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Long Beach Breakwater System

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ABSTRACT

The Long Beach breakwater structure is located in Long Beach, California. It is one of three breakwater structures that span 13.4 kilometers along the shoreline. These breakwater structures were constructed by the US army to protect naval ships in World War II. Recently, this breakwater system has received attention from the community questioning its relevance after the war.

Breakwater structures reduce the intensity of wave action on the shoreline, and reduce erosion. They also provide a defence against possible storm waves. They are typically designed to absorb the wave's energy by using mass or with the use of a slope. The Long Beach breakwater structure is known as a rubble mound breakwater, constructed of rockfill for a span of 4 kilometers. This helps to protect low-lying property and structures along the coast line.

Although breakwater systems reduce the energy of waves, they also have adverse effects on the shoreline. They prevent the sea's natural circulation which causes sedimentation and poor water quality. This has the people of Long Beach interested in the removal of the breakwater as they want cleaner beaches in an effort to increase tourism.

The following paper will outline the community's main arguments to remove the breakwater, design principals of rubble mound breakwater systems, the need for these systems, and the adverse effects they have on the environment. It will also look at the results of the initial reconnaissance study conducted by the engineering firm. In this study, the engineering firm determined a rough estimate of the cost of the project, as well as the possibilty of profits for the city if they reconfigure the breakwater structure.

1 INTRODUCTION

The city of Long Beach is located in Los Angeles County of Southern California. As seen in Figure 1.0, Long Beach is a harbour on the pacific coast of the United States of America. The Port of Long Beach is the United States' second busiest container port and one of the world's largest shipping ports.

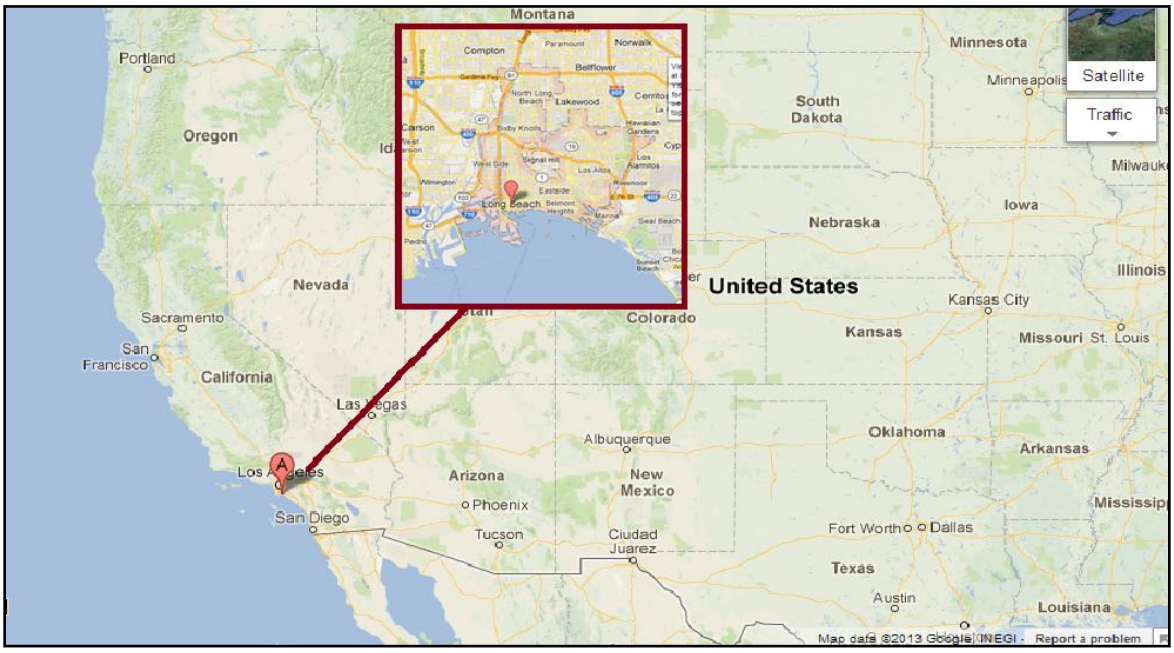

Figure 1: Location of Long Beach, CA
Source: Google Maps

The city started as a seaside resort with small agriculture resources and quickly grew with the discovery of oil on Signal Hill in 1921. Since then, the city has been known for its manufacturing sectors as well as its high technology and aerospace industries.

Due to the location of long beach, the Federal Government chose to construct a series of breakwater systems along the coast, starting with San Pedro bay and ending in the Long Beach Breakwater (as seen in Figure 2.0). These breakwater systems were to provide a deep and sheltered harbour for the U.S. Navy's Pacific fleet, as well as to provide protection from submarine attacks. Over the span of 40 years, the breakwater system was constructed in three major sections, with gaps for ships to pass. Together, these breakwaters span 13.4 km along the coast. This port was used by the US Navy since WWI, until they closed their base in 1996. [1] Considering the departure of the US Navy, the residents of Long Beach are lobbying for the removal of the Long Beach section of the breakwater system.

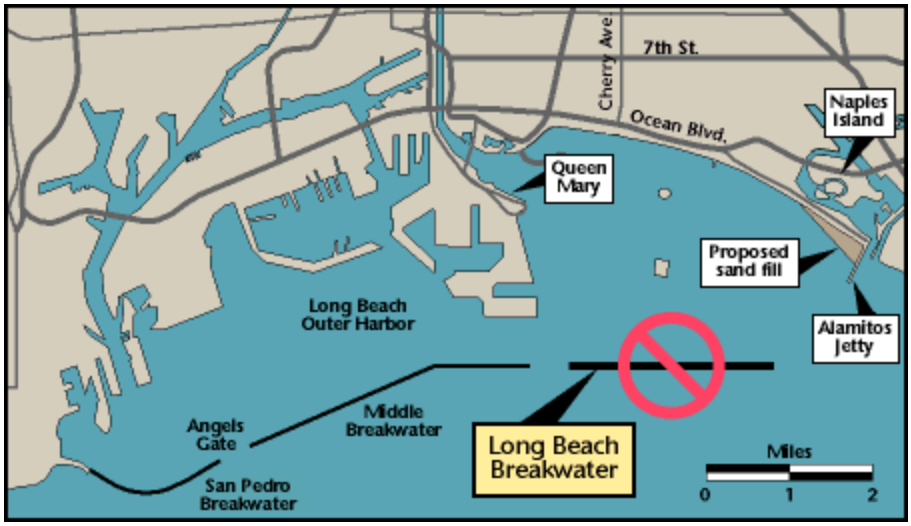

Figure 2: Breakwater Structure Locations
Source: http://www.lbsurfrider.org/sink-the-breakwater/

2 ECONOMIC OPPORTUNITIES

The nationally recognized environmental group, The Surfrider Foundation, is leading the grassroots effort to "Sink the Breakwater". The project's goal is to reconfigure the current breakwater which prevents the natural flow of ocean currents in the Long Beach Harbour. They want to remove or reconfigure the Long Beach harbour portion of the breakwater only; the other sections will still remain to protect the harbour against the ocean waves. This foundation has lots of support from the community. Figure 3.0 shows various members of the city during a council meeting. According to this foundation, there are some economic benefits involved with removing this breakwater, which are highlighted in the following sections. [2]

Figure 3.0: Community Support for the Breakwater Removal
Source: http://www.presstelegram.com/portlet/article/html

2.1 TOURISM

Currently, Long Beach and the surrounding water inside the breakwater system is very polluted. It is so polluted that people are not allowed to swim in or use the water. This makes the beach very unattractive to locals and tourists that visit the area. The removal of the breakwater will increase wave action in the area and hopefully wash out the pollution from the surrounding water. Once the water is safe to swim in, the city can advertise the beach and increase tourist businesses around the area.

2.2 SURFING AND SWIMMING

Before the construction of the Long Beach Breakwater, people were able to surf along the coastline. By reconfiguring the location of the breakwater to allow wave action from the south, surfing may be possible. This will benefit the town financially because surfing will attract people to the beach and the surrounding businesses to take part in the popular sport or to watch sporting events.

The water in the Long Beach harbour is said to be contaminated due to the breakwater preventing wave action, which makes the water unsafe to swim in. More people would be attracted to the area if they could go to the beach to swim and enjoy the water.

2.3 PROPERTY VALUES

The entire city, especially residents near the shoreline, will experience an increase in property value if the beach is clean and marketable for use. Currently, according to the Surfrider Foundation, the property values in Long Beach are lower than those of the similar beach towns nearby. The increase in value will come from having access to a clean popular beach, which will also make houses near the shoreline in greater demand.

3 HOW BREAKWATERS WORK

The main function of a breakwater is to protect the shoreline from excessive wave action. This creates a man-made shelter for boats and structures located in the harbour. The breakwater achieves this by reducing the wave energy as it collides with the structure, causing the water on the other side to remain relatively calm.

There are three main types of breakwaters; rubble-mound, vertical wall, and floating. The Long Beach Breakwater is a rubble-mound breakwater, which has a cross section like the breakwater in Figure 4.0. Rubble-mound breakwaters are made of rock and other earth material. The innermost section, called the core, is constructed of dense material with minimal fines to prevent internal erosion of the structure. The next layer, called the under layer, acts as a foundation for the outer layer while also protecting the inside core from being eroded. The armour layer is the main protection for the structure, and is composed of large rock. The large rock is irregularly shaped that interlock with voids; the larger the void, the more wave energy is reduced. Rubble-mound breakwater structures are selected for their ease of construction, and are suitable for irregular bottoms and weak soil. [3]

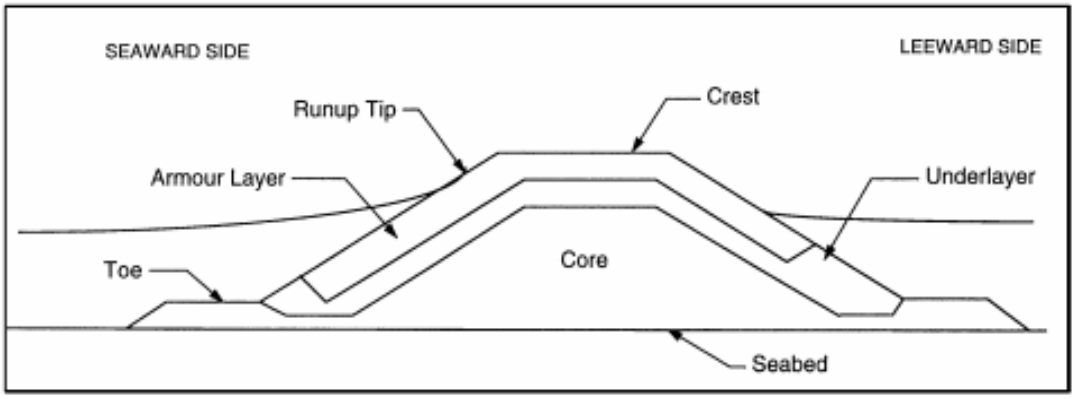

Figure 4.0: Typical Rubber-Mound Cross Section
Source: http://www.ipenz.org.nz/ipenz/publications/transactions/transactions98/civil/4palmer.pdf

4 IMPACT ON ENVIRONMENT

Although the breakwater structures help protect the shoreline and reduce erosion, they also have negative effects on the surrounding land and water. They are designed to block the natural flow of the wave, which prevents the wave action from removing pollutants from the area. The pollutants get held up behind the barrier and reduce the quality of the water.

The Long Beach breakwater system also blocks the plume from the Los Angeles River to run into the ocean, shown in Figure 5.0. The dirt and debris from this river enter the harbour and get stranded

there as the waves cannot clean it up. The same problem is encountered when there is excessive rainfall in Long Beach, causing the runoff from the storm to get trapped in the harbour as well.

By removing or reconfiguring the breakwater structure, it will cause the shoreline to be exposed to wave action that could cause adverse effects. By allowing waves to hit the shore, it could increase erosion along the shoreline and expose residents to the chance of flooding. It could also potentially harm any structures in that area that have been built since the construction of the breakwater, as they are not designed for high wave action.

Figure 5.0: Trapped Pollutants in the Long Beach Harbour
Source: http://www.cagreens.org/longbeach/images/Port_Crud.jpg

5 PROJECT ANALYSIS

In 2009, the Long Beach City Council commissioned a Reconnaissance Study to determine the feasibility and benefits of the project at a federal level. Since the breakwater is owned by the federal government, they have to follow the US Army Corps of Engineers' study process before any plan can become reality. The city contracted out a local engineering firm, Moffatt & Nichol, to provide the study. Reconnaissance studies are not comprehensive reviews of every possible alternative, benefit or cost. These studies are used to determine if there is enough federal interest to warrant a more detailed review.

In summary, Moffatt & Nichol's study determined that it is not optimal to remove the breakwater entirely as there are too many negative impacts that cannot be effectively addressed. The construction cost would be between 10 and 310 million for the alternative designs which can be seen in Figure 6.0. By alternating the design, the engineers predict improving wave heights as much as 4 times in some areas, which could satisfy the lack of wave action on the shoreline for water quality and recreational use. There are some concerns about the existing port infrastructure and navy anchorage that may not be designed to handle an increased wave action.

The study also concluded that the city of Long Beach would have the potential to gain increases of $52 million per year in local spending and economic activity as well as $6.7 million per year in taxes and parking fees or fines. However, the Army Corps feasibility study phase will cost around $7 million and take 4 years, while the City would be responsible for half of this cost. [4]

The Reconnaissance study was accepted by the Army Corps in November 2010, but is having issues with funding.

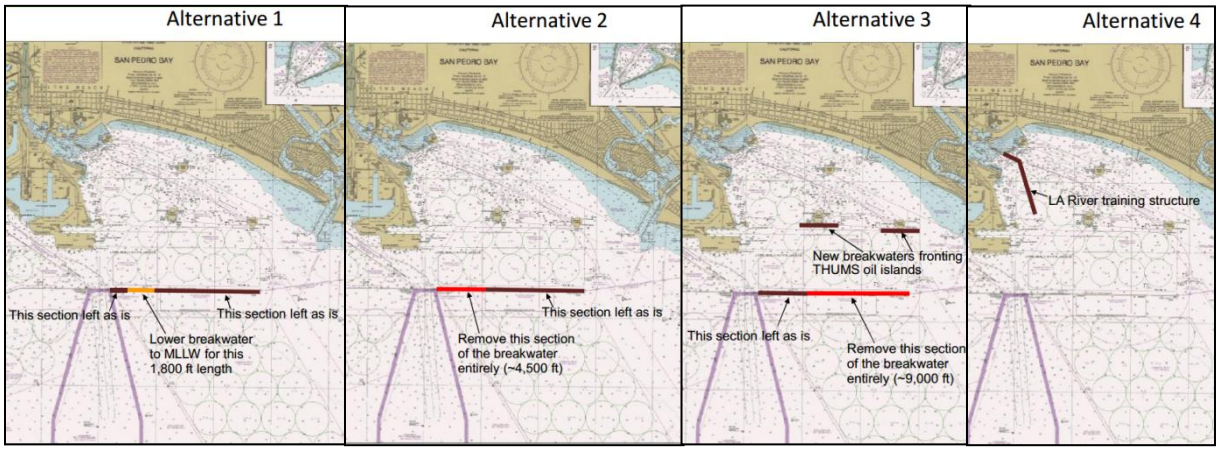

Figure 6.0: Alternate Breakwater Designs
Source: http://www.longbeach.gov/civica/filebank/blobdload.asp?BlobID=23122

6 CONCLUSIONS

This study outlines the benefits and complications of removing a breakwater from a city's shoreline. Although the community would like to remove it for economic, recreational and environmental purposes, it is not as easy as it seems, as the breakwater provides protection for the shoreline and any surrounding structures. It is also costly to remove and reconfigure a large structure in the ocean. Since the structure is owned by the federal government, feasibility studies have to be made as well as a detailed project analysis before any action can be taken.

It was determined in an initial study that the breakwater reconfiguration would be the optimal solution and there are four alternate designs up for review. As the breakwater does protect the shoreline and the surrounding areas, it poses to high of a risk to completely remove. An increase in wave activity up to four times is predicted with the reconfiguration alternatives outlined in the initial study. The case is now in the hands of the Army Corps where it will proceed, provided they receive enough funding.

REFERENCES

[1] Port of Long Beach "http://www.polb.com/about/default.asp"

[2] Surfrider organization "http://www.lbsurfrider.org/sink-the-breakwater/breakwater-facts/"

[3] Design and construction of rubble mound Breakwaters "http://www.ipenz.org.nz/ipenz/publications/transactions/transactions98/civil/4palmer.pdf"

[4] City of Long Beach Breakwater Study Executive Summary "http://www.longbeach.gov/civica/filebank/blobdload.asp?BlobID=23112"