Bay Estuary Program as a non-regulatory institution that works to build public and private partnerships for bay management will also be explored, with emphasis on its role coordinating monitoring efforts and disseminating open science communication products.

## 1 Introduction (500-1500 words)

Provide background for the instructor that helps integrate the case study into disciplinary material and, if possible, relate the case study to ABET General Criteria (Student Outcomes 1-7), Program Criteria for Civil Engineering and Environmental Engineering, and general definitions and statements (e.g., ABET’s Statement on Implementing DEI Concepts into Program Criteria). The references in this section should focus on pedagogical aspects of the case study. As Section Editor, I can assist with the latter.

ABET General Criteria Student Outcomes:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. an ability to communicate effectively with a range of audiences.
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Regarding DEI. The ABET information can be found here <https://www.abet.org/about-abet/idea-inclusion-diversity-equity-accessibility/> Social justice issues relevant to the spill could be addressed.

This case study provides an example of the roles and responsibilities of public institutions and private organizations and how they can work together to address environmental problems (Environmental Engineering Program Criterion e)

My notes:

This is about bay management as the engineering challenge - strength of partnerships, key players, and how they work together to manage the bay. What are the threats and challenges to bay management? How has it been effective in the past? What is the role of TBEP and, more generally, research/volunteerism/regulation? This is the engineering problem.

Managing the bay and protecting water quality is the design process, constraints to this are economic, political, and social forces that are at odds with environmental protection

Role of data/monitoring to support bay management - make this a key concept that relates to Piney Point.

Introduce mining as an economic driver in Central Florida, highlight past environmental issues with mining in the region (earlier Piney Point spills, Mosaic/Alafia), also chronic issues with port facilities and fertilizer losses

What is it about fertilizer mining that creates problems? A waste-intensive process… many facilities located near critical infrastructure to support transport (ports)

Introduce Piney Point and events of 2021

Effective management of the natural environment requires concerted public and private efforts informed by science to ensure the long-term sustainability of environmental resources. Management goals are nearly always relative to competing societal interests that are at odds with a healthy, naturally functioning environment. The contemporary history of Tampa Bay, Florida is an exemplary model for how such efforts can be successful to recover a degraded aquatic environment. In February 1974, a news segment airing on Sixty Minutes drew national attention on the effects of unchecked growth in the region, while noxious macroalgal blooms, loss of seagrass, and a decline in fisheries were evidence of this growth. The discharge of untreated wastewater into Tampa Bay was a culprit for many of these maladies. Several decades later, external nutrient loads to the bay were reduced by 2/3 and seagrasses recovered to an all-time high (since recorded) of 41,656 acres in 2016, exceeding the management goal by several thousand acres.

The events leading up to the recovery of Tampa Bay are the product of multiple factors, some of which were opportune while others were more intentional. In the 1960s, a growing nationwide environmental movement influenced public sentiment on how unchecked economic growth and development can severely harm the environment. Notable events such as the Cuyahoga River catching on fire and widely read texts like “Silent Spring” further motivated change in a national environmental ethic. These sentiments trickled down to Tampa Bay communities as local environmental disasters combined with unfettered growth lead to public calls for local and state regulatory reform and environmental restoration. No longer was it considered acceptable to discharge untreated sewage directly to the bay, as legislation was passed that required all wastewater treatment plants to upgrade to advanced treatment technologies in addition to tighter controls on stormwater pollution. These efforts were reinforced at the federal level with enactment of the Clean Water Act in the same year. Gradually and over several decades, water quality in the bay improved and the seagrasses returned.

Local public and private environmental groups continue to be key players in coalescing public support to improve water quality in Tampa Bay. The Tampa Bay Estuary Program (TBEP), in particular, has been a consistent voice over the last three decades that has worked to build partnerships to restore and protect Tampa Bay. This work is implemented through a scientifically sound, community-based management plan. The TBEP is part of a broader National Estuary Program consisting of 28 similar programs around the country that have been established at Congressionally recognized “estuaries of national significance”. Since it’s inception, the TBEP has worked to engage local communities, private businesses, and local/state government to work towards the comment good of a healhty Tampa Bay. The TBEP also manages the Tampa Bay Nitrogen Management Consortium that has worked to reduce nitrogen loads to the Bay. The managmeent apporach is simple; reduced nitrogen loads will lower algal growth, promoting a light environment in the water that is supportive of seagrass growth. The TBNMC has quantified and allocated sources of nitrogen among public entities that directly or indirectly discharge to the bay, with regulatory oversight by the Florida Department of Environmental Protection (FDEP).

Despite the nationally recognized success story of Tampa Bay, current challenges have emerged that

## 2 Background (1000-2000 words)

Provide background information for the study that relates to the events, design process, etc. Make sure to include sufficient information (including pictures, figures, graphs, etc.) so that a novice (i.e., student) can understand the case study. Include references to the events that allow for the reader to investigate further.

My notes:

History of Piney Point - emphasis on facility management, oversight (or lack of), multiple owners.

Why was there an emergency discharge?

What was the response - monitoring effort and environmental (short-term, red tide, present), legal outcomes

What did TBEP do? updates, facilitate monitoring, dashboard, media requests

long-term closure plan for piney point, other facilities in the region - deep well injection, disposal of phosphogypum via road construction? Piney Point well may be precedent for future activities, but still a lot of unknowns, related to groundwater/drinking water?

Figures:

* map
* water quality
* red tide
* seagrass/macro?
* fisheries (we now have good nekton data to report)

## 3 Student Activities (500-1000 words)

### 3.1 Classroom discussion questions

Include at least 3 discussion questions based on the case study that can be used in a classroom situation.

My notes:

Something about communication/transparency of information

Something about history of past partnerships, why were they so important

Something about reactive v proactive, i.e., Piney Point was a disaster waiting to happen, but somethign was only done once it happened. What are the forces at play that prevent proactive action?

### 3.2 Individual student responses

Include at least 3 questions/prompts based on the case study that can be used in a homework assignment or on an exam. These could include further reading (be sure to provide references to readily available materials) or personal reflections.

My notes:

Something about interpretation of the figures/tables in this chapter

## 4 Conclusion (500-1000 words)

Include a discussion of key take-aways.

My notes:

Bring everybody to the table (highlight Mosaic’s role in the TBNMC)

Something about resiliency and the bay’s ability to recover from this event

## References