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An Engineering, Economic, and Political Approach to Beach Erosion Mitigation and Harbor Development: A Review of the Beach Communities of Camp Ellis, Maine, Wells, Maine, and Cape May, New Jersey

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AN ENGINEERING, ECONOMIC, AND POLITICAL APPROACH TO BEACH EROSION MITIGATION AND HARBOR DEVELOPMENT: A REVIEW OF THE BEACH COMMUNITIES OF CAMP ELLIS, MAINE, WELLS, MAINE, AND CAPE MAY, NEW JERSEY

By

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The history of coastal engineering projects is fraught with problems. In this thesis I examine the federal navigation project at Wells, Maine. In Wells, an incomplete understanding of the coastal setting led to a faulty engineering design responsible for a poorly functioning inlet and harbor and damage to neighboring beaches and wildlife habitat. Project planners and designers did not account for all unforeseen problems that arose. Reviewing the history of Wells Harbor demonstrates how proper attention to the natural setting, economics, and the political environment is essential to a successful project and enables agencies and stakeholders better to address contingencies when they arise.

An embedded case study of the Wells Harbor Navigation project examines the project's different components separately and holistically. Additional embedded case

studies were constructed for the Saco River Navigation Project in Saco, Maine, and the Cold Spring Inlet Navigation Project in Cape May, New Jersey. Cross-case analysis of the two Maine projects reinforces findings while differences observed with the New Jersey project offer robust results of interest to a wider range of coastal managers.

Analysis of the natural setting at Wells Harbor reveals that engineering designs were based on misconceptions of coastal processes in the project areas. Subsequent design changes and mitigation efforts recycled the original flawed data, hence creating larger projects with larger problems. Economic analysis highlights a history of under-estimated cost and over-estimated benefit projections at Wells. Traditional benefit-cost analyses did not account for all possible costs, or for uncertainty of benefits, and therefore poorly measured changes to social well-being. As a result, an economically marginal project was authorized. Once the project began and problems surfaced, federal economic guidelines and a lack of community and state resources limited the possible response options. A series of interviews and a review of the Wells Harbor Project history depict a contentious political environment. Special interests applied political pressure to get authorization of the marginal project. As problems arose during construction, relationships between local, state, and federal interests deteriorated, impeding consensus on a plan to address the community's problems. Cross-case analysis with both the Saco River Project and the Cold Spring Inlet Project support these findings.

Results stress the importance of policy makers and coastal managers encouraging continued research on coastal settings to improve their understanding of local and regional coastal processes. These studies reveal the limitation of traditional benefit-cost analysis as a decision-making tool. Other economic models that incorporate the uncertainty of the setting and the value of non-market amenities are more appropriate for coastal projects. Sound partnerships between agencies, the participation of all stakeholders, and full disclosure of information is necessary for addressing problems when they arise and avoiding future complications.

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CHAPTER 1

INTRODUCTION

We, as a civilization, have long tried to modify our surroundings and control the natural processes that shape the Earth in order to better suit our lives. The great engineering projects of the 19th and 20th centuries serve as excellent examples of these grand ambitions. Railroad tracks spanning North America joined the Atlantic and Pacific oceans. Engineers crossed deserts, forded canyons, and tunneled under mountain ranges to reach their destinations. Western expansion in the U.S. brought multitudes of people to dry and inhospitable lands. Massive water diversion projects were designed to bring nourishment from thousands of kilometers away. Areas that received little to no annual precipitation became agricultural oases. Monstrous dams tamed raging rivers and created reservoirs that flooded millions of acres and provided power and water to the population. These development efforts were also prevalent along our coastlines.

For thousands of years, prior to modern times, the great cultural and economic centers of the world emerged near oceans and seas. The proximity provided a means of trade with the rest of the world and a bountiful source of food for the people. This continued into modern times. As more people moved toward the coast, the demand for developable land and the infrastructure to accommodate the new inhabitants increased. Land was reclaimed from the sea via dikes and the filling of wetlands. Shorelines were reinforced and river mouths and lagoons were transformed into armored inlets and commercial harbors.

Today much of the coastline of the lower 48 United States shows some sign of anthropogenic development. Many of the U.S. coastal engineering projects of the 20th century were federal projects aimed at improving the economic condition of the nation. These were difficult and expensive endeavors that were not always successful due to the problems and challenges this dynamic natural setting presented engineers. For as many successful coastal engineering projects there were a number of documented failures (Pilkey and Dixon, 1996). It is essential to learn from these failures, not only for the people directly affected but also for future management efforts. As population migration into the U.S. coastal zone continues (Bartlett et al., 2000), the pressure to develop increases. With more people than ever before utilizing the coast and its limited resources, planners must be absolutely sure of the potential ramifications their actions may have.

Wells Harbor in Wells, Maine, serves as one example of a problematic coastal engineering project. In the 1960s, the Town of Wells, a community along Maine's southern sandy coast, was granted a federally funded navigation project for a tidal estuary. The U.S. Army Corps of Engineers constructed two jetties to stabilize the inlet and dredged an anchorage in the basin backing the town's two beaches. The harbor was designed to service both recreational and commercial fishing boats.

Almost immediately there were problems with the project. Engineering design did not account for the tidal nature of the setting. Shoaling within the inlet and anchorage restricted travel and limited mooring space. Orientation of the jetties allowed for waves to travel down the axis of the inlet. The two beaches bordering the inlet readjusted after jetties had blocked the flow of sediment through the system. Some properties near the jetties accreted while others along the beaches experienced accelerated rates of erosion that eliminated much of their dry beach (Kelley and Anderson, 2000).

Efforts to remedy the situation were not successful. Engineering and economic constraints limited the number of mitigation responses. A divided and contentious political environment strained relationships between local, state, and federal interests (Humm, 1984). This prevented any cooperation between parties resulting in an in ability to reach consensus.

Problems continue presently, and there is the possibility that some issues may ultimately be resolved in court, which is in no one's best interests. It is therefore important for coastal managers to understand how this project progressed to where it is currently and why they have been unable to move forward on an agreed upon response plan. The purpose of this thesis is to answer these questions and present the findings to coastal managers.

The Wells Harbor Project and other projects like it are comprised of three components: natural setting, economics, and political environment. I propose the following theories as explanations for the problems experienced at Wells.

1. Flawed engineering design was based on a partial understanding of the natural setting and is the source of many of the problems associated with the project.
2. The coastal processes within the natural setting limit the response options available to the community and the state.
3. A series of incomplete Benefit Cost Analyses underestimated costs and inflated benefits leading to the justification of an economically marginal project and its subsequent alterations.

4. Economic conditions and constraints limit the response options available to the community and the State.
5. Special interests exerted political pressure to get authorization of the project after it was initially turned down.
6. Ideological differences created a contentious political environment that prevents consensus on any resolution.

A case study of Wells Harbor is created to demonstrate these theories. Case studies of the Saco River Navigation Project in Saco, Maine and the Cold Spring Inlet Project in Cape May, New Jersey are also created and used for cross-case analysis. The Saco River Project has a very similar physical and socioeconomic setting to the Wells Harbor Project. It is used to reinforce the findings from the Wells Harbor case study and make general comments about projects in Maine. The Cold Spring Inlet Project has a markedly different physical and socioeconomic setting from the Wells Harbor Project, and similarities and differences provide robust results of interest to coastal managers outside of Maine.

The thesis begins with an overview of coastal management issues in Maine and the U.S. and is followed by a review of the existing relevant literature. A methods chapter that explains the structure of the case studies and the objectives of the analysis follows this and is followed by the three case studies. The next chapter is a cross-case analysis of the two Maine projects and a cross-case analysis of a general Maine case and the New Jersey project. The thesis concludes with a policy recommendations chapter.

CHAPTER 2

BACKGROUND AND PREVIOUS WORK

Introduction to the Problems

Jetties at the mouth of the Webhannet River were designed by the U.S. Army Corps of Engineers in 1959 to provide a safe inlet and anchorage for the surrounding communities. The project has a history of problems that remain unresolved. Problems include sediment shoaling within the inlet and anchorage, dangerous wave energy, and altered sediment flow in the littoral system. These conditions produce accelerated rates of erosion at the adjacent beach communities of Wells Beach and Drakes Island and an improperly functioning harbor and inlet. The Army Corps conducted numerous studies reviewing the project and is unable to arrive at a solution that satisfies federal, state, and local interests.

Planners and managers in Maine must understand how these problems arose and why they still exist, which entails a review of the coastal management issues facing southern Maine in addition to a review of the issues surrounding federal civil works projects and the interaction between stakeholders and the different agencies. Coastal managers need this knowledge better to serve the stakeholders of Maine in the future.

This chapter begins with a look at coastal activities and management issues on a broad scale. The focus narrows to Maine coastal issues, issues specific to the southern Maine beach region, and finally to the community of Wells. This is followed by a review of the issues raised in the literature on Army Corps civil works projects. The chapter concludes with a review of the research on stakeholder involvement and agency interaction in a coastal management setting.

Coastal Resources and Activities

Two thirds of the Earth's surface is covered with water with 15% of its land considered coastal zone, with 50% to 70% of the world's population living on this land. The number of people living in the coastal zone will grow as the world population approaches the 8 to 12 billion range (Rahman and Huq, 1998). In the U.S. alone, 75% of the population is predicted to live in a coastal county by 2015 (Bartlett et al., 2000).

The high concentration of people is due in part to the many resources and activities associated with the coastal zone. Rahman and Huq (1998) identify the following six categories as some of the major coastal zone resources and activities.

Navigation and Communication

Coastal waterways serve as travel routes for commercial and recreational vessels around the world. Networks of communication cables lie along the ocean bottom, connecting people and continents.

Living Marine Resources

Over 100 million people in the world depend on fisheries for their income, with 95% of the world's fish harvest coming from the oceans (Rahman and Huq, 1998). In the U.S. alone, total landings for 2001 were over 4.3 million metric tons at an estimated value of $3.2 billion (NMFS website, 2003).

Mineral and Energy Resources

Oil and gas exploration are expanding in coastal zones as more fossil fuel is found under the Continental Shelf. In the U.S., the state of Louisiana's coastal zone alone is host to 30,970 oil and gas wells, 31,000 workers on offshore platforms, and 21,000 miles of pipeline (Kelley, 2002a).

Tourism and Recreation

Beaches and ocean offer a variety of recreational activities to vacationers. More people are visiting coastal areas with a percentage relocating permanently.[1] Tourism revenue is a vital part of regional and national economies. New Jersey's coast generates $10 billion in tourism related revenue annually. This accounts for half of the state's annual revenue (MMS, 2003).

Infrastructure Development

With industry and a growing population concentrated in the coastal zone, adequate infrastructure is needed to accommodate residents and commercial interests. This includes roads, harbors, utilities, and waste treatment facilities, to name a few.

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[1] The Town Office of Wells, Maine reports that of the homes along their beaches, 44% are seasonal, and more of them are being converted to year-round residences. There are 274 mobile housing units arriving each year with more people occupying them year-round (Carter, 2002). York and Cumberland Counties

Waste Disposal

Estuaries and open water absorb much of our waste, both unintentionally and intentionally. A recent EPA study reports that 44% of the nation's estuaries are considered impaired in that they don't fully support drinking water, recreation, and aquatic life (USEPA, 2001). Before 1972 and the advent of modern federal environmental legislation, the U.S. was dumping considerable amounts of waste into the ocean. In 1968 figures show 38 million tons of dredged materials and 9 million tons of combined industrial and sewage waste dumped into the ocean. Today this is mainly dredged material with some biological waste and vessels (USEPA, 2003). Title 33, Navigation and Navigable Waters, of the U.S. Code, lists a number of statutes[2] that outline acceptable waste disposal practices in U.S. coastal waters (LII website, 2003).

Coastal Conflicts and Management Issues

This level of activity concentrated in a relatively small area creates conflicts and problems. The job of the coastal manager is to address these problems in a way that satisfies the greatest number of stakeholders while maintaining the productivity of the coastal zone.

Problems arise in the coastal zone due to poor resource utilization and stakeholder conflict. These user conflicts fall into three basic categories: limited space, adverse effects of one use on another, and adverse effects on an ecosystem (Cicin-Sain and Knecht, 1998).

are home to Maine's sandy beaches. York experienced a population growth of 13.5% from 1990-2000 and Cumberland experienced a population growth of 9.2% during that same time (US Census, 2001).

[2] Marine Plastic Pollution Research and Control Act and the Ocean Dumping Act are two examples.

The coastal zone is also subject to the effects of a steady worldwide sea-level rise (SLR). SLR predictions for the next century range from approximately 0.1 meter to 1.0 meter with substantial regional variations (IPCC, 2001a). SLR amplifies the effects of natural processes like storms and erosion that already cause damage to development. This, in turn, complicates existing user conflicts.

Both user-conflict and SLR manifest themselves in the issues confronting coastal managers. Although there are many issues, the following partial list covers some of the more critical ones confronting U.S. managers as identified by various authors (Beatley et al., 1994; Cicin-Sain and Knecht, 1998; Hershman, 1999; Rahman and Huq, 1998). It is clear in review that the issues are all interconnected in some form, which requires that managers not only consider individual issues but also how each affects the others.

Shoreline Erosion

Over 75% of the U.S. coastline is eroding (Pilkey and Thieler, 1992). This is most prevalent along soft coast where natural processes (storms, waves, winds, currents, and tides), amplified by SLR, eat away at beaches and bluffs. There is also an anthropogenic component to erosion. Manmade structures like jetties block natural sediment flow while dams prohibit rivers from supplying sediment to the coast (Beatley et al., 1994). Erosion is a particular concern for U.S. barrier islands, faced with increased settlement trends, and limited space (Bartlett et al., 2000).

Coastal Hazards

Hurricanes, tropical storms, and Northeasters bring destructive waves, winds, and flooding to coastal areas, damaging development and infrastructure (Beatley et al., 1994). Increased frequency and force of these events are connected to SLR and a changing global climate (IPCC, 2001b). Shoreline erosion removes natural buffers, exposing development to coastal hazards. This is a concern for coastal areas with dense populations.

Habitat and Land Loss

Habitat and land are lost to a combination of natural and anthropogenic processes (Beatley et al., 1994). SLR will claim a portion of coastal land. In a "do nothing" policy environment, a one-meter SLR event over the next 50 years would cost the U.S. approximately $65.6 billion (Yohe, 1990). This figure does not factor in the loss of coastal habitat like wetlands. Anthropogenic activities like tourism can greatly degrade those systems (Cicin-Sain and Knecht, 1998), and coastal settlement jeopardizes endangered species habitat (Bartlett et al., 2000). Agricultural and industrial pollution add additional stress to the system (Beatley et al., 1994).

Access

In the U.S., state and federal government view the coast as a resource open to the public. Accessibility differs from state to state and is a challenge for managers. States like Oregon maintain that the coast is public domain and actively protect access (NOAA, 1998). A state like Maine grants more rights to the private property owner, giving them more control of a greater portion of coastal land, which makes it more difficult for the public to gain access to the coast. Access becomes an issue of managing a public resource while acknowledging the rights of private property owners.

Community Character and Identity

Changing economies and demographics along the coast lead to changes in a community's identity. Towns once dependent on fishing might move toward tourism. Towns and managers must decide the direction they want to head and plan accordingly.

Agencies and Regulatory Tools

U.S. coastal management takes place on multiple levels: local, state, and federal. On the federal level there are a number of regulatory agencies that bear some responsibility for portions of the coastal zone.[3]They operate within the guidelines and regulations established in federal statutes.[4] States have a similar agency and regulatory framework that works within the minimum federal standards to address the needs of their stakeholders. The management framework and approach differs from state to state. On the local level, municipalities operate within the state's guidelines and manage through zoning and development regulations. Efficient and productive management requires that the three levels work together toward common goals.

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[3] Environmental Protection Agency (EPA), the U.S. Army Corps of Engineers (USACE), the divisions of the National Oceanic and Atmospheric Administration (NOAA), and the divisions of the Department of the Interior (DOI), are just some.

[4] Examples include the Clean Water Act (CWA), the Oil Pollution Act (OPA), and the River and Harbors Act.

Initiatives like the Chesapeake Bay Program (CBP) and the National Estuarine Program (NEP) helped make cooperative coastal management a reality in the U.S. They combine the resources of federal and state agencies and engage stakeholders in the planning and implementation process (Imperial et al., 1992). The Coastal Zone Management Act (CZMA) of 1972 and its subsequent amendments outline the cooperative relationship that currently exists between federal and state government in the coastal zone (CZMA, 1972). The act provides federal funds to states that develop management plans addressing federal management objectives. This agreement provides the framework for each individual state's coastal management plan.

Coastal Management in Maine

Maine has over 4000 km of coastline (USACE, 1971). The coastal zone is used for a variety of activities. The natural deep ports and inlets make the Maine coast a desirable location for shipping and industry. Portland harbor is one of the larger oil ports in the nation. Shipbuilding continues as a part of Maine's coastal heritage. Both commercial and recreational fishing are important to communities' economic and cultural identities. The Maine coast is a favorite tourist destination for people around the country and world. The economic activity and amenities draw people to the coast. Settlement trends follow national predictions, even outpacing them. In the 1990's, 92% of Maine's population lived in the 16 NOAA designated coastal counties in the state, accounting for over 1 million of the 1.2 million people living in Maine (Van Arsdol et al., 2000).

The highest settlement concentration is along the southern coast. This is an area approximately 80km in length situated in between Portland and Portsmouth and within commuting distance of Boston (MSPO, 1998). Its two counties, Cumberland and York, host the majority of Maine's sandy beaches and beach resorts. They support a key year-round population and summer tourism business essential to local and state economies (MSPO, 1998).

Of Maine's 1,286,670 residents, 459,692 lived in Cumberland and York counties alone in 2001. From 1990-2000, Cumberland County had a population increase of 9.2% and York County had a population increase of 13.5%. This growth was higher than the state average of 3.8%. Population density is also at higher levels in these counties than the rest of the state. In 2001, Cumberland County's population density was 319 people per square mile and York County's population density was 194 people per square mile. The state average was 42 people per square mile (U.S. Census Bureau: Maine, 2001).

Maine coastal managers are faced with many of the same issues other U.S. coastal managers must address. The Maine State Coastal Plan (MSPO, 2001) identifies the following as "high priority" issues: fishery resource management, aquaculture, habitat (wetlands) preservation, coastal hazards, shoreline erosion, coastal development, and public access. Past plans also focused on oil spill mitigation (MDEP, 1994), "watershed management", and non-point pollution from storm water and agriculture (MSPO, 2001).

Again, at the heart of these issues, are user conflict and SLR. Not all activities are compatible, and conflicts arise. SLR further complicates issues by amplifying the destructive effects of natural forces. Average SLR in Maine between 1932 and 1992 was 2.2 mm/year (Kelley et al., 1996). According to the IPCC, this may increase as rates around the world accelerate over the next century (IPCC, 2001a).

Policy Tools and Management Framework

Maine became a coastal zone management state under the CZMA in 1978 (MSPO, 2001). It receives approximately $2.6 million each year in federal money to support their coastal management programs. This is matched by state funds (Kelley, 2002b; Leyden, 2003). A retreat policy was adopted statewide as a means of addressing future SLR and of preserving the natural character of the coast. Retreat allows the state to manage SLR proactively in a way that works within economic constraints and the social environment. The approach has been compared to other state plans and is considered very progressive and well developed (Lameka et al., 2000).

The state of Maine uses a number of statutes[5], enforced by state agencies,[6] to guide management in the coastal zone. Maine has a bottom-up management style, where the individual municipalities, working in conjunction with the state planning office, are responsible for the management of their lands (Lameka et al., 2000). Municipalities must abide by state minimum standards and are responsible for projects both administratively and financially, for the most part. The state does lend assistance through grants and [illegible]

Priority issues were identified as beach erosion, coastal hazards, property damage, public access, and balancing habitat preservation with fishing and development activity (MSPO, 1998; SBPC, 2000). They are very similar to management issues identified on the national and state levels, reflecting user conflict and a need to accommodate natural processes. They also reflect the character of the southern coast.

These are beach communities with a dependence on tourism revenue. Wells is representative of this region with 44% of the town property in seasonal ownership. The majority of the owners reside in the greater New England region (Carter, 2002). Their concerns focus on the preservation and future development of the region as a tourist destination. They also wish to preserve their maritime heritage including a history of commercial fishing.

Another common coastal management issue specifically identified in regional reports is the need for better cooperative management between the municipalities and the state of Maine (MSPO, 1998; SBPC, 2000). They cite a willingness of the state to regulate, but not accommodate, municipalities with specific problems and needs. Municipalities feel that their voices and concerns are not being heard.

Individual communities voice similar concerns (Higgins Beach Public Improvements Ad-Hoc Committee, 1999; WHPC, 1991). Stakeholders have the perception that state and federal agencies are not doing all they can to help alleviate community problems. This view is reinforced in a study conducted by Lameka et al. (2000). A series of interviews with a variety of Maine beach stakeholders revealed a perception that stakeholder concerns are not being addressed by state or federal agencies and that there exists a communication barrier between stakeholders, further complicating effective management.

Problems in Saco and Wells

Wells faces the same problems identified by regional planning groups and other southern Maine communities. The community has a variety of stakeholders, commercial fishing operations, and wildlife habitat to maintain. The residents of Wells Beach and Drakes Island must deal with shore erosion and exposure of development to coastal hazards. In some places no dry beach can be found during high tides (Kelley and Anderson, 2000). Additionally, Wells Harbor is difficult and dangerous to navigate due to sand bars and high wave energy.

A defining piece of their problem is the role the federal navigation jetties play. Wells Beach and Drakes Island residents coexist with a federally designed inlet and anchorage. Erosion rates, harbor failings, and exposure to coastal hazards are linked to the design and presence of the jetties (Kelley and Anderson, 2000). The jetties created a use conflict between harbor and the beach users that remains unresolved.

A similar navigation project exists to the north of Wells Harbor on the Saco River. Jetties there caused many of the same problems for the beach community of Camp Ellis. The authors of an SLR study in Maine attribute the erosion and loss of property at Camp Ellis to a combination of faulty navigation project design and natural processes (MSPO, 1994). A second study of Camp Ellis makes a case that its problems are common to other federal navigation projects experiencing difficulties. A comparison of several federal project histories leads the author to identify faulty economic analyses, poor knowledge of coastal processes, and contentious relationships between the federal, state, and the local stakeholders as the underlying problems associated with problematic federal coastal projects (Pilkey and Dixon, 1996).

A multiple case study by Kelley and Anderson (2000) draws upon the similarities of the two projects and compares the project histories of both Saco and Wells to identify common factors responsible for the problems each community experiences. The study documents a similar pattern of a poor understanding of coastal processes, faulty economic assumptions, and an impasse in current mitigation efforts due to an environment of desperation and distrust among stakeholders and government agencies.

A smaller case study of the Wells Harbor project focuses on the relationships between stakeholders within the community (Humm, 1984). A mediator was brought in to help reach a consensus and formulate a plan to address their harbor and beach problems. A productive relationship was never established between the different community interests, and the formulated plan fell apart prior to implementation. The mediator painted a picture of irreconcilable differences.

There are two common themes in these studies. First, there was a problem with the design and construction stages of these projects. Second, stakeholder and agency relations are not productive. Reviewing case studies of other Army Corps projects provides evidence that these are not isolated events. General patterns emerge in the history, and they help explain what is happening at Wells. The same is true for a review of the literature on agency and stakeholder participation in coastal management. The following sections summarize some of these patterns.

U.S. Army Corps of Engineers[7]

From their beginnings, the U.S. Army Corps of Engineers[8] and their projects have been targets for criticism. In 1830, Former West Point superintendent Alden Partridge called the Corps "a privileged order of the very worst class, a military aristocracy" (Shallat, 1994). Accusations of corruption, political favoritism, flawed projects, and questionable economics plagued the organization. The Corps took it upon themselves to answer the accusations through internal review, a tactic they still use today (Hillyer, 1996). The internal reviews were questioned heavily by critics, but the Corps maintained that they were accurate and impartial and moved on (Shallat, 1994). They became involved in civil works during the 1800's. Their role along the coast began with maintenance of navigation channels. In 1930 the Rivers and Harbors Act expanded their presence in coastal management by charging them with the task of studying coastal erosion and shoreline protection (Pilkey and Dixon, 1996). This is the basis for their involvement in coastal projects today. Currently, there are many Army Corps projects along Maine's coast (Figure 2.1).

The Corps still bears a striking resemblance to its original form. They remain an organization of engineers under the supervision of military officers answering to

[7] It should be noted that the following critical review of Army Corps projects represents the common theme in the literature. Most reviews were prompted by some problem that arose as a result of a project. By nature they are critical. Although the objective of this component of the research is to present a balanced and objective case, there are very few positive Army Corps critiques. The ones that exist are produced by the Army Corps and must be read with that in mind. This does not affect the value of the information in the author's view. Valuable points can be drawn from the reviews and are representative of what is happening at Wells and Saco.

[8] The Army Corps of Engineers date back to the 1600s in France where engineers designed and built military fortifications to protect the king and his army. Engineering technology advanced and these skills were applied to civil works expanding France's urban centers (Shallat, 1994). George Washington employed several of the French engineers during the Revolutionary War to build fortifications for the Continental Army (Pilkey and Dixon, 1996; Shallat, 1994). In 1802, the Army Corps became and official and permanent department of the military through an act of Congress and became based out of West Point Academy (Pilkey and Dixon, 1996).

Congress. Criticism continues. Federal coastal projects are a source of controversy still associated with questionable economic forecasting (Griswald, 2000a; Hayes, 1995; Milon, 2002; Pilkey and Dixon, 1996), improper engineering design (Kelley and Anderson, 2000; Pilkey and Dixon, 1996), and manipulation by special interests (Griswald, 2000b,c; Kelley and Anderson, 2000; Milon, 2002; Pilkey and Dixon, 1996). In response to these controversies over the past decade there has been an increased demand for review of these projects.

The Army Corps Response

Official review of federal coastal projects is limited by design. Congressional guidelines acknowledge only the Corps as the designated reviewer of federal coastal projects.

An example of internal review was project performance reports requested by the Office of Management and Budget (OMB) for federal shore protection projects. In question were the accuracy of predicted costs and economic trends, the true value of benefits received, and whether shore protection was actually inducing the risky development it is designed to protect. The Corps answered these questions with two internal studies followed by a large internal review (Cordes and Yezer, 1995; Hillyer, 1996; Hillyer et al., 1996). Surveys and economic models show acceptable economic performance (Hillyer et al., 1996), no additional development in risky areas (Cordes and Yezer, 1995), and justification to continue shore protection (Hillyer, 1996). Results are presented in general terms with no easy means of replicating methods or analysis. Assumptions and decisions were made with little explanation. The Corps even

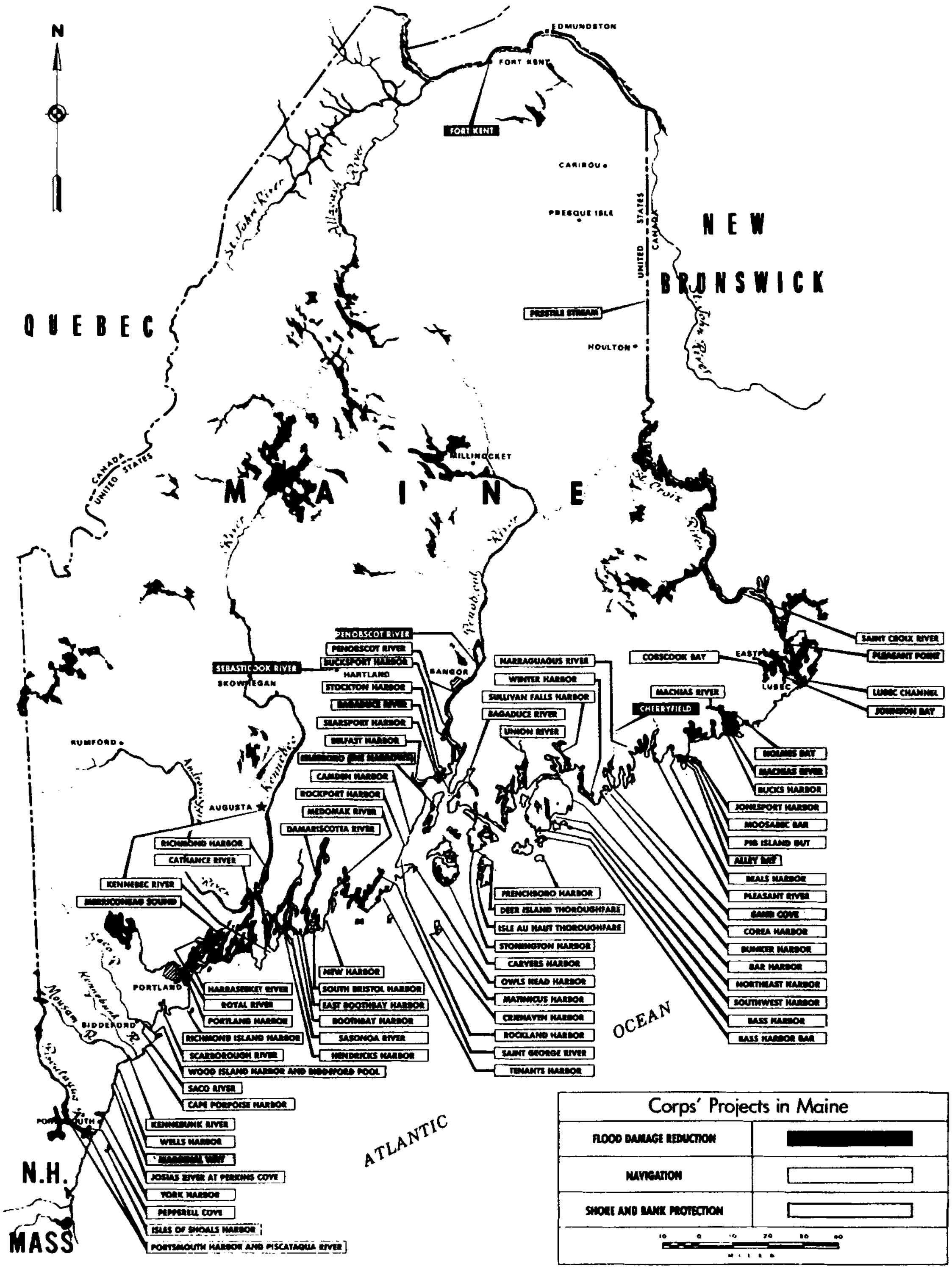

Figure 2.1 Army Corps projects along Maine's coast (USACE, 1995).

acknowledges problems with their data and studies. Incomplete records make it difficult to definitively answer the OMB's questions (Hillyer, 1996).

Outside Review

Critics of the Army Corps are not satisfied by these internal reviews. Some groups outside the Army Corps have taken it upon themselves to review Army Corps projects in order to offer another perspective. A number of patterns arise with federal civil work projects both on and off the coast. In general these patterns fall under three broad categories: natural systems, economics, and political environment.

Understanding the Natural System

Army Corps projects exist within a natural system. Engineers and designers must understand the effects projects will have on the system in order to properly design and construct them. This is particularly true in a dynamic water setting. The potential consequences of not fully understanding the natural systems include unexpected economic costs, ecosystem and community damage, and ultimately project failure.

Problems range from underestimating potential effects to not understanding the system at all. The Saugus River Flood Protection project is an example where the Army Corps understood the estuarine system but greatly underestimated the potential effects of the project (Hayes, 1995). The Army Corps assumed that a floodgate would periodically disrupt the flow of salt water into the river during storm surges. They underestimated the frequency of storm activity and the effect of additional closures on the estuary. It was shown that the productivity and health of the estuary might have been drastically altered if the project had gone forward as planned.

When the Army Corps began the Central and Southern Florida Project, they studied the effects of diverting water from the Everglades. They acknowledged that there would be disruption but underestimated the extent. Today, a large percentage of the habitat has been destroyed and the current restoration project is the most expensive ecosystem restoration ever undertaken in the U.S., costing billions (Griswald, 2001b; Milon, 2002).

The proposed deepening of the Chesapeake and Delaware Canal is a documented example where the Army Corps proceeded with engineering plans despite the fact they did not understand the processes at work. Two separate engineering reports listed the flow of water in the canal in two different directions. This misunderstanding was also conveyed verbally during public meetings with different Army Corps managers and local stakeholders. Their data determine project design, ultimately affecting the surrounding habitat and communities (Griswald, 2001a).

Bregman (1983) depicts a similar misunderstanding in her case study of maintenance of dams and locks on the Upper Mississippi. The foundation of the lock and dam structures was compromised because they were built in high velocity zones of the river with shifting mud and silt as a foundation. Engineers identified the problem, and yet the Army Corps proposed to solve it by building a bigger structure in the same location.

Bregman's 1983 case study highlights another point of criticism. Army Corps projects based on faulty environmental data are often corrected through bigger engineering efforts based on the same faulty information. The problem perpetuates itself resulting in large engineering projects, with increasing construction costs that multiply the negative effects on the natural setting.

Pilkey describes this pattern of behavior along the coast as engaging in "dogmatic science", treating all coastal areas the same (Pilkey and Dixon, 1996). Both Pilkey and Dixon (1996) and Kelley and Anderson (2000) provide an example of this along Maine's coast. The jetties on the Saco River were designed without a proper understanding of the coastal processes. Faulty assumptions that prompted the original design were recycled throughout the life of the project, amounting to 25 studies and 17 models at considerable economic cost and damage to the community of Camp Ellis.

Criticizing the Economics

Critics also point to errors in the economic analyses. Inaccurate benefit and cost predictions are at the heart of most criticism. Several reviewers have shown great disparity between projections and real values, which can have dire consequences. These projects are accepted and rejected based on these predictions. Inflated benefits or deflated costs can justify spending public funds on a disastrous venture. Once a project is started it is legally difficult to stop, and the scale of the engineering does not allow for easy dismantlement.

Milon's (2003) review of the Central and Southern Florida Project reveals inaccurate cost predictions for flood control and water management projects. Actual population settlement trends far outpaced the original projections, leading to bigger projects and higher construction costs. A similar pattern is found in a number of coastal shore erosion and navigation projects around the U.S. and Maine. Reviews show inflated benefit figures and underestimated costs that drove questionable projects and encouraged large-scale engineering solutions (Kelley and Anderson, 2000; Pilkey and Dixon, 1996).

Griswald (2001a) documents similar issues in his review of the Chesapeake and Delaware Canal. The Army Corps calculated very optimistic economic benefits for Baltimore Harbor contingent upon increasing the capacity of the Chesapeake and Delaware Canal. Citizen groups showed that this was far from the case and argued that the predictions were fabrications and they were also able to show that construction costs were deflated and did not accurately address the full scope of the project.

The Army Corps' own economists and engineers indicated that benefit predictions for the Snake River Dams were greatly exaggerated. The navigation and energy benefits would never be realized. Additionally, they claimed that the Army Corps discarded recreational benefits calculated for a free flowing river. Cost calculations for the dams were incomplete. The projections ignored the cost of regulatory compliance needed to satisfy guidelines in the Clean Water Act, an act that the Army Corps enforces (Griswald, 2001d).

The Army Corps' proposed repairs and expansions of project design for the dams and locks of the Upper Mississippi were justified by projections of increased barge traffic. Opponents, mainly environmentalists and trucking interests, were able to show that projected barge traffic and commerce predictions were overestimated and optimistic at best. Actual benefits would not have justified undertaking the project (Bregman, 1983).

Sullivan and Hitchner (1978) reviewed the benefit calculations for the proposed Tocks Island Dam that would have flooded the Delaware Water Gap area of New Jersey and Pennsylvania. The project was touted as a flood control project with recreational, water supply, and energy benefits. Flood control benefits were overestimated. Past flood damage had occurred to homes within the established flood plain and were not even supposed to be there. The water benefits for New York City and Philadelphia were overstated. Other sources of water existed, and the cost of breaking existing water contracts and agreements was not considered in the calculations. Energy benefits were unfounded. People were receiving energy for less money than energy that would be produced by the project. Recreational benefits were extremely optimistic and did not consider the effects of the many substitutes within the metropolitan area.

The Tocks Island case study brings to light another criticism of project economics. Projects are approved if they can perform economically, meaning that benefits outweigh costs. Benefits can be inflated with inaccurate data or by misrepresenting the facts. They can also be inflated by expanding the scope of the project.

This pro-development approach can have long-lasting negative effects on the project area. The Tocks Island Dam project was originally a flood control project proposed in response to the death and property destruction following a flood in 1955. Considering only the flood protection benefits, the project costs could not be justified. Planners expanded the size of the project and incorporated recreational, power, and water supply benefits. The costs increased somewhat while the benefits grew exponentially. This pattern of project expansion to produce added benefits is also seen in the Central and

Southern Florida Project (Milon, 2003) and the Upper Mississippi maintenance projects (Bregman, 1983).

The expansion of Army Corps projects is also driven by a directive in the guidelines urging planners to undertake projects that maximize net benefits (USACE, 2000). Maximization makes sense and is in the best interest of the public; however, a problem arises when there are several plans with acceptable benefit to cost ratios. Simpler and less intrusive projects may not even be considered based on a large-scale engineering project's greater economic return. Greater economic return does not necessarily mean the best option for communities and the environment.

Hayes (1995) demonstrates this point in her review of the Saugus River flood control project in Massachusetts. The floodgate met economic guidelines by having a benefit to cost ratio greater than one and by maximizing project benefits. Hayes points out that the uncertainties with a project that size carried the potential for large-scale damage to surrounding communities and estuarine ecosystems. Smaller-scale options that included non-engineering initiatives satisfied project objectives but were not considered due to the benefit-maximizing criterion. This encourages expensive engineering projects that place a substantial economic burden on the local sponsor. Critics point to the Army Corps' tendency to rely on engineered solutions as a fundamental flaw in the overall process (Bregman, 1983; Griswald, 2002b; Kelley and Anderson, 2000; Pilkey and Anderson, 1996; Sullivan and Hitchner, 1978).

The Political Environment

Army Corps projects are funded with Congressional appropriations and therefore are subject to the politics behind the funding. Congressmen and senators are elected officials serving their constituents and will stand behind or block a project based on the public's opinion. This allows special interests such as environmental groups and industry lobbyists to play a role in federal projects. They will exert pressure on congressional representatives to vote in line with their interests. The outcome can go two ways. Pressure can lead to constructive decisions that choose projects benefiting society or pressure can override better judgment and lead to poorly designed projects.

Public opinion can push through questionable projects. The Tocks Island Dam was originally a flood control project that expanded in order to justify federal participation. Originally, the Army Corps did not feel it was a justified flood control project and turned it down. Public pressure, stemming from fear of another deadly flood prompted Congressional representatives to convince the Army Corps to reevaluate the project and make the economics work (Sullivan and Hitchner, 1978).

Special interest groups are just as powerful. The shipping and barging industry were key proponents and major backers of the redevelopment projects along the Upper Mississippi (Bregman, 1983) and the Chesapeake and Delaware Canal deepening (Griswald, 2001a). The oil industry has considerable power in the state of Alaska. Congressional delegates and state officials fast tracked expansion of oil drilling operations along Alaska's North Slope. The projects destroyed wetland habitat with undetermined consequences. The state has only restored a fraction of the wetlands that are required by law. Officials who voiced opposition to the projects were relocated out of the region (Griswald, 2001c). Agricultural interests in Florida were the force behind the expansion of water supply and flood control projects responsible for the destruction of the Everglades (Milon, 2003).

Groups also have the power to block projects. Citizen groups in Maryland have successfully held up efforts to deepen the Chesapeake and Delaware Canal (Griswald, 2001a). Private property owners wield some power along the coast. The community of Wells successfully blocked further dredging of their harbor in the 1970's when they suspected a connection between the project and the increased erosion along their beaches (Humm, 1984).

Another aspect of the political environment that drives projects is the relationship between the Army Corps, other agencies, and stakeholders. The Corps is frequently presented with scientific and anecdotal data from other government agencies and stakeholders regarding the natural setting of projects (Bregman, 1983), but choose to proceed as planned (Milon, 2003) sometimes with dire consequences for the ecosystem.

The Everglades serve as an example. The National Park Service expressed concerns early on in the Central and Southern Florida Project. They suspected water diversion would have negative effects on Everglades National Park. They asked for more time to investigate, but the Army Corps chose to proceed and not honor their request (Milon, 2003). Pilkey and Dixon (1996) presents a number of examples where state agencies and stakeholders expressed concerns over the effects of coastal projects but were ignored by Army Corps.

Stakeholder Involvement

An inability or unwillingness of the Corps to work with different stakeholders is present in many of the case studies (Bregman, 1983; Griswald, 2000a,b,c,d; Kelley and Anderson, 2000; Pilkey and Dixon, 1996; Shallat, 1994). This includes local property owners (Griswald, 2000a; Kelley and Anderson, 2000; Pilkey and Dixon, 1996), non-governmental organizations (Bregman, 1983), other federal agencies (Griswald 2000c; Milon, 2002), and state agencies (Kelley and Anderson, 2000; Pilkey and Dixon, 1996). This is not a problem specific to the Army Corps. Problems arise between property owners, state agencies, and non-governmental agencies that ultimately hinder efforts to find solutions. This seems to be present in both southern coastal Maine communities (Humm, 1984; Kelley and Anderson, 2000).

Studies of coastal management programs show that cooperation and involvement of stakeholders are essential for successful implementation of projects. A study of two shoreline management plans in the U.K. demonstrates this. The study shows that within a complex multi-use socioeconomic, environmental, and political problem it is essential to have participatory consultation, an inclusive process, and stakeholder involvement. Consensus must be reached early and often, and public participation is the core of this decision making process (O'Riordan and Ward, 1997).

Another cross case analysis of several European coastal management programs shows that stakeholders want to participate and care about the issues but they sometimes doubt the sincerity of others. They believe that their input is valuable but often times not considered when making decisions (Davos et al., 2002). This creates an environment of mistrust and frustration (Davos et al., 2002; O'Riordan and Ward, 1997).

These findings hold true for the U.S. A review of the National Estuary Program (NEP) and other U.S. joint coastal management programs come to similar conclusions and offer some additional points. Beyond what the European case studies reveal, success also depends on political saliency, adaptive plans, and the ability of the program or project to learn from past experience and respond accordingly (Imperial et al., 1992).

A second review of the NEP adds to this argument by focusing on the local and state government officials (Tuler et al., 2002). Interviews show officials demand the same respect and input when working with other agencies or stakeholders. This affects their level of participation and ultimately the success of the project.

Two studies comparing Maine and California's beach management policies reiterate these points. Interviews with a variety of Maine stakeholders reveals a number of concerns including poor communication between stakeholders, a perception that officials do not care about stakeholder concerns, a lack of stakeholder education on coastal issues, conflicting policies between preservation and development, and an exclusion of stakeholders early on in the process (Lameka et al., 2000; Ricci et al., 2000).

Applying This to Wells

Wells has much in common with other coastal communities in the U.S. They are managing their town and resources locally under guidelines established in state and federal statutes. The community faces development issues, multiple user conflicts, and an influx of people in search of coastal amenities. They must also contend with natural forces driven by an accelerating rate of SLR. Wells is attempting to balance these factors while moving forward and maintaining their identity as a harbor and beach town.

Problems over the past 43 years with the federal navigation project on the Webhannet River have been stumbling blocks the community has not been able to clear. Local, state, and federal governments have not been able to work towards a common goal. Many of the patterns highlighted in the Army Corps case studies are present at Wells. A charged political environment and poor understanding of the natural system drove poor economic decisions. The town now has two jetties that do not function as they were intended. The poor relationships that evolved between stakeholders and agencies, prevents the reaching of consensus on a solution. Reviewing the case in greater detail, taking into consideration the points made regarding federal engineering projects, and stakeholder participation along the coast, will offer more insight into Wells' problems and will provide coastal managers with valuable knowledge needed to better serve their communities.

CHAPTER 3

METHODS

Introduction

The problem at Wells Harbor is complex, consisting of different components interacting with each other to produce the current situation. Understanding the problem requires examining and analyzing each part separately and together, holistically. The case study format provides the means to view the problem as a whole and observe the interaction of its components.

Case studies have proved useful in the coastal zone management setting. Suman (2001) compiled six case studies of coastal zone management issues, three from the U.S. and three from outside the U.S. The case studies provide perspective on a wide range of management issues. Cross comparison of the studies in and outside the U.S. allows for "rich comparisons", particularly when examining the "economic, institutional, and environmental" components of the management issues. Comparisons illustrate similarities and differences and allow for effective policy evaluation.

Other examples where case studies were used to illustrate coastal management issues include Kelley and Anderson's (2000) multiple case studies of the Wells Harbor Project and the Saco River project in Maine. They were able to demonstrate how the events at Wells follow a similar path to the history of the Saco River project and alluded to questions about the economic and political environment as driving factors in both. Pilkey and Dixon (1996) used a multiple case study to demonstrate common patterns in Army Corps coastal projects around the U.S. Mike Griswald (2000a; b; c; d), constructed similar studies in his series for the *Washington Post* examining a number of Army Corps projects, coastal and non-coastal, to illustrate patterns common to federal engineering projects.

Case Study Model

The case study takes either a single or multiple form. Both can achieve the same goals of the researcher. The multiple case better addresses external validity concerns and allows for more robust results through comparison. Within both forms, Berg (2001) makes three further distinctions: intrinsic (to better understand a situation), instrumental (provide insight into an issue), and collective (group of instrumentals). A multiple case study may exhibit a combination of all three.

This research uses an embedded explanatory multiple case study form as defined by Yin (1994) to present the information. The explanatory structure is designed to answer questions of how and why. It is particularly useful for identifying causal relationships (Berg, 2001). Each case study is comprised of several embedded units. This allows for a focused examination of key elements and a holistic view of their interaction as they define the problem (Yin, 1994).

Three cases are reviewed. The main study is of the Wells Harbor Navigation project. The other two studies are the Saco River Navigation Project in Saco, Maine and the Cold Spring Inlet Navigation Project[9] in Cape May, New Jersey. The Saco River project has a very similar setting to Wells as shown by Kelley and Anderson (2000) Wells follows a similar history to Saco. The Cape May project has a very different

[9] Cold Spring Inlet is now often referred to as Cape May Inlet.

setting, with a different regulatory, socioeconomic, and coastal environment, although the problem is still one of a federal navigation project responsible for damage to adjacent shoreline. The unit of analysis for each study is the navigation project, defined by its starting dates to present. All projects have a variety of stakeholders and all levels of government agencies involved in the process. The ability to compare the Wells project to another Maine coastal project and a project outside of Maine provides robust results in analysis.

Embedded Case Study Structure

Each of the case studies is comprised of three embedded units. The choice of these units is based on patterns and factors identified in previous research (Bregman, 1983; Griswald, 2000a,b,c,d; Hayes, 1995; Kelley and Anderson, 2000; Milon, 2002; Pilkey and Dixon, 1996; Sullivan and Hitchner, 1978). The first unit is the natural setting, covering coastal process pre and post-jetty construction. The second unit is economics, summarizing the benefit and cost forecasts throughout the life of the project. The third unit is the political environment, covering the political history that shapes the project. The following describes in detail the data used to construct each unit and the analysis performed.

Natural Setting

This unit draws a picture of pre and post-jetty construction conditions. Specifically, it covers how engineering has altered processes in and around the project area. Information and data are gathered from a number of sources including Army Corps reports, work of non-Army Corps researchers, field observations, and interviews. Pilkey and Dixon (1996) used a similar method of analysis in commenting on the effects of engineering decisions in their review of federal coastal projects.

Analysis aims to determine the extent to which engineering decisions are responsible for the current conditions. The written record from Army Corps reports depicts a history of engineering decisions and their justification. This is compared to body of information on coastal processes prior to and throughout the project's life. Causal relationships are identified in this comparison and provide the ability to comment on the extent engineering decisions are responsible for the current situation.

Economics

This unit employs a technique used in Milon's (2003) economic review of the Central and Southern Florida Project. A history of benefit and cost predictions, as reported in Army Corps studies, is compiled to present a summary of economic decisions over the life of the project. Data come directly from Army Corps feasibility studies, interviews, and administrative documents.

Analysis looks for patterns in the benefit and cost predictions. The objective is to determine whether the true benefits and costs were accurately measured or whether they were over and under valued. This is determined by comparing the original predictions to the current present values when possible. Once this is established we ask whether planners were able to accurately predict trends and, if not, why. This information is used to comment on the effectiveness of the benefit-cost analysis as a decision-maker in coastal zone projects and management.

Political Environment

This unit consists of two parts. The first part is modeled after Tuler et al.'s (2002) review of the factors influencing local governments' participation in the National Estuary Program. Open-ended interviews are conducted with people who are representative of the different groups and agencies involved in the project. The interviews are designed to establish people's perception of the problem, perception of the quality of relationships, and their perception of success. Analysis entails of determining the compatibility of perceived problems and solutions. This serves as an indicator of the state of the political environment and identifies inconsistencies and roadblocks in the negotiating process. The perception of relationships serves as an indicator of the ability of the process to move forward. Poor relationships between stakeholders and agencies imply a difficult environment for negotiation.

The second part constructs a written history that chronicles the changes in attitudes, policy, and relationships over the life of the project. This is based on a similar technique used by O'Riordan and Ward (1997) in their study on the value of stakeholder participation in the two U.K. shore management projects. The history is constructed from the written record namely Army Corps documents, personal correspondence, and interviews. Analysis entails of connecting shifts in the political environment with decisions and changes made in the project in order to establish causal relationships.

Interviews

Information from interviews is used throughout the studies. All interviews are open-ended and take "semi-standardized" format, where there are several set questions, and subsequent probe questions are used to extract more information (Berg, 2001). The open-ended structure has several benefits. The format allows for more in-depth explorations. Open-ended interviews preserve the voices of the subjects and they are appropriate for small subject fields where statistical analysis is difficult[10] (Tuler et al., 2002).

The initial subjects are chosen based on the record of their involvement in the project. Subsequent subjects are identified during the course of interviews. Whenever possible, interviews are conducted in-person. When not possible, interviews are conducted via telephone or email. Interviews are designed to identify the perceptions of people. They are not intended to obtain quantifiable information, although some do.

Cross-Case Analysis

Upon completion of the cases studies, two stages of analysis are conducted. A cross case analysis will be completed for the Wells Harbor and Saco River projects. Similarities and differences will be highlighted in order to explain how and why projects have followed their specific histories. From this, a short narrative, summarizing both cases will be created to represent the general experience in Maine. This approach is modeled after Denzin and Lincoln's (2000) interactive synthesis method. The purpose is

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[10] Tuler et al., (2002) had subject fields of 17 or less.

to create a narrative that could be applied to a majority of case studies of federal coastal projects in Maine.

This narrative is used to conduct a cross case analysis with the project at Cape May, New Jersey. The purpose of this is to identify similarities and differences between a "general" Maine case and one from outside the state. This helps further explain how and why the projects in Maine proceeded the way they did. The use of a case outside of Maine provides robust results. The results and findings from the cross case analyses are used to develop policy recommendations, specific to Maine and to other U.S. coastal regions. These findings and recommendations are important to coastal managers facing similar situations.

CHAPTER 4

CASE STUDY 1: WELLS HARBOR

An Improved Harbor

The Town of Wells was a recipient of a federal navigation project in the early 1960s. Jetties were constructed at the mouth of the Webhannet River along Maine's southern coast to create a safe inlet and anchorage for the community (Figure 4.1). Local interests endorsed the project, seeing it as beneficial to the community and region and providing both recreational and commercial benefits. Congress approved the project and appropriated the necessary federal funds while the community committed their share of the cost, establishing a partnership between them and the federal government.

Project design was altered several times during the construction phase, adding costs and delaying completion. Early designs did not achieve the navigation goals as specified in the overall plans. Episodic modifications were made to correct problems with limited success.

Beach property owners did not want dredge spoils placed on their land and effectively blocked dredging during the 1980s (Humm, 1984). Efforts to address community problems had little success. Tension between local stakeholders, the State of Maine, and the Army Corps of Engineers created problems. Limited funds and unfavorable economic conditions prohibited several mitigation options while Maine state regulations prohibited other affordable options. Currently, there is an impasse on how to proceed and conditions continue to deteriorate, both in the physical setting and the political environment.

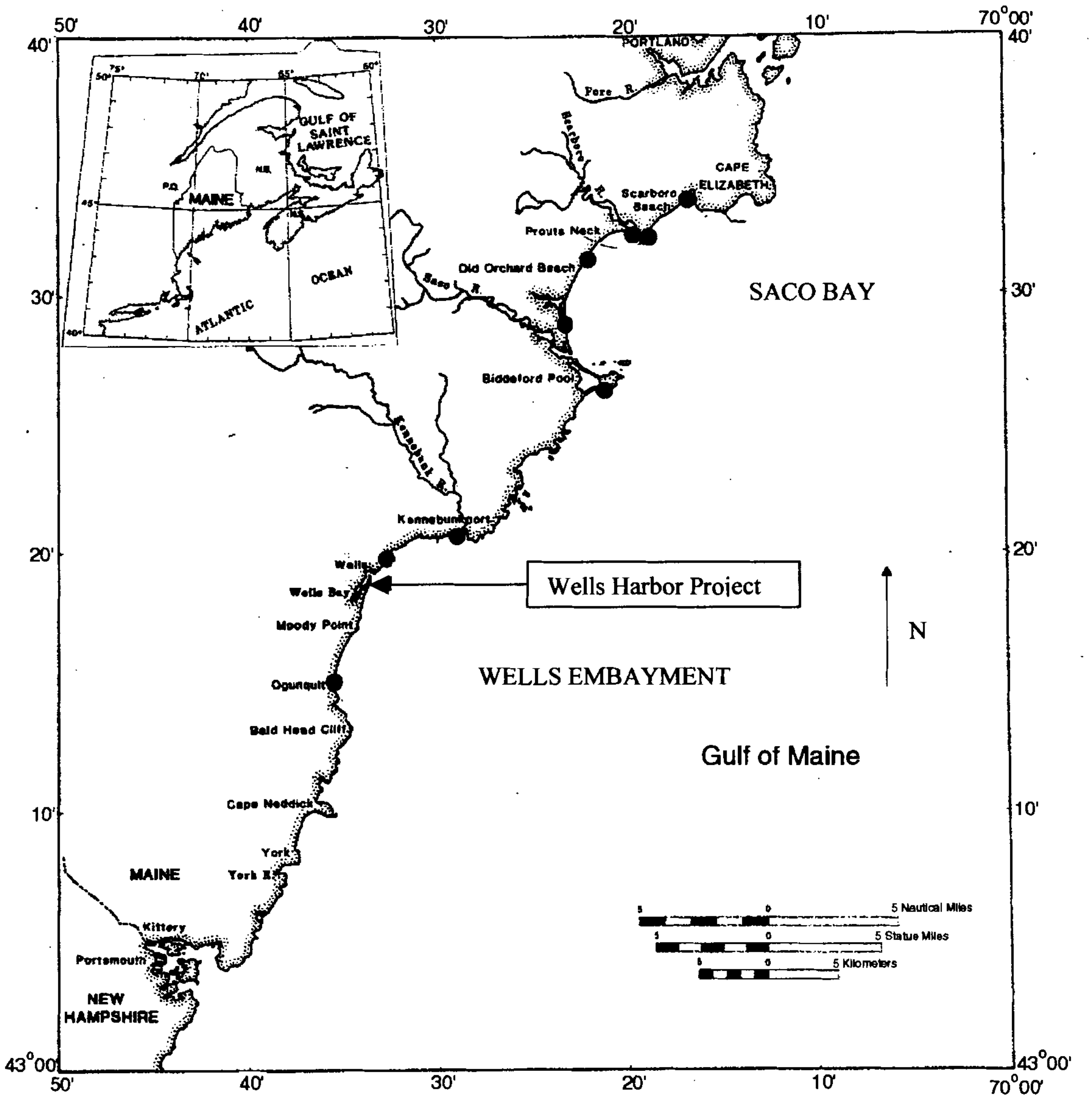

Figure 4.1 Map of Maine's southern coast and location of the Wells Harbor Project (Kelley et al., 1989b).

Wells Harbor Project Construction History 1953 - Present

Formal requests for a harbor and inlet began in 1953 (Smith, 1994). The U.S. Army Corps of Engineers and local interests agreed on a design in 1961. Document HD 202/86/1 (USACE, 1959), submitted July 16, 1959, authorized by The River and Harbor Act of 1954, granted permission to construct two jetties at the mouth of the Webhannet River inlet. The south jetty was to be 287 meters long and the north jetty was to be 195 meters long. The entrance was to be dredged 30 meters wide and 2.5 meters deep with an inner channel 30 meters wide and 2 meters deep. The inlet and channel led into a 7.4-acre anchorage with a mooring capacity for 150 vessels (Figure 4.2).

The town of Wells was responsible for moving a shallow waterline, which interfered with construction and the building of a public launch. This fulfilled the federal government criterion that federally funded projects be public in nature. Favorable responses came from a number of federal agencies and the Maine Governor's office.

A design memorandum submitted in August 18, 1961, expanded upon engineering plans. The project goals remained the same: provide an inlet and anchorage for recreational and commercial fishing vessels. The first stage of construction began in November 1961 and ended in August 1962 (USACE, 1962). Both jetties were completed during this time. Dredging began on the inner channel but stopped short of the entrance to the anchorage. The dredger was unable to keep up with the sediment shoaling in behind it. Rapid erosion along the northern tip of Wells Beach resulted in a sand-spit forming and blocking the anchorage site behind the inlet (USACE, 1962; Byrne and Zeigler, 1977). A sand bar formed at the seaward end of the north jetty. This forced sand

Figure 4.2 Aerial photo of Wells Harbor and adjacent beaches, 1991 (Photo courtesy of J.T. Kelley).

around the end of the jetty and posed a problem to dredging because of waves pushing the sand into the inlet (USACE, 1962).

A supplement to the original design memorandum was accepted on September 21, 1962 (USACE, 1962). The supplement proposed a design change to correct the shoaling problems. The changes included a 207-meter stone revetment around the northern tip of Wells Beach, a 30-meter stone riprap wave absorber along the inner channel on the southern side of the inlet, a 30-meter extension of the north jetty, and a 122-meter groin at Drakes Island.

Alterations began in December 1962 and continued to June 1963 (USACE, 1965a). All alterations were made with the exception of the groin, which was blocked by public opposition. In its place, the north jetty was extended another 30 meters to create a 60-meter extension. This brought the north jetty's total length to 255 meters.

Dredging of the channels resumed in July 1962. Problems arose with the dredging company management, and work was halted during the winter due to stormy conditions. The contract with the dredging company was terminated in November 1963 (Byrne and Zeigler, 1977). A second company was brought in to continue the dredging. Dredging began in August 1964 and ended in May 1965 when the contractor withdrew because of high shoaling rates and loss of a dredger, sunk during a storm (Byrne et al, 1977). Only 75% of total dredge had ever been completed and that was subject to constant infilling by sediment (USACE, 1965a).

A second supplement to the design memorandum was submitted on August 13, 1965 (USACE, 1965a). This supplement proposed lengthening the jetties and orienting the additions to the south to block incoming easterly waves. The supplement proposed to re-dredge the entire project to original specifications and to dig an additional retention basin for sediment south of the anchorage location.

Construction was completed in 1967 (Table 4.1). The south jetty was lengthened by 396 m and the north jetty was lengthened by 373 m (Bottin, 1978).

Years of Construction	North Jetty	South Jetty	Description	Reason
1961-1962	195 m	287 m	Original design	Start of project
1962-1963	60 m	0 m	Adjustment	Shoaling
1965-1967	373 m	396 m	Adjustment	Shoaling and wave hazards
Total Length	**628 m**	**683 m**		

Table 4.1 A summary of Wells Harbor Jetty construction from 1961 – 1967 (Bottin, 1978; USACE, 1959; 1962; 1965)

The anchorage and channel were dredged again in 1970, 1971, and 1974 (Smith, 1994). In response to accelerated beach erosion, property owners organized to stop dredging operations in 1974[11] (Humm, 1984).

Shoaling continued in the inlet and harbor creating an unsafe environment for boats. Sediment shoals blocked boat passage at low tide and high wave energy within the inlet made travel dangerous (Bottin, 1978). Figure 4.3 shows an example of the shoaling problems experienced in the harbor.

[11] In mediation stakeholders expressed a desire for the Army Corps to gather better coastal process data before proceeding. The fact that some property owners forbid access for pipes and pumps, effectively blocking any future dredging, revealed an underlying desire to end the project all together (Humm, 1984).

Figure 4.3 Shoaling in Wells Harbor, 1988 (Photo courtesy of J.T. Kelley)

The Army Corps commissioned a study of Wells Harbor to understand better the processes creating the problems (Byrne and Zeigler, 1977). Past efforts and alterations were deemed unsuccessful. The Army Corps, in partnership with U.S Army Corps Waterways Engineering Experiment Station, constructed a concrete model of the harbor and shoreline at their research center in Vicksburg, Mississippi, to observe the wave processes. The final report determined that the inlet design was too wide and could not self-scour. They proposed construction of stone spur dikes in the entrance of the inlet to narrow the inlet and a breakwater to reduce direct wave energy and help promote self-scour (Bottin, 1978).

The proposed alterations were not constructed, and the project remained inactive until the late 1980s, although the harbor remained used. During the interim, dredging was considered but never started. The intended sites for spoils disposal were the eroding beaches at Wells and Drakes Island. Beach property owners denied the town access to their properties (USACE, 1980a), and the Rachel Carson Wildlife Refuge surrounded the original spoils site within the marsh and the USF&WS would not allow disposal within the Refuge (Kelley and Anderson, 2000). Beach property owners changed their stance in the late 1980s as their beaches continued to erode. By this time a general concern over eroding salt marshes blocked any further dredging plans. The town was allowed two small dredges in 1990 and 1991 to clear the entrance of the inlet (Smith, 1994).

The issue was revisited in 1996 and the state of Maine required that the Army Corps conduct a dredging alternatives analysis in 1997 (USACE, 1997a). A reconfiguration of the channel and anchorage design was negotiated, and all parties agreed to a compromise plan in 1998. The new plan reduced the footprint of future dredges. It involved reconfiguring the mooring design and moving the anchorage off the flood tidal delta and to the natural tidal channel. Spoils were placed on Wells Beach and Drakes Island. As part of the deal, the Town of Wells provided a conservation easement for a portion of the flood-tidal delta deemed critical to the future health of the marsh, and they agreed to implement and pay for a 5-year monitoring program in the marsh area. This was designed to determine clearly if a significant link between dredging in the harbor and inlet and erosion of the marshland existed (Cost and Carter, 1998). The dredge and nourishment took place in 2000 after more negotiations (Kelley and Anderson, 2000). An emergency dredge to clear the inlet entrance took place in 2002 (Table 4.2). All parties are currently awaiting the results of the monitoring program in 2005 to determine what the future of dredging will be at Wells Harbor.

Year	Volume of Dredged Material Cubic Meters	Disposal Site
1962	190,374	Open Water
1964	18,579	Open Water
1967	145,265	Upland
1970-1971	29,568	Upland
1974	10,169	Near shore
1990	11,174	Beach
1991	3,823	Beach
2000	137,620	Beach
2002	N.A.	Beach
TOTAL	**> 546,572**	

Table 4.2 Dredging history of Wells Harbor, 1962-2002 (Maine Geological Survey, 2003; USACE, 1980a; 1997a)

Wells Harbor – The Natural System

A summary of the construction history gives some indication of what has happened at Wells Harbor over its history. To understand better the specifics and answer the question of why there continues to be problems, it is necessary to break the project down into its different components. The following section begins with a review of the Maine coast and specifically the Wells Harbor Project region. This is followed by a comparison of pre and post-jetty conditions.

Background on the Maine Coast

The Maine coast is approximately 4,000 km long (USACE, 1971). The climate is northern temperate. Average temperatures range from 5 to 10 degrees Celsius. Severe conditions are common in winter. Three to five extratropical storms[12] strike the coast

[12] Commonly referred to as Northeasters

each year bringing high winds and large storm surges. On average, prevailing winds in the Gulf of Maine are north to northwest during fall and winter and south to southwest during spring and summer. Tides are semidiurnal with greater tidal ranges in the north (Kelley, 1987).

The Maine coast is classified into four compartments: northeast, north central, south central, and southwest (Figure 4.4). Rocky cliffs, high relief, and the largest tidal range characterize the northeast compartment. Granitic islands scattered throughout broad deep estuaries characterize the north central compartment. The south central compartment is comprised of deep, narrow, elongated estuaries. The southwest compartment has low-relief topography with estuarine embayments and the majority of the state's sand beaches (Kelley, 1987).

Southwest Compartment

This compartment extends from Kittery in the south to Cape Elizabeth in the north and includes Wells and Saco Embayments (MSPO, 1983). Sandy beaches cut by tidal inlets and separated by rocky headlands characterize the southwest compartment setting (Kelley et al., 1995a). These beaches are part of a discontinuous barrier system in northern New England that extends 100 km south of Wells Beach and 50 km north to the barrier system fed by the Kennebec River (Fitzgerald et al., 2000; Kelley et al., 1995a).

Ninety percent of the beaches in southwest coastal Maine are barrier spits (Kelley, 1987). Most of these barrier spits are backed by extensive marshland (MSPO, 1983). Their sediment sources are mainly submerged glacial deposits, eroding headlands, and existing shoreface deposits. There is minimal river input of sediment for Maine's barrier beaches (Kelley et al., 1995a,b; Kelley et al., 2002; MSPO, 1983) other than the Saco River (Kelley et al., 1995b) and the Kennebec River in the southcentral compartment (Fitzgerald et al., 2000).

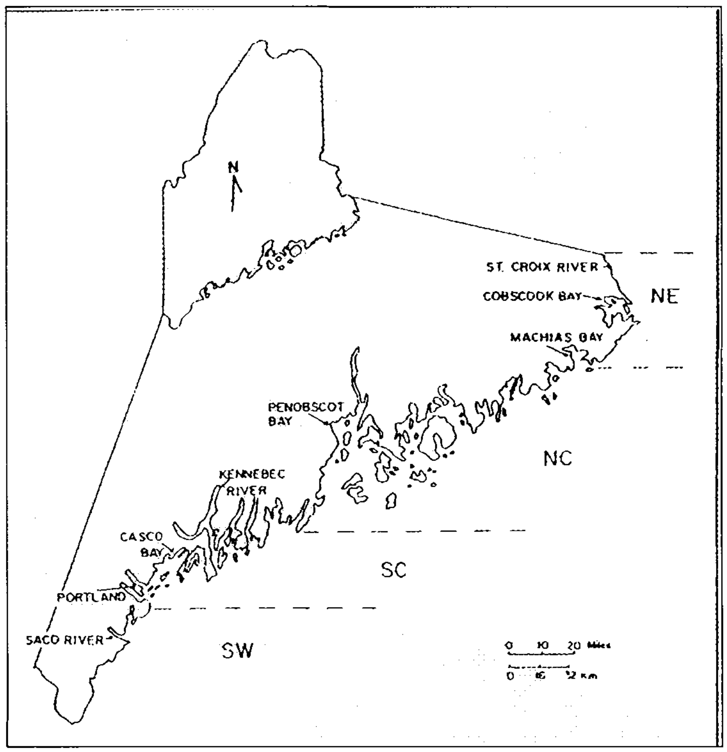

Figure 4.4 Maine's four coastal compartments (Kelley, 1987)

Headlands interrupt longshore currents blocking the transfer of sand across compartments. Wave refraction reworks shoreface deposits into curved beaches commonly found along this section of the coast (Nelson and Fink, 1980).

Quaternary History

Coastal Maine was glaciated during the Wisconsinan Ice Age (Nelson and Fink, 1980). Glaciers reached their maximum extent 20,000 years ago in Maine (Kelley, 1987). They began receding, and ice reached the current Maine coast between 13,000 and 14,000 years ago (Kelley et al., 1995a; Kelley et al., 1996; Kelley et al., 2002; Miller, 1998; MSPO, 1983; Thompson, 1978). The retreating ice sheets left moraines and other coarse-grained glacial deposit formations (Kelley et al., 1996; Kelley et al., 2002; Miller, 1998). Erosion of those sand and gravel deposits provided the sediment for the area beaches.

Retreat was followed by a period of transgressive seas. Seas advanced up to 100 km inland and formed the DeGeers Sea (Kelley et al., 1996). The muddy Presumpscot Formation was deposited during the retreat of the last ice sheet in the late Pleistocene (Bloom, 1963; Kelley et al., 1995a) and ranges in thickness from zero meters over outcrops to 30 meters in the valleys (Thompson, 1978). It is described as a "gray sandy, silty clay of marine origin…poorly sorted, glacially abraded deposit" (Bloom, 1963).

Following deglaciation, rebound of the land occurred and relative sea level fell with a low stand 10,700 years ago. Deposits at approximately 60 m depth mark the extent of the regression (Kelley et al., 2002). Sea level has risen at varying rates since then. Recent records from the Portland tidal gauge show a steadily increasing average rate of sea-level rise (SLR) of 1.99 mm per year since 1912 (Gehrels et al., 2002).

Formation of Beaches in Wells and Saco Bays

A late Holocene slowdown in SLR (approximately 8,000 years ago) allowed for sediment from reworked glacial deposits to consolidate into beaches and dunes. In Wells Bay, sediment anchored to glacial deposits like present-day Moody Point and Drakes Island as spits. SLR continued to erode deposits, and longshore currents extended the spits north and south, forming barrier spits. Barrier spits moved inland drawing sand from eroding glacial deposits and headlands. Not all glacial deposits were eroded. Some were overtaken by SLR and are currently submerged (Miller, 1998). Their sand is locked up and out of the system (Kelley et al., 2002).

A similar course of events took place in Saco Bay. The Saco River was the major source of sediment for the bay, feeding adjacent beaches and beaches in the northern end of the bay (Farrell, 1970; Kelley et al., 1989a; Nelson and Fink, 1980). Longshore currents reworked glacial sediments and formed spits that extended both north and south (Kelley et al., 1989a; USACE, 1955). From the start of beach formation to present, there is evidence of the landward movement of beaches in both bays due to SLR (Barnhardt et al., 1997; Kelley et al., 2002; MCP, 1979; Nelson and Fink, 1980).

Study Area - Wells Harbor and Beach Areas

Wells Harbor and adjacent beaches lie within the Wells Embayment of the southwest compartment. Wells Embayment extends from Cape Neddick in the south to Cape Porpoise in the north (Smith, 1994). The harbor is 32 km north of Portsmouth and 48 km south of Portland (Hussey, 1970). The study area (beaches and harbor) begins at Moody Point, continues north to the Webhannet River inlet, through Drakes Island and

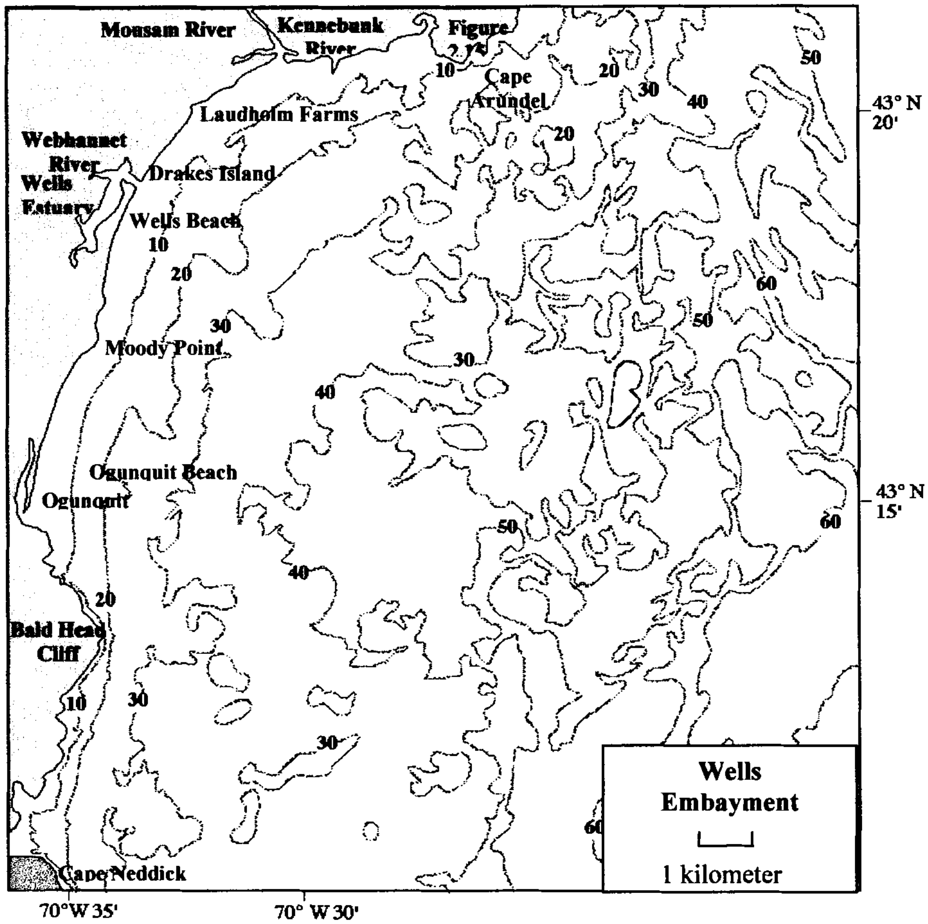

Figure 4.5 Map of Wells Embayment and the Wells Harbor Project area (Heinze, 2001).

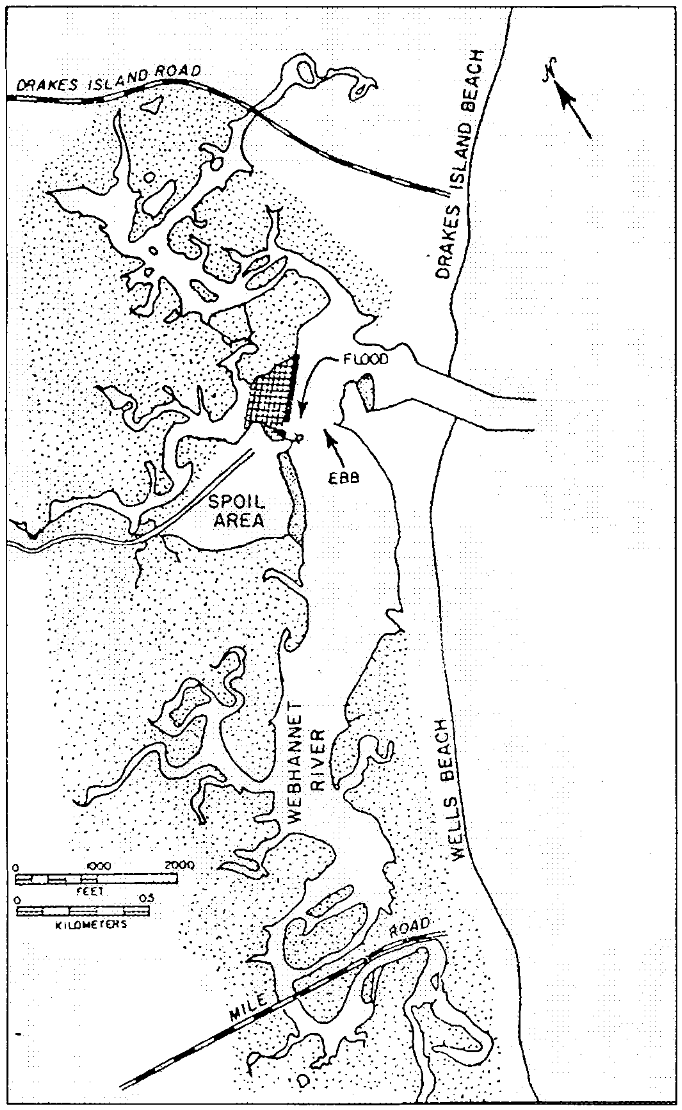

Figure 4.6 A map of the Wells Harbor Navigation Project area, including Wells Beach, Drakes Island, and the estuary (Byrne and Zeigler, 1977)

Laudholm beaches (Hussey, 1970). The harbor itself is located within the Webhannet estuary, behind Wells Beach and Drakes Island (Figures 4.5, 4.6).

Wells Beach is segmented into smaller compartments by rocky outcrops. Marsh backs the beach system from Moody Point through Drakes Island (Hussey, 1970). The dune system is relatively small at Moody Point, becoming larger and more established north through Drakes Island and Laudholm beach. The frontal dune system is extensively developed with homes and seawalls from Wells beach through Drakes Island.

Coastal Processes Affecting Wells Harbor and Adjacent Beaches

The orientation of the beaches lies between the approach of northeast and southeast storm hazards (Barringer and Ten Broeck, 1978). The majority of the waves reach the area from the southeast due to the dominant winds, parallel to the axis of the inlet. Observations show three waves from the south for every wave from the north (Smith, 1994). Miller's (1998) estimates offer a more detailed breakdown of wave direction. He reports that 32% of the waves come from the east-southeast direction, 31% come from the south-southeast direction, and 16% come from the north-northeast direction.

The tide is semidiurnal averaging 2.6 m with a spring tide of 3 m and a neap tide of 2.1 m (Mariano and Fitzgerald, 1989; Miller, 1998). The discharge from the Webhannet River is minimal at 0.6 m^3 per second (Mariano and Fitzgerald, 1989; Smith, 1994). The low level of freshwater input creates a tidally dominated estuary (Mariano and Fitzgerald, 1989; Miller, 1998; Smith, 1994). Ebb currents reaching average maximum velocities of 110 cm per second dominate the channel thalweg. Flood currents reaching average maximum velocities of 76 cm per second dominate shallower areas of the inlet (Mariano and Fitzgerald, 1989).

Along the beaches currents are shore-normal (Smith, 1994). They deposit sediment in the summer and remove it during the winter (Miller, 1998). Profile data for beaches in Saco and Wells Bays supports this statement. There is berm build-up in June and July, peaking in late Fall, then declining by December and January (Heinze, 2001). Longshore currents driven by winds travel both north and south. Observations possibly suggest a net longshore movement to the north (Byrne and Zeigler, 1977; Smith, 1994).

Dominant storm activity comes in the form of extratopical storms, 3 to 5 times a year. Beaches are sheltered from direct attack from the north and northeast but they are open to forces from the east. Storms may last 12 hours and span 2 high tides with surges of 1.56 m (Kelley, 1987; Nelson and Fink, 1980).

Sand Sources

Presently sand sources for the beaches are limited. The Webhannet River does not contribute to the system (Kelley et al., 1995a; Smith, 1994). There are submerged sand deposits at 60 m depths and between 30-40 m depths. These deposits have not been eroded, and their sand is locked up adding nothing to the system (Kelley et al., 2002). Sediment sources for the beaches include existing sand located in the shoreface deposits and eroding headlands. The shoreface deposits at Wells and Drakes Island have much less sand then other beaches in the embayment, most of which are also considered sand starved (Kelley et al., 2002).

Pre-Jetty Conditions

The current Little River estuary system north of Wells Harbor is representative of the littoral system at the Webhannet River estuary prior to jetty construction (Figure 4.7). Sand is exchanged between Laudholm beach, Crescent beach, and the inlet (MSPO, 1983; Nelson and Fink, 1980). The system maintains a natural equilibrium, balancing sand budgets along the shoreface of the beaches and within the estuary.

Prior to the jetties, there was a circular sand movement from the beaches, into the Webhannet River Inlet, and back into the beach system (Figure 4.8). Sand traveled both north and south along the beaches at Wells and Drakes Island. Sand was pushed into the inlet and the estuary by waves during flood-tidal periods, forming a flood-tidal delta. During ebb tide, sand was pushed out through the inlet and back into the beach system where it was redistributed along the shoreface and formed ebb-tidal sand bodies. Sand was also able to bypass the inlet and travel from beach to beach (Byrne and Zeigler, 1977). Mariano and Fitzgerald's (1989) work on sediment transport and hydraulics in Wells Inlet also supported this interpretation of sand circulation.

Sand bodies were present seaward of the inlet, in the inlet, and within the estuary. The system maintained equilibrium by exchanging sand from one area to another. Sand bodies would migrate along the shoreface, through the inlet, and into the estuary (Byrne and Zeigler, 1977; MSPO, 1983; Nelson and Fink, 1980; Timson and Kale, 1975). Historically, travel in and out of the inlet was possible only by small boat and during the highest tides due to the presence of these sand bodies (Kelley and Anderson, 2000).

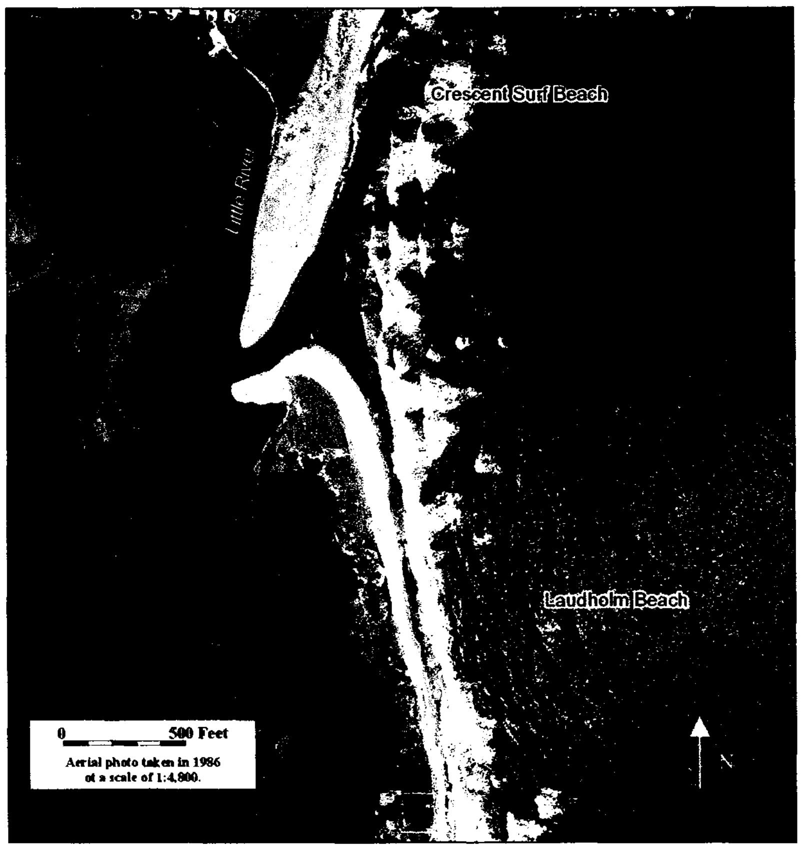

Figure 4.7 A 1986 aerial photo of the Little River Inlet. The setting is representative of the Webhannet Estuary prior to jetty construction (Photo courtesy of J.T. Kelley)

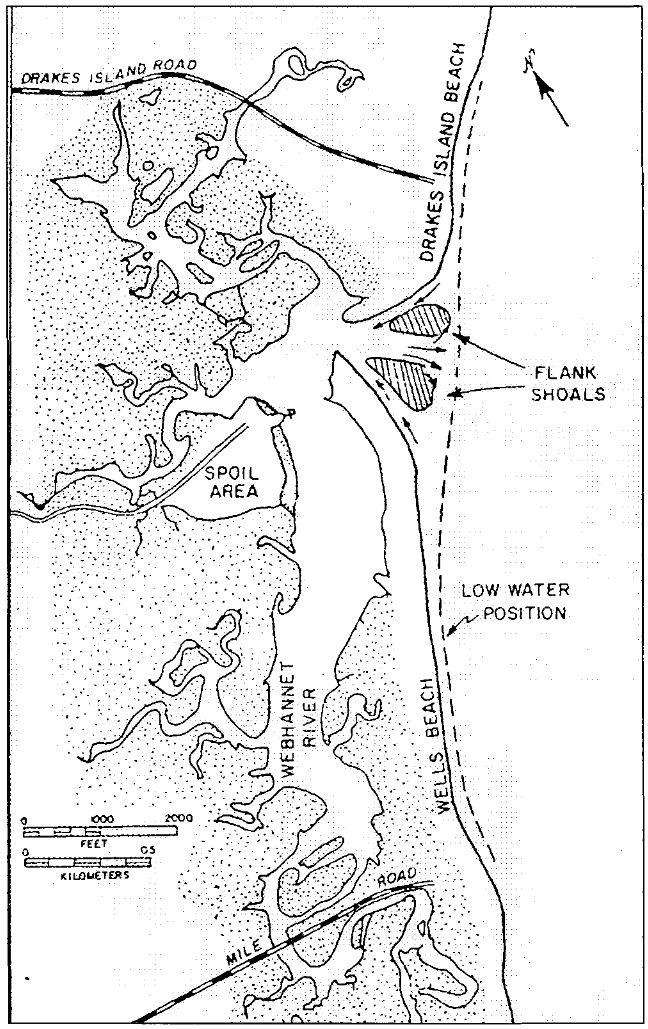

Figure 4.8 A representation of sand movement around the Webhannet River Inlet prior to jetty construction. Flood tidal currents transported sand down the sides of the channel depositing it in the estuary, forming a flood tidal delta. Ebb tidal currents transported sand down the middle of channel, seaward. Longshore currents transported sand both north and south along beach faces (Byrne and Zeigler, 1977)

Post-Jetty Conditions

After jetty construction, longshore movement across the inlet was blocked (Byrne and Zeigler, 1977). The ebb-tidal bodies that migrated toward the inlet became impounded along the outsides of both jetties (Smith, 1994) (Figure 4.9). Some of the sediment impounded along the jetties traveled to the inlet entrance and blocked passage of vessels (Mariano and Fitzgerald, 1989). Sediment was inferred no longer to easily bypass the inlet and travel from beach to beach (Smith, 1994).

The jetties are oriented parallel to the direction of the dominant waves and winds. These waves transport sediment into the inlet, down the sides of the channel, and into the estuary and anchorage during flood-tidal periods. The tidal prism travels straight through the original anchorage area (Timson and Kale, 1975). The wider anchorage slows the water down and the sediment is dropped (Byrne and Zeigler, 1977). During ebb-tidal periods, sediment is carried from the estuary and straight down the middle of the channel, depositing within the inlet, especially at its mouth. Ebb and flood tidal sand bodies formed in the north and south ends of the anchorage (Byrne and Zeigler, 1977; Timson and Kale, 1975). The flood tidal delta did not allow the original anchorage placement to accommodate the number of vessels for which it was designed (Byrne et al., 1977; Smith, 1994; Timson et al., 1975). Travel in the inlet continues to be hazardous due to the presence of sand bodies and the direct exposure to easterly waves.

Dredging the inlet and anchorage has posed problems. The location of the original anchorage and later settling basin was over the flood-tidal delta. By 1980 the Army Corps assumed a shoaling rate of 16,820 m^3/year, much greater than their original estimation of 3,058 m^3/year (USACE, 1980a). When sand was removed from the delta

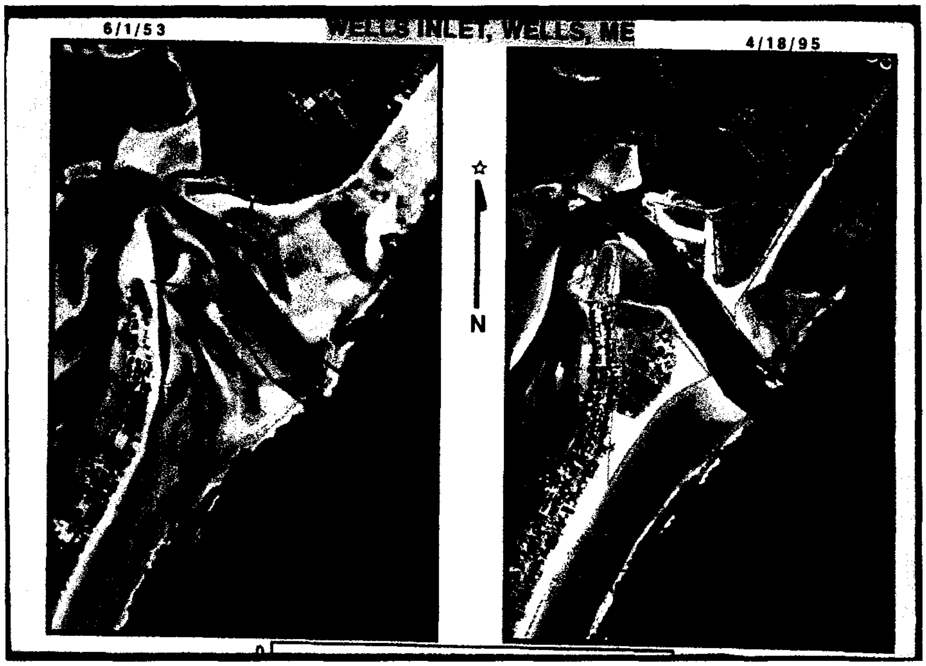

Figure 4.9 Photographic comparison of the Webhannet River Inlet in 1953 and 1995. The aerial photo on the left is from 1953 and the photo on the right is from 1995, after the jetties were constructed. Accretion along the outsides of both jetties is apparent in the 1995 photo (Photo courtesy of J.T. Kelley).

body other sand bodies within the estuary began to erode. The flood delta was replenished with this sand and with sand from the inlet. Once the flood delta reestablished itself, the donor sand bodies began a period of accretion. This sand came from both the inlet and inside the estuary, implying that the salt marshes surrounding the anchorage were eroding (Byrne and Zeigler, 1977; Timson and Kale, 1975). This is how the system maintained equilibrium. Further removal of sand prompts the system to begin replenishment, repeating the entire process and further eroding surrounding salt marshes (Smith, 1994).

Beaches along the jetties accreted, giving some property owners more land. Trending north and south away from the jetties, Wells Beach and Drakes Island have eroded considerably. The current shoreface provides little protection for development (Smith, 1994; Timson and Kale, 1975). These sections of the beaches are submerged during high tides, with water at the base of the seawalls (Kelley and Anderson, 2000).

Accretion and erosion occurred shortly after completion of the jetties. By the late 1970s the beach system reached equilibrium (Dickson, 2002; Mariano and Fitzgerald, 1989; Smith, 1994). The jetties now act as headlands and form two separate compartments with minimal exchange of sand between the two beaches. Existing shoreface deposits within each compartment are the primary source of sand for each beach. Sand impounded along the jetties is effectively removed from the system and does not redistribute itself (Smith, 1994). The beaches within the compartments are reshaped by wave refraction and resemble the other crescent shaped beaches within the embayment. This was not predicted in the original design memorandum. There was to be accretion along 396 meters of Wells Beach and along 309 meters of Drakes Island

(USACE, 1959). Byrne and Zeigler (1977) showed that this was more or less correct in their study. The problem was that beach, beyond these zones of accretion, were supplying this sand and no new sand was replenishing them. Gains in storm protection from this accretion were diminished due loss of beach in other areas.

Future extension of the jetties might eliminate any exchange of sediment that still occurs across the inlet mouth. This would be detrimental to Drakes Island, inferred recipient of the majority of longshore sand transport (Byrne and Zeigler, 1977). Removal of the jetties would also bring changes as equilibrium reestablished itself. This would not necessarily help the beaches due to the fact that dredging has removed anywhere from 366,986 to 573,416 m^3 of sand from the system (Dickson, 2003) (Figure 4.10). Beaches are not able to revert back to the pre-jetty days, with so much of the sand missing. As a result, development would be jeopardized.

During the 2000 dredge, the anchorage was moved from the tidal delta into the natural channel of the estuary. The new configuration requires less dredging within the estuary and allows the flood tidal delta to remain untouched. Shoaling conditions are still prevalent within the inlet and its entrance. Dredge spoils were used for nourishment along Wells Beach and Drakes Island. Most of this sand was removed from the beach system or impounded along the jetties in a short period of time (Wells Beach fieldtrip, 2003)

The results of the 5-year erosion-monitoring program will determine the extent of future dredges. Until then, waves will continue to enter directly into the inlet, depositing sediment and creating a hazardous boating environment. Short of artificial nourishment, the beaches will continue to erode. Even though they are in a state of equilibrium, SLR

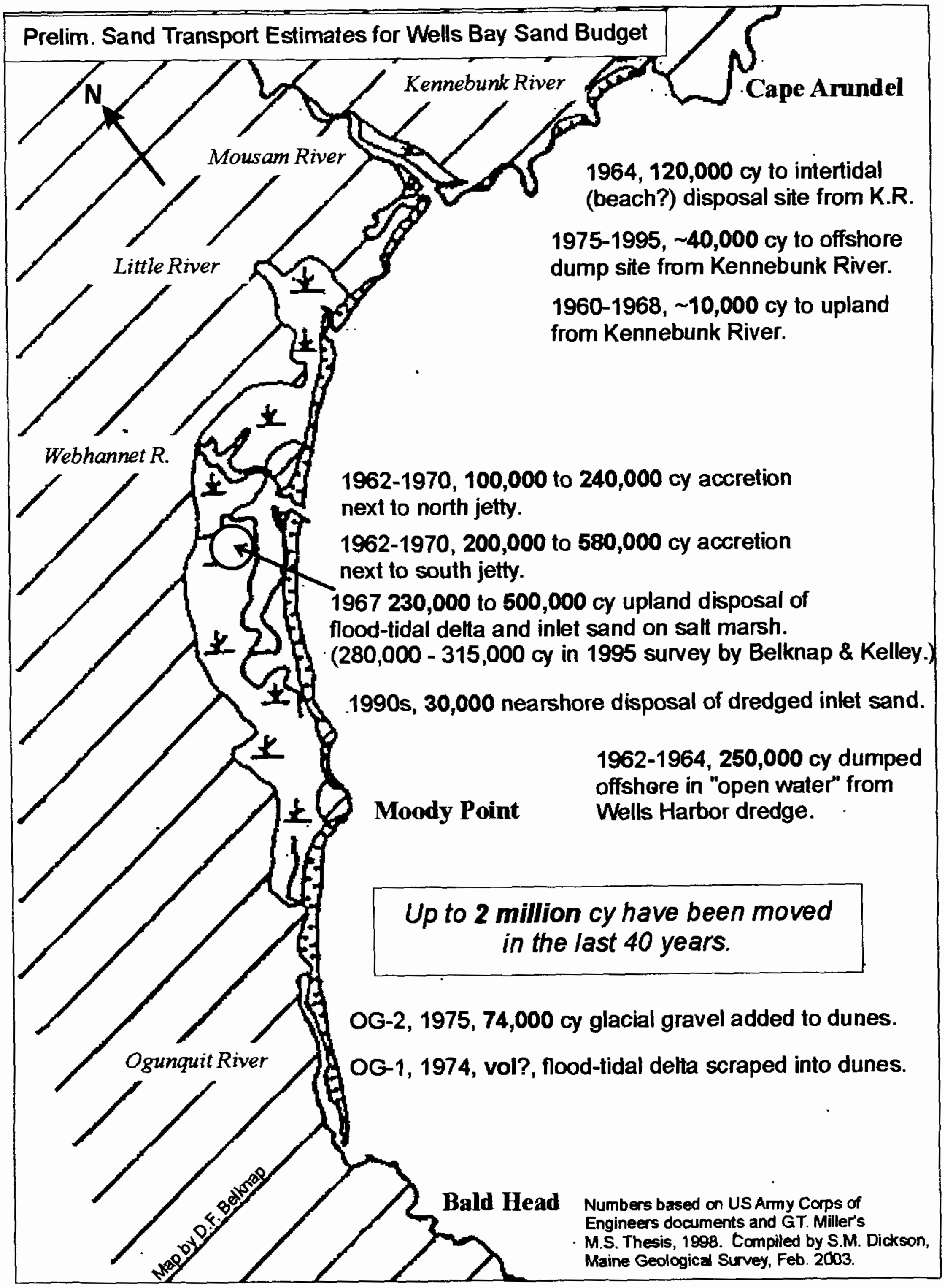

Figure 4.10 Historical anthropogenic sand transport for Wells Bay from the 1960s to the 1990s (Dickson, 2003)

and natural erosion will continue to remove sand. With no sediment source outside the shoreface, the high water mark will migrate toward the seawalls until no beach is left.

Wells Natural Setting Analysis

I see two characteristics of the natural setting that are key to understanding the problems associated with the project design. The first is that the beaches of Wells Embayment are sand starved. The configuration of these crescent-shaped compartments does not allow sediment to enter the system from the outside. The rocky headlands block any exchange. Within the compartments there are no substantial sources of new sediment. Fluvial input is minimal, and all till bluffs are armored. Drowned glacial deposits were not given sufficient time to erode while exposed sub-aerially, locking up their sediment from the system. The main source of sediment for beaches is the shoreface deposits within the system. This situation leads into the second characteristic. This area maintains a dynamic equilibrium with its existing sediment supply. There was a circular exchange of sediment from the shorefaces through the inlet into the estuary and back. The area is tidally dominated. Both ebb and flood tidal bodies existed within the entire system. If one body was altered, it triggered an adjustment within the system to reestablish the balance.

Problematic Engineering Design

In general, the construction of the jetties and anchorage had two major effects on the system. First, construction removed a considerable volume of sediment from a system that has no current source of sediment (Dickson, 2003). Second, construction impeded the exchange of remaining sediment between the beaches and the estuary. In effect, the jetties operate as two new rocky headlands forming two compartments out of one (Dickson, 2002). Shoaling sand in the inlet now originates from the backbarrier and estuary. A new equilibrium has been established where two new crescent shaped beaches were formed from wave refraction and impoundment of the original ebb tidal bodies. The result is accretion along the jetties and erosion farther down the beach.

Functionally, the design of the jetties is also flawed. The orientation of the jetties exposes the inlet to direct attack from a heavy easterly wave component and storm surges. This allows waves to travel parallel to the axis of the inlet creating hazardous conditions for boats. The placement of the inlet and anchorage over ebb and flood tidal bodies also creates problems. Based on the fact that the system will actively reestablish equilibrium if disturbed, digging out the sand bars and delta bodies would only result in them filling in again.

Was There Sufficient Information to Avoid These Problems?

It would be difficult to believe that the engineers made the decisions they made fully understanding the nature of the system. This is evident both in their initial belief that storm protection would be provided for Wells Beach and Drakes Island, and their gross underestimation of the sedimentation rate within the inlet and anchorage.

Dr. Stephen Dickson of the Maine Geologic Survey acknowledges that the existing body of information on the sediment transport and budgets may have been lacking at the start of the project, but he is quick to add that this was remedied soon after the emergence of erosion and shoaling problems (Dickson, 2002). Today there is substantial information and data on the coastal processes in the Wells Embayment, from both the Army Corps and independent researchers. It is reasonable to hope that a more in-depth feasibility study might have occurred during the conception of the project. Subsequent studies of the area were able to identify the critical sediment budget and transport issues missed during the planning stages. It is also not fair to say that there was absolutely no indication that problems would arise. During the earliest visits to the site, state and federal officials voiced concerns over dredging on a flood tidal delta. The common belief was that any dredged basin would fill right back in (Dickson, 2002; Kelley, 2003; Lang, 2003).

Knowing What They Know, Would it Have Made a Difference?

It is not clear whether the project would have gone ahead as it has if the current information on the area had been available from the start. One would like to think that some design specifications would have been different, but recent activity does not necessarily back up this assertion. The true nature of the system was well understood by the Army Corps' own planners, shortly after completion of the jetties (Byrne and Zeigler, 1977). Yet up until recently they continued to promote a full dredge of the original anchorage area, over the flood delta. They continued to deny any connection between dredging and the speculated erosion of the surrounding salt marshes. It wasn't until 1997 that they considered moving the anchorage off the flood delta into the natural channel of the estuary.

The overall pattern of design and construction mirrors patterns observed at other federal engineering projects. An incomplete and inaccurate understanding of the natural setting produced poor engineering decisions that lead to complications. These complications were identified, and the design of the project was revisited. Unfortunately, the same data and assumptions used to design the original project were used to make the adjustments to the design. This began a cycle of expanding engineering projects to address problems brought about by the original engineering solution.

In summary, the engineering decisions and an incomplete understanding of the natural system contributed considerably to the current problems in Wells. Whether or not this would have been different knowing what we know today about the area is open to debate. Recent actions do not necessarily support this assumption, and the presence of common patterns from other projects speaks to the contrary.

Wells Harbor – The Economic Justification

The following section chronicles the history of economic decisions and predictions made by the Army Corps of Engineers during the course of the Wells Harbor project. The section begins with an explanation of federal economic guidelines that the Army Corps must adhere to when determining whether a project will receive federal assistance. This is followed by the history of economic analyses for Wells Harbor, synthesized from a number of Army Corps project reports. The emphasis is on the evolution of predicted benefits and costs from start to present. All dollar figures are listed in that report year's dollars unless otherwise noted.

An Overview of Federal Navigation Project Economics

The Army Corps must operate within federal economic guidelines when involved in a public project. This is to ensure that public money being invested in projects will benefit the nation and not just private interests. These guidelines also maintain that a project will not be undertaken if the economic benefits to the nation are outweighed by its economic costs. The Army Corps uses the criterion that the benefit to cost ratio of a project must be greater than or equal to 1. When planning a project, the Army Corps will look at several options to achieve their goals. Often, more than one option will satisfy the benefit to cost criterion. The Army Corps will then choose the options that maximizes net benefits overall (USACE, 1991a).[13]

Economically, benefits are defined by the combined consumer and producer surplus in the market. For policy purposes they are defined subjectively as benefits that increase the welfare of the nation or National Economic Development (NED). This is distinguished from benefits received by a town or region, otherwise known as Regional Economic Development (RED) (USACE, 1983a; USACE 1991a; USACE, 2000). RED benefits might include nourishment of a private beach or transfer of a company from one region to the project area. The definition of benefits reflects the opinions and priorities of

[13] A benefit to cost ratio greater than 1 does not necessarily mean that a project improves social well-being. The benefit cost analysis the Army Corps employs ignores the distribution of benefits and costs. They operate under the general assumption that "winners" theoretically could pay back the "losers". In other words, the beneficiaries could potentially payback the public's tax dollars with the gains they make. Many times the beneficiaries are a small group and the majority of the public rarely reaps any of the benefits of the project they funded. This topic is covered in more detail in Chapter 8, Policy Recommendations.

the policy-makers who define them and are more concerned with equity rather than efficiency. Equity is concerned with the perceived fairness of the action whereas efficiency in this context is the action that produces the best overall, utility-maximizing result. The two do not have to be mutually exclusive, but in this setting one does not necessarily imply the other.

Costs are defined as the opportunity cost of not using the resources for the next best alternative. Labor and materials spent on beach nourishment might have been spent on another public works project needed by a region. From the perspective of policy-makers, price adequately reflects this opportunity cost (USACE, 1991a). The majority of a project's cost goes toward the construction phase of the project. Construction is a combination of labor and materials. Beyond this, other costs will include yearly maintenance and follow-up studies.

Not all costs are considered in the calculations. The Army Corps is interested only in the costs that directly affect the ability of the project to provide the predicted benefits. Incidental costs that may occur as a result of the project, but that do not affect the project's ability to produce the predicted benefits, are not considered in the economic analysis (USACE, 1983a; USACE, 1991a). Unfortunately, not all incidental costs are "incidental". Massive erosion caused by the presence of federal coastal projects generates substantial costs to a region and the nation. This became an issue at a national level and changes were made in the River and Harbor Act of 1968, as amended by Section 111. This allows for mitigation up to $5 million if shoreline damage is caused by a federal navigation project (USACE, 2000).

Additionally, a distinction is made between projected costs and sunk costs. In the event of a problem during a project, it is necessary to reevaluate the costs and benefits prior to changing the project design. No prior costs, or sunk costs, that do not directly affect the future flow of benefits are considered in calculating the new benefit to cost ratio (USACE, 1991a). An example is a dredge design that did not work because the area filled with sediment soon after completion. A new dredge design that eliminates this problem will not consider expended dredging costs because the old design does not provide any benefits to the new project.

Because most costs are tied to the construction phase of a project, they are expended quickly and early. Benefits on the other hand, are not fully realized at the beginning of a project and accrue over time. This makes it necessary to average total costs and total benefits evenly over the length of the project, on an annual basis, in order to compare the two. Most projects' life spans are 50 years and no more than 100 years (USACE, 1991a). Average annual benefits and costs are converted to a stream of present values using an appropriate discount rate (USACE, 1983a; USACE, 1991a). The annual benefits and charges are then used to compute the benefit to cost ratio which will determine whether or not the government will fund the project (USACE, 1991a).

Once a project is accepted, the Army Corps determines the cost share of the federal government. The remaining cost is the responsibility of the project sponsor, usually the state or municipality receiving the project. This share is calculated based on the percentage of benefits deemed NED and private. This is applied to the construction phase of the project and sometimes to a portion of the annual maintenance costs.

The economic guidelines governing Army Corps navigation projects are found in the Planning Guidance Notebook (USACE, 2000), the National Economic Development Procedures Manual – Overview Manual for Conducting National Economic Development Analysis (USACE, 1991a), and the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (USACE, 1983a). These guidelines are extensive. Their design reflects a desire to streamline the planning process while establishing practices that treat the public's money in an equitable and responsible manner.

The Original Project – 1959 Feasibility Study

The following summary comes from data and information found in the original 1959 Army Corps feasibility study for Wells Harbor (USACE, 1959). The original project proposal presented several harbor plans and designs. They were limited to the smaller harbor design due to a $250,000 local contribution cap, imposed by the Town of Wells. This plan called for a 2.4 m deep at mean low water (MLW) channel entrance with a 1.8 m deep (MLW) anchorage. The channel would terminate behind the north end of Wells Beach where a 7.4-acre anchorage would accommodate 150 vessels. The Corps and town interviewed people, conducted written surveys, and reviewed activity at other Maine harbors. They determined that the harbor would attract 150 vessels. The benefits and costs for the project are listed in Table 4.3 and 4.4.

Benefit Classifications
Recreational (boating)
Commercial Fishing (lobster)
Shore Protection (Wells Beach and Drakes Island)
Land Enhancement (public landing and parking)

Table 4.3 Benefit classifications for the original Wells Harbor Project – 1959 (USACE, 1959).

Cost Classifications
Material and Labor - jetty construction
Dredging
Engineering and Design
Administrative
Navigation Aids - buoys
Authorization Study
Infrastructure Changes - move waterline

Table 4.4 Cost classifications for the original Wells Harbor Project – 1959 (USACE, 1959).

Recreational benefits for boating were a combination of new boat purchases, transferred boats from other harbors, and transient use from day visitors. Commercial benefits were defined as increased catch due to a larger lobster fleet and lower operational costs for transferred boats due to the closer proximity of the harbor. Lobster boats were further divided into fulltime or part time operations.

Shore protection benefits were predicted for Wells Beach and Drakes Island based on the impounding of sediment from a northerly and southerly longshore currents. It was assumed that Wells Beach would widen by 396 m and Drakes Island would widen by approximately 305 m. The protection was calculated as a percentage of home values based on a lower probability of storm damage due to a larger beach buffer. It was projected that land enhancement would result directly from the construction of a public landing and parking lot formed from the disposed dredge spoils. (See Appendix A for a full explanation of the formulas used to calculate benefits from 1959.)

Costs were a combination of the materials and labor needed to complete the project to specification and the studies and administrative work necessary to design and implement the project. Additional costs included navigation aids and follow-up studies.

Calculating Benefits

Town officials mailed 2,000 questionnaires to townspeople in Wells. One hundred and forty seven people responded, a low response rate at just over 7%. One hundred and twenty-three were in favor of development and 23 were in opposition. Of the 123, 77 reported that they would buy a new boat and 45 who owned boats in neighboring harbors would move to Wells Harbor. By word of mouth, town officials determined that there would be heavy transient usage from boat owners in neighboring ports. The Army Corps used the history of high volume activity in neighboring ports as a predictor for the level of activity in Wells (USACE, 1959) (Table 4.5). Using these, the Army Corps calculated the monetary benefits of the fleet and combined this with the Shore Protection and Land Enhancement benefits to compute total annual benefits (Table 4.6).

Vessel Type	Vessel Numbers
New Recreational Vessels	103
Transferred Recreational Vessels	27
Transient Recreational Vessels	6
New Commercial Vessels	11
Transferred Commercial Vessels	3
Total Vessels	**150**

Table 4.5 Projected fleet size for Wells Harbor from the 1959 study (USACE, 1959).

Benefit Classification	Annual Benefit
Recreational Vessels	$17,070
Commercial Vessels	$8,260
Shore Protection	$1,000
Land Enhancement	$1,250
Total Annual Benefits	**$27,580**

Table 4.6 Projected annual benefits for Wells Harbor by category from the 1959 study (USACE, 1959).

Calculating Cost

Total construction costs were calculated using the prices of materials and labor needed to complete the project. Jetty construction cost $7.50 per ton of stone. Dredging of the entire project cost approximately $1.65 per m^3. A 15% contingency fee was added to these construction costs. Engineering, design, and administrative costs were also figured into the total (Table 4.7).

Activity	Cost
Jetty Construction – 17,500 tons	$151,000
Dredging – 178,906 m^3	$337,000
Engineering and Design	$14,000
Administrative	$38,000
Total Construction Cost	**$540,000**

Table 4.7 Projected total construction costs for Wells Harbor from the 1959 study (USACE, 1959).

Federal guidelines required that the project construction costs be divided into a federal and local share based on the percentage of benefits that go toward RED and NED (USACE, 1983a). It was determined that federal funds would cover 63% of the construction and the town of Wells would cover the remaining 27%. This kept their share at $205,000, less than the $250,000 limit they required. The Army Corps committed to covering subsequent dredging, jetty maintenance, and aids to navigation.

These costs were converted to annual charges for a project with a 50-year lifespan using a discount rate of 2.5% and an amortization rate of 1.03%. Annual maintenance charges and navigation aids were added on to calculate the total average annual cost. They assumed an infill rate of 3,058 m^3 per year at a cost of approximately $1.96 per m^3 dredged and jetty repairs for 175 tons of stone each year at $10 per ton. Table 4.8 shows the annual costs by category.

The calculated annual benefits and costs gave the Army Corps a cost-to-benefit ratio of 1.0 for the proposed project. Although this was marginal, it allowed them to begin the project and commit federal funds.

Activity	Annual Cost
Jetty Construction (Jetties and Project Dredge)	$19,500
Dredging Maintenance	$6,000
Jetty Maintenance	$1,800
Navigation Aids	$100
Total Annual Cost	**$27,400**

Table 4.8 Projected annual costs for Wells Harbor from the original 1959 study (USACE, 1959).

The Original Project – 1961 Design Memorandum

After acceptance of the feasibility study, the Army Corps produced a design memorandum outlining technical features in finer detail. Project design remained the same, but costs and benefits estimates changed. These changes resulted from changes in prices of labor and material, and new benefits resulted from updated information regarding recreational and commercial use of the harbor (USACE, 1962). The new total cost of construction came to $580,000, translating to $28,400 in annual costs over 50 years.

Table 4.9 outlines the changes in the annual benefit. Land Enhancement benefits were removed,[14] and there was an increase in Shore Protection. With the new calculations, the new benefit to cost ratio became 1.2, an increase from the original ratio of 1.0. This reinforced the decision to undertake the project.

[14] They were removed because the cost of construction would eliminate the economic benefits in the end (USACE, 1959)

Benefit Classification	Annual Benefit
Recreational Vessels	$23,880
Commercial Vessels	$8,700
Shore Protection	$1,500
Land Enhancement	$0
Total Annual Benefits	**$34,080**

Table 4.9 Projected annual benefits for Wells Harbor from the 1961 design memorandum (USACE, 1962).

New Project Design - 1962 Supplement to Design Memorandum

At this time, engineers noticed a design flaw in the project. Shoaling was blocking the channel, and erosion of the northern tip of Wells Beach required immediate mitigation. The design issue was addressed with a 60-meter extension of the north jetty (USACE, 1962). The Army Corps felt that this would solve the problems they were facing. These changes amounted to a change in the original project design. The Army Corps was required to conduct a new economic evaluation if the original design changed to determine if the benefit to cost ratio remained at least 1.0. The annual benefits remained the same at $34,080 because the overall objective of producing an inlet and anchorage for 150 vessels had not changed. Changes in cost resulted from the extension of the north jetty (Table 4.10).

The original cost estimate from 1959 was $548,000 and the working estimate as of 1962 was $443,000. The Army Corps had come in under the projected budget presented in the original design of 1959 (USACE, 1959). The additional $100,000 did not change the projected total cost, and therefore the benefit to cost ratio did not decrease. Additional stone required additional yearly maintenance, but the increase was minor and did not affect early economic predictions. Based on this, the Army Corps proceeded with the changes.

Activity	Costs
Construction	$79,000
Engineering and Design	$3,000
Administration	$12,000
Total Additional Costs	**$100,000**

Table 4.10 Projected total additional costs for north jetty extension from the 1962 supplement to the design memorandum (USACE, 1962).

New Project Design – 1965 Supplement to Design Memorandum

Shoaling problems continued within the inlet and anchorage areas. High wave energy within the inlet made travel hazardous and damaged dredging equipment (USACE, 1965a). Engineers believed that a 396-meter and 373-meter extension to the south and north jetties, respectively, would stop sediment from entering the inlet from the sides. A retention basin was also designed to trap sediment moving into the anchorage from within the estuary (USACE, 1965a). The extensions were oriented slightly to the south to block incoming waves from the east and to decrease wave energy within the inlet and to decrease the amount of sediment transported into the entrance. Again, this amounted to a change in the accepted design of the project requiring another reevaluation of the benefits and costs.

Construction to that point cost $576,000. The new proposed construction would cost an additional $878,000 bringing the total construction costs to $1,454,000. From this total, the Army Corps deducted $370,000 for prior dredging and mitigation to the northern tip of Wells Beach. These expenses represented "sunk costs" and did not affect the future flow of benefits (USACE, 1965a). The final cost projection was $1,084,000.

Using an interest rate of 3.125% and an amortization rate of 0.854%, the annual costs were calculated. The annual maintenance costs were recalculated assuming a sedimentation rate of 10,704 m^3 per year at approximately $2.10 per m^3 (Table 4.11). Jetty maintenance increased to 1,000 tons of stone a year at $6 per ton (USACE, 1965a).

Activity	Cost
Construction	$43,200
Jetty Maintenance	$6,000
Dredging Maintenance	$22,400
Total Annual Cost	**$71,600**

Table 4.11 Projected annual costs for project modification from the 1965 supplement to the design memorandum (USACE, 1965a).

The realized annual benefit for 1965 was $40,920. The benefit to cost ratio was well under 1 over the remaining life of the project. By federal guidelines, the Army Corps was unable to proceed with the additions unless benefits increased (USACE, 1991a). Other than the increased construction costs for the jetties, a majority of the cost change comes from the maintenance dredging. Maintenance dredging started at $6,000 per year in the original design (USACE, 1959). By 1965 maintenance dredging increased to $22,400 a year. Jetty maintenance jumped from $1,800 a year in the original design (USACE, 1959) to $6,000 a year in the second supplement. Maintenance accounted for

28% of the annual cost in 1959. By 1965, maintenance accounted for 40% of the annual cost.

This prompted a revue of projected annual benefits. Based on projected growth in national population, GNP, and dispensable income through the year 2020, the Army Corps reasoned that the original design for a 150-vessel harbor would not accommodate growth patterns to be experienced in the U.S. Increased disposable income was used as an indicator for greater demand for recreation. Based on these projections, it was determined that the demand for space at Wells Harbor would increase by 10 times during the 50-year project life. This growth necessitated expansion of the harbor in 5 increments approximately every 10 years to eventually accommodate 1500 vessels. This represented an increase in both recreational and commercial fishing fleet (USACE, 1965a).

By the 50th year of the project it was projected that there would be a fleet of 1,215 recreational boats and 135 commercial boats. These would produce a total of $413,100 in benefits. Assuming a straight-line economic growth of 38.6625%, the annual benefits came to $159,715 for the remainder of the project.

Costs were recalculated to account for the expansions. Total construction cost was projected at $316,200. Using the same straight-line growth assumption, the annual costs came to $122,250 for the remainder of the project. These were combined with the annual benefits and costs already realized by 1965 (Table 4.12 and 4.13).

Benefit Classification	Annual Benefit
Realized Annual Benefit	$40,920
Annual Benefits for Remainder of Project	$159,715
Total Annual Benefits	**$200,635**

Table 4.12 Adjusted annual benefit projections for project modifications from the 1965 supplement to the design memorandum (USACE, 1965a).

Activity	Annual Cost
Realized Annual Cost	$73,200
Annual Cost for Remainder of Project	$122,250
Total Annual Cost	**$195,450**

Table 4.13 Adjusted annual cost projections for project modifications from the 1965 supplement to the design memorandum (USACE, 1965a).

This produced a benefit to cost ratio of 1.03. Based on this ratio, the Army Corps was able to go forward with the changes in the project.

Economic Analysis - Post 1965

Little happened on the project after the modifications made in 1965. The jetty extensions and dredging were completed in 1967. Subsequent dredges occurred in 1970, 1971, and 1974 to clear the channel entrance and anchorage (USACE, 1980a). Dredging and activity on the channel ceased after 1974 due to beach property owners' concerns over the accelerated erosion of their beaches. In the interim the Army Corps conducted a new economic analysis of the project (USACE, 1980a). The report reviewed the economic feasibility of continued maintenance dredging of Wells Harbor and the inlet.

The Army Corps decided to approach the project as a new venture. They acknowledged that previous construction and design were unable to meet project specifications. All prior costs were treated as sunk costs. The project was viewed as purely a redevelopment project with existing navigation jetties. Three options were presented for benefit to cost comparison. Two options investigated dredging the project on a 3-year cycle. The first looked at the remaining 31 years of the project life while the second treated the project as a new endeavor and projected over 50 years. The third alternative was a "do-nothing" option that allowed the current shoaling to continue without any future dredge.

The study assumed that shoaling would continue at approximately 16,820 m^3 per year, an increase from the 10,704 m^3 used in the 1965 analysis. Dredging plans would clear approximately 49,696 m^3 of sand every three years. Additionally, an initial 64,987 m^3 would need to be removed to return the project to its original depth and dimensions. The dredging plan was the same for both the 31-year and 50-year projections. The appropriate discount and amortization rates were applied along with a 10% contingency fee. The 31-year plan had an annual cost of $137,950 and the 50-year plan had an annual cost of $136,826.

Benefits were calculated based on peak operation capacity experienced from 1973-1974 (Table 4.14).

Vessel Type	Number of Vessels
Permanent Recreational Fleet	87
Overnight Transient	35
Short-term Transient	25
Commercial	18
Total Vessels	**165**

Table 4.14 Wells Harbor peak boat activity from 1973-1974 (USACE, 1980a)

The Army Corps assumed those levels would return after a full dredge. The same benefits apply to both dredging plans (Table 4.15).

Benefit Classification	Benefit
Recreational Fleet	$177,790
Commercial Fleet	$43,550
Total Annual Benefits	**$221,340**

Table 4.15 Projected total annual benefits for Wells Harbor from the 1980 maintenance report (USACE, 1980a).

With these benefits, both plans generated a benefit to cost ratio of 1.6. This justified the Army Corps continuing with the maintenance of the project.

The final "do-nothing" alternative was also considered. In this scenario the assumption was that there would be no cost because there would be no further maintenance activity. The Army Corps assumed that the shoaling rates would reduce the total recreational fleet to 16 permanent boats and daily activity to 3 boats using the public ramp. The commercial fleet would be reduced to 3 lobster boats. The total annual benefits would be approximately $20,350. This was still a benefit to cost ratio greater than one, but it was not chosen because it was not the benefit maximizing option. The dredging plans supported greater economic activity; therefore, based on federal economic regulations, they were chosen over the "do-nothing" option.

Small dredges occurred in 1990 and 1991. A modified larger dredge occurred in 2000 with another emergency dredge for the entrance in 2002. Originally, the 2000 dredge was economically justified by the prediction that the harbor fleet would be between 200 and 250 vessels. The original 150-vessel fleet no longer justified federal involvement (USACE, 1997a). This calculation also did not factor the original jetty construction into the costs.

The long-term dredge program outlined in the 1980 report has not occurred. Changing costs and benefits over the 23 years from the 1980 report might warrant another economic analysis; however, both the Town of Wells and the Army Corps are currently pursuing approval of an extended dredging program.

Economic Summary

The following are summary charts documenting the progression of costs and benefits predictions throughout the life of the Wells Harbor project. All calculations are in year 2003 dollars unless otherwise noted.[15]

[15] Historic costs were put into current 2003 dollars using the Gross Domestic Product Deflator inflation index with a base year of 1996.

Original Estimate (1959)	Design Memo Estimate (1961)	Supplement #1 Estimate (1962)	Supplement #2 Estimate (1965)
$2,845,192	$2,936,840	$2,712,314	$5,179,491*

Table 4.16 Total projected construction cost estimates for Wells Harbor 1959-1965 (2003 dollars)

* This does not include the $370,000 (1965 dollars) of mitigation performed on Wells Beach and the inlet.

1965	1970	1975	1980
$593,713	$1,612,021	$1,709,879	$2,044,067

Table 4.17 Total historic federal and local expended costs for Wells Harbor 1965 to 1980, reported in the specific project year's dollars. They have not been converted to current dollars because each figure was compiled from several different years and include the previous years' figures. They were never normalized. They are useful as an indicator of what was actually spent during the major construction years of the project (USACE, 1980a).

Original Estimate (1959)	Design Memo Estimate (1961)	Supplement #1 Estimate (1962)	Supplement #2 Estimate (1965)	Reconnaissance Report Estimate (1980)
$143,195	$172,564	$170,233	$958,654*	$440,765**

Table 4.18 History of projected annual benefit estimates for Wells Harbor from 1959-1980 (2003 dollars)

* Includes the physical expansion of the harbor into the year 2016
** Does not include the cost of prior jetty construction, just dredging and maintenance.

Original Estimate (1959)	Design Memo Estimate (1961)	Supplement #1 Estimate (1962)	Supplement #2 Estimate (1965)	Reconnaissance Report Estimate (1980)
$142,261	$143,803	$141,861	$933,880*	$274,714** $272,475***

Table 4.19 History of projected annual cost estimates from 1959-1980 (2003 dollars)

* Includes the expansions of harbor into the year 2016
** 31-year plan (does not consider original construction costs of jetties and harbor)
*** 50-year plan (does not consider original construction costs of jetties and harbor)

Original Estimate (1959)	Design Memo Estimate (1961)	Supplement #1 Estimate (1962)	Supplement #2 Estimate (1965)	Reconnaissance Report Estimate (1980)
1.00	1.20	1.20	1.03	1.60*

Table 4.20 History of estimated benefit-cost ratios for Wells Harbor from 1959-1980 (2003 dollars)

*Does not include the cost of prior jetty construction, just dredging and maintenance.

Wells Harbor Economic Analysis

This project was marginally justified with a benefit-cost ratio of almost exactly one. It was justified on its predicted ability to generate recreational boating benefits and commercial fishing benefits. The basis of their benefit figures comes from a survey and "word of mouth". The original survey[16], mentioned in this section was sent to 2000

[16] No copy of the original survey was available for inspection.

people in Wells.[17] Of the 2000 people, 147 responded, giving a response rate of just 7%. Of the 147 responses, 123 were in favor of the harbor for both recreational and commercial purposes. This represented 84% of the total respondents. The Army Corps read these biased results as a favorable endorsement of the harbor.

Statistically, this is not a good indicator of a community's interest in the project. It is, however, a rough measure for boat usage if one were to assume that all positive respondents followed through and put a boat in the harbor. The Army Corps, via "word of mouth", determined that in addition to the 123 potential boaters in the town, at least 27 more would come from the surrounding areas and round off a fleet of 150 vessels. These questionable calculation methods are of concern considering that a slight change in benefits could have produced a benefit-cost ratio of < 1, and the project theoretically would never have materialized.

Familiar Cost Patterns

Over the history of the project some familiar cost patterns emerged. In particular, it is clear that costs were underestimated from the start. Cost projections increased after authorization and the start of construction. In 2003 dollars, the initial costs estimate for the 50-year project was $2.85 million in 1959. By 1965 this jumped to $5.18 million. Annually, this was a jump from $142,261 to $342,112. This figure did not include the proposed expansions of the harbor to accommodate the growing fleet. In that case, the annual costs jumped to $933,880, an increase in over $700,000 a year from the original estimate. By 1980 the annual costs were back down to $272,475 covering dredging and

[17] No explanation was offered for how the 2000 were selected.

maintenance for 50 years, but none of the initial construction costs. Even this figure was higher than the original combined price of construction and maintenance.

Much of these economic gyrations were driven by an underestimation of the sedimentation rate and growing maintenance costs resulting from a physically expanding project. The yearly maintenance costs went from 28% of the total projected costs in 1959, to 40% of the total projected costs in 1965, to approximately 100% of the total projected costs by 1980. Through this time period, Army Corps predictions for sedimentation rates rose from 3,058 m^3/year to 16,820 m^3/year within in the inlet and anchorage, five times the original figure (USACE, 1980a).

There are also "incidental" costs not considered in the accounting of the project. These costs are not considered because they have no direct bearing on the performance of the navigation project even though they are a result of the project's presence. These include deterioration of recreational beach, damage to existing protective structures, higher probability of damage to development, and loss of habitat both along the beaches and in the salt marshes of the estuary. These have never been calculated but are likely substantial. The value of the Benefit Cost Analysis decreases because it does not consider the economic effects in these areas and therefore is incomplete.

Familiar Benefit Patterns

Just as costs rose, so did benefits. For the most part they kept pace with the increases in costs. The benefit-cost ratio ranges from 1.0 to 1.2 and back to 1.0 from 1959 to 1965. In 2003 dollars the annual benefits in 1959 were $143,195. By 1962 they had increased to $170,233 keeping pace with the minor additions made to the project design. Major changes in the design called for in 1965 (doubling the lengths of both jetties) drove costs up considerably. To justify such an addition to the project there needed to be a considerable increase in benefits. Army Corps planners broke from the established methods of benefit calculation and now based benefits on projected national population growth over 50 years. They thus determined that Wells Harbor would expand to accommodate 1500 vessels, ten times the original figure. In hindsight (and maybe at the time) a tenfold expansion in use seems ridiculous. By doing this, however, planners were able to once again justify embarking on an economically marginal project with a benefit-cost ratio, again, of 1.0.[18]

It becomes clear in review that, along with undervalued costs, there was a considerable overvaluation of benefits. By 1980 the Army Corps had acknowledged (although not specifically) that previous economic forecasts were not viable. All prior costs, $4,070,555 in 1980 dollars, were considered sunk, and future benefits were based on experienced levels of activity.

How Accurate Were the Original Projections?

With the exception of the 1965 projections, projected mooring space ranged from 150 to 200 boats. Despite the haphazard method of surveying used to generate the original boat numbers, records show that this number is reasonable. In 1973 they were able to bring in approximately 150 boats (USACE, 1980a), and in 2002 there were 142 paid spots in the harbor (Wells Harbor, 2002). This does not even account for transient use and day-use of the public boat ramp. Based on the records, it is difficult to know

[18] No physical plans were presented for how these vessels would be accommodated.

whether they were able to achieve the mix of recreational boats projected to use the harbor.

Commercially, the number of lobster and fishing boats did increase. The original report in 1959 predicted that 14 additional lobster boats would use the harbor (USACE, 1959). Mooring records for 2002 list 24 commercial boats using the harbor and of those, 11 are reported as lobster boats. This is in line with the original projections. The number of boats, however, is not what generates the benefits. The benefits are based on landings for new boats and closer proximity for existing boats. Records do not support a vibrant lobster industry for York County and show a marked decrease in the ground fishing industry for Maine since the beginning of the project (Figures 4.11, 4.12, 4.13, 4.14, 4.15, and 4.16).

The Maine Department of Marine Resources does not consider York County or Wells Harbor to be a particularly productive harvesting area. They feel that most lobstermen and fishermen were going either north or south out of the harbor to better grounds (Wilson, 2003). This would negate the benefit of proximity to the lobster grounds, and harbor planners felt that commercial operations out of Wells Harbor would have. It is not clear whether the commercial benefits were achieved, but the data definitely supports a meager contribution from York County and a dying ground fishing industry for the entire state. In fact, the Army Corps no longer is able to use increased landings as a benefit in project justification unless expressly supported by the National Marine Fisheries Service (Habel, 2003).

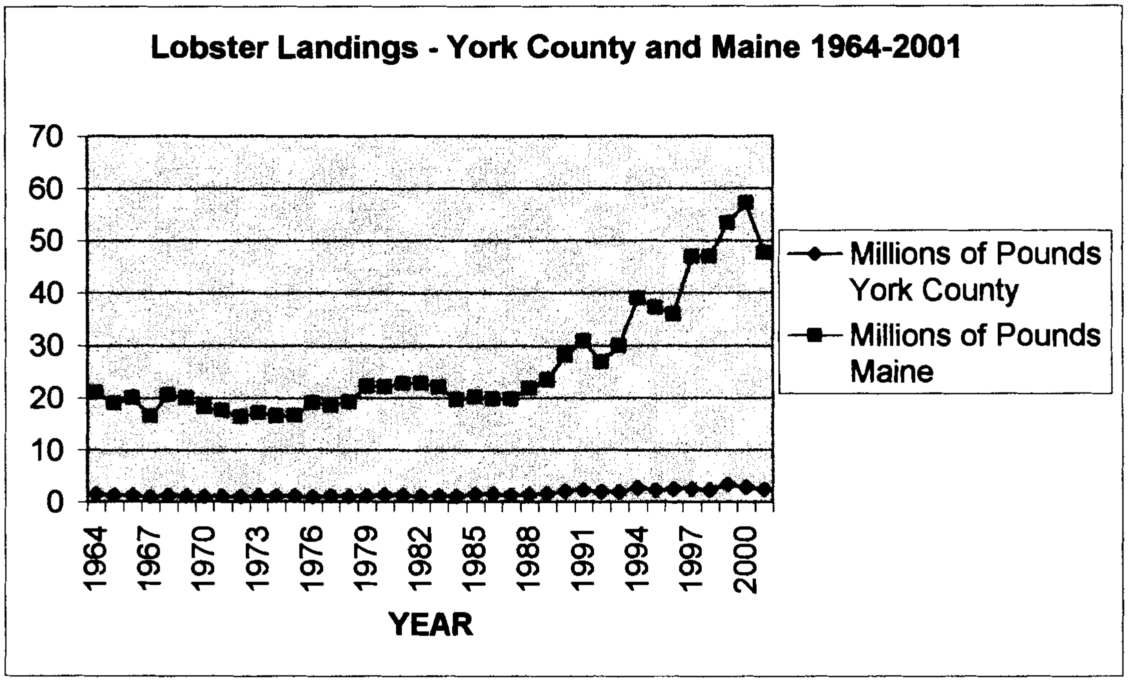

Figure 4.11 Lobster landings in pounds for the State of Maine and York County 1964 - 2001. York County has not experienced the boom the rest of the state has experienced since 1990 (Maine DMR website, 2003; Wilson 2003).

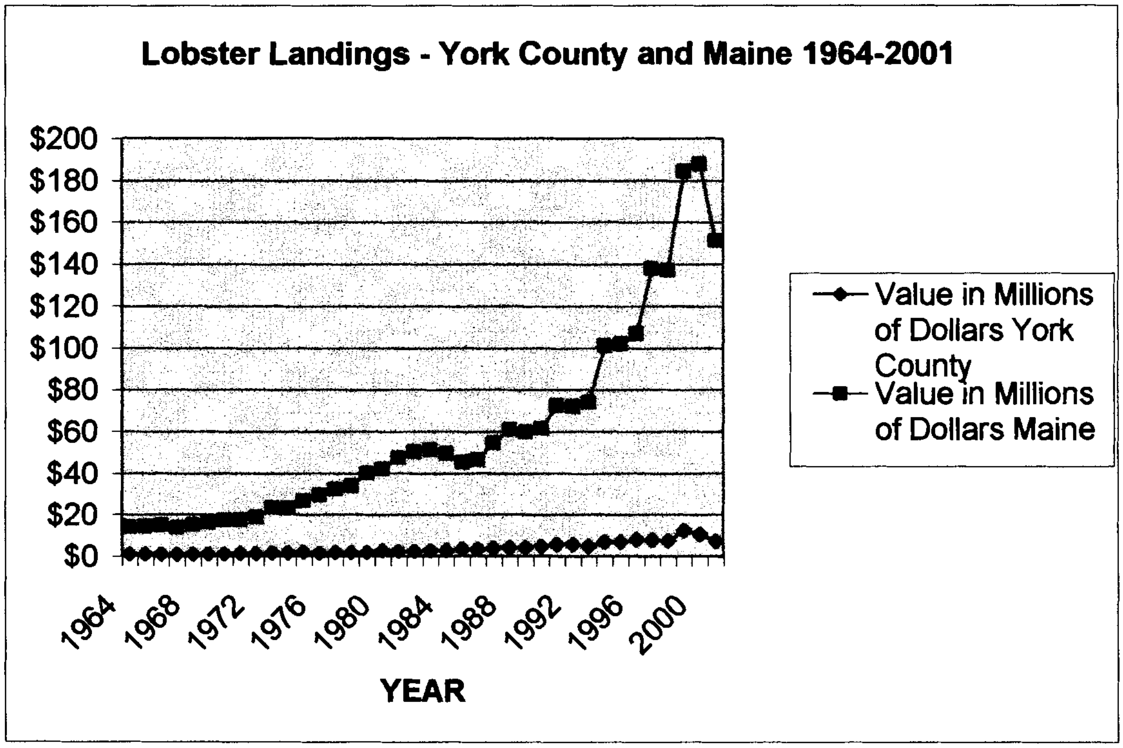

Figure 4.12 Value of lobster landings in 2001 dollars for the State of Maine and York County 1964 - 2001 (Maine DMR website, 2003; Wilson 2003).

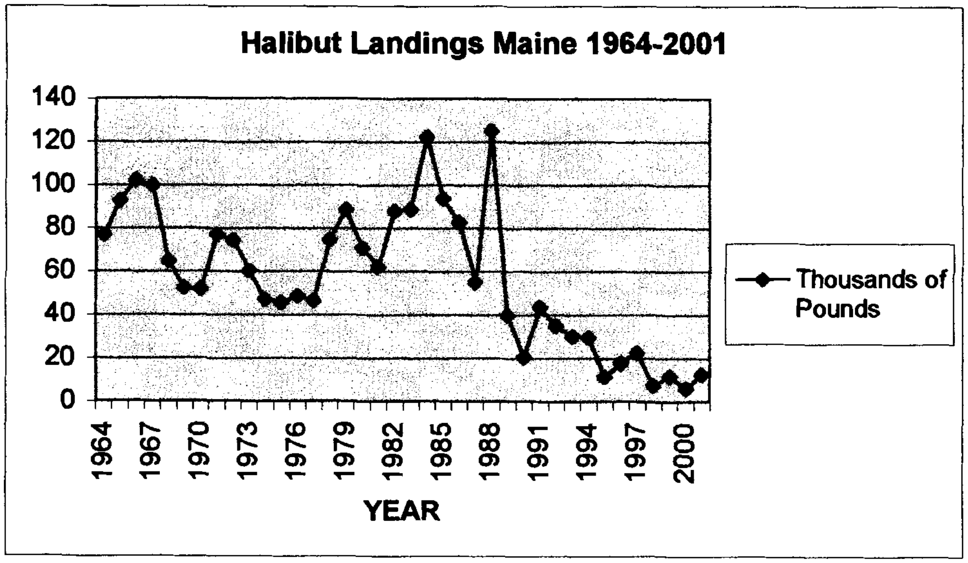

Figure 4.13 Halibut landings in pounds for the State of Maine 1964 - 2001. The graph shows a substantial decline in recent years (Maine DMR website, 2003)

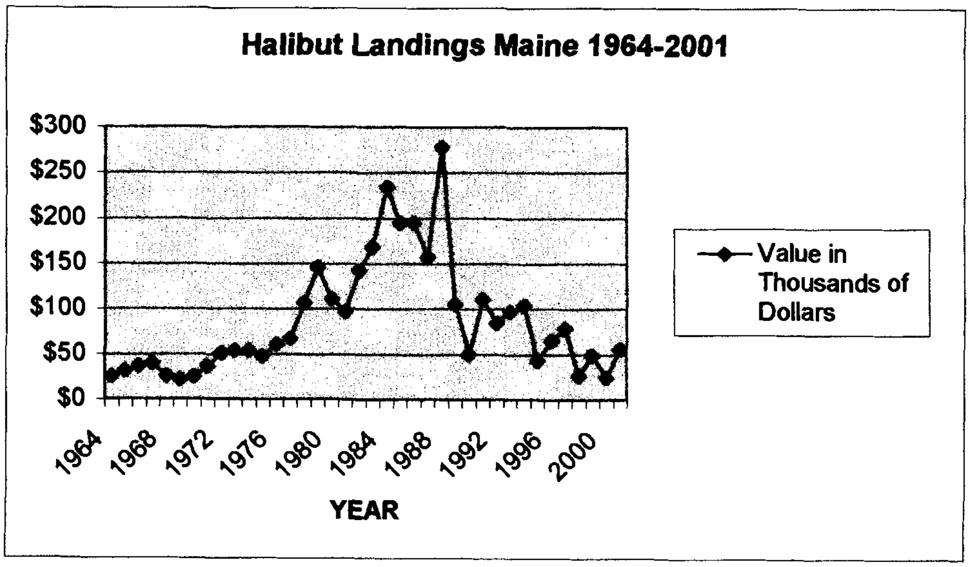

Figure 4.14 Value of halibut landings for the State of Maine in 2001 dollars 1964 - 2001 (Maine DMR website, 2003)

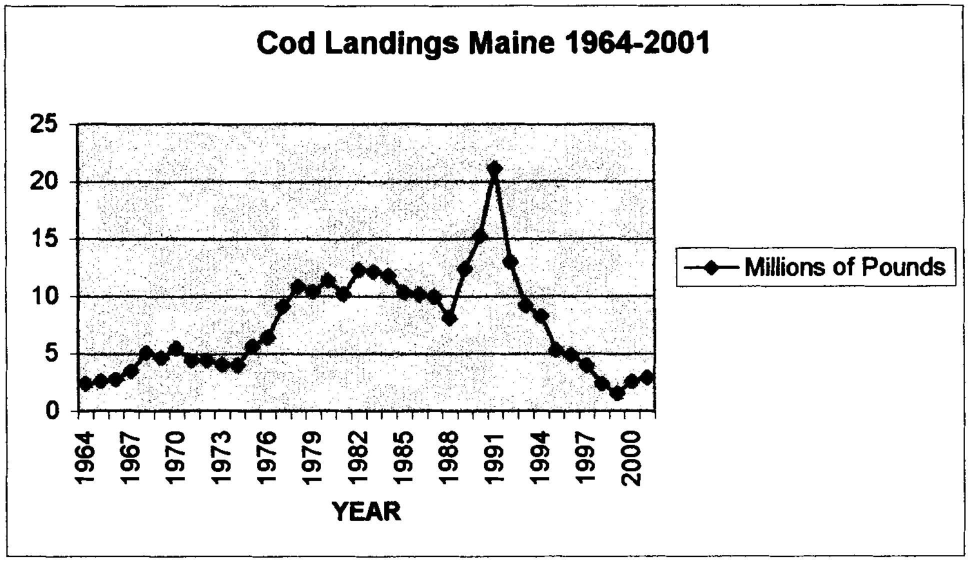

Figure 4.15 Cod landings in pounds for the State of Maine 1964 - 2001. Like halibut, there has been a substantial decline in recent years (Maine DMR website, 2003).

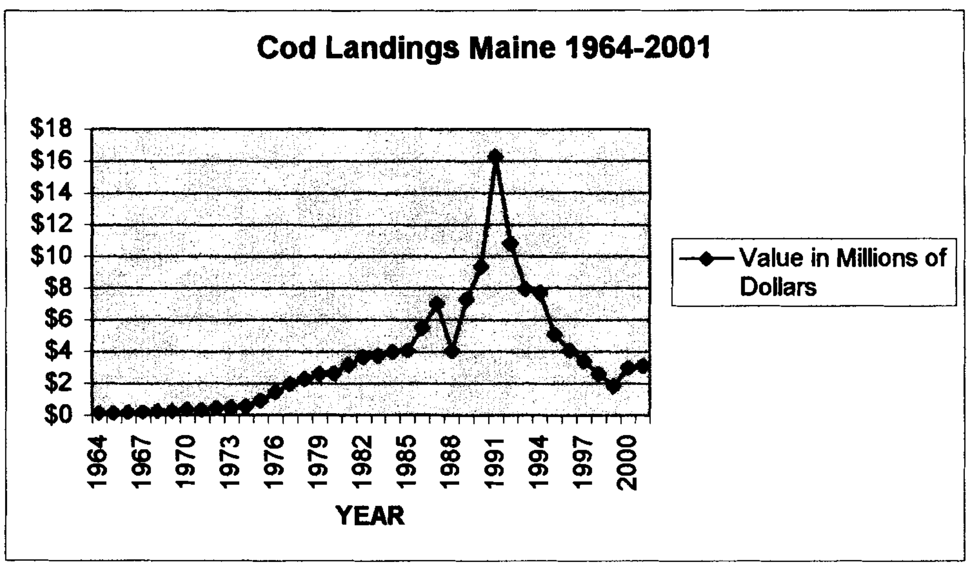

Figure 4.16 Value of cod landings for the State of Maine in 2001 dollars 1964 – 2001 (Maine DMR website, 2003)

In regard to storm protection, it is easy enough to see that the original projections of accretion along the lengths of Wells Beach and Drakes Island were wrong. Accretion along the jetties does protect the few properties in that area, but far more properties now have less beach then they would have without the jetties.

What Do these Results Reveal?

It is important to appreciate the role played by the economic analysis in these projects. The benefit-cost ratio test is the final hurdle for project approval. Once it is satisfied, Army Corps projects start and are difficult to stop. It takes an act of Congress and a lengthy review period, not to mention money, to decommission a federal navigation project, and this does not necessarily remove the structures (Habel, 2003; Michaud 2003). For this reason, it is important to approach marginal economic projects with caution. As is seen in this case, if the benefits or costs had been more closely reviewed, any slight shift would have made this project unfeasible. Theoretically, the project and its problems would not have materialized if this were a simply a case of adhering to economic guidelines.

The computation of benefits needs to account for uncertainty in the setting and must consider the irreversible nature of the project. Probabilities should be used to generate expected values that incorporate more than one scenario. Beyond the cost of construction and maintenance, the potential loss of environmental amenities needs to be considered in the overall cost projections. Again, probabilities should be used to generate expected values from a range of scenarios. This may not have been possible at the start of the project, but it is possible now and for future projects.

Wells Harbor – The Politics

Interviews

Open-ended interviews were conducted with 7 people representing 7 different interests involved in the Wells Harbor Project. These interests include: Maine Geological Survey, Maine Audubon, the New England Division of the Army Corps, the Town of Wells, the Maine Coastal Program, U.S. Fish & Wildlife Service, Maine Sea Grant Extension, and Save our Shores (SOS) Wells.

Interviews were designed in order to identify the groups' perception of the problem, the relationship with other groups, and their perception of success. The following is a summary of the results.

Perceived Problem	Frequency (n=7)
Project Design	6
Harbor and Inlet Shoaling Creates Hazardous Setting	6
Beach Erosion Threatening Natural Setting	5
Beach Erosion Threatening Development	5
Dredging Threatens Estuary and Salt Marsh	5
State and Town Relationship	3
State Regulations Unreasonable	2
Town and USF&WS Relationship	2
Public Funding Private Interests	2
Divisions Within Community	1
State Regulations Not Understood By Stakeholders	1
Town and Maine Audubon Relationship	1
Balancing Working Harbor with Healthy Beach	1
Lack of Long Term Planning for SLR	1
Lack of Funding	1
Unwillingness to Consider Other Options	1

Table 4.21 Problem areas with the Wells Harbor Project identified during interviews with the 7 groups listed above. The frequency column shows how many groups out of the 7 felt that this particular area was a problem.

Relationship Rating	Number of Responses
0	13
1	8
2	21
KEY: 0 - poor, 1 - neutral, 2 - positive	

Table 4.22 Relationship ratings for the Wells Harbor Project. Each of the 7 people was asked to rate their relationship with the other 6 groups. Poor was a 0, neutral was a 1, and positive was a 2. There were a total of 42 possible responses from the 7 groups.

Perceived Success	Frequency (n=7)
Working Beach and Working Harbor Per Design	2
Working Beaches	2
Change State Regulations to Address Local Problems	2
Small Working Harbor with Minimal to No Dredge	2
Remove Jetties - Allow Harbor and Beach to Return to Natural States	2
Partnership of State and Stakeholders Toward Common Goal	2
Acceptance of Current Equilibrium in System	1
Working Harbor	1
Establish Routine Dredging Schedule	1
Remove Public Funding for Such Projects	1
Preserve Habitat on Beaches and within Estuary	1

Table 4.23 Perceptions of success for the Wells Harbor Project as identified by the 7 groups. The frequency column shows how many of the groups out of the 7 felt that particular solution was viable.

The Health of the Current Political Environment

Health in the context of the political environment is a subjective term. Here, a healthy environment is defined by consensus and open communication. The interviews reveal a political environment in poor health. Perceptions of the problem are varying. Some are compatible, some are not, but the wide range indicates a lack of consensus and focus. This translates negatively when attempting to address the problems in a manner that suits all or even a majority of stakeholders.

This view is supported when looking at the responses regarding the health of the relationships between participating parties. There are a possible 42 different responses with 7 groups commenting on each other. One third of the responses identified poor relationships with only one half identifying positive relationships. Within this, 6 of the 7 groups are not aware of the perception of at least one of the other groups. Group A may believe they have a mutually positive relationship with Group B when in fact Group B views the relationship negatively. This is indicative of poor communication and paints a picture of a negative negotiating environment.

The perceptions of success are wide ranging. No more than 2 groups share any single view of success. This again is indicative of a lack of consensus. Additionally, some views are incompatible. It would be impossible to develop a harbor and at the same time dismantle the jetties to allow the harbor and beaches to return to their natural states.

Based on the responses, the political environment is unhealthy. In its current state, it is doubtful whether any consensus toward a plan can be reached. Something in the current political environment needs to change before any progress is made on these issues.

Political History and Environment of Wells

The Wells Harbor Project has been politically charged from its inception. The Army Corps did not want to construct a harbor due to marginal economic returns and an unstable environment (Habel, 2003). State and federal officials also voiced their doubts during the initial site visit. They did not believe that an anchorage placed over a tidal delta could be maintained (Dickson, 2002; Kelley, 2003; Lang, 2003). Local business interests lobbied for the project and were able to convince Senator Margaret Chase Smith to push the Army Corps forward on the project (Habel, 2003; Lang, 2003).

Problems plagued the project through the 1960s and 1970s. The harbor continued to shoal. Wells Beach and Drakes Island were experiencing accelerated rates of erosion, and residents watched as sand became impounded alongside the jetties. Beach property owners blocked future dredging after the 1974 dredge. They suspected erosion was due to the presence of the jetties and blamed the Army Corps. The harbor filled with sand and went from 186 moorings in 1974 to 40 in 1980 (USACE, 1980a).

Factions formed within the community. The non-beach property owners and harbor enthusiasts wanted the harbor for economic development while the beachfront property owners felt that future dredging would harm their investments. Beach property owners were able to block attempts to dredge by denying access to their property for disposal equipment (Carter, 2002; Humm, 1984). The residents of Drakes Island offered the town access to their beach properties for the sum of $1.3 million so that the residents could reap the benefits of the federally paid sand (Carter, 2002). This further deteriorated relationships within the community. An outside mediator was brought in to help solve issues between the town and beach owners. They were successful in opening a dialog but were not successful in implementing any plan (Humm, 1984).

During this same time issues over habitat arose. Maine Audubon, concerned over shorebird habitat on both beaches, was able to reach a cooperative management agreement with the property owners along Wells Beach and Drakes Island. The agreement ensured the safety of nesting areas while allowing property owners to maintain their autonomy. The program has been a success and established Maine Audubon as a participating party in the present debate (Carter, 2002; Jones, 2003).

Another habitat issue was the Rachel Carson Wildlife Refuge located in the salt marsh surrounding the anchorage. The Refuge was established in 1966 in Wells during the time of jetty construction. It is under the management of the United States Fish and Wildlife Service. The initial area encompassed 5,000 acres and was planned to grow to 7,600 acres, stretching from Kittery to Cape Elizabeth (USF&WS, 2003). The original spoils disposal area is located within the Refuge. Because the Army Corps could no longer use the Refuge for dredge disposal, they needed access to the beaches. The presence of the Refuge established the USF&WS as another participating party in the debate.

By the late 1980s, the town regrouped with property owners. Those who once blocked a dredge now supported a dredge. Their change of heart resulted from increased erosion in front of their homes and from the realization that the only nourishment they would receive would come from dredge spoils (Figure 4.17). This was further bolstered by the state's newly initiated policy of retreat from the coast. The Sand Dune Rules and Shoreland Zoning Act eliminated future construction of hard protective structures like seawalls and greatly limited development and construction within the coastal zone.

This began to unite the two factions within the town (Carter, 2002). A highly publicized grounding of then Vice-President Bush's boat on a harbor shoal further strengthened their resolve (Kreis, 1988). Plans for a new dredge were formulated in 1990. Key opposition came from the Rachel Carson Wildlife Refuge and state agencies that felt the proposed dredge was too destructive to the intertidal flats and salt marsh environments surrounding the anchorage (Cohen, 1990; Macey, 1988). The town had to settle for a small emergency dredge to clear the inlet. Bad feelings between the community of Wells and both the USF&WS and the State of Maine began to grow. Community members approached Senator Cohen to get Vernon Lang, the USF&WS field representative, removed from the project (Lang, 2003). A similar thing had happened to Andy French, the Refuge manager and local Wells resident, in 1988 (Kreis, 1988).

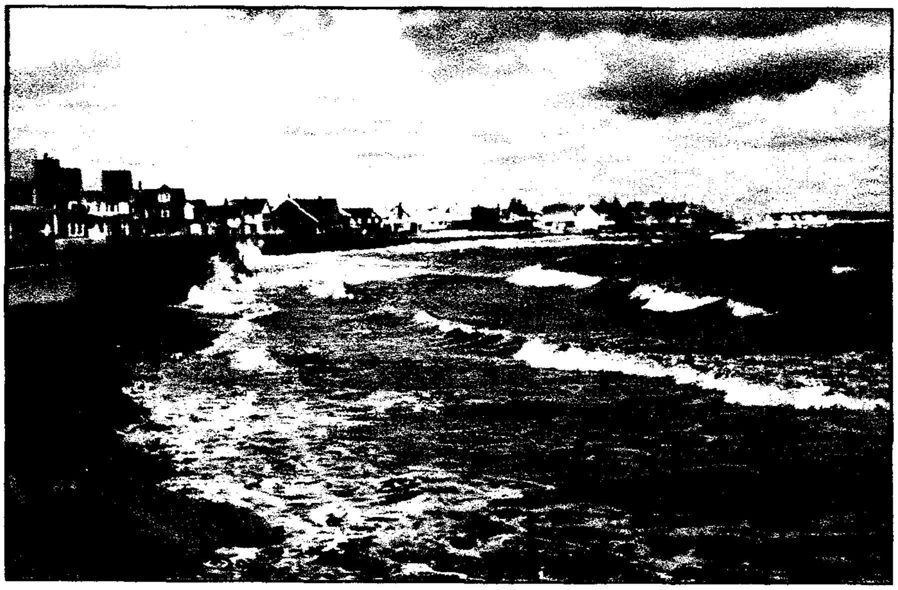

Figure 4.17 Photograph of eroded Wells Beach from 1983. There is very little dry beach and the waves are breaking on the seawalls (Photo courtesy of J.T. Kelley).

By the early 1990s the erosion problems along the beaches became more serious. The state and the town proposed a plan to move sand impounded along the jetties back to eroded areas of the beach (Kimberall Chase, 1994). Governor McKernan enlisted the aid of the Maine National Guard to complete the construction. State and local funds fueled the project, and the Army Corps agreed to act as consultant. This represented a cooperative effort by local, state, and federal interests.

The project faced several problems. The sand targeted for removal was a part of peoples' properties. It required their permission for removal and the permission of all residents to operate machinery over their properties. Wells was not able to get all residents to agree (Dynan, 1994). The town urged the state to take the sand by imminent domain, and Governor McKernan was ready to send in the machinery. Maine Geological Survey (MGS) and the Maine Department of Environmental Protection (MDEP) both blocked the project citing legal problems. Resource regulations prohibited the disruption of sand with dune grass, and there were private property takings issues. The project was cancelled, enraging the community. SOS Wells publicly blamed MGS (Kelley, 2003).

The relationship between the state and Wells was in shambles. The community accused state agencies of arrogance and of obstructionist tactics, some vowing to never cooperate with the state in the future (Dynan, 1994). Some residents refer to this as the time when the state "washed their hands" of Wells and their problems (Foley, 2002). This further solidified the community's resolve. SOS Wells has been at the forefront of dredging efforts for the harbor and shore protection ever since. They advocate on behalf of beach property owners on Wells Beach and Drakes Island.

The town and the Army Corps proposed another dredge plan in 1996. It received strong criticism from MGS, Maine Audubon, and the USF&WS (Ahearn, 1996; Bartlett, 1996; Marvinney, 1996). Negotiations went on for two more years and agreement was reached on a compromise dredge. The town agreed to rearrange the existing anchorage, moving the moorings to the natural channel within the estuary. This greatly reduced the amount of dredging. Additionally, the flood tidal delta within the estuary was placed into a conservation easement, removing it from future dredging operations. The town also agreed to institute an extensive monitoring program of the salt marsh at their own expense (Carter, 2002). The objective was to determine what effects the dredge had on the surrounding marsh. The monitoring program was instituted for 5 years, at which point the data will be analyzed by a board of scientists to determine whether dredging will continue in the future.

The dredge was to occur in 1998, but USF&WS held up the process to ensure that the town would pay for any damage to the Rachel Carson Wildlife Refuge (Cohen, 2000). Once this agreement was made the dredge proceeded in 2000. The spoils were placed upon Wells Beach and Drakes Island. The immediate impact of the replenishment was short-lived, and the beaches are returning to their pre-nourishment states with sand impounding along the jetties and settling in the entrance of the inlet. The inlet entrance already needed another emergency dredge in 2002 to maintain navigability. The town and the Army Corps have already begun the application process for the next dredge in anticipation of the end of the monitoring program in 2005.

The town maintains its isolation from the state and has hired its own geologists and economists to plead its case (Carter, 2002). Relationships between the parties have not improved. During the summer of 2002, an estimated 500 property owners organized by SOS Wells attended a meeting at Wells High School to protest changes to the existing Sand Dune Rules. The meeting became a shouting match, and speakers were met with boos and jeers (Cohen, 2002). The DEP, MGS, and Maine Audubon all supported the changes that included clearer and more detailed definitions of acceptable development activity in frontal dune areas and methods for computing the value of homes when determining the extent of storm damage. Properties owners felt that the state was denying them the ability to protect their properties. This has stressed the already poor relationship with the town. All parties are anxiously awaiting the results of the monitoring program in 2005.

Wells Harbor – Political Analysis

There are three important stages in the course of the political history of the Wells Harbor project. The first is the project authorization stage. The second occurred during the years immediately following jetty construction and the emergence of erosion problems. The third stage began in the late 1980s early 1990s and is representative of the current political environment.

Stage 1: Project Authorization

During the authorization period, heavy influence was exercised by special interests, mainly by Vander Forbes, a local restaurateur and property owner in Wells (Kelley, 2003). Both state and federal agencies felt that the site would not accommodate the type of project being requested, physically or economically. Business interests in Wells pressured Senator Margaret Chase Smith to see that a harbor project was authorized, and that it would receive federal funding (Habel, 2003). The Senator requested that the Army Corps accept the project and appropriated the necessary funds. Regardless of whether the Army Corps wants to take on the project or not, they must do as they are told by Congress. Without the support of senators and congressmen, the Army Corps would lose its funding.

Stage 2: Community Divided

Shortly after completion of the jetties, the beaches adjusted to establish a new equilibrium. This meant loss of beach for many of the property owners away from the jetties. They immediately drew a connection between the beach erosion and the navigation project. They are the ones who brought dredging to a halt for the remainder of the 1970s and all of the 1980s.

The majority of these stakeholders were out-of-state, seasonal residents with second homes (Carter, 2002). They viewed the harbor as a problem and did not trust the Army Corps to make the decision in their best interests. This created a rift in the community. A segment of the community wanted to see a working harbor, which meant resuming dredging. They were for the most part year-round residents and were interested in the economic development the harbor would bring. The community effectively was split into a beach faction and a harbor faction. This was at the root of delays of mitigation for the beaches and harbor.

Stage 3: Community Versus the State of Maine

As the 1980s came to an end, loss of dry beach continued to be a critical issue, and the navigation project was not operating at full capacity. It was during this time that the factions within the community found some common ground. The only economic sources of sand for beach nourishment was in the harbor, and the least expensive place to dump dredging spoils were the beaches. Dredging the navigation project became the means to the ends sought by all. The Army Corps was the agency that could make this all happen and was embraced by the community.

The State of Maine became the new obstacle. Regulatory and ideological changes in coastal management occurred in 1983 with creation of the Sand Dune Rules later incorporated into the Natural Resource Protection Act of 1988 (DEP, 1988). The rules themselves did not necessarily prohibit dredging and nourishment, but they embodied a movement toward future-thinking coastal planning that accounted for SLR, limited resources and a desire to maintain the integrity of Maine's natural coastal environment. This did not and does not mesh with the pro-development stance of Wells or the Army Corps. The New England office of the Army Corps summarized it by describing Maine as the "last frontier" for coastal development in the 1900s with the potential for many Army Corps projects. The state's approach to coastal management since 1983 has frustrated the Army Corps' plans for the Maine coast (Habel, 2003).

The state was and still is reluctant to grant the permission for a dredge of the harbor until the full effects on the surrounding environment are better understood. This has solidified the factions in the community and their relationship with the Army Corps against the common obstacle: the State of Maine.

Regulatory Versus Development Interests

The conflict has become an issue of regulatory versus development interests. Development and land-use issues are decided on the local level in Maine. It is a "home rule" state. The State plays the role of regulator, monitoring activity to ensure that it meets minimum standards set forth in the state legislation. The issue has become polarized with the community (and Army Corps) on one side and the State of Maine on the other. Additionally, there is also the USF&WS, which also takes a regulatory stance and is seen as another roadblock to future dredging in the estuary and nourishment of the beaches. Maine Audubon also influences such decisions. They monitor bird habitat in the state and, with a full-time lobbyist in the state legislature, try to discourage any activity that threatens birds or their environment (Jones, 2003; Kelley, 2003).

Holistic Analysis

Each component of the case study impacts the project in a particular way. In order to better understand how the project progressed and why problems are not being resolved it is necessary to understand the interaction of the different components. In answering these questions, the project is divided into three phases.

Phase 1: Project Authorization

Initially the project was rejected by state and federal agencies.[19] Political pressure was applied to the Congress and Congress, in turn, applied pressure on the Army Corps. This resulted in a reevaluation of the project. Incomplete coastal data led to unanticipated economic costs, and poor economic forecasting generated overvalued benefits. This produced a marginal benefit-to-cost ratio that barely authorized the project. The question remains whether the political pressure influenced the flawed economic data and incomplete coastal process data or whether they truly were mistakes.

[19] The original technical reasons for the rejection still exist.

It is reasonable to believe that a combination of both occurred. The relationship between the Army Corps and Congress creates a complete dependency of the agency on Congress for funding and employment. Political pressure by a member of Congress might prompt the Army Corps to make the adjustments necessary for a project work. It is also conceivable that better quality data were not available at the time (Figure 4.18).

Phase 2: Project Construction

Once authorized, construction of the project began. An initial project design was created based on the coastal process and economic data (Figure 4.19). The construction phase started and problems arose. This brought about a review in the project design, recycling the original flawed economic and coastal process data. Design modifications were made and construction continued. This cycle repeated itself twice before stakeholders stopped the dredging operations. During this phase, there was an interaction between the economics and engineering aspects of the project. On one hand, unqualified opinions of the coastal processes generated false cost figures. On the other hand, economic constraints helped determine the engineering and design specifications. Old, often incorrect, data was recycled through the process and problems escalated.

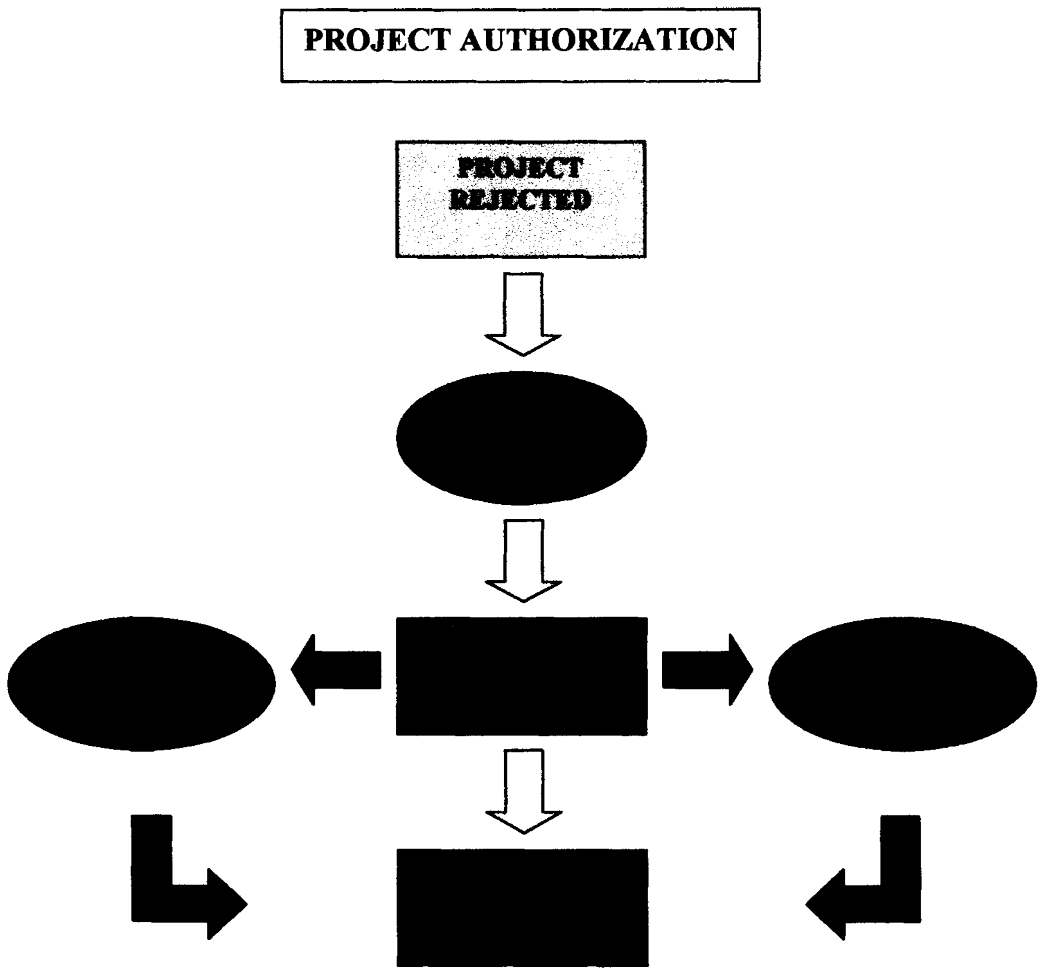

Figure 4.18 Project Authorization Phase for the Wells Harbor Project.

PROJECT CONSTRUCTION

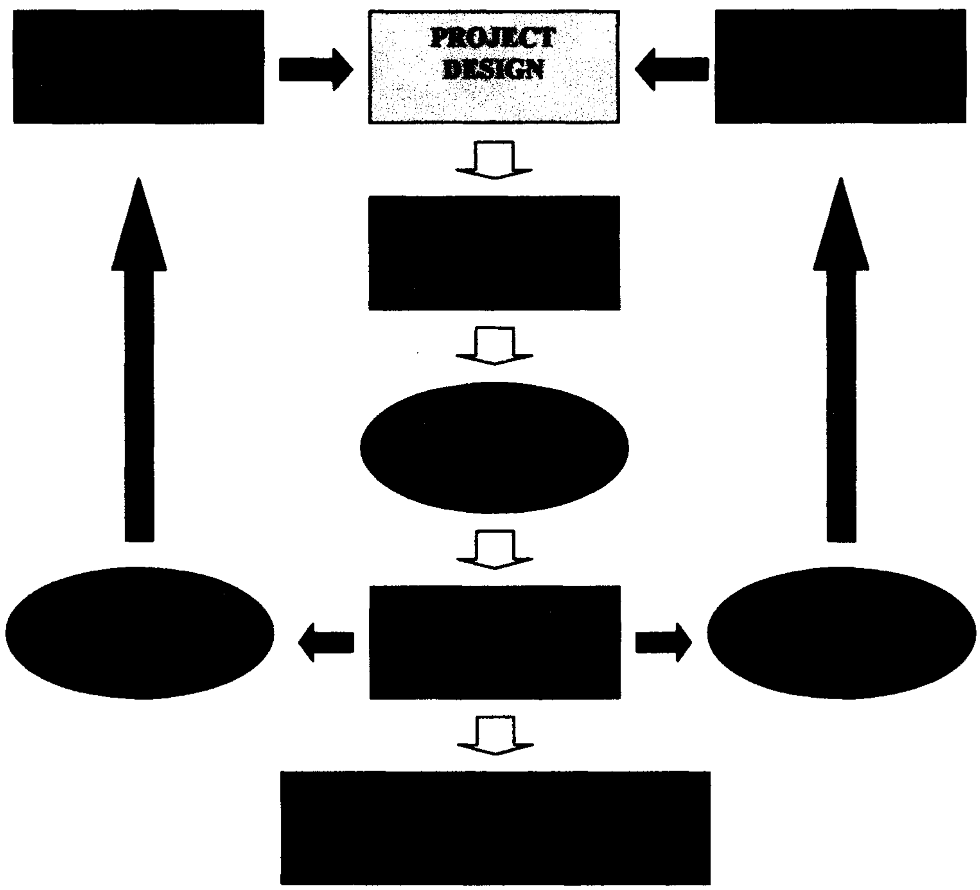

Figure 4.19 Construction Phase for the Wells Harbor Project

Phase 3: Mitigation

Construction of the project was completed, and problems persisted, both in the anchorage and along the adjacent beaches and salt marsh. Attempts were made to address the problems. Actions were taken, but the participants have not been able to embark on any decisive, concerted plan. All three components are responsible for this inability to move forward (Figure 4.20). The coastal processes of the natural setting limit the engineering options available to address the problems. Economically, they have limited response options due to the federal criteria. The community is not able to circumvent this by investing their own money because of their limited resources. Politically, there is no consensus; there is distrust and there is an atmosphere of "no-compromise". Ideological differences in coastal management exist between all parties. This does not allow for any movement and further complicates existing engineering and economic problems by stifling negotiation efforts and creating the situation experienced currently.

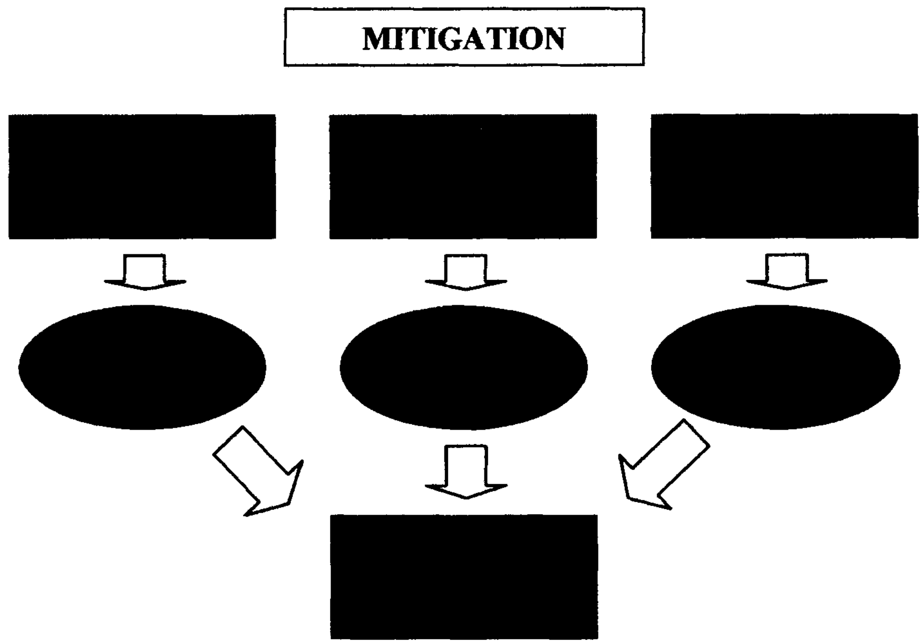

Figure 4.20 Mitigation Phase for the Wells Harbor Project

CHAPTER 5

CASE STUDY 2: SACO RIVER NAVIGATION PROJECT

Developing the Saco River

In 1824 the Army Corps embarked on a navigation project to improve the inlet and channel on the Saco River along Maine's southern coast (Figure 5.1). The end result consisted of two stone jetties over 3.2 km in combined length and a maintained channel stretching from the inlet to the head of navigation at the cities of Saco and Biddeford. Since the project's beginning, the area has experienced a shift from lumber and manufacturing to commercial fishing and recreational use. The inlet has also experienced continuous shoaling in the channel and high rates of erosion on both Hills Beach and Camp Ellis Beach. Many homes have been lost and the community of Camp Ellis is on constant vigilance as each passing storm sends waves and debris into the homes and streets of the community.

The community and state have struggled for years to get the Army Corps to take responsibility for the problems. Over that time, relations have deteriorated within the community, with the state, and with the Army Corps. Within the last 10 years, efforts to restore relationships have made some progress, and the state and community succeeded in getting the Army Corps to accept responsibility and to provide funding for mitigation. Unfortunately, it is no longer a simple matter of spending some money. It is a complicated problem with many contributing factors and no clear solution.

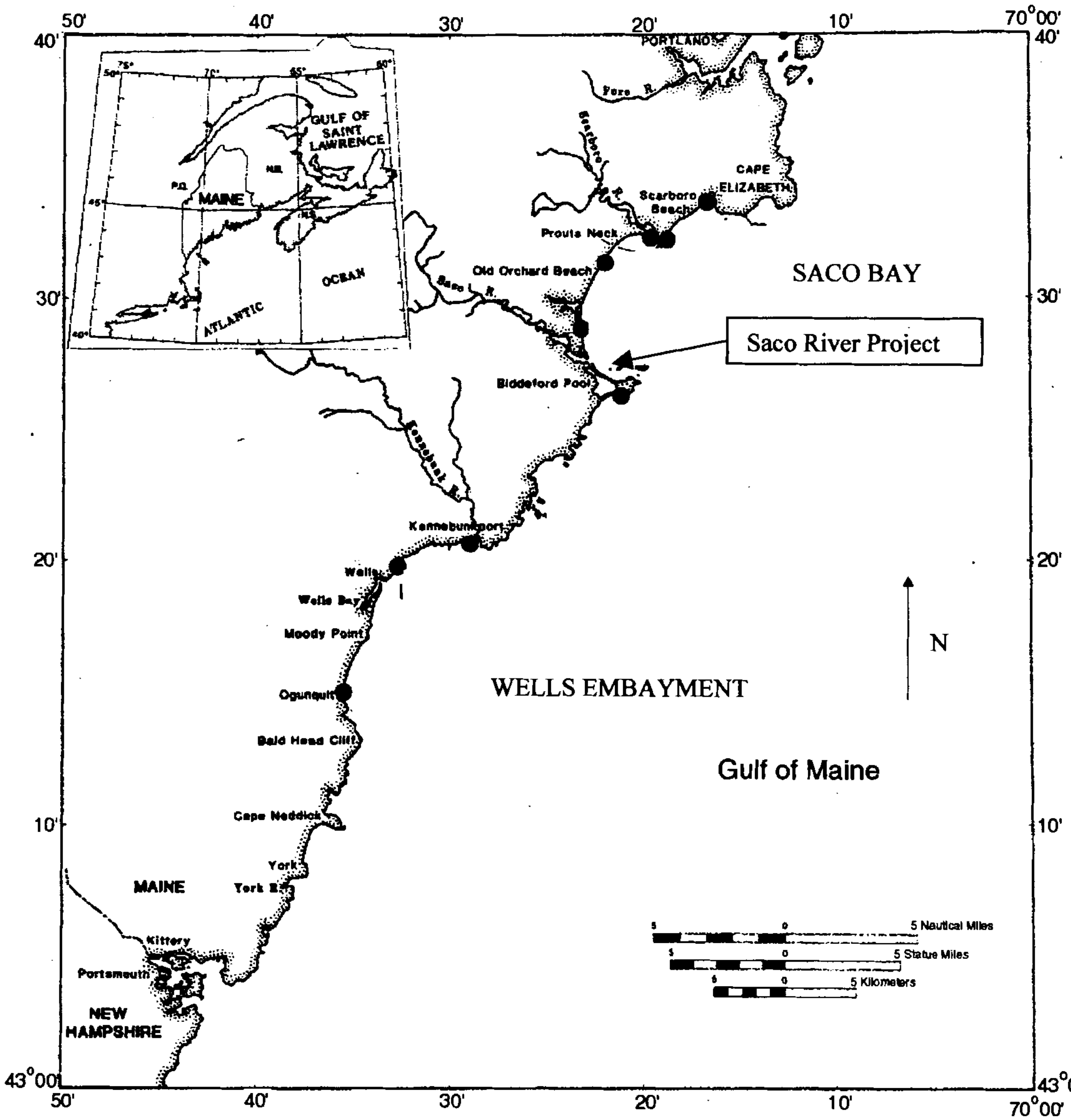

Figure 5.1 Map of Maine's southern coast and location of the Saco River Project (Kelley et al., 1989b).

Saco River Navigation Project Construction History – 1800s

The navigation project officially began in 1824. Federal money was used to build piers, place aids to navigation, and remove obstructions along the Saco River (USACE, 1910). In 1866, construction began on a jetty on the northern shore of the inlet. Its purpose was to stabilize the inlet and to block shoaling sand from entering the inlet from the north. Additionally, the river channel and the 10 piers along its course were improved. Between 1869 and 1871, a dogleg extension was added to the end of the north jetty. By 1873, the north jetty was 1315 m long at a height of 3 m above mean low water (MLW) (USACE, 1886; USACE, 1910).

Shoaling continued in the inlet and in 1886 other sorts of improvements were made to the north jetty. Engineers began heightening the jetty in an attempt to stop the wash over of sediment. By 1897, the entire north jetty had been heightened from 3 m to 4.6 m above MLW along its entire length (USACE 1955; USACE, 1992). Local business interests requested an improved 1.8 m channel from the inlet to the head of navigation at the cities of Saco and Biddeford to better accommodate coal-carrying vessels (Pilkey and Dixon, 1996; USACE, 1886). This was approved and carried out by the Army Corps.

Increasing the height and length of the north jetty did not stop shoaling, and construction of a southern jetty was authorized in 1891 to address the problem. When completed, the south jetty was 1372 m long at a height of 1.7 m above MLW. It is considered a "half-tide" jetty, allowing the flow of water and sediment over its top during higher tides (USACE, 1934). During that same period, several smaller submerged riprap jetties were constructed along the river channel between the inlet and the cities of Saco and Biddeford to help maintain the channel's course and to encourage self-scouring of sediment (USACE, 1992).

Saco River Navigation Project Construction History – 1900s

Shoaling problems continued into the 1900s and engineers were now faced with the additional problem of erosion along Hills Beach to the south and Camp Ellis Beach to the north of the inlet. Between 1900 and 1912, the southern jetty was lengthened both shoreward and seaward. It was reattached to a landward migrating Hills Beach, and its overall length increased to 1463 m (USACE, 1955). Erosion problems persisted at Camp Ellis, and in 1912 a 22 m spur jetty was built off the north jetty, parallel to the shore to slow the rate of erosion along the beach.

Despite problems with shoaling and erosion, channel development continued. In 1912 the Army Corps deepened the channel from 1.8 m to 2.1 m to encourage more commercial vessel traffic (USACE, 1992). Between 1925 and 1930, the channel from the inlet to the head of navigation was deepened again to 2.4 m. Shoaling was still an issue and was addressed with another lengthening of the north jetty. A 1.7 m above MLW the extension brought the total length of the north jetty to 1768 m (USACE, 1930). Between 1935 and 1938, local officials again approached the Army Corps to increase the channel depth, this time to 4.6 m. The Army Corps denied this request but lengthened the north jetty again to stop sediment shoaling at the mouth of the river. The extension was 253 m long at a height of 1.7 m above MLW (Pilkey and Dixon, 1996). The north jetty was 2012 m long.

Erosion problems continued along the shore. In 1953, a 213 m stone revetment was built by the city of Saco to protect roads in Camp Ellis from being undermined by the eroding beach (USACE, 1955). In 1958 the north jetty was heightened along the first 213 m from land. This was to prevent sand from crossing the beach to the river (USACE, 1968; USACE, 1992).

These actions did not solve the problems of beach erosion or channel shoaling. The jetties continued to be outflanked by erosion along the shore. Between 1968 and 1969 both the north and south jetties were extended shoreward. This time they were secured to stone revetments on each beach. Cracks were filled and tightened, ensuring that no sand could pass from the river to the beaches at the junctions with the jetties. The shoreward 259 m of each jetty were raised again. The north jetty was raised to 5.2 m above MLW, and the south jetty was raised to 3.4 m above MLW (USACE, 1992). A history of jetty extensions is summarized in Table 5.1, and a history of heightening is summarized in Table 5.2. See Figure 5.2 for a photograph of the current project.

Year	North Jetty (meters)	South Jetty (meters)
1866-1871	1315	0
1891-1893	0	1372
1900	0	91
1927-1930	453	0
1936-1937	274	0
TOTAL	**2042**	**1463**

Table 5.1 History of jetty construction on the Saco River Inlet from 1867 to 1937 (USACE, 1930; 1934; 1955)

Year	Heightening Activity
1866	North jetty constructed at 3m above MLW
1886	North jetty raised to 4.6m above MLW
1891	South jetty constructed at 1.7m above MLW
1927	North jetty extensions built at 1.7m above MLW
1958	Buried shore segment of north jetty raised from 3m to 4.6m above MLW
1968	259 m shore section of north jetty raised from 4.6m to 5.2m above MLW
1968	259 m shore section of south jetty raised from 1.7m to 3.4m above MLW

Table 5.2 History of jetty heightening on the Saco River Inlet from 1866-1968 (USACE, 1886; 1910; 1930; 1934; 1955; 1968; 1992).

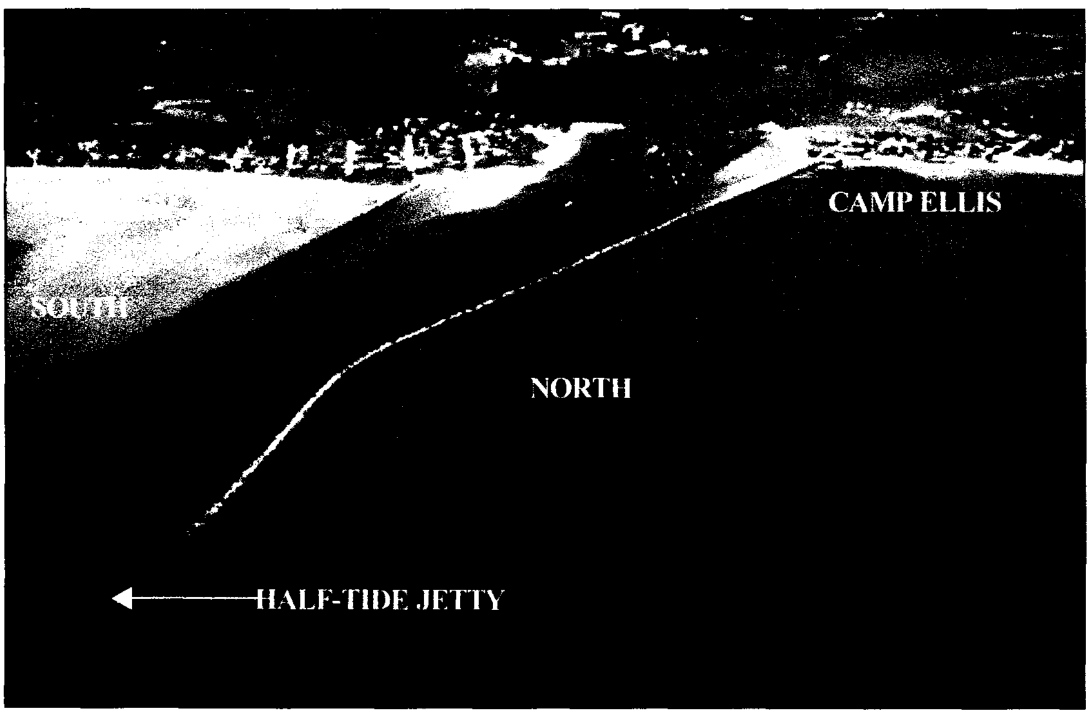

Figure 5.2 Aerial photo of the Saco River Inlet 1993. Camp Ellis Beach lies to the north and Hills Beach lies to the south (Photo courtesy of J.T. Kelley).

Development continued during this time period. In 1968, a proposal to dredge two anchorages, 10.5 acres in total acreage, and a 10-acre turning basin at the head of navigation, was accepted (USACE, 1968). Erosion problems continued along the adjacent beaches. In 1971 a 198 m stone revetment was built along Hills Beach to protect property from erosion (Pilkey and Dixon, 1996). Navigation improvements continued in 1982 with the construction of another 3-acre anchorage and installation of 13 icebreakers[20] in the river. This was to maintain the channel year-round and to protect anchorages and piers heavy winter ice flows (USACE, 1982). Table 5.3 summarizes the history of navigation development projects on the Saco River.

Year	Development Activity
1827	Piers improved, navigation aids, obstructions cleared from entrance
1886	Channel deepened to 1.8m from the mouth to the head of navigation
1910	Channel deepened to 2.1m from the mouth to the head of navigation
1925	Channel deepened to 2.4m from the mouth to the head of navigation
1967	Construction of 2 anchorages 10.5 acres in total area and a 10 acre turning basin at the head of navigation
1982	Construction of a 3-acre anchorage and installation of 13 ice breakers

Table 5.3 The history of channel improvement and navigation development on the Saco River from 1827 to 1982 (USACE, 1886; 1910; 1930; 1934; 1968; 1982)

Beach erosion at Camp Ellis has been an issue since the early 1900s and now is the main concern of stakeholders and government agencies. Over 30 homes were lost, and damage regularly occurs to roads and infrastructure. The Army Corps conducted

[20] Stationary structures placed upriver of the anchorage to intercept and break ice flows.

numerous studies from the early 1900s to present. None of the early studies acknowledged a connection between the jetties and the erosion on adjacent beaches. In 1992 a Section 111 Study finally did acknowledge a connection, and several mitigation options were presented but none satisfied the federal benefit-cost ratio criterion (USACE, 1992).

> "That report, together with a subsequent report by the Waterways Experiment Station concluded that (1) most if not all of the erosion problems on Camp Ellis Beach within the first 1300 feet north from the jetty were attributable to the jetty's effect on waves, (2) erosion for an additional 1,200 feet further north along the beach and (3) that the potential benefits of several alternative solutions did not offset estimated costs of those solutions." (USACE, 2001, p1)

The Army Corps continued to study the problem. They built a physical wave model in 1995 to better understand the coastal processes around Camp Ellis. The Army Corps then proposed another breakwater structure that was ultimately rejected as too expensive and in violation of Maine coastal regulations (Kelley and Anderson., 2000). The Army Corps did not pursue the project, and the city of Saco was left to address the problem on its own. Nourishment of Camp Ellis had been attempted over the years, but only in conjunction with dredging maintenance of the river and with very limited success (Table 5.4). Sand is removed from the system quickly.

Year	Volume (m^3)	Cost (that year's dollars)
1969	66,787	$211,000
1969	55,912	$176,643
1978	61,164	$412,371
1978	38,228	$257,732
1982	5,581	$51,049
1992	65,702	$767,277
1996	68,810	$1,180,000
Total	**362,184**	**$3,056,072**

Table 5.4 Recent nourishment history for Hills Beach and Camp Ellis Beach. Reporting volume and cost in the project year's dollars (Duke University, 2002; USACE, 2001).

The problems were addressed anew in 2001 with a revised Section 111 Study. Economic conditions were more favorable, and funding was secured for studies and work. Currently, local stakeholders, the state, and the Army Corps are working together to formulate a mitigation plan. Again, a review of the different components of the case history sheds light on how this project became so problematic and why participants weren't able to reach consensus on a solution. The Saco River Project history offers some insight into the current situation at Wells Harbor, due to its longer history.

Saco River – The Natural Setting

The study area lies within Saco Bay. Saco Bay is approximately 11 km from southwest to northeast (USACE, 1955). The bay is the northern boundary of Maine's southwest arcuate embayment compartment. It is bound by two rocky headlands, Prouts Neck to the north and Fletchers Neck to the south (MCP, 1979; USACE, 1955; USACE, 1991; USACE, 1992). Within the bay, there are numerous islands and rocky outcrops (USACE, 1955) (Figure 5.3).

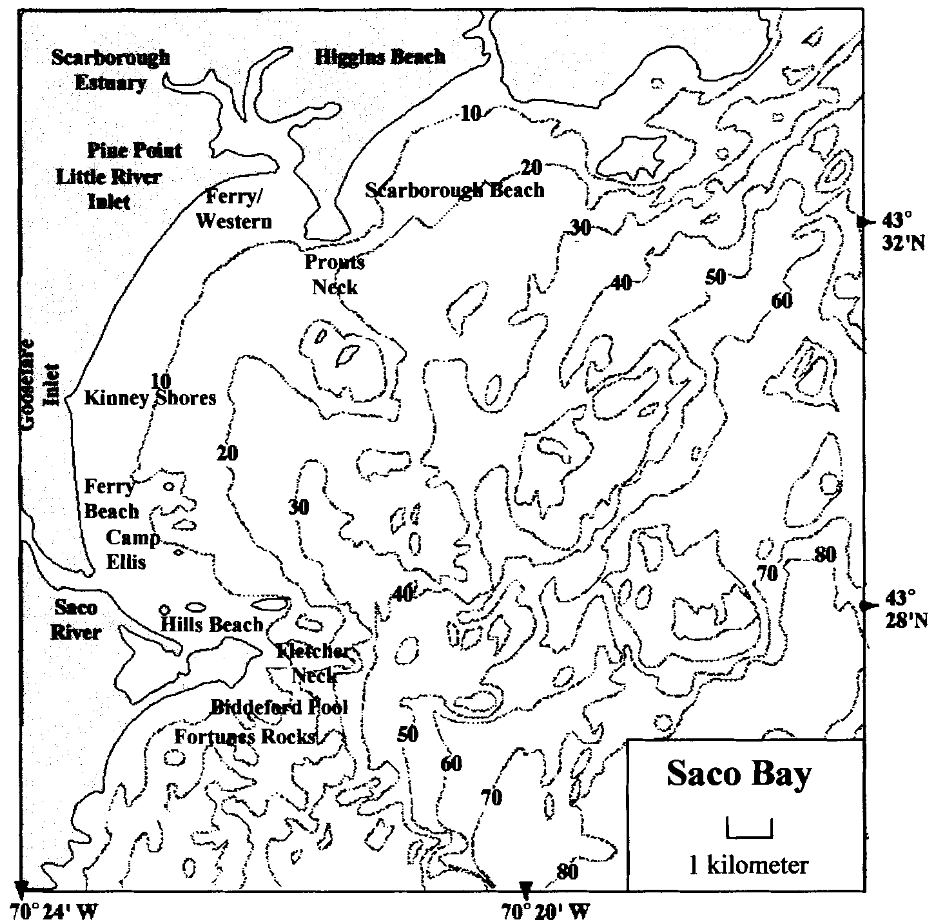

Figure 5.3 Map of Saco Bay and Saco River Project area (Heinze, 2001).

The study area is located at the south end of the bay, just north of Fletchers Neck, approximately 24 km south of Portland and 149 km north of Boston. The area includes the Saco River inlet and the adjacent beaches. Hills Beach lies directly to the south of the inlet while Camp Ellis Beach, Ferry Beach, and Kinney Shores lie to the north. Kinney Shores is bordered to the north by Goosefare Brook (Nelson, 1979; USACE, 1955).

The navigation project starts at the mouth of the Saco River and extends upriver approximately 8 km to the head of navigation at the cities of Biddeford and Saco (USACE, 1924). The project was originally designed for commercial vessels servicing the manufacturing and textile factories along the Saco River. Today, recreational vessels and a small fleet of commercial fishermen are the primary users.

The beaches of Saco Bay are popular tourist destinations. Hills Beach, Camp Ellis Beach, and Ferry Beach are all recreational beaches located just to the south of Old Orchard Beach, one of Maine's largest beach resorts. These beach areas are heavily developed. Homes and roads are found in the front and back dunes from Hills Beach through Camp Ellis Beach (USACE, 1955). The frontal dunes are not as developed near Ferry Beach, where there is a larger, healthier dune system with mature maritime forests established in the back dune (Kelley and Anderson, 2000).

Coastal Processes of Saco Bay

The winds in Saco Bay generally follow the same patterns as Wells Bay (see chapter 4). Hurricanes are the most destructive storm activity but are rare. The most common storm activity comes in the form of extratropical storms.

Wave activity differs from north to south in Saco Bay. The north end of the bay is sheltered from north and northeast waves by Prouts Neck and Nova Scotia. Northern areas are exposed to south and southwest waves during the summer. The southern end of the bay is the opposite. That area is exposed to waves from the northeast but is sheltered from south and southwest summer swells by Fletchers Neck (Barringer and Ten Broeck, 1978; MCP, 1979; Nelson., 1979; USACE, 1991; USACE, 1992). The study area is exposed to forces of erosion from northeast waves and is blocked from nourishment delivered by southwest swells. Hindcast wave data reports mean monthly wave heights ranging from 0.3 - 0.6 m and maximum monthly wave heights from 3.9 - 4.4 m between 1956 and 1975 for the project area, north to Portland (Jensen, 1983).

Tides are semidiurnal and range between 2.4 m and 2.7 m (MCP, 1979; USACE, 1910; USACE, 1955). There is a turbulent tidal environment within the estuary of the Saco River. Ebb and flood current velocity increases down river with ebb currents relatively faster on average. A June 1992 measurement recorded a 3.76-million m^3 tidal prism during ebb tide and a 1.94-million m^3 tidal prism during flood tide. That same day maximum ebb and flood velocities of 1.15 m per second and 1.26 m per second respectively were observed. These conditions support sediment suspension in the water column and are indicative of down river sediment movement (Manthorp, 1995).

Researchers agree that longshore currents play an important role in sediment transport within the bay; however, they have not been able to agree on the direction of these currents around the study area. The Army Corps maintained that the net longshore flow is to the south in the vicinity of the Saco River (USACE, 1886; USACE, 1910; USACE, 1924; USACE, 1930; USACE, 1955; USACE, 1991; USACE, 1992). They believed that a nodal point existed at Old Orchard Beach where the longshore current splits to the north and south. They pointed to the north growing spit near Pine Point and the south growing spit near Camp Ellis as their evidence (USACE, 1991; USACE, 1992).

Others felt that the net longshore current was to the north, not the south (Farrell, 1970; 1972; MCP, 1979; Nelson, 1979; Nelson and Fink, 1980). Their evidence also included the northward extending Pine Point, the closing of Goosefare Brook, and anecdotal information from residents who reported watching waves carry sand from their beaches to beaches north of them (Kelley et al., 1995b; Kelley and Anderson, 2000). Both factions did agree that longshore current can shift to the south during storms (Farrell, 1970; USACE, 1992). Currently it is generally accepted that net movement is to the north, and southern longshore currents are possible under storm conditions.

The River's Contribution

Starting in Crawford Notch, New Hampshire, the Saco River is approximately 200 km long, dropping over 580 m in elevation before emptying into the Gulf of Maine along the southern coast of Maine. There are three major tributaries, the Ossipee River, the Little Ossipee, and the Old Course. In total, it drains over 4,400 km^2 of land (Figure 5.4) (MCP, 1979; USACE, 1930).

The river passes from higher mountains through glacial lakes, outwash plains, bogs, forests, and agricultural lands. The majority of these areas have abundant supplies of sand and silt (MCP, 1979; Thompson and Borns, 1985).

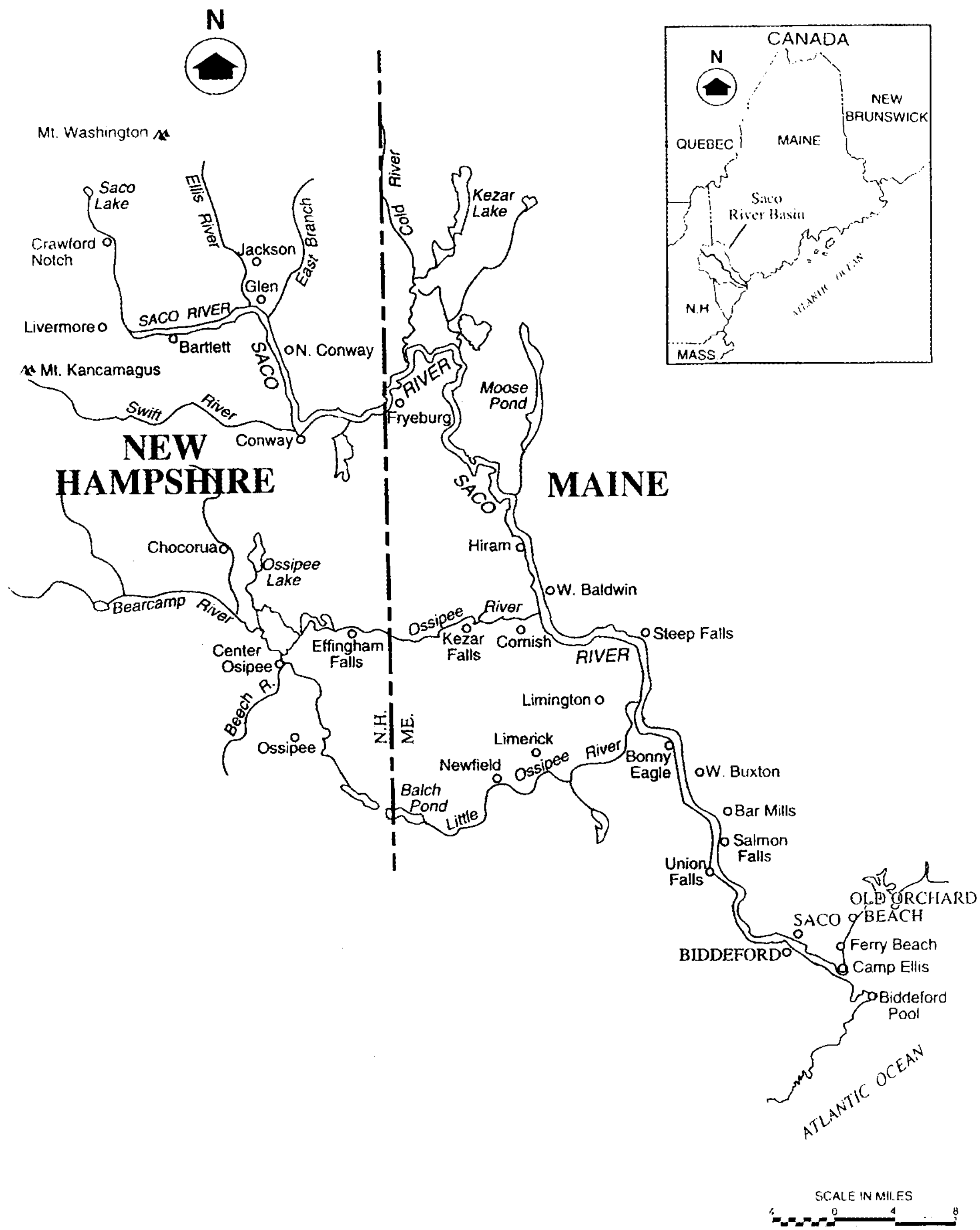

Figure 5.4 The Saco River corridor and its tributaries from the New Hampshire border to the Gulf of Maine (USACE, 1995).

The river has a mean discharge of approximately 91 m^3 per second with a maximum-recorded spring discharge of 1303 m^3 per second (MCP, 1979). As of 1979, there were 8 dams on the Saco and 27 on its tributaries. This has not interrupted the flow of sediment dramatically. Most of the dams are for power and have minimal storage capacity. Water is drained through the bottom of the dams allowing sediment to pass on down the river (MCP, 1979).

Sand Sources for the Beaches

There is some disagreement as to how much sand is supplied to the beaches of Saco Bay by the Saco River. The Army Corps takes the position that no appreciable amount makes it to the river's mouth due to the number of dams upriver (USACE, 1955; USACE, 1991). Their original analyses identified considerable amounts of sand, gravel, and timber being washed down the river and deposited around the islands near the river's inlet (USACE, 1886). The Army Corps considered the immediate project area sand starved (USACE 1955; USACE, 1992).

Others feel that the river adds considerable sediment to the system. They point to the sand bodies and bars found throughout the lower reaches of the Saco River as evidence that sand is still being carried downriver (Farrell, 1970; Kelley and Anderson, 2000; MCP, 1979; Nelson and Fink, 1980). Current meters show ample speed to transport sediment downriver (Manthorp, 1995). Only considering the volume of suspended sediment, a minimum sediment discharge of 6,100 m^3 per year was calculated. When also considering the infilling rate of the Saco River anchorage, sediment passing through the jetties represented by the infilling of Biddeford Pool, and the infilling rate of the Scarborough River anchorage, a range from 10,000 m^3 per year to 16,000 m^3 per year was calculated (Kelley et al., 1995b; Kelley and Anderson, 2000).

Other than the river's contribution, sand circulating within the system originates from the existing shoreface deposits. Sand is not able to bypass the rocky headlands bordering the bay and is not able to enter the beach systems from the outside. There are drowned glacial deposits off the coast, but the speed with which they were covered did not allow for significant erosion. Their sand is effectively isolated from the system (Kelley et al., 2002).

Pre-Jetty Conditions

Prior to jetty construction there were both ebb and tidal delta bodies in the Saco River (Farrell, 1970; USACE, 1991). The channel was "bifurcated", separated by ebb bodies at the mouth of the river (USACE, 1991; USACE, 1992). There was an exchange of sand along shorefaces and the delta bodies (Farrell, 1970; USACE, 1992). It is speculated that all the inlets, delta bodies, and crescent-shaped beaches of Saco Bay maintained equilibrium through exchange of sand from one area to another, prior to engineering alterations (USACE, 1992).

Post-Jetty Conditions

The ebb tidal bodies were eliminated with the construction of the north jetty. The bifurcated channel became a single channel (USACE, 1991b). The exchange of sand from inlet to shoreface was interrupted by the current jetty configuration (Nelson et al., 1979). Sand that does come down the river is carried over 1.5 km beyond the beaches and presumably lost from the system or is deposited in either the inlet mouth to form a northward pointing shoal at the end of the jetties (USACE, 1992), Biddeford Pool (Kelley et al., 1995b), or the Hills Beach area.[21]

Substantial accretion occurred along both Hills Beach and Camp Ellis Beach after the initial construction of the north and south jetties. This was a result of the remaining ebb bodies migrating toward the inlet and impounding along the outside of the jetties (USACE, 1991b; USACE, 1992). By 1896, accretion had stopped, coinciding with the heightening of the north jetty to 4.6 m (USACE, 1991b). This marked the beginning of a period of erosion for both beaches. Hills Beach eroded at first then accreted. It appears as if the compartment has now achieved equilibrium and reformed into its own crescent-shaped beach (USACE, 1992). Camp Ellis Beach, with the exception of a period in the early 1900s, has eroded constantly to the present.[22] By 1934 the shoreline had eroded to the pre-project position (USACE, 1991b).

Northeast waves strike the north jetty and are reflected inshore. As they travel along the relatively smooth surface of the jetty, they are amplified both in their base and height (USACE, 1992). These waves create longshore currents near the beach and scour the sand from the area (Figure 5.5). This sand is transported northward away from Camp Ellis and accretes at Pine Point blocking the Scarborough River inlet (Figure 5.6) (Barber, 1995; Kelley et al., 1995b). So much sand was accreting in the Pine Point area that the Scarborough River Inlet shrunk to one-third its normal width (Kelley and Anderson, 2000) and required construction of a jetty in 1962 (Farrel, 1972). Northward

[21] The beach appears to have achieved equilibrium therefore sand may be coming from the river.

[22] It is speculated that this short accretionary event was due to the disposal of dredge spoils and that remnants of the ebb-tidal delta were impounded along the jetty.

sand movement is also supported by observations at Goosefare Brook after spoil placement on Camp Ellis Beach. Nourishment at Camp Ellis is closely followed by sand closing the entrance of Goosefare Brook to the north (Kelley et al., 1995b). Corps reports estimate a loss of over 5.96 million m^3 by 1955 (USACE, 1955). Southwest swells that would normally carry nourishment material have even more of a difficult time reaching Camp Ellis Beach with the jetties now blocking the approach.

Figure 5.5 Storm waves at Camp Ellis Beach (Photo courtesy of Stephen Dickson, MGS)

As was mentioned, nourishment has been used at Camp Ellis Beach. This was in conjunction with maintenance dredges of the inlet and channel. The benefits were temporary, and sand was removed from the system and transported north. Over 30 homes have been lost to the sea, and the road bordering the beach in Camp Ellis is constantly

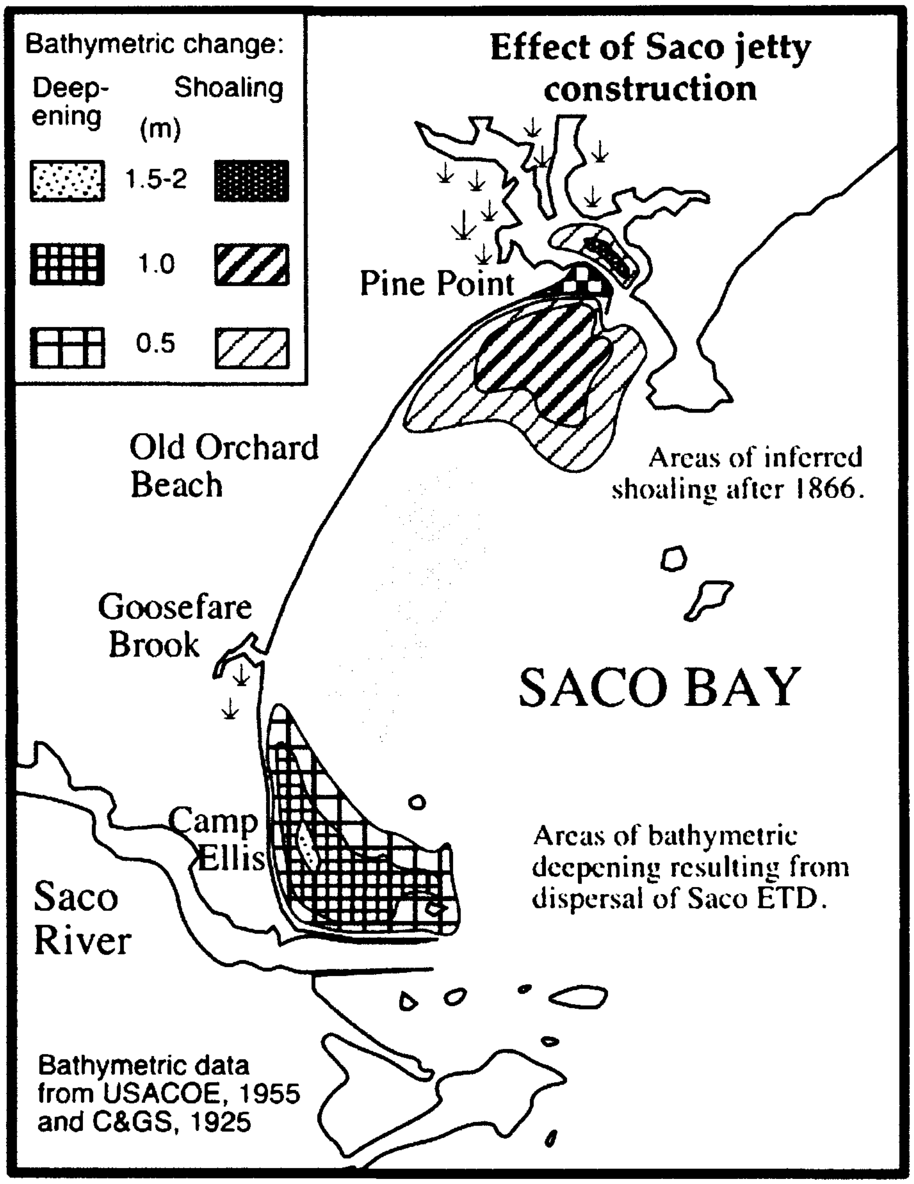

Figure 5.6 Longshore currents transport sand from Camp Ellis Beach north to Pine Point and the Scarborough River Inlet (Kelley et al., 1995b).

being over washed by water and sand (Pilkey and Dixon, 1996). In the current state, erosion will continue, destroying development and infrastructure.

Saco River Natural Setting Analysis

Several factors are important when examining how the engineering decisions have altered the natural setting of the inlet and adjacent beaches. First is that the Saco River contributes sand to the system. The amount ranges from 10,000 to 16,000 m^3 per year (Kelley et al., 1995b). The river is the greatest supplier of new sediment. Sand is introduced into the near shore system and exchanged along the beaches and delta bodies of other inlets to the north.

This observation leads into the second factor. Net longshore transport is to the north. Direction can change with storms, but transport is predominantly to the north. Again, sand from the Saco River travels north, feeding the beaches in Old Orchard and Scarborough. It has even closed smaller inlets in the past (Kelley and Anderson, 2000).

The final factor is the orientation of the inlet and beaches within Saco Bay. The southern end of the bay is directly exposed to the force of extratropical storms. The headland to the south blocks the replenishing southerly swells bringing sand during the summer months. Even without the jetties, the area is at a disadvantage in that respect. Without the benefits of natural nourishment, the immediate region around the Saco River is dependant on the exchange of sand from the river to counter the effects of erosion.

Flawed Design

Problems with the design of the project are rooted in a misunderstanding of the factors affecting the natural setting. First, the Army Corps believed (until very recently) that the net longshore flow for the immediate area was to the south, not the north. This resulted in construction of the first jetty on the north side of the inlet to stop shoaling sand believed to originate from the north.[23]

This obviously did not have the desired effect, and shoaling continued. In the same frame of mind the Army Corps believed that shoaling would stop if another jetty was added and if both were lengthened incrementally over time. They believed sand was coming from the north and either migrating around the end of the jetty and depositing in the inlet or actually traveling over the jetty and through the spaces in the rock. The lengthening of the jetties effectively moved the sand coming down the Saco River far out of the beach system. Now, apparently none of the sand makes it to the beaches in southern Saco Bay, although no one knows where it goes.

The belief that considerable amounts of sand were traveling over and through the jetties is the basis for heightening and tightening the jetties. This created the phenomenon seen today of waves being reflected and amplified onto the shores of Camp Ellis. This is the source of considerable damage to structures, flooding of streets, and scouring of the remaining sandy beach. Again, this engineering decision was based on a flawed understanding of the coastal processes of the project area.

[23] Problems would have existed if the south jetty were constructed first due to the tidal nature of the inlet. Both jetties were needed to create a deep enough channel, regardless of the direction of sand flow.

This is a common pattern seen in other Army Corps projects. Problems are addressed with expanding engineering designs. These expansions are sometimes based on the original flawed information, and the scale of problems increases with the size of the physical project.

Availability of Information at the Time

This project began in 1824, and it is safe to say the knowledge of coastal processes and marine geology was inferior to present understanding. The processes affecting southern Saco Bay and Camp Ellis were not as well understood as they are today; however, there was ample opportunity to learn much earlier then the Army Corps was able to do.

Residents and researchers knew for years that the sand traveled north, not south. They expressed this to the Army Corps to no avail (Dickson, 2002; Farrell, 1972; SOS Camp Ellis, 2003; Michaud, 2003). The Army Corps' earliest reports acknowledged that the river carried a good deal of sand to the coast. The evidence was debris piles and sand bars deposited in the lower reaches of the river (USACE, 1886). After this initial report the assumption was that the numerous dams located upriver and along the Saco's tributaries eliminated this source of sand. This was a viable assumption if the dams were backed by reservoirs. This was not the case. The dams were "run of the river" structures used for flood control and hydropower. By design they did not impound sediment like reservoirs. There is no indication that the Army Corps ever investigated this or made any attempt to verify this assumption.

Would Things Have Gone Differently?

Again, one would like to think that given the current knowledge of the project designers would adjust their plans accordingly if developing the area today. It is hard to say whether this would have happened based on the history. The Army Corps disregarded most anecdotal and written reports on the area. It is unrealistic to expect them to change the design whenever someone presents their own theory, but over the years, an overwhelming amount of information surfaced revealing that their original assumptions were wrong. It hasn't been until the last few years that they changed their stance. This might be due in part to the amount of public money spent without studying the project and becoming any more enlightened. An example was an $850,000 physical model of the project area built in Vicksburg, MS, during the early 1990s. It resulted in no action and no better understanding of the area (Kelley, 2003).

A secondary problem was that most of the Army Corps' data on the coastal processes came from sites outside the project area and were re-used, despite their inaccuracy, for close to 100 years. Wave, tide, and wind data were gathered from other areas along Maine's coast. Information on currents and sediment transport were determined using a wave model in Vicksburg. Nothing was done by the Army Corps to evaluate what was happening specifically at Camp Ellis. In 2003 they are finally making plans to make their first observations on site. This pattern does not support the belief that the Army Corps would be any more or less conscientious if the project were being constructed today. Therefore, it is not clear whether things would have been different.

Saco River – The Economic Justification

1886 Army Corps Report

The economic purpose of the Saco River Navigation Project was to generate commercial benefits. At the time, the cities of Saco and Biddeford were home to a vibrant manufacturing sector, primarily textiles. These businesses required production materials to manufacture their products and coal for energy. Transport occurred either by railway or by boat up the Saco River from the Atlantic (Table 5.5).

Shoaling in the river mouth made boat travel hazardous and permitted only smaller draft boats passage during the highest tides. The original navigation project from 1824 and the subsequent addition of a northern jetty in 1866 secured the migrating inlet. It was hoped that the jetty would also block the flow of sediment into the river mouth. By 1886, commercial interests requested further improvements of the channel through to the head of navigation. They also had the breakwater heightened to block the continued shoaling sediments (USACE, 1886).

River Borne Commerce - April 15 to December 1, 1883
Commerce: Coal, sand, cotton, iron, paving, pitch, paper, gravel, lime, cement, plaster, ashes, timber, and ice **Number of Vessels:** 40 – 50 schooners each year **Total Tonnage:** 38,000 tons (33,800 of which were coal)

Table 5.5 Commercial activity on the Saco River in 1883 (USACE, 1886)

The 1886 Army Corps report noted that considerably more commerce arrived by railway, particularly coal, the principal product originally coming from ships along the river. All finished products left by railway, leaving most ships empty for their return trip (USACE, 1886).

There were no specific benefit calculations presented in this report. Business interests along the river supplied all relevant commerce data. Both the channel improvement and the jetty heightening occurred. It appeared as if a strong enough case was made, in the eyes of the Army Corps, that the region's productivity justified the expenditure of public funds on the development project.

1910 Army Corps Report

By 1910, the south jetty was constructed and had already been lengthened. All previously authorized improvements, with the exception of lengthening the north jetty, were completed. Once again, commercial interests wanted to increase the capacity of the channel by deepening it to 2.3 m MLW. Justification was based on a need to accommodate larger vessels with greater drafts. Newer ships with larger drafts were blocked by the sand bar at the mouth of the river and found the 1.8 m MLW depth of the channel an impediment. They often had to wait for the highest tide conditions, sometimes for a week. Ships were under loaded in order to pass over the bar and through the channel. This raised rates, and some ships were reluctant to run the route (USACE, 1910).

In addition to channel expansion, engineers continued to struggle with shoaling problems at the mouth of the river. The full proposal in 1910 was a combination of improvements to the channel and lengthening of the north jetty (USACE, 1910). The projected cost was $218,000, over $3.5 million in 2003 dollars.[24] To that date, $351,775 had been appropriated from the start of the project (USACE, 1910).

There was some dissent within the Corps regarding project benefits. Some felt that benefits did not justify costs. The Board of Engineers did not share this opinion. They acknowledged that predicted benefits could not be achieved based on the existing size of the project. This meant that it was necessary to expand the size of the project in order to produce the benefits needed to justify the costs to date.

> "…under existing conditions resulting benefits are incommensurate with the cost. Furthermore, it is not probable that a change for the better will occur unless some increase in depth is obtained." (USACE, 1910, p.5)

They decided against jetty extensions and opted to invest only in the expansion of the channel. Engineers felt that shoaling would continue down the length of the jetty, no matter how long the extension. Short-term changes were expected to occur but in the long run conditions reverted back. This reduced the project price to $55,000 with $3,000 annually for maintenance (USACE, 1910).

Again, benefits were based on commercial activity, both on the rails and river. The volume of trade for 1909 was approximately $18 million for Saco and Biddeford (USACE, 1910). A summary of commercial activity is listed in Table 5.6.

[24] Converted using a GDP deflator with a base year of 1996.

River Borne and Rail Commerce – 1909
Commerce: Coal (majority), textile production inputs, machinery production inputs
Total Rail Tonnage: 63,276 tons received (40,000 tons were coal), 131,714 tons shipped
Total River Tonnage: 50,746 tons received (mainly coal), nothing shipped

Table 5.6 Commercial activity on the Saco River in 1909 by rail and river (USACE, 1910).

Again, specific benefit levels were not calculated. Justification was based on improved freight rates for both water and rail. Past experience showed a drop in rail rates by half from $0.70 per ton in 1890 to $0.35 per ton in 1900 between Portland and Saco. The reduced rates coincided with the initial improvements on the river channel (USACE, 1910). Water freight charges improved due to increased load capacity. Deepening the channel through the mouth also cut down on the time spent waiting for a high tide.

The exact effects were not known, but they assumed that a possible benefit of between $12,100 and $15,350 a year might be realized. The Army Corps openly admitted that this was speculation and that the actual results were unknown. They did not know if more ships would even start coming to the Saco River. They did not know how it would affect rail charges, nor did they know about future coal consumption overall.

There were other charges involved in water transport that would affect the ultimate benefits. There was a $0.12 per ton charge to tug the ships up the river and a $0.20 per ton offloading charge at the docks. The Army Corps proceeded with channel improvements based on the justification that increased channel capacity would attract the commercial traffic needed to generate the benefits that would validate project costs to date (USACE, 1910).

1924 Army Corps Report

By 1924 total project appropriations were $406,775. Commercial interests were again pushing for a deeper channel to accommodate larger vessels and cut down on the time needed to enter the channel. Shoaling at the river mouth continued. Another request to extend the north jetty was proposed to address the problems. District and division engineers rejected the project, reiterating previous comments that benefits would not justify costs and that even though lengthening the jetty might slow shoaling in the short run, the process would resume in the future (USACE, 1924).

The Board of Engineers requested a review and it was determined that benefits, amounting to $24,000 from increased size of coal shipments, justified both the jetty extension and the deepening of the channel to 2.4 m (USACE, 1924). Average coal shipment sizes had increased from the beginning of the project and projections led planners to believe shipments would continue to increase. Project planners were not allowed to consider the effects on rail freight charges this time. It is implied that these effects were not as relevant as previously believed. Commercial activity is summarized in Table 5.7. The cost was $122,000 with $3,000 each year in maintenance. The Army Corps acknowledged that private interests were benefiting from the project and required that the community provide 16%, or $20,000 of the cost.

River Borne Commerce - 1923
Commerce: Coal (mainly), cotton, and timber **Average Annual Tonnage:** 55,000 tons **Anticipated Tonnage for 1923**: 65,000 tons

Table 5.7 Commercial activity on the Saco River in 1923 (USACE, 1924)

1930 Army Corps Report

By 1930, $524,271.75 had been appropriated for the project, with $20,000 coming from local sources. These were all improvement costs and did not include funds spent on mitigation, such as jetty repairs along the shoreline or construction of the spur dike on the north jetty[25] (USACE, 1934).

The 1930 study investigated the possibility of further development for the Saco River project. This was an unsolicited search for development opportunities by the Army Corps. After review, it was determined that the costs of construction would far outweigh the benefits received from any navigation, flood control, irrigation, or hydropower project. The average annual water freight from 1920 to 1927 was approximately 50,000 tons at $502,000. This was very similar to the conditions prior to the 1924 report and does not represent the increase they predicted from the previous channel deepening.

[25] These costs did not directly effect the performance of the navigation project and therefore were not included in project accounting.

1934 Army Corps Report

The year 1934 marks the final extension of the jetties and an end of development for the Saco River navigation project as an industrial corridor. The remaining 262 m of the north jetty were added to extend it to Sharps Ledge and its present location (USACE, 1934). Savings in freight charges were no longer the intended benefits; the intended benefits were considered the foregone expense of dredging the shoals at the entrance of the inlet. Benefits were foregone maintenance charges. Setting up a dredging operation for a relatively small area was cost prohibitive, and it was determined that the cost of extending the jetty was less than the cost of continued dredging. This was the feeling despite continued concerns that the shoaling would only stop for a short time before reestablishing itself at the entrance (USACE, 1934). The cost for the extension was $69,000 plus an additional $500 in annual maintenance to the existing $3,000 annual maintenance costs.

Commercial interests requested an increase in the channel depth to 4.6 m, but this was not justified by the projected river commerce. In the 5 years prior to this report, commercial river traffic decreased by 25% (USACE, 1934). The water borne freight continued to average approximately 50,000 tons per year and was almost entirely coal. Considerable freight continued to be brought in by rail. The general feeling was that this would not change to water as a result of improvements. The Board of Engineers finally agreed. It was generally felt that the supply of coal was meeting demand and that, if anything, the demand would decrease over time (USACE, 1934).

1968 Army Corps Report

The final shipment of coal sailed up the Saco River in 1940. This was also the last year the project was dredged prior to 1968. Repairs were made to the jetties but nothing more. The Saco River had changed from a shipping route supporting commercial interests to a primarily recreational boating location and a harbor for a small fishing fleet. Subsequent development was focused on generating recreational benefits and decreasing the cost of operation for fishermen based on the Saco River (USACE, 1968).

The 1968 report investigated the feasibility of creating anchorages within the river and a turning basin at the head of navigation (Table 5.8). Existing conditions did not meet mooring demands. Boats were forced to seek shelter at other harbors during storms and continued shoaling forced most of the lobster boats to unload at Biddeford Pool to avoid delays and damage due to overcrowding and hazardous navigation conditions (USACE, 1968).

Navigation Development Project - 1968
Project Description: 2 anchorages, 10.5 acres in total area and a 10-acre turning basin at the head of navigation **Benefit Classifications:** 1. Reduction of tidal delays 2. Increased use of existing fleet 3. New additions to fleet 4. Increased transient use 5. Reduction in damages

Table 5.8 Saco River Navigation project expansion plan and benefit classifications in 1968 (USACE, 1968)

Additionally, the entire project was dredged to its original 1.8 m depth to accommodate the new traffic. Dredging was completed under a separate authority and did not fall under the budget of the new development project (USACE, 1968). There were secondary benefits mentioned in the report, in particular the benefits from placing dredged spoils on the eroding beaches. The Army Corps acknowledged that serious erosion problems existed on the adjacent beaches for years, although they did not accept responsibility. Benefits from nourishment were not included in the project, but they were considered an important component and established a connection between dredging and the health of adjacent beaches that continues today.

The recreational benefits were calculated in a similar manner to Wells Harbor benefits. Refer to Appendix B for complete formulas. Improvements were designed to make room for the fleet listed in Table 5.9.

Vessel Type	Number of Vessels
Recreational Fleet Existing	260
Recreational Fleet New	130
Transient New and Old	168
Commercial Lobster Existing	20
Commercial Lobster New	6
Sardine Fleet	NA

Table 5.9 Projected size of the Saco River fleet using the expanded anchorages from the 1968 development project (USACE, 1968).

The existing commercial lobster fleet landed 60,000 pounds of lobsters annually. An increase of 10,000 pounds was expected for the existing fleet, of which they would realize 80% of the revenue after expenses. The 6 new commercial lobster boats would add 21,000 additional pounds of lobster annually, of which 40% of the revenue would be realized after expenses (USACE, 1968).

The sardine (Atlantic Herring) fleet returned to use the anchorage. Both the sardine boats and the lobster boats benefited from foregone damage due to better navigation conditions. Specifically it was predicted that 5 lobster boats and 12 sardine boats would realize a decrease in damages (USACE, 1968).

Sixty boats that moored in the shallows near the head and mouth of the river were the primary recipients of benefits from project improvements. The other 200 boats already used one of the two marinas or yacht club (USACE, 1968). New recreational boats occupied new spaces in the anchorages, and improved conditions attracted more transient day use. Annual benefits are listed in Table 5.10.

Benefit Classification	Annual Benefit
Recreational Vessels	$20,400
Commercial Vessels	$9,840
Transient	$890
Damage Reduction	$3,400
Total Annual Benefits	**$34,530**

Table 5.10 Predicted annual benefits for the 1968 Saco River anchorage project (USACE, 1968)

The total cost of construction came to $202,400. A combined interest and amortization rate of 3.125% was used to discount construction costs (Table 5.11). Maintenance dredging costs were calculated assuming a sedimentation rate of 2,294 m^3 per year. The resulting benefit to cost ratio came to 2.7.[26]

[26] The Army Corps split the recreational benefits in half, claiming that half went to private interests. Therefore it is assumed that not all benefits go toward the benefit to cost ratio, reducing it to 1.85, still well within the acceptable criteria.

Activity	Cost
Construction	$8,000
Maintenance Dredging	$4,500
Maintenance Navigation Aids	$350
Total Annual Cost	**$12,850**

Table 5.11 Projected annual costs for the 1968 Saco River anchorage project (USACE, 1968).

1982 Army Corps Report

The last development project performed on the Saco River was in 1982. The project's aim was to provide year-round opportunities for commercial fishermen by building another anchorage near the City of Saco and providing sufficient protection from flowing ice during the winter months. Four options were investigated. One was discarded due to an inability to achieve the project goals. Of the other three, one entailed installing icebreakers to protect existing anchorages, and the other two proposed constructing a new 3-acre anchorage in addition to the installation of icebreakers. A new anchorage project was chosen with 13 icebreakers. This was the biggest in physical scope, chosen because it maximized net benefits (USACE, 1982).

The project catered to an estimated 16 vessels. Of the 16 vessels, 6 normally moored at Camp Ellis during the winter, 5 pulled out of the water, and the other 5 normally moved to another port for the winter. The 5 that moved to other ports represented a transfer of income from one port to another and therefore did not represent the majority of the benefits. The majority of benefits went to the other 11 boats in the form of additional fishing income. The transferred 5 boats received benefits in foregone costs associated with higher priced ports (Table 5.12).

Benefit Classification	Annual Benefits
Additional Fish Landings	$112,800
Foregone Boat Hauling Fees	$2,300
Foregone Relocation Fees	$3,500
Less Water and Road Travel	$1,600
Avoided Ice Flow Damage	$1,500
Total Annual Benefits	**$121,700**

Table 5.12 Predicted annual benefits for the 1982 Saco River project (USACE, 1982).

Additional fishing days represented 60% of the value of the new and additional catch, primarily finfish. The 11 boats not transferred from other winter harbors were the recipients. Foregone boat hauling fees went to the 5 boats that pulled out of the water during winter. The 5 transferred boats received the savings in relocation fees, and all received the savings in reduced water and road travel times. When computing the savings in damages due to ice flows, the Army Corps primarily considered the 6 boats normally moored at Camp Ellis for the winter. In all, benefits were very localized and focused on a small segment of the overall fleet.

Table 5.13 compares annual costs and benefits for the three plans. Plan 1 was the non-dredging option and plans 2 and 3 were the variations on a new anchorage.

	PLAN 1	PLAN 2	PLAN 3
Annual Benefits	$45,400	$121,700	$121,700
Annual Costs	$12,200	$29,000	$33,300
Benefit - Cost Ratio	3.7	4.2	3.6
Net Benefits	**$33,200**	**$92,700**	**$88,400**

Table 5.13 Predicted annual benefits, costs, benefit-cost ratios, and net benefits for the three versions of the 1982 Saco River development project (USACE, 1982).

A combined interest and amortization rate of 7.625 % was used to calculate annual figures. For all projects, benefits exceeded their costs. Any one would have satisfied the benefit-cost ratio criterion. Plan 2 was chosen because it had the greatest net benefits. It is clear within the report that planners would also lean toward plans 2 and 3 for because of the secondary benefit of beach nourishment.

Beyond the Scope of the Navigation Project

Erosion of adjacent beaches became an issue in the early 1900s and presently remains an issue. In 1920, the first erosion study was conducted to determine the effects on Hills Beach. Since 1920, there has been at least 12 Army Corps studies investigating the erosion problems at Camp Ellis (Pilkey and Dixon, 1996). Since 1970, there have been 23 scientific studies studying erosion and coastal processes in the project area (SBIT, 2002). Proposed mitigation options were discarded because they either were not cost effective or because they did not comply with State of Maine natural resource regulations. It is estimated that approximately $6.5 million has been spent on studies (SOS Camp Ellis, 2002).

Property Damage

Over 30 homes have been lost since the beginning of the project, and it is predicted, based on current erosion rates, that 60 more could be lost over the next 50 years (USACE, 2001).[27] The total value of these properties is over $8 million.[28] This

[27] Other than the erosion environment created by the waves and the northern jetty, sea-level rise will also play a part in the future loss of development. It is not clear whether the Army Corps accounted for this in their calculations. The State of Maine calculated different sea-level rise scenarios for Camp Ellis to determine the extent of the damage (MSPO, 1994).

figure does not include infrastructure damage. The loss of Surf Street would mean loss of utilities to Camp Ellis (Michaud, 2003). The City of Saco regularly repairs damage along Surf Street. The estimated average annual maintenance costs for the City of Saco are $19,700, which includes beach restoration, infrastructure repair, clean up, evacuation, and overtime for safety officials (USACE, 2001)[29]. Some form of repair takes place after every major storm.

Other "Incidental" Costs

There are other costs not included in economic reports. For the life of the project, the Army Corps had not acknowledged a connection between the jetties and erosion along the beach. Their position changed in the 1990s. The cost of seawalls, spur dikes, riprap, and other repairs to the beach-jetty interface are tied to the presence of the project. These used both local and federal funds.

Current Efforts and the Economic Rationale

Currently, $5 million in public funds from the Section 111 Study was allotted to address the erosion problems at Camp Ellis Beach (USACE, 2001). Almost $2 million has been spent on studies, and more are currently underway. It appears that any viable solution will be well in excess of the remaining $3 million (Dickson, 2002; Michaud, 2003). This takes the community over the $5 million spending limit imposed in the Section 111 Study. Congressman Tom Allen was able to secure additional appropriations

[28] It is difficult to determine where the 60 homes are located. The actual number may very well be smaller.

[29] As a note, this figure is much smaller than the $67,000 a year estimate used in the Corps' 1987 report proposing construction of a large seawall in Camp Ellis (USACE, 1987a).

of $1.22 million in federal funds for 2003, and it seems likely that he will need to secure much more.

A recent, unpublished, analysis of economic benefits by the Army Corps shows a potential of $48 million in property value benefits, as opposed to the $8 million in the 2001 Section 111 Study (Michaud, 2003). This was calculated looking at communities just north of Camp Ellis near Old Orchard Beach. The rationale is that if there is sufficient beach protection at Camp Ellis, the value of homes would be comparable to communities up the coast and Camp Ellis would enjoy the same property values experienced by their neighbors with healthy beaches. This is based on the assumption that Camp Ellis would start generating the revenue generated at beaches like Old Orchard.[30] The Army Corps is comfortable with this line of reasoning, as is the City of Saco for obvious reasons (Michaud, 2003).

Saco River Economic Analysis

There are essentially two economic periods in this project's long life. The first 120 years can be considered an industrial period. This essentially lasted from 1824 to the 1940s. As industry left the Saco River, the second period began with project development oriented toward accommodating commercial fishing and recreational boating. It remains this way today. In total, the project has spanned over 3 economic lifetimes (50 years per life as defined by the Army Corps).

[30] Camp Ellis would have to go through some major redevelopment in order to resemble the beach resorts to the north. It is doubtful that the community would be able to keep the type of beach necessary to keep property values at the levels they need as long as the jetties are still there.

Period 1: Industry

The original purpose of the navigation project was to develop the area and help the existing manufacturing industry grow. The benefits received were production inputs delivered at a lower cost, predominantly coal. The original intention was to also have these ships leave with finished products for distribution. Early on in the project's life, timber was shipped from the port, but records show that this was phased out and the manufacturing industries took over (USACE, 1924). Manufacturers did not use the river to ship finished products out to the market; trains were used for this.

Early in the project's history, the accounting records of benefits and costs were not nearly as well defined as they are in projects today. Due to lack of information, it is difficult to measure whether or not the predictions were accurate. Some familiar patterns do emerge. There is a constant physical and conceptual expansion of the project. This was to generate the benefits needed to justify the escalating costs. This was specifically referred to in the previous sections. The majority of commerce data on which benefits were calculated, came directly from the commercial parties asking for the project. There is no evidence that the Army Corps checked any of the data. Finally, the project was very focused and localized in nature. The idea that the "winners" could theoretically compensate the "losers" in the development of the national economy seems unlikely in this scenario. A good example is the fact that the river tug was owned by a few of the businesses on the river. They constantly were pushing for a bigger and deeper channel. This would allow bigger boats to enter and bring the cost of coal down, and it would also open it up to more traffic that would have to pay the tug fees to travel the river.

Toward the end of the industrial phase of the project, additional development and expansion were based on lowering the maintenance costs of the existing project. The Army Corps was not trying to improve the industry along the Saco River; they were looking for ways to address the growing maintenance costs of their expanding project. This became a cycle where new projects were necessary to maintain the expanding project, which, in turn, expanded the project even more. At the end of Period 1, maintenance costs escalated without any noticeable improvement to the project for the money spent.

The Accuracy of Period 1 Economic Predictions

Due to a lack of information, it is difficult to say how accurate the predictions from Period 1 were. This phase of the project spanned over 100 years and 3 major wars. It is possible that the project generated the benefits for which it was designed, but it is unlikely that the records will reveal the answer. It is clear, however, in reviewing the reports that some of the initial economic assumptions were wrong, in particular the effect on railway commerce. Railways continued to carry finished products out of the area - not the ships as was originally hoped. Additionally, rail rates did not drop as anticipated. This is implied by their omission in benefit calculations of later projects.

Period 2: Recreation and Commercial Fishing

Industry started leaving the Saco River, and the final coal shipment by boat went up the river in 1940 (USACE, 1968). The community still had the jetties and harbor. The usage converted to recreational and commercial fishing vessels. Both groups used the harbor prior to this but the Army Corps was now primarily interested in the development of the latter.

Justification of government involvement followed a pattern similar to Wells, which makes sense given that the projects are contemporaries. The Army Corps wanted to increase the size of both the recreational and commercial fleet while improving the conditions for the existing vessels. What actually materialized were several development projects targeting a very small segment of the society.

The Accuracy of Period 2 Economic Predictions

Records are poor, and it is difficult to say whether the project achieved the intended benefits. It is plausible that usage increased, and that demand met the expanding facilities. Commercially, lobster in York County has not been a leading contributor to the overall industry in Maine. This was shown in the Wells section. Finfishing in Maine experienced a decline during that time to present. In contrast, Atlantic Herring, or Sardine landings increased from the time of the projects to present (Figures 5.7 and 5.8).

Incidental Costs

There were other costs that must be considered in reviewing the economics of this project. First and foremost was the loss of 30 homes in Camp Ellis due to accelerated erosion caused by the jetties (Michaud, 2003). As was previously stated, the Army Corps believes another 60 homes will be lost if nothing is done to address the current problems. They alone are valued at over $8 million (USACE, 2001).

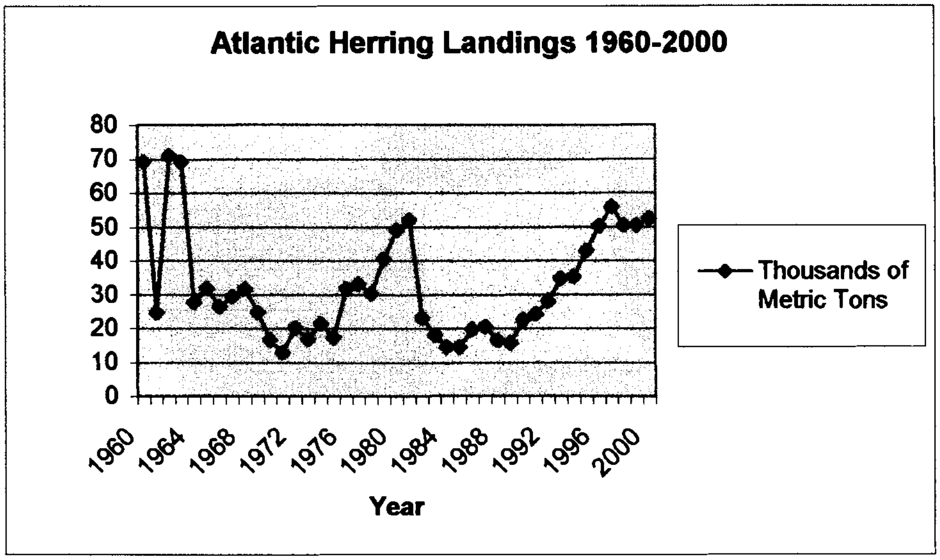

Figure 5.7 Atlantic Herring (sardine) landings by metric ton for the State of Maine from 1960 to 2000 (Maine DMR website, 2003).

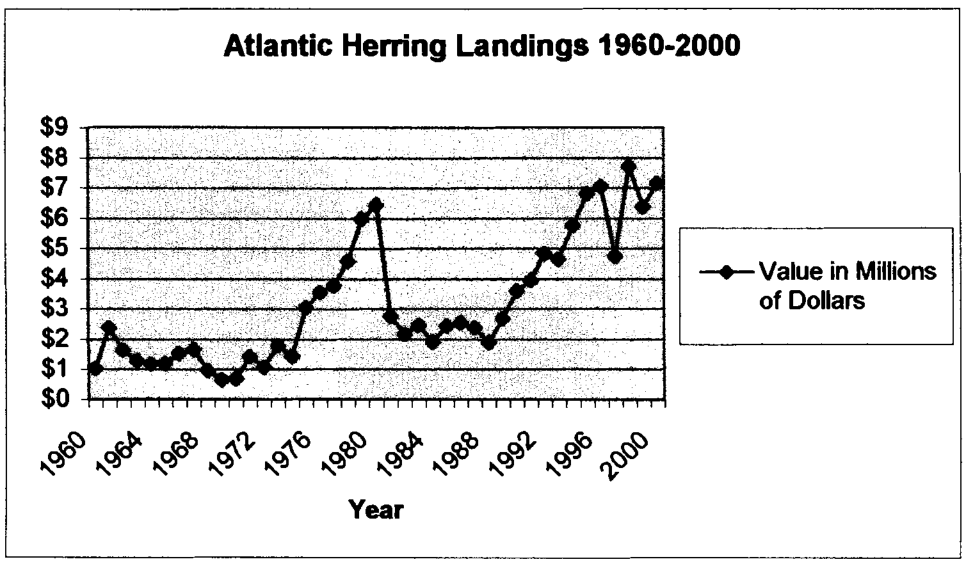

Figure 5.8 Value of Atlantic Herring landings in the State of Maine in 2001dollars from 1960 to 2000 (Maine DMR website, 2003).

There was the loss of the recreational beach fronting Camp Ellis. No one has calculated a number for this as of yet. Rip rap and repairs to property added to the cost figure. Annual maintenance performed by the City of Saco averaged $20,000, and it is reasonable to expect this to climb as conditions deteriorate and sea level rises. There have been millions of dollars in studies, with very little action. Another cost is for travel and meetings by the Saco Bay Implementation Team as they address interested parties. Currently $5 million has been allotted for mitigation, and it appears that this number will triple in time (Michaud, 2003). Costs have far exceeded original estimates.

Analysis Summary

The project increased in scope early on to generate the benefits needed to justify the increasing costs of construction and maintenance. This expansion is the root of erosion problems experienced along adjacent beach communities. This generated a need for more protective structures, which, in turn, required more maintenance. Economically the project turned from development to maintenance and mitigation. These costs have far exceeded the original cost projections.

The delay in response resulted in a deterioration of the communities. This drove down their value and decreased potential economic benefits produced by the area. Meanwhile, costs escalate as damage continues. This produced a situation where it was difficult to generate the benefits to justify mitigation costs. As each year passed, the gap between benefits and costs increased. Unless some leeway is given in applying the criteria for computing the benefits and costs, this cycle may repeat itself until the community is gone. Fortunately, new efforts have found the means economically to justify action, and the community will hopefully break out of this downward cycle (Ouellette, 2002).

Saco River – The Politics

Interviews

Open-ended interviews were conducted with 9 people representing the Army Corps, Saco Bay Implementation Team, Maine Geological Survey, City of Saco, SOS Camp Ellis, Congressman Allen's office, and the Maine State Planning Office.[31] Several of these interviews (Army Corps, MGS, and Maine SPO) were with the same people questioned on the Wells Harbor project.

Again, the objective of the interviews was to determine people's perception of the problem, define the health and status of relationships among participating parties, and determine their perception of success.

Perceived Problem	Frequency (n=9)
Jetties accelerate erosion that threatens development in Camp Ellis	9
Current regulations do not address unique case at Camp Ellis	6
Inaction (state and federal)	3
Unreasonable expectations from stakeholders	1

Table 5.14 Problem areas identified for Saco River Project during interviews with the 9 people representing the groups listed above. The frequency column shows how many people out of the 9 felt that this particular area was a problem.

[31] SOS Camp Ellis was represented by 3 people and Maine Geological Survey was represented by 2 people. Their separate voices were preserved because there was not agreement among them. This is why there are 9 people and 6 groups.

Other issues were mentioned during interviews. These included relationship issues between groups and criticism of others' actions. These were not included because in the author's opinion. They were not the driving problems in peoples' minds. Qualifying statements followed these criticisms acknowledging the overall progress made. Those criticisms seemed more a sign of frustration over their plight.[32]

It is more difficult to quantify the quality of the relationships in the Saco River Project then it is with the Wells Harbor Project. This is mainly due to the ongoing nature of negotiations and planning. People are working together, and most do not want to jeopardize progress with negative comments about others.

Something that is clear is that it is a different working environment than that in Wells. There are two main reasons for this. The first is the length of time the project has been going on. The Army Corps and community of Camp Ellis have been involved in studies of the erosion problem for over 100 years. The community has experienced the loss of over 30 homes and must face the prospect of property loss daily. Although there remains a level of distrust between groups, this is overridden by a sense of urgency. All parties are working against a clock and understand the potential consequences might be devastating. There is also a desire among agencies to end the ongoing debate associated with this project.

The second reason is the level of involvement from Congressman Allen's office. This is not to say that Senators Snowe and Collins have not supported the communities of Southern Maine. Both have aided the communities and helped appropriate federal funds when needed. This is appreciated by Saco and was noted during interviews. The

[32]Interviews with stakeholders in Camp Ellis took place prior to a large Northeaster hitting the Maine coast. Anxiety was at a high level during the interviews.

difference is the day-to-day hands-on assistance provided by a representative from the Congressman's office. He fills the role of intermediary and facilitator that has been missing for some time. He is successfully getting people to work through their differences. He helped to define objectives and goals. To the community, this represents a commitment by their congressman and means that their case is being heard in Washington. To the Army Corps, this is a message that a member of Congress, the source of their funding and directives, has invested a personal interest in the project and its outcome.

This keeps the process moving forward and is taking the focus off relationships and placing it on problem solving. Relationships between groups are improving. This was indicated during the course of interviews. If the process continues to move forward toward a solution, it is probable that relations will only continue to improve. This has positive implications for future endeavors along Maine's coast, beyond Camp Ellis and Saco.

Perceived Success	Frequency (n=9)
Slowing erosion to manageable rate where the town can afford to nourish	8
A working beach and working harbor	2
Flood-proof and relocate homes	2
Jetty removal and restoration of beach and harbor to natural state	1
Either a working beach or working harbor	1

Table 5.15 Perceptions of success identified for Saco River Project during interviews with the 9 people. The frequency column shows how many of the people out of the 9 felt that particular solution was viable.

Health of the Current Political Environment

The political environment was unhealthy but is rapidly improving. This is evident when reviewing the different responses regarding perceptions of problems and potential solutions. There is not the wide range of responses found in Wells. In each category, there is one overwhelming response that either has complete, or nearly complete, consensus from the participants. All view the jetties as the problem behind the accelerated erosion along Camp Ellis. All but one feel that the solution is finding a way to slow the erosion to a point where the town can manage their own problems with the resources they have. There are some incompatible perceptions, but they are few and held by a minority.

Although interviewees declined to give any definitive statements regarding their relationships with the other participants, it was clear that they are better then what is experienced in Wells. Their hesitation to comment reflects a respect they have for the current process. People are more focused on attaining the goal then on each other's actions.

The Early Industrial Years: 1800s – 1930s

The Saco River Project has a long history, approaching 180 years and spanning a number of Congresses and events in U.S. history.[33] Despite the project's longevity, the record of early Army Corps reports reveals that not all believed the Saco River deserving of a federally funded project. Engineers and officers within the Army Corps voiced doubt as to whether economic benefits justified the costs and whether project design could prevent shoaling in the inlet at the river mouth.

In 1886, Colonel of the Engineers, C.E. Blunt, wrote the following concerning development of the river channel.

> "I accordingly do not recommend the appropriation or expenditure of any money for next year for the improvements suggested in this report…a large proportion of all goods needed there have come, and will continue to come, by railroad entirely, irrespective of any river improvements." (USACE, 1886, p.4).

As was discussed in the previous section, the area already received the majority of its goods via railroad, and all manufactured goods were shipped out via railroad. This practice continued throughout the project (USACE, 1910). Local interests pushed for improvements, and the then acting Chief of Engineers, John G. Parke, authorized the project despite the objections of his officer (USACE, 1886).

In 1910, similar comments were made regarding another channel development project. Colonel John G.D. Knight, the Division Engineer, did not feel that the cost of increasing the channel capacity was justified by the benefits from water borne commerce. Additionally, he did not feel that remaining components of previous projects were economically worth finishing.

> "I do not deem this locality worthy of improvement by the General Government, and I am of the opinion that the completion of the existing project is not justified." (USACE, 1910, p.4)

Concern over the effectiveness of extending jetties was also voiced in this report. Engineers acknowledged that conditions along the channel had improved but the mouth of the river continued to experience shoaling problems. As previously stated, it was

[33] Abraham Lincoln was one of the earliest authorizers of efforts to develop the river (Michaud, 2003).

believed that lengthening might stop shoaling for a brief period, but the fix would only be temporary (USACE, 1910).

The Board of Engineers, after a meeting with local interests along the Saco River, did not agree with the opinions of the Division Engineer and requested a more in-depth study of the area. A new survey, of the same scope, was completed and endorsed by a different Division Engineer, Colonel W.M. Black. The new development plans were approved and initiated (USACE, 1910).

By 1924, further channel and project improvements were proposed. This time Division Engineer, Colonel H.C. Newcomb, and District Engineer, Lieutenant Colonel Wildurr Willing, both felt that the project was not worth expanding beyond its current dimensions. Again, the Board of Engineers voiced opposition to this opinion after consulting with local interests and authorized another survey. A different District Engineer, Major S.C. Godfrey, conducted the survey and determined upon review, that the improvements were warranted. The Division Engineer, Colonel Newcomb, still disagreed, but the Army Corps went ahead with improvements despite his dissenting view (USACE, 1924).

By the 1930s, it became clear to all that the project's productivity had peaked earlier that century. Benefits did not justify additional development of the project for industrial commerce (USACE, 1930; USACE, 1934). Dissenting views held by officers and engineers, were now shared by the Board of Engineers and no further review for development was requested.

Conflicts of interest emerged early in project development. Practically every project report contains internal dissenting views. The pattern that ensued was one of meetings between the Army Corps Board of Engineers and local commercial interests followed by the commissioning of a second survey that produced favorable economic and engineering results. To support further the idea of commercial interest exerting pressure upon the process, it should be noted that all economic data was compiled by the industry asking for the improvements and was accepted at face value by the Army Corps.

It should also be noted that the only tugboat operation on the river was owned and operated by Saco River manufacturing operations (USACE, 1924). Although this makes sense for businesses receiving coal via river transport to own the tugboat, it also raises the question of who was receiving the benefits from this project. It is not only in the best interests of business to get the freight cost of coal down, it is also in their best interest to get larger coal shipments because they are paid a greater tug fee. This could drive the political efforts to continually expand the size of the project.

Recent History and Erosion Problems

River borne commerce began to decline in the 1930s. The last year that coal was shipped up the Saco River was 1940 (USACE, 1968). Project development ceased from 1940 to 1968, but erosion and shoreline repairs did not. Homes were damaged and lost. A large winter storm in 1978 caused particular damage, requiring substantial repair to area beach development (Pilkey and Dixon, 1996). Residents of Camp Ellis and Hills Beach were concerned, and both the City of Saco and State of Maine pushed the Army Corps to develop a solution to address the erosion problem.

A change in Maine's coastal management policy in 1983 presented both the town and Army Corps with new restrictions on mitigation options. New hard structures, such as seawalls, groins, and breakwaters, were banned from use in Maine (Pilkey and Dixon, 1996). Despite these rules and the federal government's obligation to respect state coastal regulations, the Army Corps often proposed solutions in direct violation with Maine law. Smaller-scale projects that worked within the state's laws could not produce the benefits needed to justify the costs. This was frustrating to the Army Corps who were used to implementing engineered solutions. It was particularly frustrating to the towns that watched more of their sand wash away as studies and negotiations continued. Divisions grew between the state, the town, and the Army Corps that persisted through the 1990s and to a lesser extent today.

There was no unified voice among the communities of southern Saco Bay. An example of this was seen in 1988. The Army Corps planned to dredge the Saco River channel and mouth and place spoils on Camp Ellis Beach. This angered the residents of Hills Beach who believed the sand came from their beach and therefore should be returned. Their legal efforts to get sand back from their neighbors were blocked by the DEP and USF&WS on the grounds that dumping sand would harm clam-flats (Gold, 1988a). Efforts by the Town of Biddeford to dispose of dredged spoils from Biddeford Pool on Hills Beach were also rejected on similar grounds and economic issues (Gold, 1988b).

Tensions were high among all parties. The communities did not trust the Army Corps, and they felt that the state was more concerned with preserving the environment then people, a view that still persists with the property owners (SOS Camp Ellis, 2003). The Army Corps's relationship with the Maine Geological Survey and DEP soured as disagreement over solutions and coastal data persisted (Dickson, 2002; Habel, 2003;

Kelley, 2003; Pilkey and Dixon, 1996). This came to a head in 1992 when the Army Corps completed a Section 111 Study for Camp Ellis and determined that the erosion was indeed their fault, but there was no economically viable engineering solution. Under project guidelines, the federal government would not provide financial assistance. This was announced unexpectedly during a planning meeting with FEMA, the State of Maine, and stakeholders. This prompted an angry letter from Governor McKernan to the Army Corps, admonishing them for being uncooperative, obstructionist, and unprofessional (Kelley and Anderson, 2000; Pilkey and Dixon, 1996).

There was a total breakdown in communications between all parties and an environment of distrust flourished. The Army Corps walked away from the project for the rest of the 1990s. During that time, serious divisions formed within the community of Saco. The City of Saco, frustrated over the ongoing problems at Camp Ellis and repeated maintenance costs, was resolved to let Camp Ellis erode rather then expend more time and resources (Michaud, 2003). Camp Ellis was left to fight the problem on their own, and their future looked bleak.

Things changed for the better in 2000. A staff member from Congressman Tom Allen's office brought everyone back to the negotiation table, including the Army Corps. Allen's office moderated discussions between the state, stakeholders, and the Army Corps. A new process began, and continues, where all parties are working toward a common solution (Ouellette, 2002). A revised Section 111 Study produced economically viable solutions. The federal government is providing public funding, and Congressman Allen continues to secure additional funds.

Relationships within the community have changed over the last 4 years with the election of a new mayor and a deputy mayor, himself a resident of Camp Ellis. They have committed the City of Saco to finding a solution for the problems at Camp Ellis (Michaud, 2003). Congressman Allen's office helped form the Saco Bay Implementation Team consisting of stakeholders, local administrators, state agencies, and Congressman Allen's office. They have been instrumental in getting the state and community to move forward in a common direction and have managed to keep the Army Corps engaged in the process actively seeking a solution.

Currently, relations are far better than they have been in recent history. People are working together to reach a solution. It is taking longer than expected, due to the need for additional studies, but it is moving forward nonetheless. There is still distrust under the surface, mainly from stakeholders. Most of this is aimed at the state and their regulatory stance on the coast. People are upset with the Sand Dune Rules, in particular the inability of the community to construct any new hard structures to protect their homes (Skinner, 2002). This has prompted local representatives to seek exceptions to the rule for Camp Ellis in the state legislature. A new bill will be presented to the Maine legislature in 2003 that would provide Camp Ellis with an exemption from state regulations and allow the community to armor the stretch of beach along Surf Street (Michaud, 2003). Local representatives are considering bills of their own seeking similar exceptions (Skinner, 2002).

Stakeholders are still wary of the Army Corps. Recent delays in the project led some residents to doubt whether the Army Corps will embark on any work (SOS Camp Ellis, 2002). A plan was due in December 2002. The meeting was delayed and didn't occur until the end of January 2003, where no plan other than to go forward with 6 more months of studies was presented. Residents present at the meeting were upset and vented their frustration (SBIT, 2003).

Despite these setbacks, officials remain positive about the process and their progress. A City of Saco administrator acknowledged that it is understandable if stakeholders are upset. Their homes and property are at risk. He emphasized that, despite the grumblings and hurdles, solutions were being entertained rather than discarded (Michaud, 2003). Congress Tom Allen's office voiced similar feelings conceding that this is a difficult task, but the continued efforts of those involved, and their dedication to reaching a solution keeps negotiations moving forward (Ouellette, 2002).

Saco River Political Analysis

There are several stages in the project's political history worth identifying. The first is the authorization stage early in its life. The second stage is the intervening years up until the year 2000 where erosion problems escalated, and the health of the political environment deteriorated to all-time low levels. The third and final stage is very recent, 2000 to present, and is characterized by renewal of negotiations and mitigation efforts.

Stage 1: Project Authorization

This stage spans the early years of the project from approximately 1886 to 1924. It is representative of a pattern common to other projects. The projects were not deemed viable either economically or in design. There was an initial move to refuse the project.

An oversight body pressured by special commercial interests within the community overturned this refusal and a new survey was conducted with positive results granting project approval. With the Saco River Project, this cycle repeated itself several times as jetty expansion occurred over time.

Stage 2: The Erosion Years

Soon after jetty construction, problems arose. Deteriorating conditions and inaction led to divisions forming between the various participants. The state and stakeholders held the Corps responsible, and distrust grew that still exists today (and carried over into other Maine federal projects). A change in coastal management ideology in the mid-80s was a leading cause for problems between the community and the state and the Army Corps and the state. Much later in the process, a division formed within the community between beach property owners and non-beach property owners. One does not see the interaction of NGOs and the USF&WS because habitat was not an issue; there is none of great concern. The result was disagreement and distrust all around. Everyone, led by the Army Corps, walked away from the mitigation process.

Stage 3: Renewed Efforts

Beginning around 2000, Congressman Allen's office took a particular interest in resolving the problems in Camp Ellis and dedicated the personnel and resources needed to complete the job. There is also the implied support of Maine's two very influential senators: Snowe and Collins (Michaud, 2003). The Congressman's office provides two services. The first is mediation that has been successful in getting people to return to the negotiating table, working toward common goals. The second is his efforts at appropriating the funds necessary to carry out any of the solutions. Aside from this, another key element in this stage is closing of the division within the community. A new mayor's office has changed the city's stance on Camp Ellis and is providing a unified voice to the state and federal government.

Holistic Analysis

Again, this project can be divided into three separate phases. The following is a summary of how all three components previously analyzed interact to drive the final outcomes.

Phase 1: Project Authorization

After the initial review of the economic data and engineering objectives, it was determined that the project was not warranted based on marginal returns and uncertain performance in the dynamic environment (Figure 5.9). Special interests within the communities applied political pressure and were able to get a second review of the project that produced favorable results and justified federal involvement. Project authorization was based on flawed economic assumptions and an incomplete understanding of the coastal processes defining the natural setting. The result was the beginning of a marginal project with an uncertain outcome subject to federal regulations and funding.

Phase 2: Project Construction

The present Saco River Navigation Project is the sum total of a history of engineering and design changes. The changes were made to address problems experienced at the project that impaired its intended function. Each change was preceded by a feasibility study reviewing the economic and engineering data. Unfortunately, much of the original data responsible for the problems was recycled. The result was a lifecycle of alterations that perpetuated and amplified the existing problems (Figure 5.10).

Phase 3: Project Mitigation

All three factors, the natural setting, economics, and the political environment contributed to an inability to move forward on a mitigation plan. The natural setting was not conducive to the project desired. Solid structures had adverse effects on the surrounding beaches. The setting has not become any more favorable and therefore continues to be an obstacle. Economically, as the community deteriorated and manufacturing moved off the river, the potential benefits generated from investment in the region declined. As costs escalated with the size and scope of the project, there was an inability to achieve a net benefit. Based on the federal guidelines, this precluded the project from any further funding. The community had limited funds to begin with and now as a result of the beach deterioration, they have even less. Politically, relationships deteriorated over the project's life. Ideological differences in coastal management further exacerbated existing problems. By the 1990s, parties walked away from the negotiation table, and there was every indication that the problem would resolve itself only when the last home fell into the ocean.

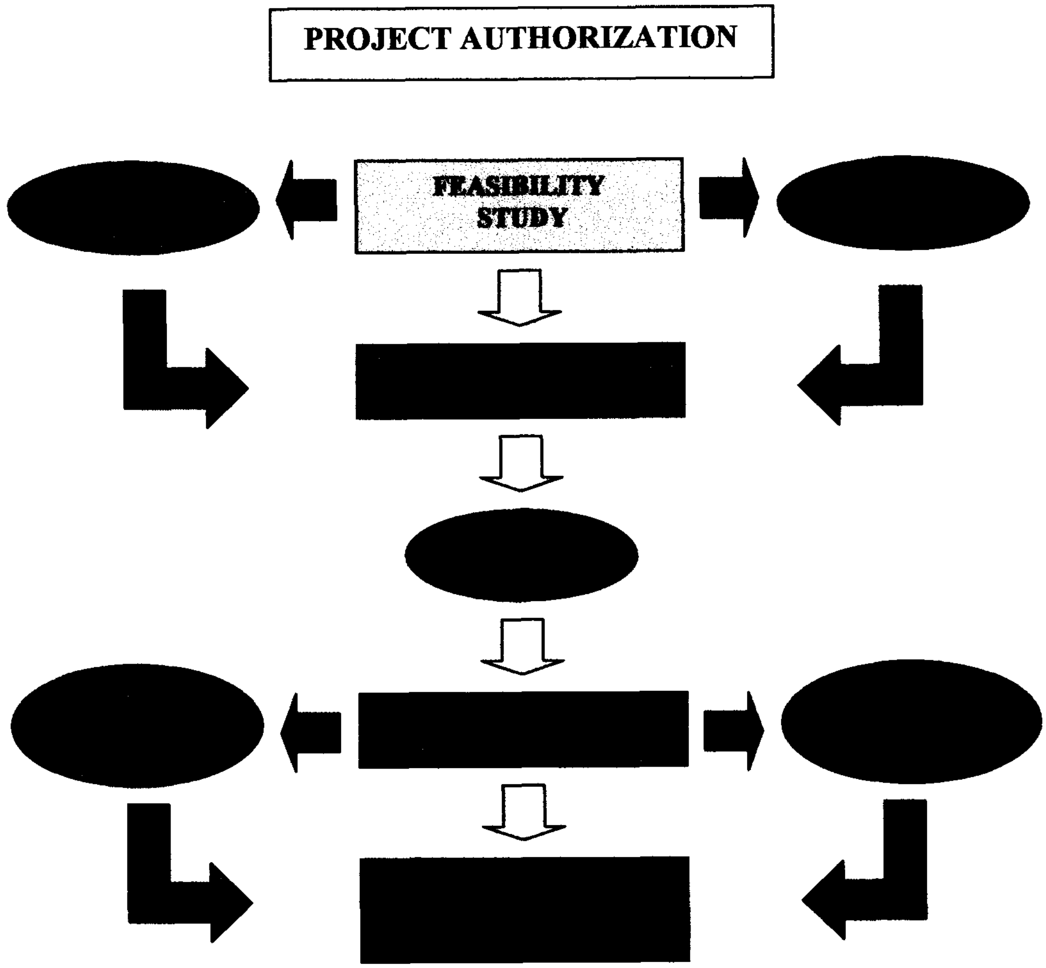

Figure 5.9 Project Authorization Phase for the Saco River Navigation Project

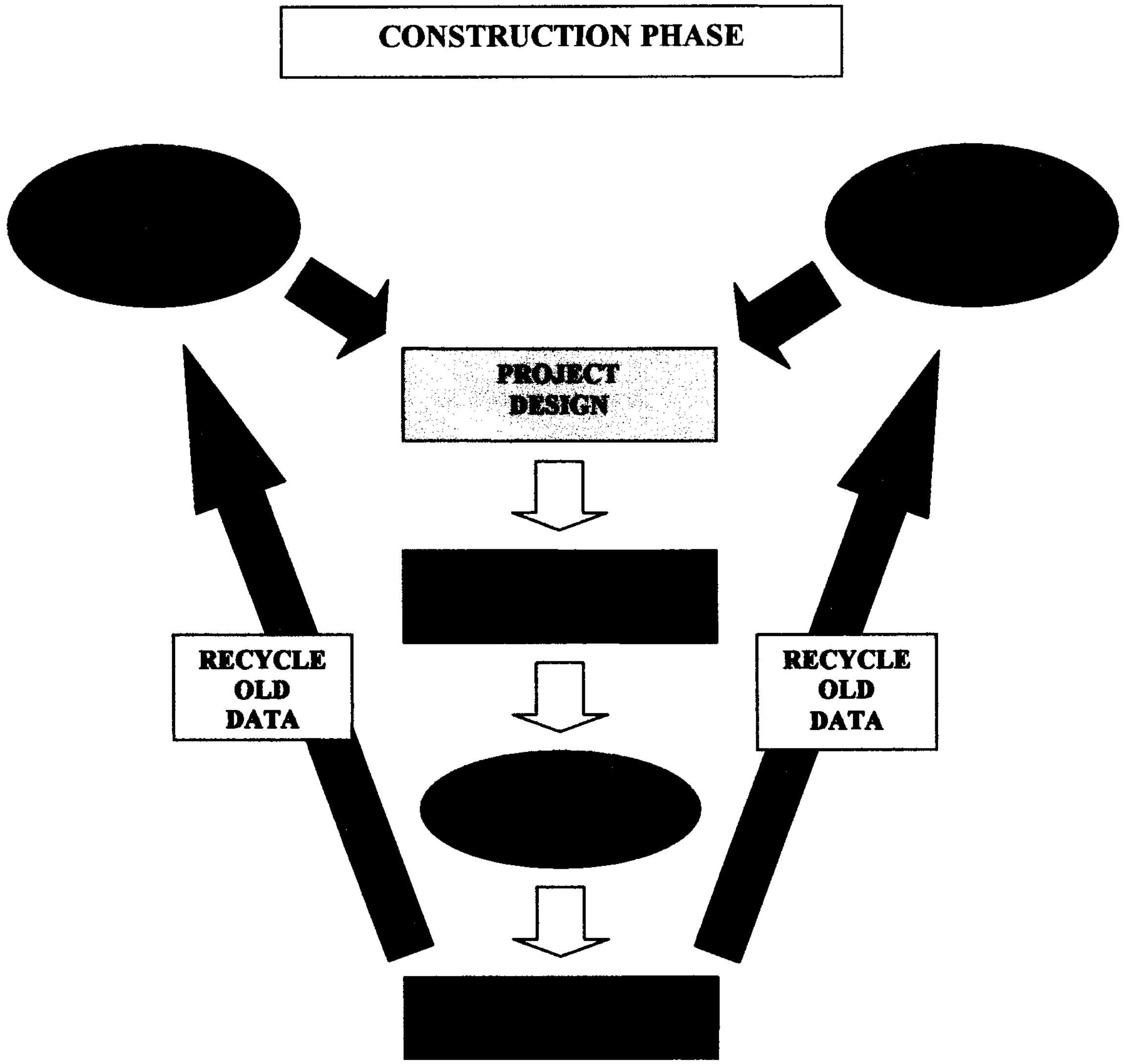

Figure 5.10 Project Construction Phase for the Saco River Navigation Project

New life was pumped into mitigation efforts in 2000 with the introduction of a mediator. Effective mediation repaired enough of the damage to the political environment to start negotiations once more. Further positive changes in the political environment opened different avenues in both the economic and engineering segments of the project (Figure 5.11). A new view of the economic situation found favorable grounds for federal involvement and the appropriation of funds has allowed plans to move forward. There has also been a move to gather new data directly from the site to determine the best possible option to help slow erosion. This is a break from the established routine and represents a move to consider different options. The problem has not been solved and there is no guarantee that it will. The mitigation process is currently moving forward.

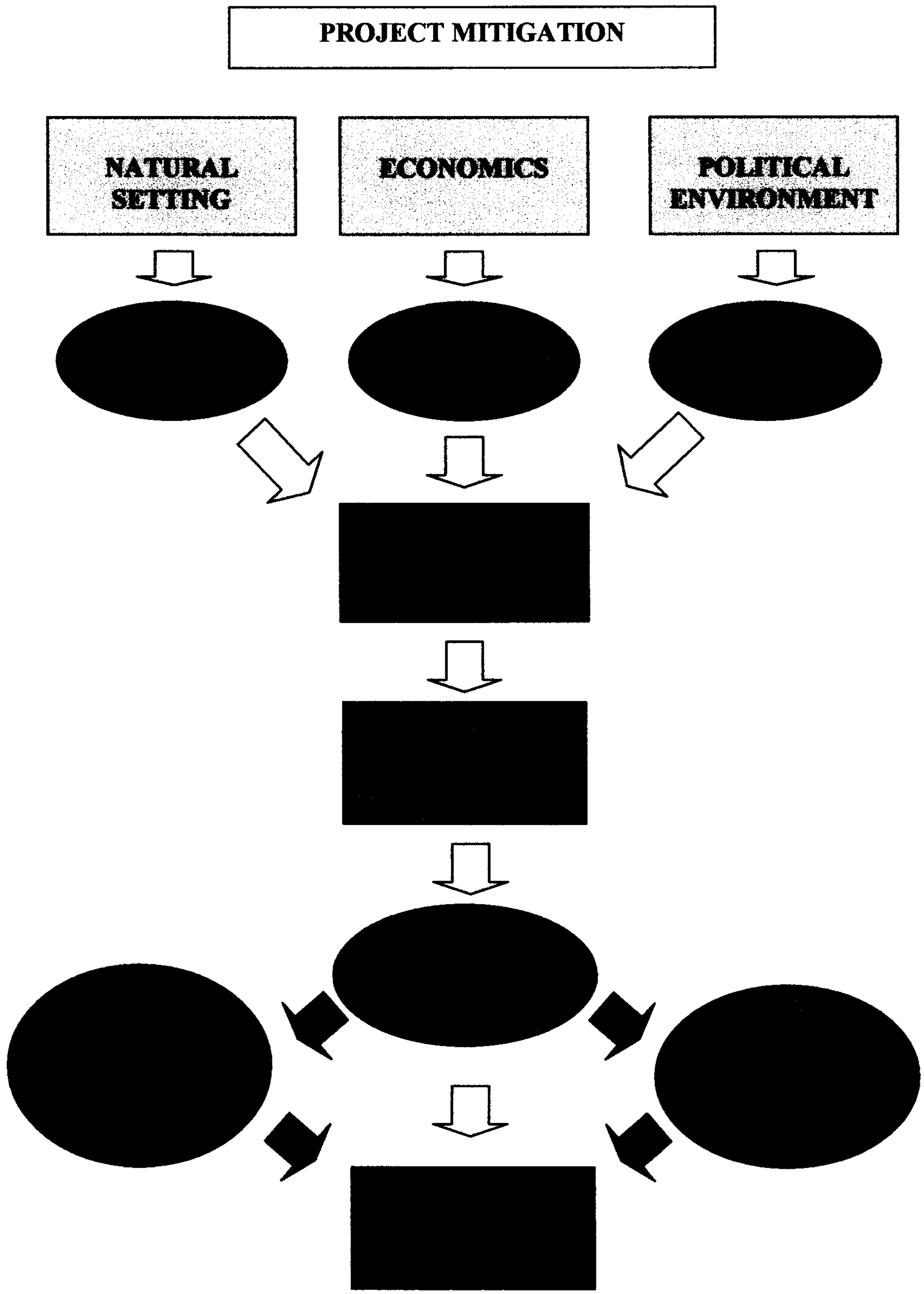

Figure 5.11 Project Mitigation Phase for the Saco River Navigation Project

CHAPTER 6

CASE STUDY 3: COLD SPRING INLET NAVIGATION PROJECT

Cold Spring Inlet and Cape May Harbor

The first attempts at navigation development in the Cape May area occurred in 1890. Local interests requested a breakwater located approximately 9.6 km east of the Cape May Peninsula to shelter ships. An Army Corps survey was completed, and the request was denied on the basis of poor economic and engineering conditions. There already existed such a breakwater at the entrance of Delaware Bay, and the shifting shoals the new one would be built on were unstable. More importantly, there was no commerce in that area that warranted the public investment (USACE, 1890).

Four years later another survey was conducted, this time to investigate the possibility of improving the Cold Spring Inlet for commercial use (Figure 6.1). Once again, the project was rejected based on economic and engineering concerns. Specifically, Army Corps Engineer, C.W. Raymond sited problems associated with establishing inlets and harbors in such a sandy and tidally influenced environment. He went on to make a broader statement about such endeavors on the whole.

> "The construction of such jetties upon a sandy coast is costly and uncertain. Owing to the instability of the beaches expensive works of shore protection are required. As shown by experience the harbors thus formed always lack accessibility. Finally the permanent maintenance of the requisite channel depths [through] such entrances is apt to be a source of constant trouble and expense. The improvement of an inlet on a sandy coast is one of the most difficult problems of harbor engineering; its cost and uncertainty are so great that it should be attempted only when necessary to improve the approach to some great port of commerce." (USACE, 1894, p 2)

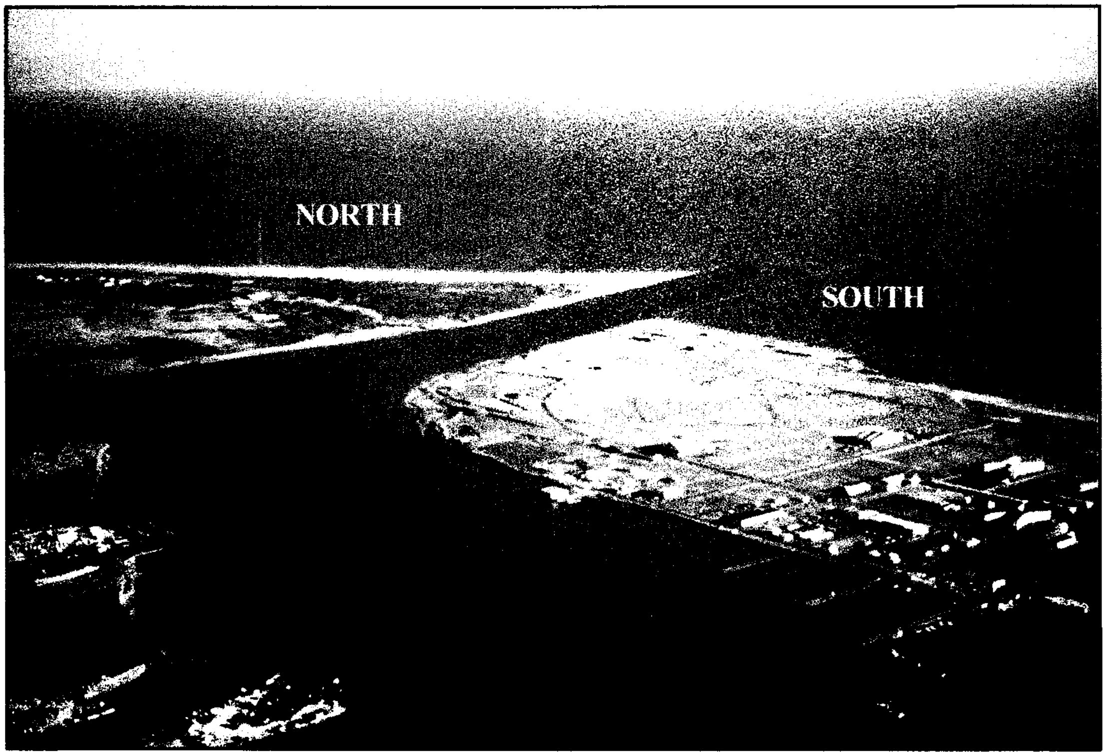

Figure 6.1 Aerial photo of Cold Spring Inlet, also referred to as Cape May Inlet, and Cape May Harbor 1978 (photo courtesy of J.T. Kelley)

Thirteen years later the project was revisited. Commercial interests wanted a stabilized inlet with a federally maintained channel extending into the back basin. By this time considerable local resources were invested into the development of the area as a commercial center. The Cape May Real Estate Company dredged 6.9 million m^3 of sand from the 60-acre basin behind the inlet to create a 500-acre harbor with 9.1 m mean low water (MLW) depth. The entire shoreline was stabilized with bulkheads, and dredge spoils were used to fill in the surrounding wetlands for commercial development. The Pennsylvania and Reading Company installed tracks, extending their rail service to the new harbor. Cruise line companies expressed interest in making the new port a stop (USACE, 1907).

Army Corps surveys reported favorable engineering conditions, but they remained concerned with the economics. They were asked to develop an area to attract commerce as opposed to aiding existing commerce. No water-based commerce existed at Cold Spring Inlet. Trains delivered everything to the area, and that amounted to only 100,000 tons per year. It was assumed that this would not change. Local parties pleaded their case, and the Army Corps agreed to go forward with the project based on the $3 million commitment already made by the community (USACE, 1907). Between 1907 and 1911 two jetties were constructed to stabilize the inlet, and a channel was dredged into the back harbor. The jetties were placed 229 m apart, and a channel 7.6m deep MLW was dredged into the harbor (Table 6.1).

Between 1907 and 1941 the Intracoastal Waterway was completed through New Jersey, extending from Cape May Harbor in the south to Manasquan Inlet in the north. Cape May Canal was completed around that same time, joining the harbor with the

Delaware Bay by cutting west across the Cape May Peninsula. At this point in time, the commercial harbor was near completion, and the Coast Guard and Navy had established a training base and air station on both sides of the inlet, extending from the ocean side beach back to the harbor shore. Commercial and government interests wanted the existing channel to be lengthened and deepened, citing commercial benefits and national security. Existing conditions did not allow for easy access for larger ships into the port on the west side of the harbor where they could seek shelter and service (USACE, 1941).

Cold Spring Inlet Navigation Project - 1907	
East Jetty:	1386 m in length, rubble mound construction, 229 m inshore wing
West Jetty:	1344 m in length, stone and rubble mound construction, 91 m inshore wing
Channel:	7.6 m deep, 122 m wide at MLW, extending into back harbor

Table 6.1 Dimensions and design of the 1907 Cold Spring Inlet Navigation Project (USACE, 1941).

The Army Corps authorized a project to expand the channel. The existing inlet and channel were dredged to a depth of 7.6 m MLW under the authority of the original project. The channel was then extended farther into the harbor under a new authority, also to a depth of 7.6 m MLW. This allowed for military ships to dock at the base without running aground on shoals in the channel and harbor (USACE, 1941). These were the last changes made to the actual navigation project itself and the only other development beyond the initial construction. Subsequent efforts focused on shore protection and most recently, habitat preservation and restoration.

Erosion and Shore Protection Projects

Erosion down drift of the inlet did considerable damage to the beaches on the Peninsula. Cape May City lost nearly all of their beaches and their source of tourist revenue. The following is an excerpt of a letter from a Cape May City official requesting federal funds for shore protection. It conveys the severity of the situation at that time.

> Our community is nearly financially insolvent. The economic consequences of beach erosion are depriving all of our people of much needed municipal services…The residents of one area or town, Frog Hollow, live in constant fear. The Frog Hollow area is a 12 block segment of the town that becomes submerged when the tide is merely 1 to 2 feet above normal. The principal reason is that there is no beach fronting on this area… Maps show that blocks have been lost, that a boardwalk has been lost… The stone wall, one mile long, that we erected along the ocean front only five years ago has already begun to crumble from the pounding of the waves since there is little or not beach… We have finally reached a point where we no longer have beaches to erode. (Nordstrom et al., 1986, p39)

Local and state projects were instituted to address the erosion problems. It wasn't until the late 1980s that the federal government instituted a federally funded nourishment plan for the communities on the Peninsula. The following is a summary of a portion of what has been done over the last 90 years. The historic records are good, but because projects were managed by a number of different entities over time, the record is not entirely complete. Other local and state projects may have, and most likely did, occurred.

The Army Corps conducted erosion studies in 1926, 1928, and 1931. Their findings did not justify use of federal funds for shore protection projects. Local interests were left to fund mitigation on their own. The State of New Jersey offered some relief in 1922 when they began providing financial assistance to municipalities for the purpose of shore protection (USACE, 1957).

The first seawall was built in 1914 to protect Cape May City (Table 6.2). Alterations and repairs were made in 1930 and 1946. A bulkhead was constructed along Cape May Point at the southern tip of the peninsula.

Year	Area	Work Completed
1914	Cape May City	Timber seawall
1930	Cape May City	Timber seawall replaced with steel wall
1946	Cape May City	Repairs to existing wall
1914 - 1946	Cape May Point	Bulkhead shorefront properties

Table 6.2 The history of seawall work on Cape May Peninsula from 1914-1946 (USACE, 1947).

Cape May City also invested in a substantial groin field (Table 6.3). From 1925 to 1946 over 24 groins were erected on the city's beaches. This groin field and a large stone seawall protected Cape May City's entire beach frontage. The Coast Guard and Naval station just west of the inlet, installed 7 groins along their beach. The community of Cape May Point installed 20 groins along their beaches between 1930 and 1943. Lower Township, between Cape May City and Cape May Point, remained undeveloped and was not protected with structures (USACE, 1947).

Year	Area	Work Completed
1925-1929	Cape May City	24 groins
1930-1932	Cape May Point	16 groins
1936-1940	Cape May Point	3 groins
1939-1941	Cape May City	8 groins; 13 repaired
1941-1945	Coast Guard-Naval Base	7 groins
1943	Cape May Point	1 groin
1946	Cape May City	5 groins

Table 6.3 The history of groin construction on Cape May Peninsula from 1925-1946 (USACE, 1947).

By 1953, the Army Corps acknowledged that the jetties were responsible for some of the erosion experienced down drift. A shore protection study was begun in 1951 and completed in 1953 (USACE, 1951; USACE, 1953). The findings justified federal involvement and the use of public funds to assist in a shore protection project for Cape May City. Lower Township and Cape May Point to the southwest did not produce the economic benefits necessary for public funding. Plans were offered to them, but no money. The Coast Guard base was under a different federal authority, and they were responsible for their own land.

The plan entailed an initial nourishment of the beach fronting Cape May City and then the placement of sand near the Coast Guard Station in subsequent years to act as a feeder beach for down drift Cape May City. The plan included repairing 5 existing groins and allotted for the construction of 5 new ones, if conditions deemed them necessary (Table 6.4).

Cape May City Shore Protection Plan – 1953
Nourishment: 636,110 m^3 of initial sand on Cape May beaches; 229,366 m^3/3yr for 50 years
Groins: Repair of 5 existing groins; construction of 5 new groins deferred
Lower Township and Cape May Point were given protection plans but no money

Table 6.4 The proposed design of the 1953 Cape May City Shore Protection Plan (USACE, 1953).

This specific plan was never initiated but served as the basis for 40 years of subsequent reports and recommendations prior to any federal project initiation.

A report on the condition of the New Jersey shoreline was completed in 1957 (USACE, 1957). It reaffirmed that shore protection options for Cape May City were justified and should be initiated. The project specifications were modified in 1960 and 1962 (USACE, 1965b). In a 1976 survey of coastal inlets and beaches, additional recommendations for the proposed shore protection plan at Cape May City were presented (USACE, 1976). The Army Corps proposed a sand bypassing system to transport impounded sediment along the east jetty, across the inlet, to the outside of the west jetty. They also proposed building more groins and constructing dikes along Cape May Point to address flooding in the community.

Recent Projects

In 1976, a Section 111 Study officially concluded that the erosion experienced down drift of the jetties was in part due to the presence of the federal project. Although the government had previously acknowledged this, the Section 111 Study opened the entire stretch from the inlet through Cape May Point up to the possibility of more federal funding and officially expanded the scope of the original navigation project to include the shore protection plans (USACE, 1976; USACE, 1980b). Phase I and II design memorandums were completed in 1980 and 1983, respectively, for the new shore protection project (USACE, 1980b; USACE, 1983). The plan is summarized in Table 6.5.

Cape May City Shore Protection Plan - 1983
Nourishment: 275,240 m^3/2yr (50 years); supplied to feeder beach on west side of inlet
Sand Bypassing System: Develop method for transporting sand from impoundment area on east side of inlet to west side of inlet
Groins: Finish the repair of 5 existing groins from original project
Monitoring Program: Lower Township and Cape May Point were given protection plans but no money

Table 6.5 The proposed design for the 1983 Cape May City Shore Protection Plan (USACE, 1983).

Once again, Lower Township and Cape May Point were not included in the final project funding due to economic considerations. The naval base at Cape May Point had been purchased by the state and turned into a state park for beach recreation but was not generating the revenue needed to justify federal funding. Lower Township remained undeveloped. Monitoring programs were suggested for both these areas. After 40 years of studies and plans and an economic reevaluation in 1987 (USACE, 1987b), construction of the main beach restoration project for Cape May City finally began in 1989.

Nourishment maintenance continues today on an average of every two years (USACE, 1997b). Nourishment in the 1960s was emergency in nature, related to the March 1962 storm that caused considerable damage along New Jersey's shoreline (Gebert, 2003). Since 1962, more than $166 million of nourishment was performed on the Cape May Peninsula (Table 6.6).

Area	Year	Funding Type	Cubic Meters	Cost (2002$)
Cape May	1962	Federal: Storm & Erosion	325,097	$4,096,360
Cape May	1967	Federal: Emergency	NA	$972,663
Cape May	1969	Federal: Emergency	NA	$146,095
Cape May	1981	State/Local	265,561	NA
Cape May	1989		91,747	$3,435,572
Cape May	1991	State/Local	34,405	$259,675
Cape May	1992	Local/Private	313,467	$1,539,991
Cape May	1993	Federal: Navigation	76,456	NA
Cape May	1993	State/Local	NA	$110,952
Cape May	1995	Federal: Storm & Erosion	688,099	$5,173,380
Cape May	1999	Federal: Shore Protection	NA	$60,251,219
Cape May	1997	Federal: Shore Protection	279,827	$2,662,455
Cape May	1999	Federal: Shore Protection	305,822	$3,625,545
Cape May Point	1992	Federal: Emergency	182,729	$2,303,755
Cape May Point	1999	Federal: Ecosystem Restoration/Shore Protection	1,813,520	$78,451,452
Cape May State Park	1986	Federal: Emergency	691,985	$1,217,624
Cape May State Park	1992	State/Local	NA	$331,155
Lower Township	1969	State/Local	NA	$366,766
Lower Township	1986	State/Local	275,240	$1,854,454

Table 6.6 A history of nourishment projects on the Cape May Peninsula from 1962-1999 (Duke University, 2002).

Lower Township – Cape May Meadows

In 1986 there was a presidential decree to focus on ecosystem restoration projects (Fraser, 2003). Projects could now be authorized based on the ecosystem restoration benefits rather than strict economic criteria (Zapille, 2003). Lower Township, now Cape May Meadows, included Cape May Point State Park and the Cape May Migratory Bird Refuge. This area was chosen for ecosystem restoration, and a Section 111 Study connected the restoration work to the original navigation project, making it eligible for federal funding (USACE, 1997b). Ownership of the area is split between the State of

New Jersey and The Nature Conservancy. The area is valued worldwide as a critical stopover for migratory birds along the Atlantic Flyway (USACE, 1998). The first appropriations were made in 2002 and construction was to begin, pending the appropriation of the remaining funds (Fraser, 2003) (Table 6.7).

Lower Cape May Meadows Restoration Project – 1998
Nourishment: Initial dune/berm construction 1.8 million m^3; periodic nourishment 496,961 m^3 every 4 years
Wetlands: Seaward restoration of 35 acres of eroded wetland
Plants: Elimination of 95 acres of Phragmites australis; plant 105 acres of emergent wetland vegetation
Fresh Water: Drainage ditches; 2 weir flow control structures; 6 new fish reservoirs in existing ponds; shallow retention basin; tidal gate

Table 6.7 The proposed Lower Cape May Meadows ecosystem restoration project - 1998 (USACE, 1998).

With the addition of the most recent ecosystem restoration plan, all areas from the inlet through to Cape May Point have some form of active federal shore protection project (Garafola, 2003). Nourishment is ongoing in Cape May City, and the construction of the Cape May Meadows ecosystem restoration project has just begun. State and local projects continue and include "innovative" programs like the Beachsaver Reef study along Cape May Point (Fraser, 2003). Cold Spring Inlet and Cape May Harbor continue to serve both recreational and commercial vessels.

Cold Spring Inlet – The Natural Setting

New Jersey's Coastline

The New Jersey coastline is approximately 755 km long (USACE, 1971) (Figure 6.2). The coast begins with a northward extending barrier spit in Monmouth County called Sandy Hook. South of Sandy Hook is a headland extending from Monmouth Beach to Bayhead (Nordstrom et al., 1986; Nordstrom, 1994). This becomes barrier islands for the next 145 km, extending south to Cape May (USACE, 1953; USACE, 1983b). The barrier islands are divided by 11 inlets, of which 5 are stabilized (Nordstrom, 1994). Marshes, bays, and lagoons back the islands. At Cape May Harbor, the barrier islands transition back to a headland on the Cape May Peninsula (USACE, 1953). Around the peninsula into Delaware Bay there is a stretch of bay-shore frontage, leading into the Delaware River towards Philadelphia.

The original inhabitants of New Jersey spent summers along the Atlantic beaches, harvesting the resources. They did not build permanent structures and left with the changing season. During Colonial times, there was very little interest in establishing settlements along the barrier island systems. It is reported that a Dutchman sold the islands north of Cape May (the Wildwoods) in the 1700s for a total of 9 pounds in order to buy his wife a dress. It wasn't until the 1800s, with the arrival of the railroads, that interest grew. By the early 1900s, the New Jersey Shore had become a premium tourist destination with resorts along its beaches (Nordstrom et al., 1986).

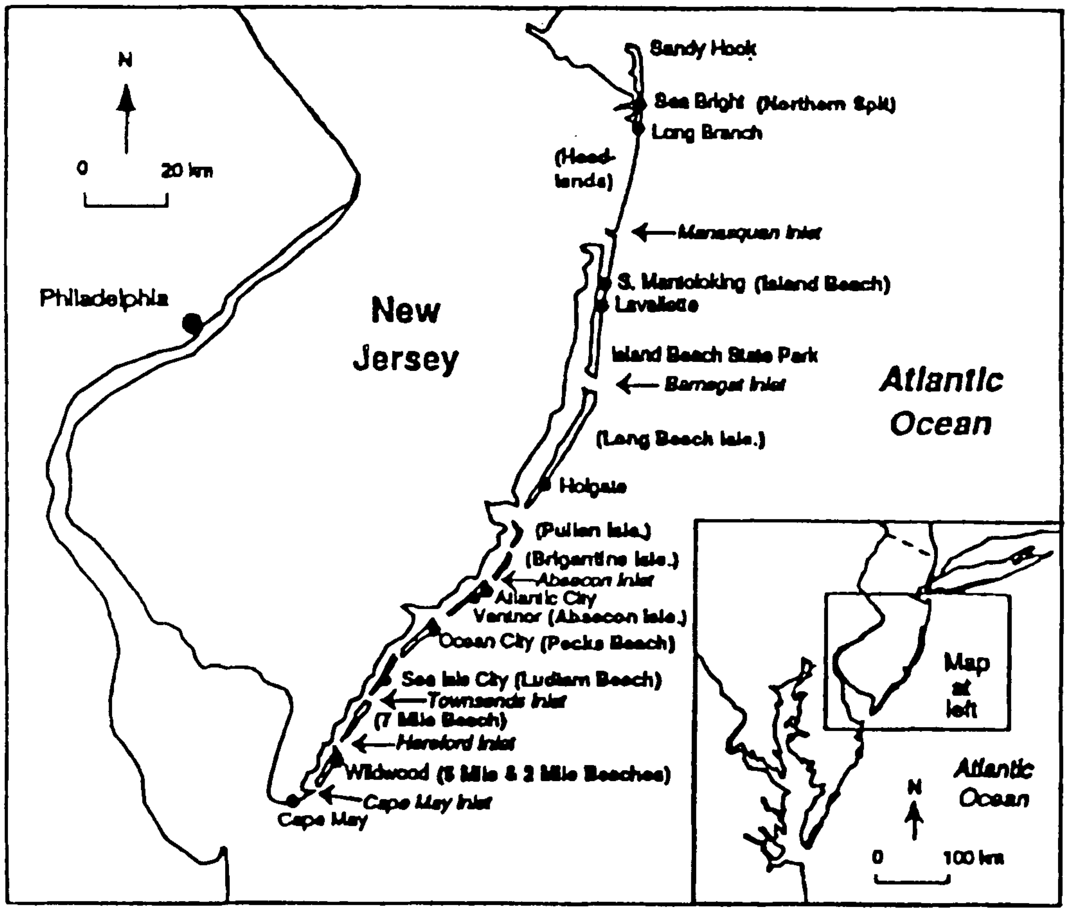

Figure 6.2 Map of New Jersey. Sandy Hook is the north-facing spit (Nordstrom, 1994).

Southern New Jersey Coast – Cold Spring Inlet

The southern limit of New Jersey's coast is at Cape May Peninsula (Figure 6.3). The peninsula is bordered by the Atlantic Ocean to the east and Delaware Bay to the west. Cold Spring Inlet is located on the Atlantic side of the peninsula approximately 9.7 km northeast of the peninsula's tip. Just to the north of the inlet is Two Mile Beach. This is a heavily developed tourist area with large dunes and beaches 90-150 m wide (USACE, 1951). A Coast Guard station occupies the land on both sides of the inlet (Figure 6.4). This area marks the southern transition from barrier islands back to headlands. Southwest of the Coast Guard station is Cape May City, a national historical landmark and popular tourist destination. Farther along the coast is Lower Township (Cape May Meadows), consisting of undeveloped lands, a state park, and a bird sanctuary. Cape May Point, a small private community, sits at the tip of the peninsula.

North along the Delaware Bay shoreline of the peninsula is the entrance to the Cape May Canal, part of the Intracoastal Waterway, linking Delaware Bay to Cape May Harbor. The total distance from Cold Spring Inlet to the entrance of the canal on the Delaware Bay side is approximately 12.9 km. The entire area is 145 km from the Philadelphia metropolitan area. The inlet is stabilized and has a maintained channel extending into Cape May Harbor (Figure 6.4). It is predominantly a commercial harbor with fish processing operations. The harbor connects both the Intracoastal Waterway heading north and the Cape May Canal heading west. The waterway has private and commercial wharves. The waterway extends north to Manasquan Inlet and is a small portion of the 4,667 km eastern waterway stretching from the Gulf of Mexico north (USACE, 1941; USACE, 1976).

Figure 6.3 Map of the southern New Jersey shoreline and Cape May Peninsula (Nordstrom et al., 1986)

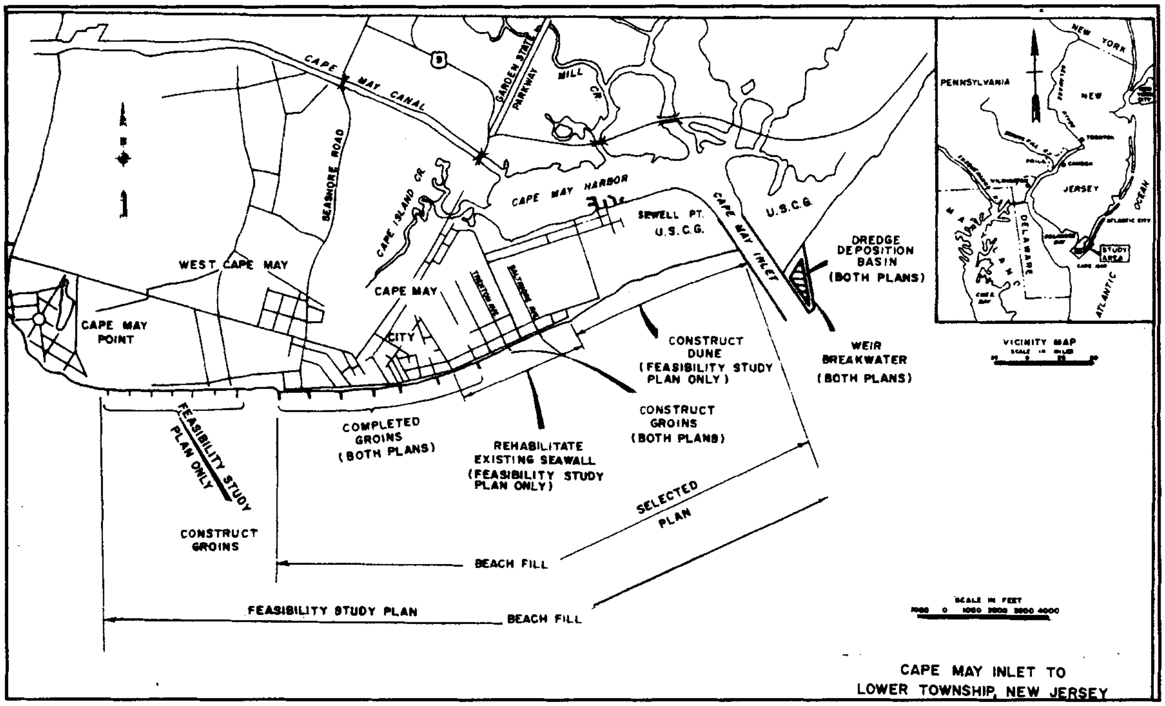

Figure 6.4 Map of the Cape May Peninsula project area – 1983 (USACE, 1983b).

Geomorphology

The project area sits on the Atlantic Coastal Plain. The plain extends from Georges Bank off of Cape Cod to Florida in the south and east as far as the edge of the Continental Shelf. It consists of unconsolidated layers of gravel, clay, sand, and silt of Cretaceous age and younger (USACE, 1951).

At the base of the sediment layers is crystalline rock, up to 1,829 m in depth near the coast, dropping off seaward and then rising again. This rock is covered by semi-consolidated sediment beds of Lower Cretaceous age 4,054 m thick at the coast, tapering to 2,713 m thick at the edge of the shelf (USACE, 1998). Unconsolidated sediment layers of Upper Cretaceous to Tertiary age, up to 1,463 m thick, cover these beds (USACE, 1957). Some Tertiary deposits outcrop in the area and are part of the Cohansey Formation, characterized by yellowish-orange quartz grained layers of silt and clay. It is both fluvial and marine in origin (USACE, 1983b).

Above the Cohansey Formation is the Cape May Formation, also composed of fluvial and marine origins and deposited during interglacial periods. It is of Pleistocene age and is characterized by yellow to brown, medium to coarse-grained unconsolidated quartz sediment (USACE, 1983b). The formation is dated to 125,000 years before present (Ferland, 1985). This formation represents most of the surficial sediment layers found throughout the New Jersey coastline, and makes up the Cape May Peninsula headland (Ferland, 1985).

Quaternary History and Beach Formation

Beaches formed during interglacial periods at high stands of sea level and the transition between transgressive and regressive seas (Uptegrove et al., 1999; USACE, 1983b). Rivers and streams drove a cycle of repeated erosion and deposition of headlands (USACE, 1983b). Rising seas reworked and consolidated sediments forming beaches. Earlier beach materials are found landward and as far seaward as the edge of the Continental Shelf. The cycles of sea-level rise and fall left a complex depositional sequence found all over the Atlantic Coastal Plain (Uptegrove et al., 1999). Barrier islands in the project area formed during the most recent rise of sea level (Ferland, 1985).

The last glaciation reached its farthest extent in the mid-Atlantic approximately 18,000 years before present (Ferland, 1985). A lowstand of the seas off the New Jersey coast occurred at this time. Sea level was 122 – 137 m lower than currently (Nordstrom et al., 1986). From 18,000 to 6,500 years before present there was a rapid rise of sea level. A small portion of this is attributed to the relatively high level of subsidence present along the New Jersey coastline. This period was followed by a relative slowdown in sea-level rise (SLR) from 6,500 to 2,000 years before present (Ferland, 1985).[34]

Fluvial deposition occurred during the lowstand. As the sea began to rise, marine forces reworked the deposits, forming barrier islands. As SLR continued, these islands migrated farther inland, enclosing the backwaters, forming lagoons and bays. Inlets opened when storms breached barrier islands connecting the ocean to the bays and

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[34] Very recent records show a SLR of approximately 4.4 mm/yr from the period 1912 to 1980 (Ferland, 1985).

lagoons. Beaches along the headland fronting Cape May Point predate the barrier islands found to the north (Uptegrove et al., 1999).

Coastal Processes – Winds, Waves, and Storms

Records from 1936 – 1947 report prevailing winds coming from the west and northwest during winter and spring, switching to the south and west during the summer and fall (USACE, 1951;USACE, 1998). Dominant storm winds are from the northeast and east. A 1951 study broke wind direction down as follows: 30% of winds blowing onshore, 20% blowing southwest, and 47 % blowing offshore. This information is supported by more recent studies (Ferland, 1985).

The majority of waves arrive at the Cape May Peninsula from the east-northeast and the northeast. They have an average height of 0.7 m and travel at a velocity of 2 – 7 meters per second with a frequency between 6 and 13 seconds (USACE, 1983b). Wave direction can also be broken down as 90% traveling south and 10% traveling north (USACE, 1951; USACE, 1957).

Storms take the forms of hurricanes or extratropical storms.[35] Hurricanes are common during the late summer and fall (USACE, 1951). They travel a northeasterly path, parallel to the coast and have little serious impact on the shoreline. Extratropical storms are not as common, but they move much slower and can span two high tides causing flooding (USACE, 1965b). The peninsula's orientation shelters it from waves and winds created by extratropical storms (Fraser, 2003).

[35] Northeasters

Coastal Processes – Tides, Currents, and Sand

Tides are semidiurnal with a mean tide between 1.25 and 1.31 m (USACE, 1998). The highest tides coincide with storm events (USACE, 1951). Currents in the region are heavily influenced by tides and, to a lesser extent, by waves. Due the peninsula's proximity to the entrance of Delaware Bay, the tidal cycles have a strong influence over the movement of water along the shoreface from Cape May Point in the south to Two Mile Beach, north of the inlet (Herrington, 2002).

Ebb tides flow north and east along the project area, while flood tides move water south and west (USACE, 1953). Both the Cape May Inlet and the Cape May Canal are synchronized with the changing tide in Delaware Bay. Water located near the entrance of the inlet is pulled in during flood periods. There is a tidal prism of approximately 2.5 billion m^3 within the inlet (USACE, 1951). Water located at the bay entrance of the canal is driven through the canal during ebb periods. Currents moving through the inlet and canal move at approximately 1.2 – 1.5 m per second (USACE, 1951). Water located away from either entrance bypasses and moves parallel to the coast at speeds of 0.76 – 0.91 m per second during ebb tides and 0.76 m per second during flood tides (USACE, 1980b). Tides and waves produce a longshore current, heading both north and south with a net flow to the south (Ferland, 1985).

Originally, creeks and rivers supplied sediment to the shorefaces during interglacial periods. Currently, creeks and rivers supply no sediment (Ferland, 1985; USACE, 1976). Their sediment is deposited in the bays and lagoons of the estuary, never making it to the ocean (USACE, 1998). Headlands were also a source of sediment for Cape May beaches, but most of these were armored, preventing further transport of sediment (Ferland, 1985). Delaware Bay may contribute sediment during ebb periods, but the speed of the current likely prevents appreciable deposition along the southern beaches of Cape May Point (Ferland, 1985; USACE, 1951).

The majority of sediment comes from the existing shorefaces along the New Jersey coastline. There is a nodal point near Manasquan, New Jersey, from where sediment travels south toward Cape May or north toward Sandy Hook (USACE, 1951; USACE, 1957). Around the immediate project area, sediment is also supplied from the continental shelf via waves (Ferland, 1985). The area has an overall greater rate of erosion than deposition.

Pre-Jetty Conditions

Prior to construction of the jetties, there was shoaling both landward and seaward of the inlet. The current location of Cape May Harbor was once a shallow lagoon with flood tidal delta deposits (USACE, 1907). Ebb-tidal delta sandbars formed in front of the entrance making travel difficult (USACE, 1894). Sediment either entered or bypassed the inlet during flood tides. During ebb tides the longshore current changed direction, and sediment moved in the opposite direction. There were periods of erosion and accretion prior to jetty construction. The earliest profile data attest to this (USACE, 1951; USACE, 1953). The presence of revetments prior to 1907 also attests to this. Beaches along the New Jersey Shore have also been moving southwest as sea level has risen (USACE, 1983b). The Cape May Inlet migrated from the north to its current location (USACE, 1907).

Post-Jetty Conditions

Construction of the jetties stabilized the inlet. The jetty length helped prevent the introduction of sand into the inlet, and the width of the channel promoted self-scouring during ebb and flood tides. The jetties also blocked the net southerly longshore movement of sand, not allowing it to bypass the inlet and reach the southerly beaches.

Sediment is impounded along the outside of the eastern jetty. Two Mile Beach is 90-150 m in width in some places. Studies of sediment flow estimate a southerly movement of 382,277 m^3 each year and a northerly flow of 191,139 m^3, creating a net southerly flow of 191,139 m^3 annually (USACE, 1976; USACE, 1983b; USACE, 1998). Any sand that is not impounded along the eastern jetty is directed offshore and away from the shoreface. The impoundment area along the eastern jetty reached its capacity as of 1934, and the system north of the inlet is believed to be in equilibrium. As a result, some sediment is able to enter the inlet around the end of the eastern jetty and form shoals in the entrance (USACE, 1951; USACE, 1953).

South and west of the inlet, there is considerable erosion. Rates accelerated after introduction of the jetties. From 1927 to 1948 the area just west of the inlet, through the Coast Guard station to the eastern edge of Cape May City, eroded at a rate of 5.2 m per year. This rate decreased along the Cape May City beaches to 0.3 m year and increased along the southern tip of the peninsula through Cape May Point to 2.1 m per year (USACE, 1951). By 1951 an estimated 512,252 m^3 had accreted east of the inlet while 1.04 million m^3 eroded west of the inlet (USACE, 1951). Tidal forces from the Delaware Bay compound the loss of longshore sediment. Tidal currents had a scouring effect, removing existing sand from the southern beaches and depositing it in shoals at the entrance of Delaware Bay (USACE, 1953).

Loss of beaches in areas like Cape May Meadows leads to breaching during storms and inundation of saltwater into freshwater areas. This kills vegetation and organisms (USACE, 1998). The extensive groin fields retard erosion to a point but are unable to correct the problem. Nourishment is required to place sand back on beaches.

Cold Spring Inlet Natural Setting Analysis

The project area and beaches to the south are fed by a longshore current providing a steady supply of sand from the north and shore normal waves supplying sand from the Continental Shelf. Despite this, erosive conditions have prevailed. A complicated and powerful tidal current environment is created by Delaware Bay. There is some speculation that these currents carry sediment, but it is more likely that the speed of the currents has a scouring effect around the tip of the peninsula carrying sand offshore to shoals found at the entrance of Delaware Bay. Army Corps reports support this assertion (USACE, 1953).

Jetty and Inlet Construction

The two jetties at Cold Spring Inlet block the longshore movement of sand from the north. As previously noted, the impoundment area along the eastern (northern) jetty filled by the 1930s, creating wide beaches on the Wildwoods barriers. Some sand is able to bypass the inlet, but is far enough offshore to miss the down drift beaches. Further complicating the situation are the tidal currents from Delaware Bay. Prior to construction, tidal currents moving sand from the peninsula were balanced by an inflow of sand from the north. Currently more sand is removed than introduced, creating a sand-starved system.

Engineer a Response

The effect of the jetties was almost immediate. They blocked flow of sand to down drift beaches. No alterations were made and, for the most part, they have the same configuration today that they had in 1907. This is mainly due to the fact that they served the function they were built for; they maintain a stabilized, self-scouring inlet. The jetties have been left alone and not altered to address down drift erosion. Erosion was addressed with groin construction where we see familiar response patterns.

Erosion was first experienced just down drift of the inlet, mainly the Coast Guard station and eastern sections of Cape May City. The response was to engineer a solution via shore-perpendicular groin structures to capture the sand bypassing the jetties. As time passed, more groins were constructed farther and farther away from the inlet. This passed the erosion problem farther down the peninsula until the entire tip of the peninsula was covered with groins. Once the groin fields were completed and the problem was not solved, the response was to lengthen existing groins. This again passed the erosion problem on down the coastline and is typical for these projects. When solutions did not rectify the problems, they were expanded in scope and size, amplifying the existing problems. The rationale for alterations was the same flawed rationale from which the initial engineering responses originated. Groins do capture sand and are able to offer some stabilization, but it begs the question of whether a better plan addressing the entire peninsula coastline rather than segments might have been more effective and not resulted in the sheer number of structures that exist today. Recent removal of some groins backs this assertion (www.climate.org, 1998).

Could Problems Have Been Avoided?

This project was initiated in the early 1900s. The current body of knowledge on coastal processes is superior to that in 1907; however, the Army Corps' own engineers predicted that this very thing would happen as far back as 1894 (USACE, 1894). Stabilization of these inlets caused deterioration of adjacent beaches and required constant attention to rectify the problems. These determinations are in print and are a part of the public record, yet they proceeded with the project regardless.

Mitigation responses focused on the immediate inlet vicinity, specifically the developed area of Cape May City and the Coast Guard station. The system was compartmentalized and responses did not reflect any future planning or vision. No one assumed that undeveloped areas south of Cape May City might be of use to the public in the future, even as the entire New Jersey coastline was experiencing intense development throughout the 1900s (Nordstrom et al., 1986). This lack of vision was costly and potentially disastrous for development and habitat. Although ecosystem restoration projects are lauded as a positive change for the Army Corps, they are extremely costly and could have been avoided with some long term planning.

Cold Spring Inlet – The Economics

Early Efforts

The earliest proposed development efforts were to build a breakwater off the coast of the Cape May Peninsula in 1890. Engineers cited poor economic conditions, namely no commerce in the area that would justify the expenditure of public funds (USACE, 1890) on the project. The Army Corps looked into improving the inlet entrance four years later. Again, they cited a poor economic environment lacking any commerce (USACE, 1894). Local interests were not discouraged, and they continued to lobby. By 1907 they finally succeeded in initiating a federal navigation project at the Cold Spring Inlet (USACE, 1907).

Jetty and Channel Construction – 1907 to 1941

Like other navigation projects, the economic objective of the Cold Spring Inlet Project was to generate commercial benefits. The major difference between this and other federal projects was that there was no existing commerce. Cold Spring was undeveloped marsh and swampland with a shallow back basin and migrating inlet. There was sparse development, and the small quantity of commerce that did pass through the area arrived and left by train. Essentially, a small group of private investors asked the federal government to invest public funds into a speculative development project. Army Corps engineers voiced their concerns regarding the role they were asked to play. Some felt that this was a legislative decision and should be handed back to Congress. The Board of Engineers reviewed the case and, based on the $3 million (over $47 million in 2003 dollars) already invested in the area by private developers, they were satisfied that the business would come if the inlet and channel were built. They authorized the project contingent on local interests completing their proposed development of the harbor area (USACE, 1907).

The original project entailed the construction of two jetties at the mouth of the inlet with a 7.6 m deep MLW channel. The project began in 1907 and was completed in 1911 (Table 6.8).

Cold Spring Inlet Navigation Project – Benefit Categories
1. Harbor of Refuge (vessels waiting for passage up the Delaware River)
2. Port of Commerce
3. Repair and Supply Port
4. Recreational Port (passenger liners)
5. Intracoastal Waterway Development
6. Military Port

Table 6.8 Projected benefit categories for the 1907 Cold Spring Inlet Navigation Project (USACE, 1907).

Specific benefit figures were not included in the report. The project was approved on the assurances of developers that the revenue would be generated. The Army Corps approved the project and Congress appropriated the funds (USACE, 1907) (Table 6.9).[36]

Jetty and Channel Construction Costs - 1907	
Construction (initial)	$1,300,000
Maintenance dredging (annual)	$20,000

Table 6.9 Projected total construction costs for the jetties and the channel at Cold Spring Inlet – 1907 (USACE, 1907)

[36] All dollar amounts are in the year of the report unless otherwise noted.

No new work was done on the navigation project between 1911 and 1941. The total costs, including construction and maintenance, up until 1940 were $1,494,591, slightly under the projected costs from 1907 (USACE, 1941).

Commerce in the harbor developed as anticipated. Between 1934 and 1939, 11,000 – 22,000 tons of commerce passed through the harbor annually. In 1939 there were 14,600 round trips from the harbor. At first, the harbor received a range of goods but by 1933, the main commerce was fish and remains this way today. Trains continued to carry the majority of the commerce in and out of the area as originally predicted.

In 1941 the military and commercial interests requested a channel modification for the project. The existing channel design coupled with shoaling in the harbor did not allow for passage of larger Navy and Coast Guard ships into Cape May Harbor. This made service and repair a problem because ships were unable to dock. The desired project entailed extending the existing channel into the harbor at a depth of 7.6 m MLW. Seaward, the channel would be extended to a depth of 6.1 m MLW (USACE, 1941) (Table 6.10)

Channel Extension Costs – 1941	
Construction	$71,000
Maintenance Dredging (annual)	$30,000

Table 6.10 Projected construction costs for the Cold Spring Inlet channel improvements - 1941 (USACE, 1941)

Project benefits were listed as national security. The harbor was a port of strategic importance along the Atlantic Coast. There was an interest in expanding its capabilities with the threat of war. Local interests backed the plan, eager to expand the dimensions of the harbor and accommodate larger commercial vessels (USACE, 1941).

Specific monetary benefits were not calculated, but it was believed that national security issues warranted the changes. The project was expedited and the channel expansion was completed (USACE, 1941).

Shore Erosion Projects

Although erosion of down drift beaches was apparent soon after the completion of the jetties in 1911, the Army Corps did not acknowledge any responsibility until 1951. From 1951 through 1991 numerous studies and plans were formulated for beach restoration from Cape May Inlet through Cape May Point. Each plan drew upon preceding reports adding to or adjusting some of the specifications. None of these plans were initiated until 1991. The economic predictions and justifications through time followed a familiar economic projection pattern. The following are examples of some of the economic forecasting used in the different reports.

1951 and 1953 Reports

In 1951, Public Law 727[37] allowed for federal assistance in shore erosion control projects (USACE, 1953). The federal government would provide up to one-third the initial construction costs and none of the subsequent maintenance costs. Two Army Corps studies determined that a portion of the erosion experienced down drift of the project was due to the presence of the jetties. Specifically, they felt that the jetties were

[37] 79th Congress, 2nd session

accelerating erosion from the Coast Guard station down to Wilmington Avenue in Cape May City. They did not believe that areas south of there were being affected to the same extent.

The original project proposal called for the repair of 5 groins and the construction of 5 new groins. Additionally, there would be an initial nourishment of 636,110 m^3 of sand to build back the eroded beaches. Engineers left open the option to build a revetment extending from the Coast Guard Station down through Cape May Point if the groins did not "work" (Table 6.11).

Groin and Nourishment Costs - 1953	
Groin repair and construction	$450,000
Nourishment (636,110 m^3 initial)	$525,000
Revetment (optional)	$1,174,000
Total Cost	**$2,149,000**

Table 6.11 Projected total first costs for the 1953 Cape May City shore protection project (USACE, 1953).

Total costs were converted to annual costs over a 50-year period using an interest rate of 3% and amortization rate of 1%. Combined with an estimated $107,270 of annual maintenance[38], the total annual cost came to $148,120 (USACE, 1953). A plan for construction of a groin field extending from Lower Township through Cape May Point was presented to the communities by the Army Corps calling for 22 additional groins at a cost of $535,000. No public funding was offered.

[38] 229,366 m^3 of sand nourishment every 3 years

Several benefit categories were cited including damage prevention for existing protective structures, the foregone cost of lost sand, land enhancement, and recreation (Table 6.12).

Projected Annual Benefits – 1953	
Protection of existing protective structures	$4,000
Foregone cost of lost sand	$19,000
Land enhancement	$6,300
Recreational value	$204,000
Total Annual Benefits	**$233,300**

Table 6.12 Projected annual benefits by category for the 1953 Cape May City shore protection project (USACE, 1953).

The annual costs and benefits produced a benefit to cost ratio of 1.58. Based on these positive economic conditions, the project was recommended with the federal government covering one-third of the initial construction costs.

1957 Report – Proposal Review

In 1957, the Army Corps reviewed their original 1953 plan and concluded that it was still appropriate with minor design changes. The revetment option was not considered, lowering the original first cost to $1,174,000. With some additions to the design, the initial cost projections rose to $1,458,000. Using the same interest and amortization rates and incorporating new maintenance charges the total annual cost projection came to $153,000. Annual benefits were also adjusted. Land enhancement was removed from the calculations and additional benefits were found in existing categories raising total annual projected benefits from $233,300 to $275,000. The new benefit to cost ratio was 1.8 and continued to justify involvement (USACE, 1957).

1976 Project - More Review and a Section 111

Total expenditures including construction, dredging, and maintenance of the navigation project totaled $3,302,309 by 1976. The annual average maintenance was approximately $58,000. The Army Corps completed a Section 111 Study and determined that the areas from Cape May Inlet through Cape May Point were eligible for greater federal cost sharing due to the role the jetties played in the erosion of their beaches. The annual benefits were recalculated for the shore restoration project (Table 6.13 and 6.14).

Projected Annual Benefits Cape May City- 1976	
Protection of existing protective structures	$34,000
Foregone cost of lost sand	$264,000
Recreation	$1,803,000
Reduced navigation project maintenance	$22,000
Storm protection	$2,202,000
Total Annual Benefits	**$4,325,000**

Table 6.13 Projected annual benefits for the areas from the inlet through Cape May City for the 1976 shore protection project (USACE, 1976).

Projected Annual Benefits Cape May Point- 1976	
Protection of existing protective structures	$4,000
Foregone cost of lost sand	$25,000
Recreation	$9,000
Storm protection	$249,000
Land Enhancement	$7,000
Total Annual Benefits	**$294,000**

Table 6.14 Projected annual benefits for the 1976 Cape May Point shore protection project (USACE, 1976).

The annual cost projections for the Cape May City segment of the project were $1,285,000 and the annual cost projections for the Cape May Point segment were $240,000. This produced benefit to cost ratios of 3.3 and 1.2 respectively (USACE, 1976). Again, this specific plan was not implemented, but it served as the justification for the project currently in progress.

The Current Project - 1980 to Present

A Phase I General Design Memorandum (GDM) was completed in 1980, redefining the proposed project. The plan maintained the general idea of the original 1953 proposal with some engineering changes. Once again areas south and west of Cape May City were not included in the plan. Benefits and costs were recalculated. Benefit categories included recreation, foregone cost of lost sand, enhanced property values, protection of existing protective structures, and lower maintenance costs on the navigation project[39]. A decision was made to include land enhancement benefits again (USACE, 1980b). The total predicted cost of the project was estimated at $13,287,000 (Table 6.15).

Projected Annual Costs and Benefits - 1980	
Annual Costs	$1,591,000
Annual Benefit	$1,706,000
Benefit/Cost Ratio	1.07

Table 6.15 Projected annual costs and benefits for the 1980 Cape May Shore Protection Project - Phase I General Design Memorandum, including the benefit to cost ratio (USACE, 1980b)

[39] Removal of the impounded sand on the eastern jetty preventing shoaling at the inlet entrance.

An interest rate of 7.375% was used to convert total costs to annual costs. Of the $1,591,000 of annual costs, $809,000 represented annual maintenance (USACE, 1980b).

The Phase I GDM was followed with a Phase II GDM in 1983. Substantial changes were made in the economic projections. This was due, in part, to additional construction considerations. Storm water outtake extensions were needed to accommodate the greater width of a nourished beach. This drove the total construction costs up to $17,122,000 and maintenance to $943,100 per year translating to an annual cost of $2,016,000 (USACE, 1983b). Annual benefits also changed (Table 6.16).

Projected Annual Benefits – 1983	
Recreation	$2,088,600
Foregone cost of lost sand	$429,100
Enhanced property values	$294,900
Protection of protective structures	$33,000
Reduced maintenance cost on navigation project	$17,200
Employment	$18,100
Total Annual Benefits	**$2,880,900**

Table 6.16 Projected annual benefits for the Cape May Shore Protection Project - 1983 Phase II General Design Memorandum (USACE, 1983b).

Construction did not start until 1989. Changes in economic guidelines during the interim restricted certain benefit calculations in shore protection projects. Specifically, recreational benefits could not constitute more than 50% of the total benefits.[40] The most recent calculations (Table 6.16) had recreational benefits accounting for over 70% of the annual benefits.

[40] This guideline was an attempt to be more equitable in determining which coastal areas received federal funding. The purpose was to take the emphasis away from large tourist areas and allow smaller coastal areas the same opportunity at funding (Habel, 2003).

The high percentage of recreational benefits and new guidelines prompted an economic reevaluation in 1987, authorized by the Water Resource Development Act of 1986 (USACE, 1987b). Projected recreational benefits were reduced considerably (Table 6.17).

Reevaluated Annual Benefits - 1987	
Recreation	$856,000
Enhanced property values	$0
Protection of protective structures	$38,000
Reduced maintenance cost on navigation project	$122,000
Employment	$0
Erosion protection (property)	$2,780,000
Storm wave inundation reduction (property)	$197,000
Total Annual Benefits	**$3,993,000**

Table 6.17 Projected annual benefits from the 1987 Cape May Shore Protection economic reevaluation study (USACE, 1987b).

After reevaluation, recreational benefits only accounted for 21% of the total benefits. The difference was made up in erosion protection and storm wave protection for development. Employment and land enhancement benefits were removed from the analysis. The annual cost projections were $2,352,500, relatively close to previous projections. This produced a benefit to cost ratio of 1.7 and the justification to fund the project. The first federally funded sand was placed in 1989 (Duke University, 2002). The project continues today on approximately a 2-year nourishment cycle.

Lower Cape May Meadows – Cape May Point Project

Amendments in the 1986 Water Resource Development Act directed the Army Corps to become involved in ecosystem restoration (Zappile, 2002). They were required to undertake these projects in a cost effective manner but were not constrained by economic benefit to cost criterion. Ecosystem restoration projects had been difficult to justify because these critical areas did not support the development and industry needed to generate the economic benefits. Such was the case with Lower Township and Cape May Point, now referred to as the Lower Cape May Meadows.

Prior to any federally backed plan, the communities were responsible for mitigation. The State of New Jersey supported many of these projects financially (Table 6.18).

Agency	Location	Project	Year	Cost
NJDEP	Meadows	Dune repair	1986	$332,019
NJDEP	Meadows	Dune repair	1986	$258,347
NJDEP/CMP[41]	Cape May Point	Beachfill	1991	$192,300
NJDEP	Meadows - Cape May Point	Dune repair – beachfill	1992	$388,888
NJDEP/CMP	Lehigh Ave. Groin	Dune Restoration	1993	$87,000
CMP	Lehigh Ave. Groin	Seawall repair	1994	$20,000
NJDEP/CMP	Between Coral Ave & Lehigh Ave groins	Beachsaver reef	1994	$300,000
NJDEP/CMP	State Park ocean frontage to Lighthouse Ave. groin	Dune reinforcement	1996	$429,000
CMP	Cape May Point	Emergency dune / groin repair	1996	$34,741
CMP	Cape May Point	Dune repair	1996	$20,000
CMP	Cape May Point	Dune repair	1997	$35,000

Table 6.18 A recent history of mitigation projects for Lower Township and Cape May Point (USACE, 1998).

[41] Cape May Point

The federal restoration project was justified based on Environmental Quality (EQ) benefits to the Meadows and on NED benefits to the surrounding communities. The primary purpose of the plan was ecosystem restoration, and a secondary output was storm damage reduction for the surrounding communities (USACE, 1998). Table 6.19 summarizes the EQ and NED benefits produced by the selected plan. The projected cost of the project are summarized in table 6.20

Average Annual Benefits – EQ And NED	
EQ	
Acres not inundated by saltwater	175 acres
Acres not eroded	173 acres
Habitat Units	388 HU
NED	
Storm damage reduction	$719,500
Local costs foregone	$201,600
Benefits during construction	$23,700
Total Annual NED benefits	**$944,800**

Table 6.19 Projected annual benefits for the 1998 Meadows and Cape May Point project. Both environmental and economic benefits were calculated for the project (USACE, 1998).

Total Cost Projections	
Initial construction (total)	$15,403,000
Interest during construction (7.125% for 2 years)	$738,000
Real estate	$145,000
Total periodic nourishment (50 years)	$58,023,000
Total Project Costs (50 years)	**$74,309,000**

Table 6.20 Projected total costs for the 1998 Meadows and Cape May Point project (USACE, 1998).

Using a discount rate of 7.375% and including all monitoring costs, the average annual cost is $2,386,000 (USACE, 1998).

As of 2003, $1.5 million has been appropriated for the ecosystem restoration project and more funds are expected for fiscal year 2004. Some initial work has been done on controlling invasive species[42]. Construction of the berm and the initial nourishment will have to wait until more funding is available due to the high costs of setup and takedown of a dredging and pump operation (Fraser, 2003). There is every indication that all the beaches from Cape May Inlet through Cape May Point will be receiving sand nourishment via federal funds in the near future.

Cold Spring Inlet Economic Analysis

The original project economically catered to a small segment of people, mostly private land developers. The benefits, although considered to add to the overall national economy, were realized by a few. Ideologically, the project was complicated in that it was not the typical improvement project of an existing public facility. It was purely development of private property that would later be accessible to the public. The government was asked to partner in a private land development project and provide support through public funds.

Despite this, it is reasonable to assume that economic objectives were achieved for the navigation project. The harbor has been, and continues to be, active both commercially and recreationally. Aiding its economic success is the presence of the Intracoastal Waterway and the Navy and Coast Guard bases in the harbor. Its proximity

[42] Phragmites australis

to Philadelphia makes it an attractive recreational and commercial fishing location. The project is heavy on incidental costs[43] and follows familiar cost patterns when considering the mitigation efforts addressing the erosion.

Cost Patterns

The original navigation project was a one-time construction with only one additional development in 1941. Once the Army Corps accepted responsibility for down drift erosion in 1951, subsequent shore protection projects were incorporated into the overall navigation project. It is here in the proposals that we see the increasing cost pattern often associated with these projects (Table 6.21).[44] The proposed designs were essentially the same from 1953 through 1987. There is a trend of increasing costs due to underestimated projections or perhaps the delay in initiation allowed for more damage to occur, driving up the cost of mitigation, or a combination of both.

	1953	1957	1976	1980	1983	1987
Total Construction	$5,645,055	$7,754,373	$39,469,399	$26,512,880	$27,919,133	$25,420,033
Total Annual Costs	$857,585	$813,731	$3,455,622	$3,174,681	$3,287,290	$3,407,832

Table 6.21 History of the cost projections for proposed shore protection projects on Cape May Peninsula from 1953 – 1987 in 2003 dollars.[45]

[43] Incidental costs include groin construction, beach nourishment, and ecosystem restoration.

[44] None of the projects were initiated until 1989 but their forecasting shows a pattern common to projects with increasing costs that evolve over time.

[45] Dollars converted using a GDP deflator index with 1996 base year.

Benefit Patterns

There is a great variation in the projected benefits for the same proposed shore protection projects. On the whole, they rise over time, keeping ahead of the increasing cost predictions, justifying continued federal involvement (Table 6.22).

1953	1957	1976	1980	1983	1987
$1,350,760	$1,462,588	$11,630,790	$3,404,152	$4,697,596	$5,784,260

Table 6.22 Summary of projected annual benefits for proposed shore protection projects on Cape May Peninsula from 1953 – 1987 in 2003 dollars.

This too might be due to the delay in project initiation. As more development and beach were harmed, there were more potential benefits generated from fixing the problem.

Within this pattern of increasing benefits, there were also shifts in benefit categories. The original project of 1907 was based primarily on commercial benefits. As commercial activity peaked, there was a shift to national security benefits in the 1940s. By 1953 the project focus shifted away from the inlet and toward repairing the adjacent beaches. Here there was an emphasis on recreational benefits. As times changed and new economic guidelines emerged, recreational benefits declined sharply and were replaced by shore protection benefits.

In 1953, recreational benefits accounted for 87% of the project annual benefits. By 1983 this changed slightly to 72%. Between 1983 and 1987 a change in the economic guidelines required that recreational benefits account for less than half the total benefits. In 1987, recreational benefits only constituted 21% of the total benefits for the same project. The loss was made up by shore protection benefits that now accounted for 75%

of the total benefits whereas in 1953 they were only 8%. The reasoning is not clear, and there are no explanations for the drastic changes for the same projects. One could speculate that the changes in benefits were, in part, to keep the total benefits at an acceptable level for public funding and in compliance with federal guidelines.

Incidental Costs

Beyond federally funded mitigation, municipalities and the state shouldered a great deal of the actual costs associated with shore protection. In Cape May Meadows and Cape May Point alone, the state and community spent over $2.1 million on various projects from 1986 to 1998 (USACE, 1998). There have been numerous revetment and groin projects paid for by all communities on the peninsula and the state. These all require annual maintenance. As existing structures are expanded, the cost of maintenance increases.

Historically, Cape May City has been a famous recreational destination, at one time frequented by the wealthy and elite (Nordstrom et al., 1986). Until very recently, there was little to no dry beach. This not only impacts tourism but it also affects the value of the beachfront homes (Pompe and Reinehart, 1994). There was a steady deterioration in beach quality from the 1950s to the 1990s. A more in-depth study is required to put a value on this loss.

Habitat loss added considerable costs to the overall project. It is difficult to place a value on the loss of the freshwater wetlands located in the former Lower Township area of the peninsula. It was for this reason that project planners were never able to justify use of federal funds in protecting the area. The area is now considered a critical stopover for migratory birds. The reason is that Lake Lilly is the only coastal freshwater lake between Norfolk, Virginia and Sandy Hook, New Jersey along the Atlantic Flyway. Migratory birds depend on its freshwater (Fraser, 2003). The Nature Conservancy deemed it valuable enough to purchase a large segment of the wetlands in the 1980s (Laubengeyer, 2003).

With recent changes in the federal policy these wetlands are eligible for federal funding. A Section 111 Study tied the problems along Cape May Meadows to the original navigation project. Now the federal government and state are engaged in a high-priced ecosystem restoration project to remove invasive species and prevent the incursion of saltwater into the freshwater system. The anticipated cost of the project is over $81 million (USACE, 1998). This is an area that has been denied federal assistance for 50 years, based on a lack of economic benefits, accounting for a small segment of the total peninsula and now constituting 75% of the cost of the active federal mitigation projects on the peninsula[46] (USACE, 1998).

Was the Navigation Project an Economic Success?

Again, the inlet and harbor appear to be active, supporting a range of recreational and commercial interests. The location of the Intracoastal Waterway through the harbor opens the area's potential to attract boat traffic; however, a more in-depth study of the actual harbor and inlet activity are needed to substantiate these claims.

It is assumed, from the perspective of the federal government, that the navigation project was successful economically. There was minimal effort on their part to provide

[46] Based on the projected cost figures of existing shore protection projects described in Army Corps reports.

the specified inlet and channel. The commerce and activity originally promised by developers came. The navigation project has performed as was originally intended. The project spans two economic lifetimes nearing 100 years in 2007. Despite the erosion problems experienced down drift, the federal government has not invested heavily in mitigation until very recently. The ecosystem restoration project at Cape May Meadows will prove to be a costly venture, and more work is needed to determine the overall effect it will have economically on the project in the future.

From the perspective of the state and community, the jetties are responsible for much of the erosion they are experiencing and the money they have spent over the years addressing the problem. Both parties acknowledge the worth of the harbor and the value it brings to the region and the state as a whole and, therefore, view it as a condition they have to live with (Fraser, 2003; Garafola, 2003). Time will tell how much the massive New Jersey nourishment program will cost and whether federal monies will continue to be available at current levels. The outcome may change the view of success and economic value of Cold Spring Inlet and Cape May Harbor in the future.

Cold Spring Inlet – The Political Environment

Introduction

The political environment surrounding the Cold Spring Inlet Project is indicative of other coastal projects around the country. There are multiple users, conflicting use issues, and different levels of government involvement. The Coast Guard and Navy have land holdings in the project area. Private developers have interests throughout the area as does the commercial fishing industry. NGOs like The Nature Conservancy have land holdings and a vested interest in the health of bird habitat. Additionally, the inlet and harbor are connected to the Intracoastal Waterway running north from the Gulf Coast. Recreational beaches, a New Jersey state park, and a nationally recognized bird sanctuary draw thousands of visitors each year (USACE, 1998). Cape May Meadows is considered a crucial stopover along the Atlantic Flyway for migratory birds (Laubengeyer, 2003).

The following section begins with a summary of interviews conducted with representative members of some of the key participants in the project. The objective of these interviews, as in the Maine cases, is to establish participants' perceptions of the problems, potential solutions, and the state of relationships. This is followed by a brief view of the politics associated with the project. The section ends with a review of state planning efforts in New Jersey and how those efforts have guided coastal communities in reassessing their future needs and goals.

Interviews

Interviews were conducted with several participants involved in the current mitigation projects on the Cape May Peninsula. These include the NJDEP, the Army Corps, the Town of Cape May Point, the State Planning Office, New Jersey Sea Grant, and The Nature Conservancy. As with the Maine cases, the information gathered is representative of a range of interests. Furthermore, the responses support the interpretation of a positive, cooperative, political environment.

Perceptions

The exact details of perceived problems change from one party to the next. All parties feel that the jetties on Cold Spring Inlet are responsible for erosion down drift but they do not agree on the extent of the effect due to the scouring tidal forces from Delaware Bay (Herrington, 2002; Zappile, 2002). All agree that the erosion problems on the peninsula would not be as bad if the navigation project had not been constructed. Some also believe that even without the current harbor there would be some issues due to the amount of shore structures along the entire New Jersey coast (Fraser, 2003). Concerns range from habitat loss and invasive species (Laubengeyer, 2003; Zappile, 2002) to loss of development and infrastructure (Fraser, 2003; Garafola, 2003; Gebert, 2003; Zappile, 2002). All concerns can be traced back to one common factor: erosion.

Regarding a solution to their problems, all interviewees seemed pleased with the progress made on the current shore protection and ecosystem restoration projects. This implied that their perception of a successful outcome involves a replenished beach. A replenished beach would ensure habitat restoration (Laubengeyer, 2003) and reduce flood damage to development (Fraser, 2003). A major reason why stakeholders and agencies are pleased with the current mitigation efforts is because strong healthy relationships existed between the participants prior to the projects.

Relationships

All those interviewed cited good working relationships with the other participants. Disagreements occur, but a strong foundation of trust and cooperation allows for negotiation and resolution. The relationship between the Army Corps and NJDEP is strong. Both respect each other's organization and role (Garafola, 2003; Gebert, 2003; Keiser, 2003; Zappile, 2003) and they are able to coordinate efforts and collaborate on projects. The relationship between NJDEP and the communities is strong. The engineers in the coastal office are all coastal residents, living in the communities they serve. Outside of work, engineers in the coastal office offer their assistance to planning boards and committees to foster good relations along the coast (Garafola, 2003). Due to the role NJDEP plays as project sponsor, the relationship between the Army Corps and the communities is also strong (Fraser, 2003; Gebert, 2003).

There seems to be a good relationship between the coastal communities and state government. The community of Cape May Point credits the efforts of Congressman LoBiondo for advocating their case in Washington, D.C., and appropriating the funds needed to begin the restoration project. They also speak favorably of the governor's office. Specifically, past governor Florio was credited with making possible the Beachsaver Reef project off of Cape May Point that has been successful in slowing erosion along the tip of the peninsula (Fraser, 2003).

Another strong relationship has formed between The Nature Conservancy (TNC) and the Army Corps. The Army Corps approached TNC to collaborate on the ecosystem restoration project at Cape May Meadows. TNC was cautious at first due to the anti-environmental reputation the Army Corps has acquired. Over time, TNC opened up and a cooperative relationship evolved. Both TNC and the Army Corps describe their interaction as extremely positive (Laubengeyer, 2003; Zappile, 2002). The Army Corps and TNC signed an agreement as a result of the good experience at Cape May Meadows guaranteeing future cooperation with all national projects affecting TNC land holdings (Zappile, 2002). TNC stated that they also had positive relations with NJDEP and the surrounding communities (Laubengeyer, 2003).

All interviews reinforced the picture of a cooperative political environment. Participants are moving forward in addressing their problems and decisions seem to be consensus-based. Some of the keys to success include full participation by all stakeholders and agencies, transparent transactions, and a flexible iterative problem-solving process defined by a future thinking, regionally based planning initiative.

The Overall Health of the Political Environment

Interviews revealed that all participants believed that the jetties were responsible for their erosion problems and that the current nourishment projects were the means of addressing those problems. Key participants seem to have mutually positive relationships that foster affective mitigation efforts. The good relationships seem to encourage a variety of response options outside the normal realm of mitigation responses. In particular, the ability to address the problems at Cape May Meadows and the surrounding communities through an ecosystem restoration project and the Beachsaver artificial reef program that has enjoyed some success along Cape May Point.

This is indicative of a healthy political environment. It should be noted that a more thorough investigation is needed to affirm these statements. It would be particularly useful to broaden the array of parties interviewed by speaking to NGOs other than The Nature Conservancy, like New Jersey Audubon and the Littoral Society of America, both critics of the ongoing nourishment programs in New Jersey. Another important group would be community residents not affiliated with local, state, or federal agencies.

A Brief Political History

The beginnings of the Cold Spring Navigation Project were very similar to the Saco River Project in Maine. The project was rejected by engineers because of difficult engineering conditions and then ultimately on poor economic projections (USACE, 1890; USACE, 1894; USACE, 1907). Eventually commercial interests were able to persuade the Army Corps to take on the project despite the protests of the Army Corps' own personnel. Developers "boot strapped" the project by investing considerable funds in a harbor and land reclamation project prior to getting any federal approval for an inlet and channel. This is a common practice with questionable public works projects (Plater et al., 1998). Commercial interests used this investment to plead their case and leverage their position, eventually receiving authorization for the project and public funds.

The intervening years up until 1989 were spent fighting erosion and storm damage. Municipalities and the State of New Jersey were the primary forces behind mitigation efforts with a limited amount of federal assistance in the form of studies and planning initiatives. New Jersey officially began offering financial and engineering assistance to coastal communities in 1922 (USACE, 1957) and has been involved in mitigation efforts in the Cape May area with numerous cooperative projects since 1930

(USACE, 1998). The state and municipalities continue to work together effectively tackling management and development issues (Garafola, 2003).

Although there is every indication that the working relationships between local, state, and federal parties have been positive, there is some discord, mainly with respect to the massive publicly funded beach nourishment projects of which the New Jersey coast is a recipient. Environmental groups, like the American Littoral Society, New Jersey Audubon Society, and other concerned citizens, are critical of the Army Corps' massive New Jersey nourishment projects. They cite huge costs, temporary results, risky development, and isolated benefits focused on a small segment of the population (Gaul and Wood, 2000; Grunwald, 1999; Neil, 1999). The Army Corps and coastal communities counter these arguments by asserting first that such projects do not encourage further risky development (Cordes and Yezer, 1995), and second that the costs are justified due to the value of the business and the development these projects are protecting (Gaul and Wood, 2000; Grunwald, 1999; Neil, 1999; www.climate.org, 1997). This debate will continue as more people question the use of public funds to protect coastal resort areas particularly in lean economic years; however, currently it has not greatly hampered cooperative nourishment projects along the New Jersey coastline.

State and Coastal Community Cooperation

New Jersey is considered a "home rule" state (Gualini, 2001; Luberoff, 1999; Neuman, 1999). Communities have control over their growth and development decisions. They greatly oppose the prospect of the state mandating these decisions and have fought past legislative attempts to give the state more power (Garafola, 2003;

Luberoff, 1999). This has not stopped the state and community from cooperating on coastal projects.

The New Jersey Department of Environmental Protection (NJDEP) was made responsible for shore projects in the 1940s (USACE, 1998). Today they are essentially two offices. There is a regulatory branch located in Trenton and a coastal office, known as the Bureau of Coastal Engineering, in Toms River. The Bureau refers to themselves as the "New Jersey Army Corps" (Garafola, 2003). The two are parts of the same department but operate as separate entities.

Beginning in the 1940s the NJDEP had access to an annual state fund of $1 million to enter into projects with coastal communities. Additional monies were appropriated when needed, usually in response to large storm events. The Shore Protection and Tourism Act of 1992, passed by the state legislature, increased this annual amount to $25 million. The money is raised via a real estate transfer tax paid by all people in New Jersey when selling a home. The money is specifically used for beach restoration and may not be used for other purposes without a vote in the legislature (Garafola, 2003; USACE, 1998). NJDEP acts as the sponsor for all federal coastal engineering projects. They assume the role of intermediary between the Army Corps and the communities. They advocate for the communities while assisting the Army Corps with New Jersey regulatory requirements and ensuring that the federal government receives payments promptly.

Communities also have the ability to raise their own money. This can be done through day-use charges on recreational beaches. The small community of Seaside Park raises over $1 million each year that they are able to apply toward local shore protection projects (Keiser, 2003). Money is also raised via local bond issues where NJDEP acts as the lender. They are able to lend the communities money at an interest rate of approximately 1% (Garafola, 2003). Communities eagerly borrow this money to initiate coastal engineering projects.

Coastal Legislation

Although "home rule" is the norm, the state determined that it needed to take greater control over increased coastal development in order to prevent the destruction and loss of a great natural resource and asset to the state's economy (Nordstrom et al., 1986). The Coastal Area Facility Review Act (CAFRA) was passed to regulate development and activity within a defined coastal zone (Neuman, 1999; NJDEP, 2003; Nordstrom et al., 1986)[47].

Other pieces of legislation like the Waterfront Development Act and the Wetlands Act of 1970 also guide development and use of the coastal zone (NJDEP, 2003) but the State Planning Act, signed into law in 1986, is the one that establishes the framework for planning on the coast and around the state. The act instituted a cooperative process for coordinating development and planning on the local and state levels. The act was in response to a migration of people out of urban areas in the state and resettlement in suburban and rural areas. The state wanted a means of containing services and costs while the public expressed a concern over the effects this uncontrolled sprawl would have on the natural environment. After much deliberation and opposition, a voluntary act was

[47] Conceptually it is very similar to Maine's Mandatory Shoreland Zoning Act

created that stressed cooperation and communication but did not require compliance. Despite this lack of "teeth" the act was successful in its objectives (Luberoff, 1999).

The State Planning Act and "Cross-Acceptance"

A stated objective of the State Planning Act is to create the following:

> "a cooperative planning process that involves the full participation of State, county and local governments as well as other public and private sector interests will enhance prudent and rational development, redevelopment and conservation policies and the formulation of sound and consistent regional plans and planning criteria" (NJ State Planning Act, 2003).

This is accomplished through a process known as "cross-acceptance" defined within the act. There are three stages of the process: comparison, negotiation, and issue resolution (Gualini, 2001; Neuman, 1999). Comparison requires the individual municipalities to review a draft of the state plan, prepared by the State Planning Commission, and to identify problems and inconsistencies with their community plans. This is in preparation for a negotiation phase, between the state and the communities, where these inconsistencies are discussed and either resolved or not. The final phase, issue resolution, represents the culmination of negotiations and is the basis of the preliminary final plan that is presented at a number of public meetings, before being finalized. The entire process is transparent and iterative. Comparison and negotiations may go through several different phases prior to reaching consensus and completion of a plan draft (Gualini, 2001). The plan itself is revised periodically, where the cross-acceptance process is reworked.

Unexpected Success

At first many participants did not put much faith in the process. This was because it lacked any mandatory compliance. Communities could go through the process and not follow any of the suggested plans if they chose. It was also for this very reason that they participated. They had nothing to lose and they did not feel compromised. They could only gain from the experience because it offered an opportunity to participate and to be heard (Luberoff, 1999; Neuman, 1999).

The 17-member State Planning Commission is comprised of the different state agencies, developers, and the governor's office, and represented a broad range of interests. It was also under Executive control not Legislative which was appealing to municipalities. They did not view the body as creating legislation and usurping local power. The commission was given ample funding and resources to ensure that the job would get done properly. It invested in the process through efforts like negotiation training sessions for municipalities prior to them confronting the state, thus creating a more valuable experience for all (Gualini, 2001; Neuman, 1999).

The State Plan originally did not include coastal communities in the cross-acceptance process because it was felt that existing coastal legislation guided their planning. The coastal communities felt differently and wanted an opportunity to participate and rectify inconsistencies in CAFRA, which they felt compromised and stifled their own development goals. Coastal communities participated in the cross-acceptance process and through the negotiation and issue resolution phases were able reduce some 500 inconsistencies with state regulations to 50 (Neuman, 1999).

The Benefits of the Process

There are mixed views of how successful the initiative has been. There are some very real benefits, intended or not, that translate toward more effective cooperative management along the coast. For instance, the process opened communications between local and state government and between different agencies. People who did not know each other now knew the other participants and what they did. This helped in determining what they could do for each other (Gualini, 2001; Luberoff, 1999; Neuman, 1999).

Participants could see the fruits of their involvement as plans they negotiated were enacted and funded. The process was strongly developmentally oriented, unlike the command and control CAFRA legislation (Neuman, 1999). This satisfied concerned property owners who felt they were losing the ability to earn any return on their investments. It did not, however, replace the existing coastal legislation, thus pleasing environmentalists. It made existing development plans more compatible with the existing regulatory statutes. Most importantly, it succeeded at getting communities to think long term on both a local and regional scale.

Cold Spring Inlet Political Analysis

Participants and Setting

It is important to note that even though this project is representative of many other coastal management scenarios around the country, with multiple users and conflicting use issues, the makeup of the users distinguishes the Cape May Peninsula somewhat from the situations at Wells and Saco, Maine. The federal government is a majority landowner and its lands have experienced some of the worst erosion problems in the area. The State of New Jersey has land holdings in the area around Cape May Point. The Nature Conservancy is also a landowner with valuable holdings in the wetlands south of Cape May City. They are not a "typical" NGO. They have land holdings and assets in excess of $3 billion worldwide. They are involved in resource extraction and development projects and have ties to industry, government, and large development interests. They do not take as hard a line on habitat preservation as other environmental NGOs do, often times compromising with competing interests to achieve partial goals (Ottaway and Stephens, 2003).

The setting also adds a unique component to the situation. Cape May Harbor and Cold Spring Inlet are directly tied into the Intracoastal Waterway, and maintaining the project is of national importance. The Coast Guard base is a training center on the East Coast. All of Cape May City is a national historic landmark falling under the authority of several state and federal agencies. Cape May Meadows is a unique freshwater coastal wetland critical to the Atlantic Flyway, affecting migratory birds across international borders. In addition to these factors, there is a state park at the bottom of the peninsula and considerable infrastructure in an around the harbor. These factors, combined with the list of participants above, most likely have something to with the area's ability to initiate mitigation plans and receive funding. There is much to lose in the way of economic investment, and majority owners are the ones in charge of regulating activity and appropriating money.

Project Beginnings

Three different proposals were rejected until the Board of Engineers decided that the investment was in the best interest of the region and the nation (USACE, 1890; USACE, 1894; USACE, 1907). This decision was made after a meeting with local developers and the Board of Engineers. It appears as if, once again, special business interests pressured the Army Corps and were able to get an otherwise marginal project approved.

The only other development of the inlet and channel occurred in 1941. Even here, special interests played a decisive role in seeing that the project was authorized and completed. That time it was the military, where channel improvements were considered a matter of national defense. The actual project was initiated prior to any study or report, and the report that followed was more of post hoc rationalization for the current work rather than a feasibility study (USACE, 1941).

Mitigation Efforts

The state and communities formed a strong working relationship along the coast. Today NJDEP not only offers technical and financial support, but they are also able to perform much of the construction (Garafola, 2003). Even with the cooperation and partnerships formed prior to the 1980s, there was a lack of direction or planning along the coast and throughout the state. This prompted the push for a statewide development plan. Although coastal communities were not originally included in the process, they embraced the idea and used the opportunity to address problems they had with existing zoning legislation and to rethink their own development goals.

The existing partnership with the state improved as communities became more familiar with different agencies and their functions. The agencies addressed a better-defined group of stakeholders and interests and were forced to incorporate their concerns in planning. This approach was also evident in communications with the federal government improving as communities and the state were speaking more with one voice and not competing agendas. The result was more effective mitigation efforts, with a greater variety of options and flexibility.

Holistic Analysis

The preceding sections addressed the individual components of the project. Each had an effect on how the project progressed and, ultimately, on how problems were addressed. It is clear that as much as the individual components drove the project. Their interaction is just as important in understanding the history of the Cold Spring Inlet Project. Again, the project is divided into three phases.

Phase 1: Project Authorization

Initially, the economics and coastal setting did not support a navigation project. Developers in the area lobbied the Board of Engineers for the Army Corps and convinced them to authorize the project despite the reservations held by the Army Corps' own engineers (Figure 6.5).

A new survey was conducted, and it was determined that conditions would support an improved stabilized inlet and channel. This was in direct opposition to a

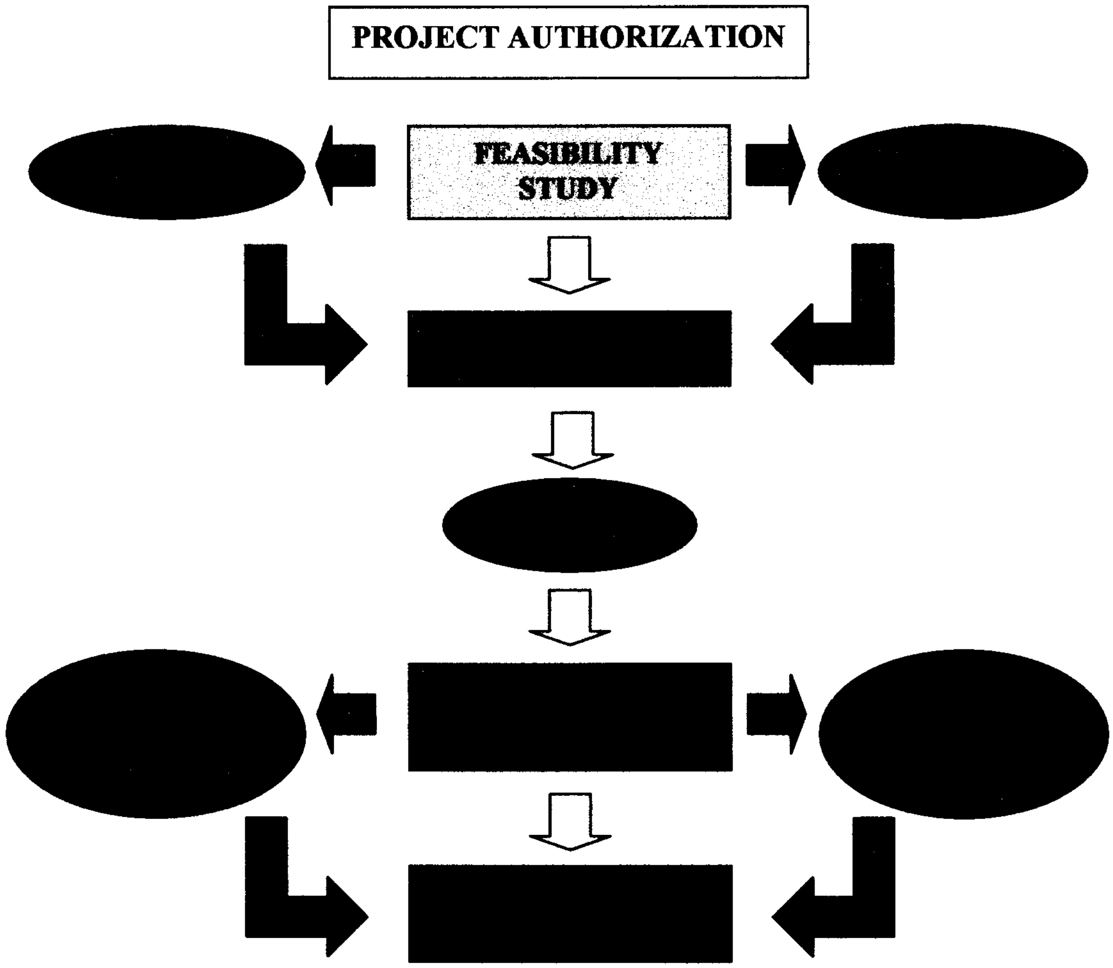

Figure 6.5 Project Authorization Phase for Cold Spring Inlet Project

report filed 13 years earlier that, in hindsight, accurately predicted the current problems. These actions reflected either a poor understanding of the coastal processes or a disregard for the existing information. Data used for economic justification came directly from local business interests, which the Army Corps accepted in good faith. Economic projections were purely speculative, based on no existing history of commerce in the area. Nevertheless, the project was authorized even with this dearth of information, and a federal project was established at the inlet.

Phase 2: Project Construction

There were two construction efforts (Figure 6.6). The first was the original federal navigation project at Cold Spring Inlet. The project design was based on questionable economics and misunderstood coastal processes. Construction proceeded, and both the jetties and channel were completed. The navigation project performed as planned, and it was not necessary to adjust the design to address problems within the inlet, channel, or harbor.

There were no serious problems with the navigation project itself, but erosion accelerated down drift along the beaches of Cape May Peninsula. This was due in part to the navigation project design. The Army Corps conducted surveys and proposed several projects, but no federally funded project materialized until 40 years after their initial shore protection report. The communities and the State of New Jersey instituted their own projects in the interim.

These projects were mainly groin and revetment construction to trap sediment and protect development. Project design was based on both economic data and coastal

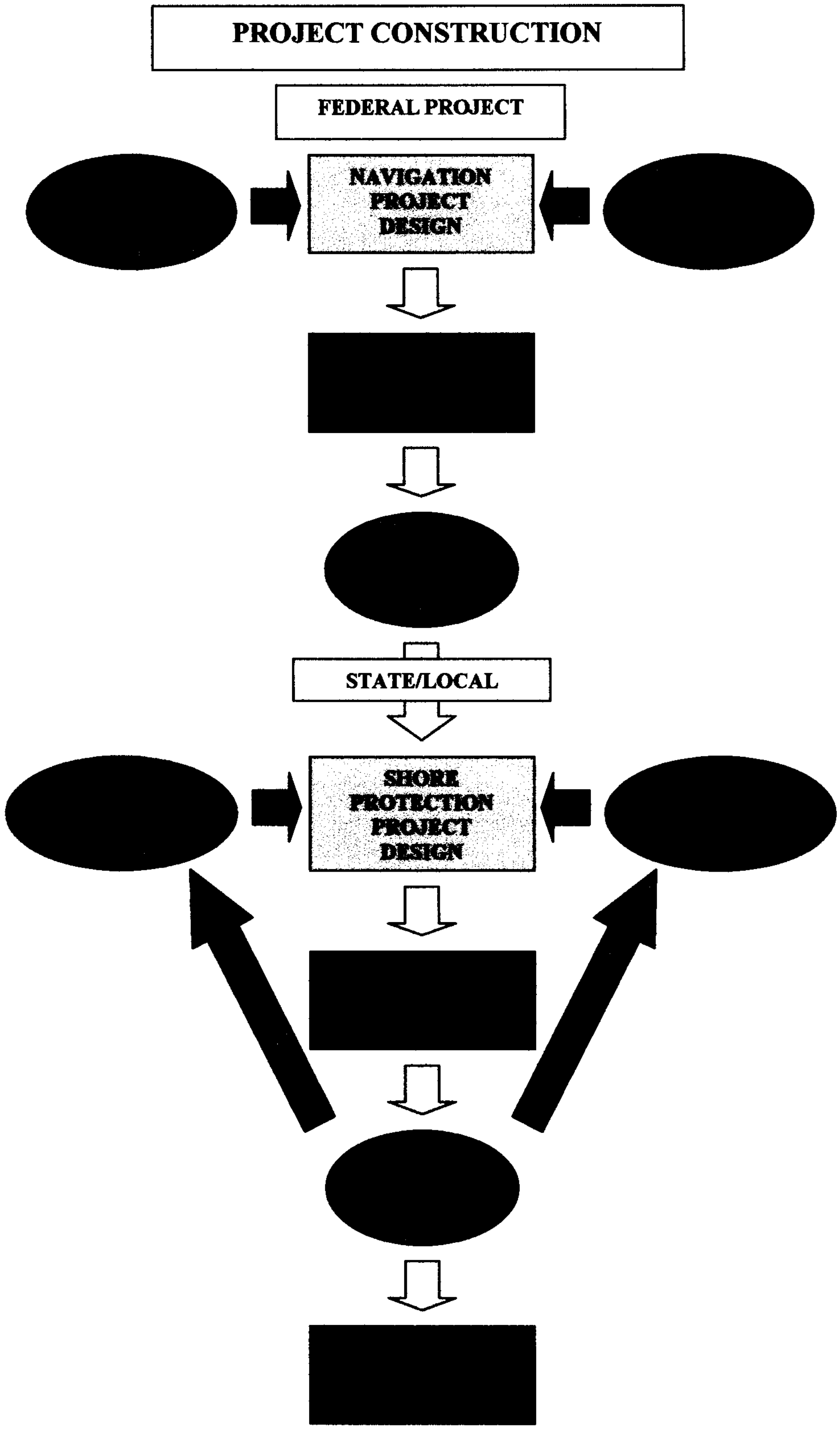

Figure 6.6 Project Construction Phase for the Cold Spring Inlet Project

process data. Initial efforts focused on the area just southwest of the inlet, the Coast Guard station and parts of Cape May City. These projects revealed a limited understanding of the complete coastal processes. The results were not satisfactory and required a review of the project design. Economic and coastal data were recycled several times as the projects first spread down the peninsula through Cape May Point and then turned back to expand the size of existing structures. These projects amplified the effects of erosion, down-drift requiring adjustments down the line until practically the entire peninsula shoreline was armored. Again, these actions reveal an incomplete understanding of the coastal processes and, based on the number of alterations, incomplete economic data. Eventually, the proposed federal plan was authorized and initiated, ending the cycle of groin construction and initiating other soft engineering plans[48].

Phase 3: Project Mitigation

Even with the typical economic patterns and engineering problems within the coastal setting, Cape May communities were not locked into a limited number of response options. They were able to pursue several options that fit the coastal setting, economic criteria, and the political environment (Figure 6.7).

Economically, the area was able to produce the benefits to satisfy federal criteria for use of public funds. Additionally, both the communities and the state had the ability to raise the monies necessary to implement the project they desired. The natural setting offered plenty of sand, extractable at an acceptable cost. By the 1990s, the coastal processes

[48] Soft engineering refers to practices like beach nourishment were no "hard structure", like a groin, is constructed.

affecting the area were better understood by engineers from the state and Army Corps due to studies conducted in the immediate area. This allowed for a variety of response options from nourishment to ecosystem restoration to newer engineering options like the Beachsaver Reefs[49]. It even led to the removal of some of the existing groins (www.climate.org, 1997).

The political environment was conducive to implementing the chosen plans. Strong positive relationships, established between the state and both the communities and Army Corps, allowed for cooperation on mitigation efforts. A common coastal management ideology, namely protecting coastal development, was also important in reaching consensus. The formalization of the decision-making process through cross-acceptance further strengthened the relationships. The results support the ability of a process-based regulatory system to be more effective than a command and control system in a home-rule setting (Plater et al., 1998). Ultimately this healthy political environment translated into finding economic solutions to problems in the natural setting.

[49] Beachsaver Reefs are concrete structures placed offshore, parallel to the beach, and are designed to dissipate incoming wave energy and block the offshore flow of sand.

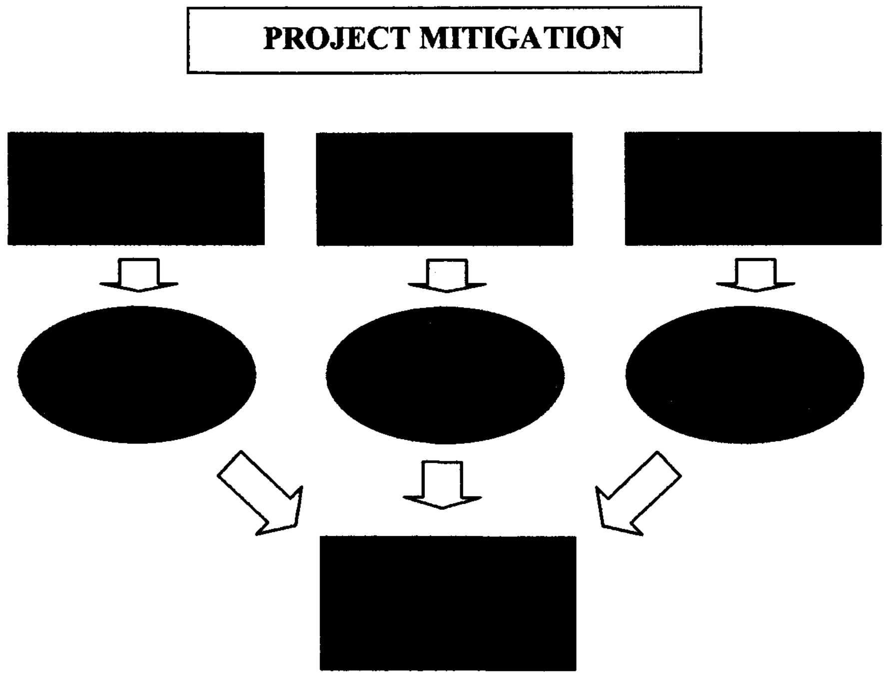

Figure 6.7 Project Mitigation Phase for the Cold Spring Inlet Project

CHAPTER 7

CROSS-CASE ANALYSIS

Kelley and Anderson (2000) believe that the Wells Harbor Project followed a similar history to the Saco River Project. They cited faulty project designs, inaccurate economic predictions, and similar volatile political environments. Review of the two case studies show that they were accurate in their assessment. Similarities are seen between the individual project units. Two comparable natural settings presented engineers with similar problems for each project. There are common economic forecasting patterns, and both political environments developed similar divisions and impasses.

When viewed holistically, the projects are also very similar. With the exception of certain details, the authorization and construction phases followed the same paths for both projects, with the natural setting, economic, and political units interacting in a similar manner. The mitigation phase proceeded in a similar fashion but diverged with the recent mediation efforts from Congressman Allen's office at Saco. Despite differences in certain details, a general model can be used to depict the collective histories of the Wells Harbor and Saco River Projects. This model helps identify the problems faced at Wells.

Similarities and differences are seen on both the unit and holistic levels when comparing the Cold Spring Inlet project to the general Maine case. Again, with the exception of certain details, they both share common authorization and construction phase histories. It is with the mitigation phase that we see a divergence between the New

Jersey case and the Maine cases. Review of the Cold Spring Inlet Project's natural setting, economic, and political units and their interaction supports the findings from the two Maine cases. These differences further help to explain the problems faced in Wells.

Wells Harbor Project And Saco River Project

Natural Setting

Both Maine projects lie on Maine's southern coast. They experience similar tidal ranges, wind, and wave regimes. Wells Harbor is positioned more northerly within its embayment then the Saco River Inlet in its embayment. This offers more protection from extratropical winter storms, but both projects are still exposed to easterly storm waves and the effects of sea-level rise.

Both areas have the majority of their sand coming from the existing shoreface deposits. Sand is exchanged throughout both systems, maintaining equilibrium between tidal bodies inside and outside the inlets. One noticeable difference between the areas is the Saco River's contribution of sand to the system. Wells Embayment does not have this type of sand source. The Webhannet River supplies no sand to the system, and beaches are considered sand-starved. Overall, there is a smaller volume of sand in the beaches of Wells Embaymet then the beaches of Saco Bay (Kelley et al., 2002).

The Army Corps approached the projects much in the same way they would inlets, like Cold Spring Inlet, with a dominant longshore component, continuously supplying sand. Based on this assumption, they anticipated that shorelines would accrete uniformly, and that sand in the inlets would disappear once the jetties were constructed (USACE, 1910; USACE, 1959). This was not the case. The specific effect the jetties had on their respective project areas differed. The jetties on the Webhannet Inlet acted as headlands impounding beach sand transported towards the inlet from both directions, whereas the jetties on the Saco River redirected the sand from the river offshore while amplifying erosion processes along local beaches.

The overall outcomes, however, were the same. Jetties interrupted the exchange of sand in the system between inlets and beaches and upset the established equilibriums. The result was accelerated erosion of the adjacent beach communities as the shorefaces adjusted. Sand was removed from the system with no means of natural nourishment. At Wells Harbor, the initial dredging placed sand inland and offshore, away from Wells Beach and Drakes Island. At the Saco River, the length of the jetties funneled sand supplied by the river out to sea where longshore currents carried it north, away from Camp Ellis Beach.

At the root of these problems was an incomplete understanding of the characteristics of longshore and tidal currents in the project areas, sand sources, and system equilibrium coupled with a lack of observational data. Past actions reveal that the Army Corps never tried to address these questions with observational data. In Wells, an engineering study was commissioned to examine the shoaling problems, later supported with the construction of a wave model in the 1970s (Bottin, 1978; Byrne and Zeigler, 1977). Byrne and Zeigler (1977) identified a connection between shoaling in the anchorage and inlet through the exchange of sand between tidal bodies and the estuary. Despite this, the Army Corps did not make an effort to substantiate or quantify the effects their actions had on this exchange. Subsequent studies were merely compilations of previous work with no new observational data (Smith, 1994). It wasn't until recently, with the relocation of the anchorage, that the Army Corps' actions reflected this knowledge. Finally in 2001, over 20 years after the connection was first identified within their study, a program was implemented to measure the loss of sand in the salt marshes caused by dredging in the harbor and the inlet (Carter, 2002).

The same was true for the Saco River project. Army Corps studies recycled previous work and reiterated the same opinions and suggestions based on observational data obtained elsewhere along Maine's coast (USACE, 1955; 1968; 1982; 1992). Studies existed that contradicted their findings and accurately described current flow, sand movement to the north, and the role of the Saco River as a source of sand for the bay (Farrell, 1970; 1972; Kelley et al., 1995b; Manthorp, 1995). The Army Corps refuted these findings and stakeholder observations. They continued to rely on earlier reports and the findings from an incomplete physical wave model.[50] It wasn't until 2001 that their views changed to the more commonly held beliefs of other researchers (USACE, 2001), and they acknowledged the need for site-specific observations to understand where the sand at Camp Ellis was going before initiating any further actions (Kelley, 2003; Michaud 2003).

Response patterns were the same. The Army Corps did not approach these problems with sound scientific or engineering methods. Their approach was very narrow, based on their previous misconceptions. Engineering problems were addressed with engineering solutions, a common pattern experienced at other federal projects discussed in Chapter 2 of this thesis (Bregman, 1983; Pilkey and Dixon, 1996). Jetties were extended several times, driven by the same misconceptions that produced the original

[50] The model did not have the Saco River built into its design (Kelley, 2003).

flawed designs. This resulted in bigger projects with bigger problems. Overall, this expansion magnified the effects of erosion while only temporarily alleviating shoaling at the two sites.

Economics

From the late 1800s to the early 1900s, inlets served industrial uses. This shifted to recreation and fishing as industry declined. The Saco River Project began as an industrial endeavor and switched to recreation and fishing at the same time that the Wells Harbor Project came online. Although the Saco River Project initially had a different economic objective, it shared a common economic objective with the Wells Harbor project by the 1960s, namely to improve conditions for fishermen and recreationists. Benefits were considered part of national economic growth, even though they were realized by a relatively small group of regional users.

Both projects have similar economic prediction histories.[51] Costs were greatly underestimated. Maintenance costs (dredging and jetty repairs), initially a small percentage of annual costs, became a larger percentage of the annual costs due to the expanding sizes of the projects and underestimations of sedimentation rates. Changes in design and additional construction greatly increased the initial first costs. Wells alone experienced an increase from $2.8 million to $5.1 million in initial construction costs projections between 1959 and 1965 (Figure 4.14).[52] Mitigation at both sites added substantial "incidental" costs to the overall figure. Camp Ellis lost over 30 homes

[51] Refer to the Economic Justification sections of chapters 4 and 5 for the complete economic histories of each project.
[52] 2003 dollars

(USACE, 2001), and Wells experienced loss of recreational beach, damage to bird habitat, and increased exposure of homes to coastal hazards. Wells is yet to determine a value for these costs.

Complementing underestimated costs were overestimated project benefits. As projected costs increased, the projected benefits also increased, justifying use of public funds in compliance with federal benefit-cost criterion. On the Saco River, early project benefits were increased commerce and decreased freight rates. The increase in commerce was not as expected. The river was mainly used for transporting coal also being supplied by train (USACE, 1910; 1924; 1934). No finished goods left on the boats (USACE, 1886; 1934). Rail freight charges initially dropped with the improvements on the river, but this too was short lived (USACE, 1934). Records were poor but the sentiment from the Army Corps reports was that the industrial benefits peaked in the early 1920s prior to the completion of the remaining construction on the jetties and channel (USACE, 1934).

From the 1960s to present, both the Saco River and Wells Harbor projects were intended to produce economic benefits from improved commercial fishing and recreational boating opportunities. This is questionable when reviewing records that show poor lobster landings in York County in comparison to the state as a whole (Figures 4.10 and 4.11) and a declining ground fishery (Figures 4.12, 4.13, 4.14, and 4.15), statewide for that time period. Commercial fishing benefits are now considered unpredictable and, as a result, the Army Corps no longer is permitted to use them in benefit calculation without the express permission of the National Marine Fisheries Service (Habel, 2003). Recreational data was incomplete for Wells Harbor, but mooring records show that the anchorage has not accommodated the fleet size originally projected for the project (Dickson, 2002; Lang, 2003; Wells Harbor, 1997; 2002; USACE, 1980).

The physical scope of these projects increased to generate the benefits that would justify the greater expenditures. This drove up maintenance costs and overall costs.[53] In an effort not only to achieve a benefit to cost ratio greater than one but also to maximize the net benefits, smaller projects were overlooked in preference to bigger, more invasive projects with greater predicted benefits.[54]

Eventually both projects entered mitigation stages where all subsequent efforts focused on addressing erosion problems. Costs exceeded the benefits of proposed mitigation.[55] Mitigation alternatives in the 1991 Section 111 Study for Camp Ellis generated benefit-cost ratios ranging from 0.2 to 0.7 (USACE, 1991). Although no specific economic calculations were made for nourishment options at Wells Beach and Drakes Island, the fact that only nourishment in conjunction with dredging had ever been considered indicated that the next best alternative was not economically justifiable. The project areas had deteriorated to a point where potential benefits would not exceed the costs of the subsequent projects, thereby losing eligibility for public funding. Communities lacked the funds to finance the projects themselves. This was partially responsible for a period of inaction during the 1980s in Wells and the 1990s in Camp Ellis.

[53] Decreased maintenance eventually became one of the projected benefits of future project development.
[54] Projects that incorporated additional dredging were popular due to the secondary benefit of spoil disposal on eroding beaches.

[55] This was mainly nourishment, because the State of Maine no longer permitted armoring.

Political Environment

Business interests in both communities and the Army Corps were behind most of the planning and decision-making responsible for the projects. State agencies served a regulatory role. The majority of the stakeholders in the communities were not involved in the process, but they entered the situation after their specific interests were negatively affected by the project.

Specifics and timing differed between the projects, but the end results were the same. Both communities divided early in the mitigation phases of the projects. In Saco, the community was split between those who supported armoring and those who supported relocation of properties. In Wells, the community split between those who supported a dredge and those who were beach property owners who felt that further project activity would jeopardize their investments. Neither community entirely trusted the Army Corps or their state government. Problems between the state and communities revolved around a change in coastal management ideology embodied in regulations like the 1983 Sand Dune Rules, later incorporated into Maine's Natural Resource Protection Act (MDEP, 1988). This was also at the root of problems between the state and the Army Corps. The state's management ideology was in conflict with Army Corps' development directive. This is now the focus of many of the current problems and has helped to serve as a unifying force between factions within the once divided communities.

Later, problems in Wells arose between the community and groups with a conservation and pro-environment focus like Maine Audubon Society and the USF&WS, who opposed dredging due to the negative effects on bird habitat. This was not the case in Saco due to an absence of valued bird habitat; however, the community of Camp Ellis shares similar views and sees environmental groups as anti-development and a threat to their interests (SOS Camp Ellis, 2003).

Divisions have prevented consensus on a common course of action. The delays caused by such divisions allowed the physical and political environment to deteriorate further, and all parties were caught in a downward cycle of inaction.[56]

There was some overlap between the cases. The poor relationship the State of Maine had with the Army Corps during the Saco River Project carried over to the Wells Harbor Project[57]. Many of the same personnel from Maine agencies worked on both projects, as did some of the Army Corps engineers. It is understandable that ill feelings and perceptions carried over. This was also seen within stakeholder perceptions. Contact between communities through groups like SOS and the Southern Maine Beach Stakeholder Group spread ill feelings and distrust. Stakeholders were aware of what was happening in other communities, and this guided their perception of their situation (Foley, 2002; SOS Camp Ellis, 2003). State development regulations concerned both communities because they faced the real possibility of losing their homes and of being unable to rebuild[58].

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[56] This inaction enabled both natural and economic conditions to worsen and further complicate the problem.

[57] Interviews revealed that there were positive one on one relationship between specific individuals but the overall relationship with the State of Maine can be described as poor (Dickson, 2002; Habel, 2003; Kelley, 2003).

[58] A dwelling damaged beyond 50% its value must be removed in accordance with state coastal regulations (MDEP, 1988).

Divergence in the Cases

A very similar pattern is observed in both cases; however, their paths have diverged in recent history, due in part to changes in the political environment. As previously noted, Congressman Allen's office entered into the negotiations at Camp Ellis in 2000. Participants are back at the negotiation table working toward consensus, feeling they have a real stake in the successful resolution of this problem. This helps keep all engaged and drives the process forward (Ouellette, 2002).

This has not occurred in Wells. Attempts to help the process have been made by Senators Snowe and Collins but not to the extent of involvement seen from Congressman Allen's office in Camp Ellis (Carter, 2002; Ouellette, 2002). The efforts in Camp Ellis have supplemented the efforts of the State Planning Office, which typically serves as intermediary.[59] Interviews revealed a perception that the State Planning Office on their own has not been as successful as they could be in this role, citing critical missed opportunities on the part of the office that have aggravated the situation (Habel, 2003; Jones, 2003).

Holistic Analysis: The General Maine Case

The natural settings, economic, and political units interacted in a similar manner. The projects I have reviewed are viewed in three phases: authorization, construction, and mitigation. Both Wells and Saco followed the same authorization and construction phases. They also started out on the same mitigation paths but, as noted in the preceding

[59] The State Planning Office is the intermediary between federal agencies and communities along the coast of Maine (Leyden, 2003).

section, there was a divergence in Saco's political environment that positively affected the engineering and economic components of that project.

Phase 1 and 2 – Authorization and Construction

Specific details differ from case to case, but the overall patterns are the same in both phases (Figure 7.1). Of note is the interplay between the coastal data and economic predictions. Both are key elements in authorizing a project and in the engineering design. The accuracy of the coastal data affects the accuracy of the economic predictions, which leads to either the justification or rejection of a project (Figure 7.2). For example, in Wells the underestimated shoaling rates in the harbor produced underestimated cost predictions. In Saco, misunderstanding sediment flow may produce a particular engineering design that is economically viable, whereas an accurate interpretation of the setting might have produced a different and more costly design, prohibiting the project from moving forward

Inaccurate coastal data doesn't necessarily mean that a marginal project is authorized, but it does increase the probability of that happening[60]. Regardless of these points, the final outcomes will depend just as much on the political environment as they do on the accuracy of the coastal process and economic data.

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[60] Accurate coastal data does not guarantee a problem-free project but it is desirable.

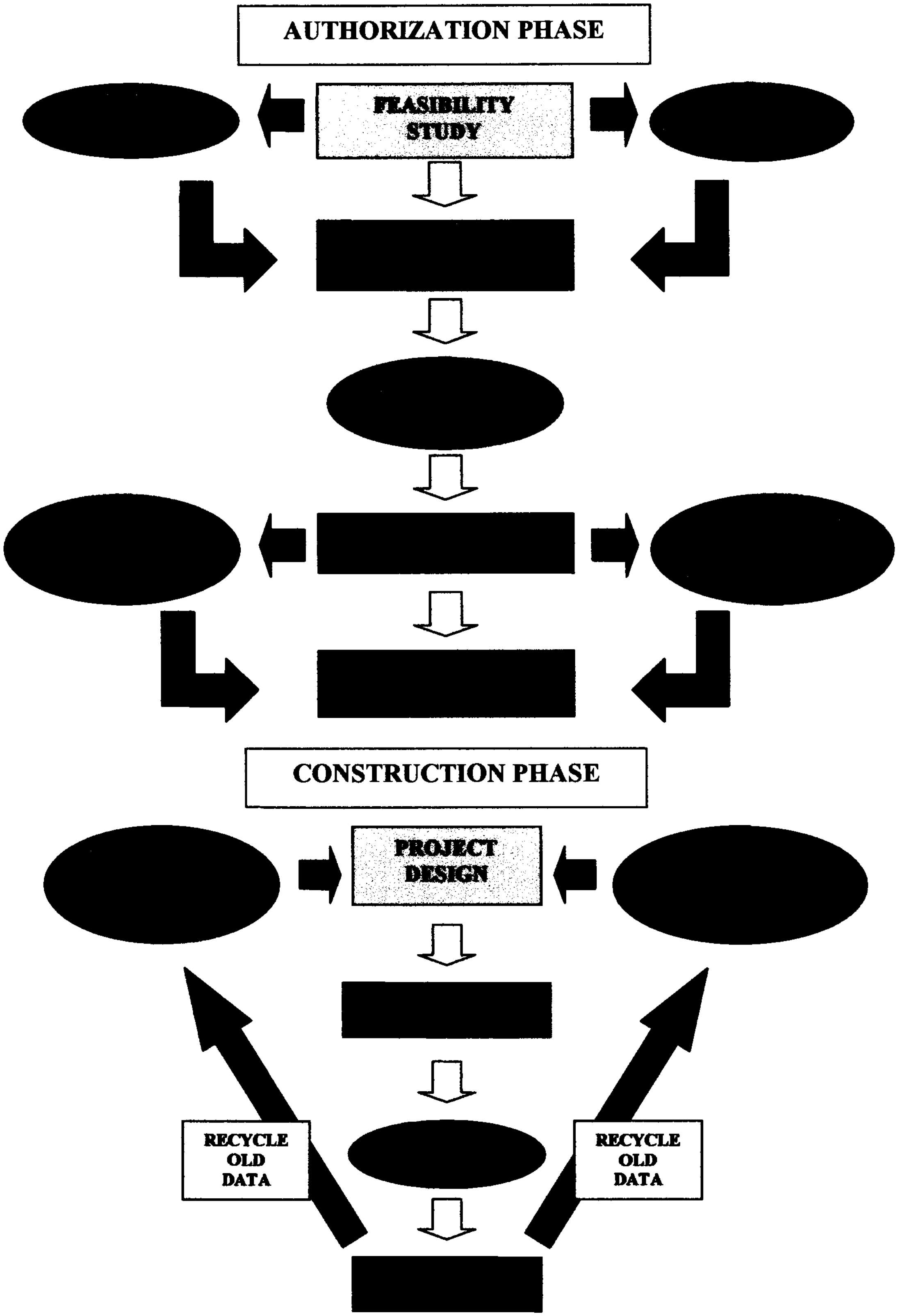

Figure 7.1 Authorization and Construction Phases for the General Maine Case

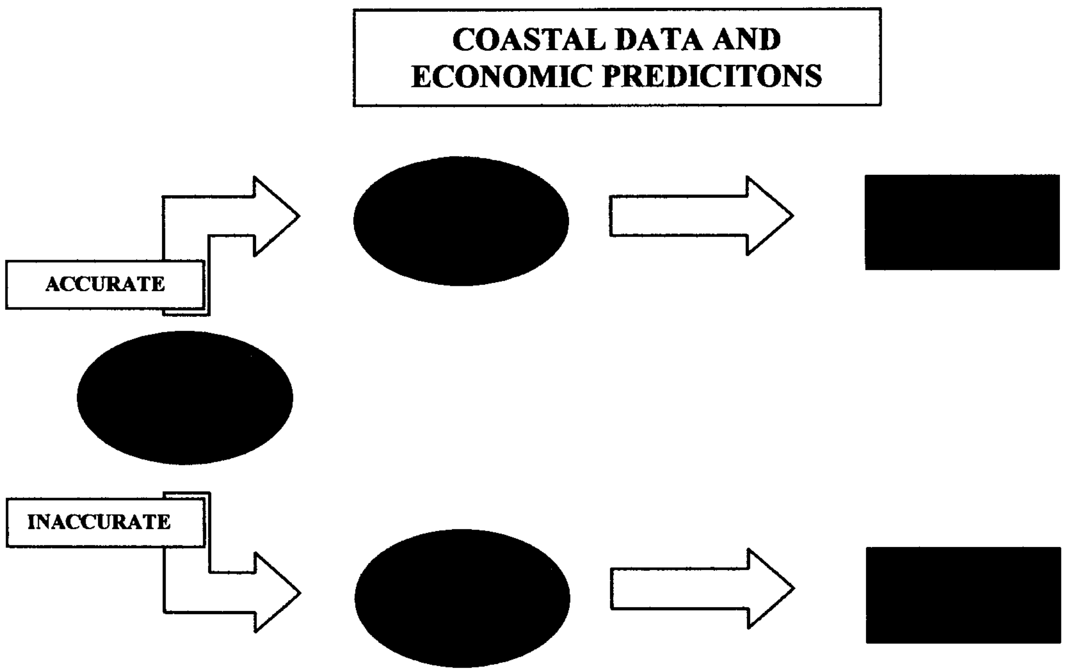

Figure 7.2 Coastal process data and its effects on the economic predictions. The accuracy of the coastal process data has a direct bearing on the accuracy of the economic projections, which in turn will decide whether a project is undertaken, committing communities and states to a certain path with restricted options.

Phase 3 – Mitigation

The mitigation phase of both projects followed a similar path. The interaction of the natural settings, the economics, and the political units lead to an impasse in response options (Figure 7.3). Flood tidal deltas were chosen as "deepwater" anchorages, and ebb tidal deltas were turned into navigational channels, and as a result, there were not many effective engineering options available for mitigation. Economically, the community was restricted to a very limited number of options. All publicly funded federal and/or state options must meet the benefit to cost ratio criterion. This limited the possibilities to the least expensive plans. As the area deteriorated, its ability to generate the benefits necessary for federal involvement greatly diminished. This only worsened in time as more problems emerged and mitigation costs rose. The communities were not able to fund these projects on their own.

Problems in the political environment affected the entire process. Ideological conflicts between all participants delayed any economically viable engineering option. As previously stated, this delay amplified existing problems. The divergence of the Saco River project from this pattern was due in part to efforts aimed at ameliorating the poor political environment (Figure 7.4).

Addressing problems in the political environment have produced more economically viable engineering options.[61] Once a change in the political environment occurred other options emerged.

[61] It wasn't the case that these options did not exist prior to mediation. It was more likely a case where poor relations created an environment where participants were not willing to search beyond the standard response options.

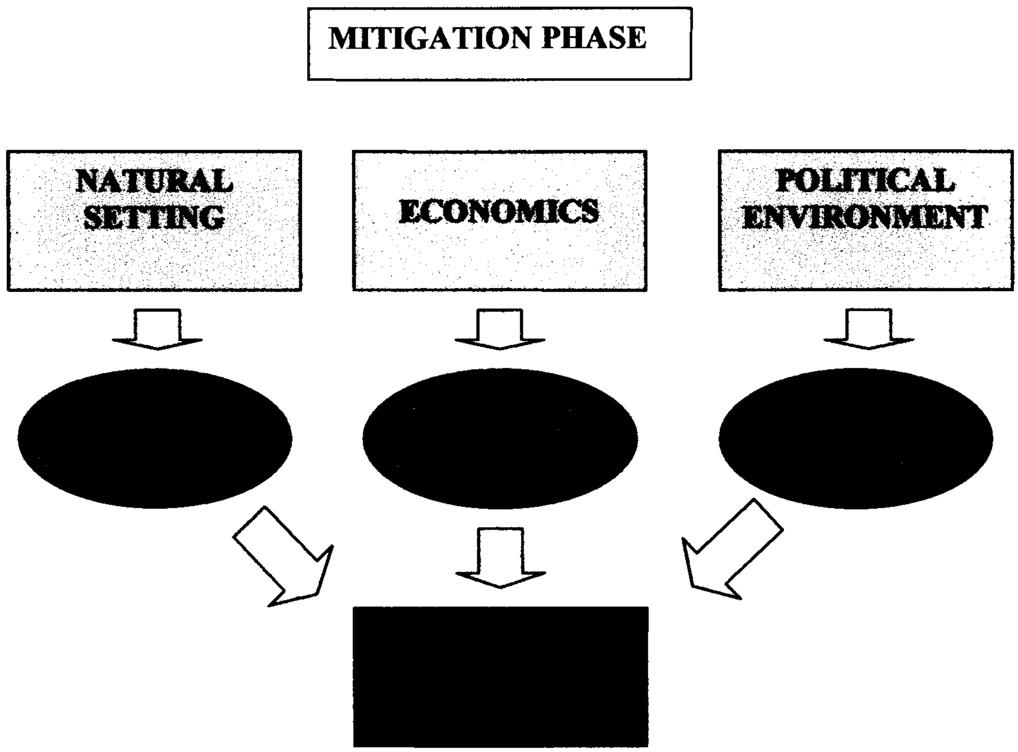

Figure 7.3 Mitigation Phase for the General Maine Case.

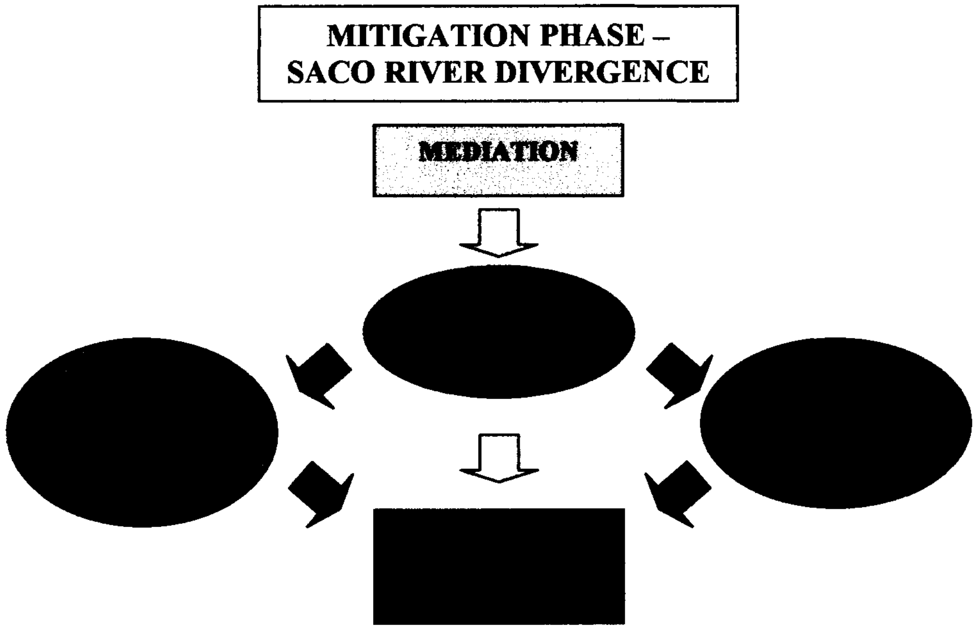

Figure 7.4 The divergence of the Saco River Project's mitigation phase. Mediation provide by Congressman Allen's office addressed problems in the political environment and led to new economically viable engineering options for the community of Camp Ellis.

Holistic Summary

The two Maine cases followed very similar paths on the unit and holistic levels. Recent developments in improving the political environment at the Saco River project illustrate the importance of this unit of the project and the effects it has on every aspect of the project. Wells Harbor is not at this point, and every indication is that the community is not ready (Dickson, 2002; Kelley, 2003). This is based on the level of distrust communicated during interviews. Past cooperative efforts and mediation have failed, and the community is wary of future attempts (Carter, 2002; Foley, 2002). They may have to progress to the urgent situation faced at Camp Ellis before they are willing to participate in any cooperative efforts that might otherwise be viewed as compromising their own personal interests.

The General Maine Case and Cold Spring Inlet, New Jersey

Natural Setting

The Maine projects lack the dominant longshore component of sediment transport found along New Jersey's coast. This is due entirely to the compartmentalized nature of the coastline. No sand comes from outside the individual beach compartments in Maine, whereas in New Jersey sediment historically arrived at Cape May Peninsula from the north at a steady rate. For these reasons conventional shore-perpendicular structures are not as effective in Maine at catching sand as they are in New Jersey.[62]

[62] This is not to say that groins are successful on the Cape May Peninsula. Beyond the direct negative effects of the jetties, groins have actually aggravated the situation in some areas (Fraser, 2003).

Sand supply and sources are another critical difference Maine and New Jersey. The Maine sites have relatively little new sand introduced into the system. The majority of the sand is found in existing shoreface deposits, and Saco River's contribution does not currently make it to Camp Ellis Beach. Nearshore glacial deposits are not economically viable options for extraction. The Cape May site receives a continuous supply of sand from the north that is trapped along the northern jetty of the inlet. Ridges on the continental shelf are also a source, and there are viable sources inside the harbor and Intra Coastal Waterway. Nourishment is more of an option in Cape May then at either Wells or Saco where nourishment is only feasible when it coincides with dredging.

While the important differences in the coastal setting distinguish the Maine sites from the New Jersey site, I think that the general engineering effects and response patterns were somewhat similar. All three projects in different ways created extremely sand-starved beaches for adjacent beach communities by blocking the flow of sand or removing existing sand from a finite supply. The effects of the jetties at the Maine inlets were discussed in the previous section. The jetties at Cold Spring Inlet impounded sand from the north and, once at capacity, redirected sand offshore away from the Cape May Peninsula beaches. Tidal and wave energy accelerated erosion in all three reconfigured systems, resulting in areas where erosion greatly outpaced the rate of nourishment.

Response patterns to erosion were strikingly similar. Erosion that threatened development was addressed with engineered solutions. In Maine, jetties were lengthened at each site, while in New Jersey groins were constructed throughout the project area. Neither achieved the desired results, and the process was repeated. The end result was the same; erosion was accelerated and spread beyond the immediate project area.

Economics

Records show a common history of underestimated cost predictions for all three projects. Although the general project design remained the same for the most part, construction and maintenance costs increased. In New Jersey this was seen with the increasing cost projections for the proposed federal shore protection plans (Table 6.21). Complementing this was a steady increase in predicted benefits. Existing benefit categories increased in value or categories were added or removed from plan to plan with minimal explanation. In Maine, it was shown that these benefits were overvalued. In New Jersey these predictions may have been more accurate due to the large populations to the north and south supporting commercial and recreational businesses.

All three projects accumulated substantial incidental costs due to collateral shoreline damage. They came in the form of property loss, loss of recreational beach, erosion-control structures, or nourishment. The communities, states, and federal government shouldered these costs. In New Jersey the state and the communities of Cape May Peninsula spent considerable resources on groins, seawalls, and nourishment along their beaches (Tables 6.3, 6.6, and 6.18). The communities, state, and federal government are engaged in a multimillion-dollar habitat restoration project in Cape May Meadows (USACE, 1998). There was also the cost of lost recreational opportunities and bird habitat destruction. Camp Ellis did not have bird habitat to lose; however, both Wells and Cape May have critical bird habitat that is threatened by the navigation projects and proposed mitigation projects.

Currently there are also significant economic differences between Maine and New Jersey. Cold Spring Inlet originated as a port of commerce and a military installation. It evolved primarily into a commercial fishing port that also services recreational boaters and the Coast Guard. The Intra Coastal Waterway feeds commercial and recreational traffic directly through the harbor. The proximity to Philadelphia and its suburbs provides a tributary population that supports the fishing industry and recreation. The beach communities attract thousands of recreational visitors during the summer months, and the bird sanctuary adds to this.

Overall, the setting has supported economic growth throughout the project's life and has the ability to produce the return that justifies investment. Cape May County had 2,900 employed fishermen in 1995. In that same year, they harvested approximately 177 million pounds of seafood at a value of $96 million. Fishermen in Cape May Harbor alone accounted for 75 million pounds of the County's total landings (USACE, 1998). Tourism in Cape May County during 1993 generated $1.9 billion in receipts and provided for 20,000 jobs with an estimated payroll of $500 million. The State Park near Cape May Point recorded 730,000 visitors during 1995, and the Cape May Bird Observatory attracted more than 100,000 visitors during 1997, responsible for an estimated $31 million of economic impact (USACE, 1998).

The Maine sites produced recreational and commercial fishing opportunities but not on a scale to justify the additional investment they required.[63] The nearest large population comparable to Philadelphia is Boston. Because of the abundance of warmer water beaches to the south and nearby Cape Cod, Boston does not provide the consumers needed to generate the desired economic benefits. A more detailed study is needed to quantify this effect.

[63] This is due in part to a decline in ground fisheries and the relatively poor lobster grounds referred to in the previous case studies.

These differences have two effects on mitigation efforts. First, the inability to generate predicted benefits limits the number of federally funded projects available to the Maine sites. They are unable to satisfy the economic criterion required for public funding, particularly on the higher cost projects. The costs of mitigation go up, relative to benefits due to inaction, making it even more difficult to satisfy economic criterion in the future. Second, the ability to generate business in the area provides the communities and state with the economic resources necessary to fund their own projects. New Jersey is able to do this, but the Maine communities cannot do so on the scale they need.

Political Environment

All projects had similar beginnings. They were initially rejected due to poor economic and engineering conditions. Political pressure succeeded in obtaining project authorization despite opposition from agencies and Army Corps engineers. All projects began within a divided political setting.

The participants in the New Jersey and Maine cases represented the same sort of constituencies. For both states, there were numerous local stakeholders including fishermen, property owners, developers, and environmentalists. Town officers represented local government. On the state level there were the Departments of Environmental Protection, the State Planning Offices, and other state agencies like MGS in Maine. On the federal level there was the Army Corps and the USF&WS.[64] NGOs also played an active role in both states.

[64] Cape May also has the U.S. Coast Guard.

Both New Jersey and Maine operate through "home rule". There is a bottom-up government structure where communities are in charge of their development, and the state acts as more of a regulator, setting minimum standards for activity within the state, and as a resource in providing assistance with planning and development (Gualini, 2001; Leyden, 2003).

A difference between the Maine and New Jersey project sites centers on the ownership of the land within the project areas. In Maine, the majority of the land at Wells and Camp Ellis is privately owned. The only exception is the Rachel Carson Wildlife Refuge, bordering Wells Harbor. Ownership of the land on the Cape May Peninsula is divided between the Coast Guard, the State of New Jersey, The Nature Conservancy, and private residents, creating a different political setting. These organizations have land of their own to lose; their Maine counterparts do not. This is not to say that the participants in the Maine projects care any less about the area, but ownership may put a different perspective on the situation encouraging New Jersey participants to cooperate more effectively. This difference in land ownership is reflected statewide. In New Jersey ownership of the coastline shoreward of the Mean High Water mark is 14% federal, 28% non-federal public, and 58% private. In Maine there is less than 1% federal, 2% non-federal public, and 97% private ownership (Ringold and Clark, 1980).

Ultimately, the defining difference in the political environments is coastal management ideology. The State of Maine's approach to managing the sandy southern coast is to preserve it as a natural resource. An objective is to avoid creating an armored coast that protects development. This approach is in line with the limited resources of coastal communities and the state and provides a means for Maine to maintain its natural coastal identity. This approach is not always in line with the wishes of stakeholders, nor is it always compatible with Army Corps directives (Foley, 2002; Habel, 2003). This puts the state at odds with the two groups.

The State of New Jersey's approach is more development oriented. It has actively encouraged development along the coast and has adopted a policy of armoring and nourishment to protect that development. This is not to say that New Jersey does not wish to preserve the natural character of the coast. Areas like Cape May Meadows have restricted armoring; however, the majority of the barrier islands have some form of armor and/or nourishment to protect beach and development. This ideology is in line with both the wishes of the communities and the mission of the Army Corps, leading to cooperative partnerships.

The State of New Jersey, as a federal project sponsor, is actively involved in community projects, providing funding, engineering support, and regulatory assistance. The State of Maine no longer acts as sponsor for coastal projects.[65] This is left to the communities.[66] The recent formulation of a voluntary state development plan in New Jersey has further improved the political environment and the ability to enact mitigation projects.

[65] The state originally helped finance the Wells Harbor project and later the DOT assisted with certain projects including the new anchorage in Wells Harbor (Kelley, 2003).
[66] Connecticut is the only other state in New England where the communities act as their own sponsors. It works well there because the communities are comparatively wealthier than Maine communities (Habel, 2003).

Holistic Analysis: Maine And New Jersey

Specific details differ, but the overall interaction of the natural setting, economic, and the political units is very similar between the Maine projects and New Jersey project for the authorization and construction phases. The mitigation phase reveals some differences and highlights reasons why the Maine projects have not been able to proceed toward acceptable resolutions.

Phase 1 – Authorization

The same basic model describes the authorization phase for all 3 projects (Figure 7.1). Marginal projects were initially rejected. Special interests applied political pressure to the Army Corps, and subsequent reviews of the projects returned favorable results. Marginal projects were authorized based on questionable economic information and flawed coastal process data.

Phase 2 – Construction

Again all three projects generally followed the same model (Figure 7.1). The New Jersey case diverged somewhat with a history of local and state projects focused on shore protection and not navigation, but the overall patterns are the same as the Maine projects. Some problem emerged with the projects, whether it was with the navigation component itself or erosion of adjacent beaches. This was addressed through changes in engineering design. The same coastal process information and economic predictions used on the original design were recycled into the new designs. This cycle amplified problems and created more damage.

Phase 3 – Mitigation

It is in the mitigation phase where the divergence between the Maine projects and New Jersey project is seen. This originated in the differences highlighted in the previous economic and political environment analyses.

The political environment in New Jersey was and is conducive to cooperative management. The strong relationships formed between local, state, and federal interests allowed for consensus on mitigation efforts. This created more options both economically and technically that worked within the political environment. Another driving force was the strong economic environment within the communities and state that presented more response options that met federal funding criterion (Figure 7.5).

The Maine projects lack this type of political environment (Figure 7.3). The problems that exist between the participants delay mitigation response and compound the issues. There are seemingly very limited engineering options that satisfy the economic criterion. The communities and state are unable to orchestrate a mutually agreed upon response due to a lack of funds, further limiting their mitigation options. The assertion that problems faced at Saco and Wells are due in large part to a poor political environment is further supported by the recent events at Camp Ellis. The progress made in mending relationships and creating a cooperative environment has already produced engineering response options that work with the economic constraints (Figure 7.4).

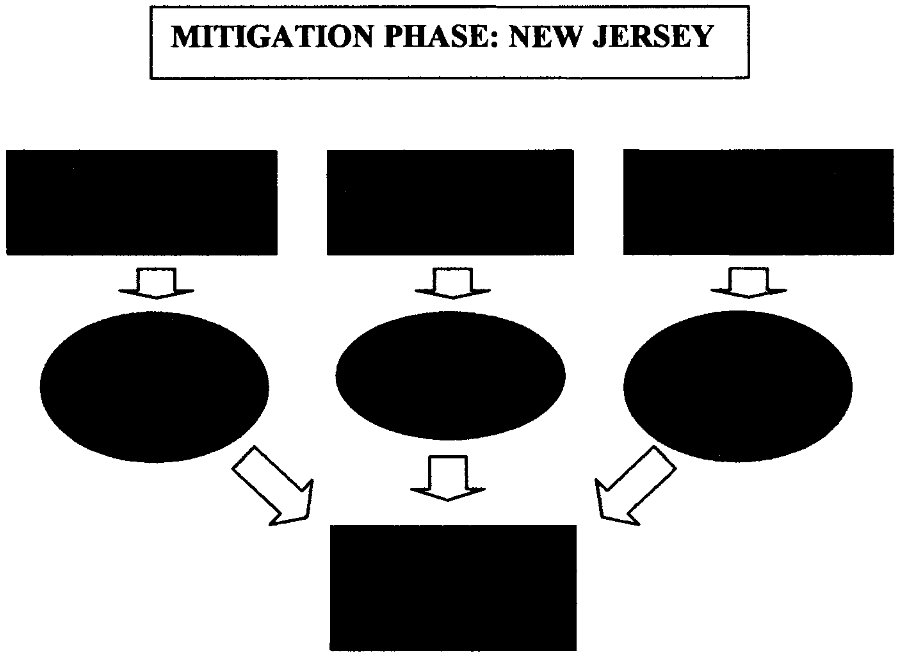

Figure 7.5 The mitigation phase for the New Jersey project. Better natural, economic, and political conditions provide more mitigation options for the Cape May Peninsula and allow for consensus to be reached on a plan.

Holistic Summary

There are similarities and differences within the individual units of the general Maine case and the Cold Spring Inlet Project. Combined, they interact in a very similar manner through the authorization and construction phases of all three projects. Similarities between Maine and New Jersey offer robust explanations for how these projects progressed and created their associated problems.

The mitigation phase highlights the greatest differences, not only between the Maine and New Jersey projects, but also between the individual Maine projects. These differences provide explanations for why the community of Wells is unable to move forward on an agreed upon response plan. This originates in the individual project units. New Jersey's natural setting provides more mitigation options than Maine, but the economic and political units are the driving forces behind the mitigation plans. With those units in place, New Jersey has more options than the Maine communities and is able to implement their plans.

Again, this assertion is further supported by the recent emergence of mitigation options for the Saco River Project. Nothing has been decided but efforts at reconciling problems in the political environment have produced economically viable and federally funded engineering possibilities. Actual costs may go well beyond existing funds, but the general feeling is that as long as the current efforts continue additional monies will be provided as needed (Michaud, 2003). The coastal processes haven't changed and, if anything, economic conditions have deteriorated. This emphasizes the importance of a working political environment in effectively addressing problems and moving forward.

CHAPTER 8

POLICY RECOMMENDATIONS

Maine's Coastal Management Ideology

The Cold Spring Inlet case study highlights certain components, missing from the Wells Harbor and Saco River projects that are limiting managers' ability to effectively respond to their problems. These predominantly occur in the economic and political units of the projects where New Jersey is better positioned to address contingencies. This is not say that Maine needs to adopt a management ideology that is in line with New Jersey.

Maine's current policy, although referred to at times as retreat, is much more than running from the rising sea. The coastal management policy, particularly along the southern sandy coastline, has received favorable marks from policy analysts as being progressive and future thinking, specifically the Sand Dune Rules outlined in the Natural Resource Protection Act (Van Arsdol et al., 2000). It is a policy that addresses the long-term effects of sea-level rise while taking into account the limited resources of the communities and the state while balancing development needs and the health of the natural environment.

Maine's sandy beaches account for approximately 2% of the total coastline (MSPO, 1998), making them a scarce state resource amid thousands of kilometers of bluffs, rocky headlands, and marsh. It is also this fact that makes them a draw for tourism. Compared to New Jersey beaches, Maine beaches are less developed and maintain much of their natural character without the same amount of armoring. If it is this characteristic that people most value, adopting a policy of protecting development at the expense of the resource does not make sense for the long-term social and economic health of the region or the state. Having said this, there are lessons that Maine managers need to understand from the Maine and New Jersey cases in order to implement better management practices that support the current coastal management ideology, locally, regionally, and statewide.

Coastal Process Data

The coastal processes along Maine's southern beaches are better understood now than they were during the construction of Wells Harbor and the Saco River Inlet. Work by Barber (1995), Byrne and Zeigler (1977), and Kelley et al., (1995b), to name a few, provide a clearer picture of the coastal processes affecting the project areas. One place still lacking site-specific data is Camp Ellis but it appears that with the current Section 111 work, data will be collected in the near future (Kelley, 2003; Michaud, 2003). The current salt marsh monitoring program in Wells will add to the existing body of knowledge of Wells Embayment and help engineers and planners design programs that work within that natural system.

Whatever the state's management policy is in the future, it is essential to continue the support of research that advances the body of knowledge on coastal processes of southern Maine and the remainder of Maine's coastline. The sentiment of state planners is "there is never enough data" (Leyden, 2003). The state needs to encourage continued work from academic institutions, NGOs, state agencies, and the Army Corps through financial and administrative assistance. This would provide more, balanced data from which to make management decisions.

Another avenue is through voluntary stakeholder programs. One such successful program is the State of Maine Beach Profiling Project (State of Maine Beach Profiling Project Website, http://www.geology.um.maine.edu/beach, 2002). This voluntary project enlisted the help of stakeholders on the southern coast to record monthly beach profiles. The program achieved several policy goals. First, it gathered essential data, at little to no cost, that was and will be used in subsequent research projects (Heinze, 2001). Second, it directly involved the stakeholders who responded positively to the experience. They were involved in work along their properties and their knowledge of the processes affecting their land grew as a result. This benefits all involved in formulating and implementing a development strategy for the future.

Economic Policy

Along the lines of research, the State of Maine and its communities are in need of better economic data for the coastal zone. This entails collecting information on industry, housing, and tourism located along the coast. Additionally a non-market valuation is needed for the vast natural coastal resources. The under or over-valuation of resources leads to poor decision-making. With the limited resources available to communities and the state, there is a need to prioritize objectives and maximize all efforts. Accurate economic data is essential to achieving this goal.

Currently this information is lacking. The State Planning Office uses data from the Saco Bay and Wells Bay regional plans. This consists of seasonal retail and service receipts and tax-assessed values for the land and homes (SBPC, 2000; WBPC, 2002). It is a very cursory economic analysis and the State Planning Office acknowledges the data's limitations (Leyden, 2003). A rough recreational valuation was conducted for Wells Beach and Drakes Island. This report is not available and has not been used in planning (Carter, 2002).

The case studies reveal the limitations of Benefit Cost Analysis as a planning tool. A positive Benefit Cost Analysis does not guarantee that a project will improve the social well-being of all people. The traditional Benefits Cost Analysis used by government agencies looks for the present value of a positive net benefit calculated from a stream of future benefits using a discount rate that adequately represents the opportunity cost of the funds and resources used in the project (Folmer et al., 1995). This alone is not enough. These analyses need to also "include estimates of any environmental damage or foregone amenity benefits which the project might cause or induce" (Conrad, 1999). A policy of net benefit maximization often times leads to a larger more destructive project over a smaller less obtrusive one because the value of an undisturbed environment is not represented in the analysis. As the previous paragraph points out, these non-market valuation data are currently missing in Maine.

Other factors that need consideration when conducting the economic analysis of a proposed project include the uncertainty of benefits and costs. The coastal zone is a dynamic natural, economic, and social environment. Benefit and cost projections must incorporate a range of uncertainty as they may change over time. This is in contrast to the Army Corps' approach that assumes a constant, unchanging flow over the project's life. A logistically simple way to address this uncertainty is to increase the minimum benefit to cost ratio criterion (for example: 1.0 to 1.5). This acknowledges the uncertainty in calculations and gives planners a greater margin for error.[67]

Another way of addressing these uncertainties would be to assign probabilities to several potential outcomes. This would allow planners to compute expected values for the benefits and costs, taking into account changes that might occur in the setting. One area where this would be useful in the coastal zone is with sea-level rise. A possible application of this approach would be accounting for sea-level rise scenarios and the effects on the project. This technique provides more accurate economic predictions that acknowledge the uncertainty of the natural setting.

Another factor for consideration is the irreversible nature of large projects. Planners must wait until economic conditions are optimal before starting. If projects are initiated at the wrong time, their irreversible nature may not provide an opportunity for benefits to cover the costs during the project's lifetime.[68] A "trigger value" must be established considering all environmental amenities and the uncertainty of benefits and costs. "Trigger values" are defined as the minimum level of net benefits that a proposed project must generate prior to planners committing to an irreversible course of action. This provides planners with a minimum threshold for when to embark on a project (Conrad, 1999).

Due to this uncertainty, planners must also consider the financial ability of states and communities to address contingencies in a timely fashion. Considerations need to be

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[67] A proposed Army Corps of Engineers Modernization and Improvement Act of 2002, co-sponsored by Senators John McCain, Bob Smith, and Russ Feingold attempted to establish a higher minimum benefit to cost ratio criteria for federal projects for the same reasons listed above (McCain, 2002).

[68] This is in contrast to the "now or never" nature of the Benefit Cost Analysis commonly used for federal projects (Conrad, 1999).

made which take into account a state and communities' present and future economic resources (Hayes, 1995). As the three case studies show, federal funding does not necessarily mean lower costs to the community in the long run.

A limiting factor in both Maine projects is the communities' dependency on federal funding. Both communities have limited funds relative to the work they want done. Federal projects are cost shared and even if a project meets economic criteria the community's share may be more than they are able to handle. Maine coastal communities need to be given the ability to raise additional money to address infrastructure needs. This is not advocating relinquishing any of their existing state tax-burden. It is advocating instituting additional means of raising money locally, such as a local option tax. Wells has different infrastructure needs than other communities off the coast. Giving the communities the ability to raise more of their own money will provide them with more options and is in line with the political ideology of the state. Maine's 1986 Coastal Management Policies Act states that financial support from the state will be given priority to relocating structures and not development projects in beach areas (MSPO, 1994).

At the heart of the economic debate is the question of whether these projects are a proper use of public funds. Justification is based on the idea that these projects improve the overall economic health of the nation. The reality is that many of these projects benefit a very small segment of the society while costs are distributed across all taxpayers. The stabilization of Cold Spring Inlet is an excellent example of where the federal government provided public funds to a small group of investors allowing them to profit from a development project but with no return to the government. This type of inequity continues today in public projects where access to the public is difficult, or denied in some circumstances, by those benefiting directly from the project.

Some groups feel that the billions earmarked for temporary nourishment would be better spent on programs addressing other societal woes such as unemployment, housing, and healthcare (Neil, 1999). Others feel that by removing public funds and making the communities and states responsible for payment, attitudes would change and many of these projects would not materialize (Kelley, 2003; Lang, 2003). For now, federal funding of these projects continues and until this changes economic recommendations must work within the current system.

Addressing the Political Environment

The three case studies clearly demonstrate the important role the political environment plays in guiding the projects and subsequent mitigation efforts. This is the area where Maine managers need to do the most work. Current and future work along the coast must be inclusive. This requires identifying all stakeholders affected by the actions in the short and long term. Once they have been identified they need to be engaged in the process in such a way that their input is weighed equally from start to finish. The process needs to be transparent so that participants do not feel that their time is spent in vain and that their efforts will materialize into action.

In the same vein, work must be done to mend existing poor relations. This is mainly between the State of Maine and the communities. Poor relations between the Army Corps and the State of Maine can be overcome if the state and the communities are speaking with a unified voice with the backing of their congressmen and senators.

These efforts need to be reinforced by an educational program. The State of Maine invests in programs to educate its stakeholders about the coastal processes affecting their beaches (Dickson, 2002; Kelley, 2003). More needs to be done in terms of educating stakeholders about the State's management ideology.[69] Although the Sand Dune Rules have been on the books since 1983, many are still unaware of the development restrictions outlined in the regulations. This is evident from stakeholders' comments on websites, in public meetings, and in interviews (Cohen, 2002a; SOS Camp Ellis website, 2003; SOS Camp Ellis, 2002). Efforts must go beyond the current practice of providing ample notice of public meetings to the communities (Whiting-Grant, 2002). The State of Maine needs to actively gather and bring people into the process to avoid these problems in the future.

Once these efforts are underway, the State of Maine and its coastal communities might consider a formalized negotiation-mediation process for addressing development issues. This could be modeled after the efforts made by Congressman Tom Allen's office in addressing the City of Saco and Camp Ellis' problems. Another model might be New Jersey's State Planning Act (NJSA, 52:18A-196). The voluntary non-committal nature of the process is feasible in Maine's political environment. It offers communities a chance to participate without the fear of legislation being thrust upon them. Their incentive would be the opportunity to have a part in shaping regulatory policy.

Finally, the State of Maine needs to reassume the role of sponsor for federal projects. The Maine Department of Transportation filled this role at one time but now the individual communities act as sponsor (Habel, 2003). The purpose would not be to

[69] This also applies to state agencies. Agencies must be clear on the management ideology and be speaking with one voice when representing the state.

assume a larger financial role or to become a developer, but to be directly involved with what is happening on the coast beyond its regulatory function. If it is to act as the manager of the public trust, a more proactive role is needed. This ultimately puts the State of Maine in a better position and does not allow communities to isolate themselves like Wells has done.

Maine and Beyond

Maine's coastal management ideology is a good fit for the economic and natural resource constraints the state and communities face. Maine needs to do a better job of conveying its message to the communities and the communities, in turn, need to participate more fully to realize more benefits. Both need to coordinate and cooperate on management to avoid situations like the one currently faced in Wells. Once the groundwork is laid between the state and community, problems with the federal government will be easier to address and should work themselves out.

The State of Maine must become even more aggressive and proactive along the coast. The Maine State Planning Office is limited by their size as to what they can accomplish. This is one more reason to get every state agency working together toward common goals. Existing legislation is strong and has held up against legal challenges. It cannot be assumed that this will happen forever. Decisions favoring property owners are setting difficult precedents in takings cases around the country (Plater et al., 1998; Titus, 1998).

Recent efforts on the part of Maine municipalities and private citizens to pass coastal development exemption legislation, allowing them to armor their shoreline, reveals a more knowledgeable stakeholder base with greater political savvy. As time goes on, the probability that some of these exemptions are accepted by a legislature more sympathetic to property rights increases. The State of Maine needs to create an environment where citizens don't view legislative and legal action as their only option. A legislative act or court decision in favor of coastal property owners in Maine could ultimately undermine the intent of current coastal policies and management ideology by exempting others opposed to the state development restrictions.

Regarding Wells, even if the state were to follow through on these recommendations, their problems may continue. The community of Wells needs to come halfway first and that seems unlikely at this time. Their distrust and anger run deep, to the point that it may be awhile before they feel comfortable with any state management initiative (Foley, 2002). The state can still do much good by implementing these policies elsewhere with the hope that Wells would eventually come around.

These recommendations are applicable to other coastal areas. For any project in a dynamic environment a thorough and comprehensive economic picture is needed to make accurate decisions. Analyses need to go beyond the immediate project and consider all contingencies. Whether or not the political structure is bottom-up or top-down,[70] strong ties between stakeholders and the states are essential for effective management, particularly in the dynamic and ever-changing coastal zone.

[70] A structure where the state makes all development decisions for the communities. California is an example (Van Arsdol, 2000).

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APPENDICES

Appendix A

Economic Benefit Formulas For Wells Harbor - 1959

Formulas for estimating recreational boating benefits from the 1959 Wells Harbor study:

The benefits of recreational craft are based on the annual net return to the owners taken as the amount the owners would receive if the boats were let out on a for-hire basis. This is computed as a percentage return on the depreciated value of the boats equal to one half the average value of the boats when new.

Transferred boats – benefits are calculated based on the *increase* in annual net return due to a closer proximity. This is estimated as 20% of the total possible net return. (If the total possible return is 11% this implies a current return of 8.8%. 20% of 11% is 2.2%. The increase therefore is equal to 2.2%. This is the percentage used to calculate annual benefits.)

New and transient boats – the benefits are calculated as 100% of the possible net return.

Benefits for transferred, new, and transient boats would be adjusted by the average number of days each type of boat may be away from the harbor.

Formulas for estimating commercial benefits from lobster boats from the 1959 study:

Transferred boats – of the 3 transferred boats, 1 will be fulltime and 2 will operate part time. A fulltime boat will bring in an average of 8000 lbs each year and a part time boat will bring in an average of 2000 lbs each year. The benefit will equal 40% of the selling price of lobster. As before, the transferred boat's total benefits are a result of the closer proximity of the boat, and increase in catch. This has been calculated as a 20% increase.

Fulltime: 8000lb * .40 * price per lb * .20 * # of boats
Part time: 2000lb * .40 * price per lb * .20 * # of boats

New boats – of the 11 new boats, 5 will be fulltime and 6 will be part time. The benefits were calculated in the same way as the transferred boats but a new boat would realize 100% of its benefits.

Fulltime: 8000lb * .40 * price per lb * # of boats
Part time: 2000lb * .40 * price per lb * # of boats

Formulas for shore protection benefits:

The estimated value of the houses that would receive protection was $40,000. The widening was estimated to provide $1000 of protection, or 2.5% of the value of the land.

Formulas for land enhancement benefits:

This is the land that can be created for development from the 200,000 cubic yards of material being dredged from the project. The Corps predicted 10 acres of new undeveloped land. At $4,000 per acre the total value came to $40,000. Approximately $15,000 would be needed to stabilize the land with dikes. That leaves a net amount of $25,000. The Corps predicted a 5% annual return on investment. This comes to $1,250 annually on average.

Appendix B

Economic Benefit Formulas For The Saco River Project - 1968

Formulas for estimating recreational boating benefits from 1968 Saco River study:

The benefits of recreational craft are based on the annual net return to the owners taken as the amount the owners would receive if the boats were let out on a for-hire basis. This is computed as a percentage return on the depreciated value of the boats equal to one half the average value of the boats when new.

Transferred boats and existing transient activity– benefits are calculated based on the *increase* in annual net return due to a closer proximity. This is estimated as 20% of the total possible net return. (If the total possible return is 11% this implies a current return of 8.8%. 20% of 11% is 2.2%. The increase therefore is equal to 2.2%. This is the percentage used to calculate annual benefits.)

New boats and additional transient activity – the benefits are calculated as 100% of the possible net return.

Benefits for transferred, new, and transient boats would be adjusted by the average number of days each type of boat may be away from the harbor.

Formulas for estimating commercial benefits from lobster boats:

Existing boats – 20 boats bring in an average of 60,000 lbs each year. They were expected to increase this by 10,000 pounds or $6000. The benefit will equal 80% of the selling price of lobster. 20% goes toward costs. The resulting benefit is $4800.

New boats – 6 new boats were predicted to land 21,000 pounds of lobster. This was a value of $12,600. They would be able to realize 40% of this with 60% going toward their costs. The resulting benefit is $5040.

Formulas for foregone boat repairs:

It was estimated that normally 5 lobster boats and 12 sardine boats would suffer $200 in damage a year from ice flows coming down the Saco River. The benefits amount to $3400 in savings.

BIOGRAPHY OF THE AUTHOR

Edmund Cervone was born in Princeton, New Jersey on December 15, 1971. He was raised in Pennington, New Jersey and graduated high school from The Pennington School in 1990. He attended Princeton University and graduated in 1994 with a Bachelor's degree in Geology. After Princeton, Edmund taught high school science for three years in New Jersey before moving to Colorado to join a medical marketing firm and later a wine and spirits company. While in Colorado Edmund struggled to balance his work and his love of skiing. Eventually skiing won over and he decided to work full time in the resort industry. It was on the slopes that he made the decision to continue with his education. He moved to Orono, Maine and entered the Ecology and Environmental Sciences graduate program at the University of Maine in the fall of 2001.

After receiving his degree, Edmund will be joining the State of Delaware's Coastal Program as a NOAA Coastal Management Fellow for a two-year appointment. Edmund is a candidate for the Master of Science degree in Ecology and Environmental Sciences from The University of Maine in August, 2003.