Sea cave, note rocks in foreground from past bluff failure.

Protective structures built at the toe of bluffs can impact the beach depending on the existing volume of sand located on that beach. If the beach, as an example, is similar to those found in northern San Diego County, where the underlying structure of the beach is a hard shelf (rock cobble) with a very thin coating of sand, then the construction of a protective structure against the bluff will have a minimal impact on the beach profile because of an already severely limited sand supply. Most of the northern San Diego County beaches are shallow in sand depth, not because of the hard structures that have been constructed to protect the coastal bluffs from erosion, but because of sand starvation caused by the elimination of sand from inland sources and local geology. Under natural conditions bluff face erosion may provide approximately 20% of sand supply to an adjoining beach. The amount of sand that is lost due to the protection of the toe of a bluff by a seawall notch fill project is often minimal because it allows the upper portion of the bluff face to provide a sand supply through continued upper bluff erosion.

Typical sea cave fill. Note minimal encroachment onto beach.

Notch fill. Note colored material used to blend with natural bluff face.

Any structure placed on a beach will interact to some degree with the natural physical processes operating in the dynamic shore environment. Based on information contained in, *California's Coastal Hazards: A Critical Assessment of Existing Land Use Policies and Practices*, (Griggs, et al.), hard structures have three potential impacts relating to physical processes:

1. Impoundment or placement loss. When a structure is built seaward of the base of a bluff, cliff, or dune, a given amount of beach is going to be covered, resulting in immediate beach loss. Depending on the type of structure this may be a relatively small area (i.e. a foot or two for a vertical seawall).

2. Passive erosion. Whenever a hard structure is built along an eroding shoreline, whether the erosion represents net retreat due to the erodibility of the bluff or cliff or from sea level rise, and erosion continues to occur, the shoreline will eventually migrate landward beyond the structure, resulting in the gradual loss of the beach in front of the seawall or revetment as the water deepens and the shoreface profile migrates landward. The property, structure, utility or facility is temporarily protected, but the beach is lost.

3. Active erosion. The ability or potential for a seawall or revetment to induce or accelerate erosion…

Protective structures may also have the potential to interfere with the public's use of the beach and may impede both horizontal and vertical access. Projection of such structures can serve as barriers

Sand and cobble beach. Note beginnings of notch and large sandstone blocks from previous bluff failure.

to horizontal access, isolating actual stretches of beach during modest tides. These structures may also alter the scenic/visual character of the contrasting natural beach, coastal cliffs and bluffs, which may ultimately affect the site as a desirable recreational and tourist attraction area.

The major issues related to protective structures include negative environmental effects, such as modifications of landforms and drainage patterns, increased bluff and beach erosion, interference with sand supply and littoral drift, loss of public beach, constraints on public access and potential impacts on flora and fauna as a result of unnatural encroachment of facilities and/or sand onto the existing beach environment. An additional issue related to placement of protective structures includes funding and equity considerations and the use of public monies for protection of private property.

There are many miles of coastal protection devices located on lands along the California shoreline. In the past, many of these structures were not designed to eliminate or mitigate adverse impacts on local shoreline sand supply or to be as visually unobtrusive as feasible. Many have been built in such a fashion that they do not fully protect existing structures, public access, or the shoreline environment. Today, such structures would need to meet specific engineering standards and mitigate for adverse impacts, if necessary. Generally, contemporary protective structures are only allowed where it can be shown that they are necessary protection to existing improvements.

Upper bluff failure in Encinitas. Note sea wall at lower right.

Contrary to the popular belief that hard structures tend to cause loss of beach sands, one recent long term study conducted on beaches within Monterey Bay seems to indicate that this is not the case.[8] During the period of this study there was no significant loss of beach profile between beaches with and without hard protective structures. The beaches tended to expand and contract at similar rates from season to season. However, this study has not removed the controversy over the impact that hard structures have on beaches. Some continue to believe that hard structures contribute to loss of sand from beaches, but this study is providing evidence that at least in some locations this may not necessarily be the case.

Beach Replenishment

Another strategy used to address shoreline erosion includes beach building/sand replenishment. This strategy involves placing large amounts of sand on eroded beaches. Sand replenishment projects may help to offset the gradual thinning and disappearance of a region's beaches. They may also limit the loss of environmental, recreational, economic, and aesthetic benefits, and reduce the increasing destruction of coastal property and development. However, beach replenishment projects may also negatively impact sensitive marine and/or biological resources if, under certain circumstances, beach material is deposited on those resources. Increased turbidity resulting from sand replenishment activities has the potential to impact plankton, fish, marine mammals, birds, vegetated reefs, and benthic invertebrates. This process may also impact shorebird foraging or nesting areas. Many of these potential impacts, however, are mitigable with modifications to project design, mitigation measures, monitoring efforts and a variety of other appropriate measures.

Beach replenishment is very expensive and in order to be effective, physically and economically, it must be done over large sections of the shore on an ongoing basis. It is because of this that