3. Alternatives Analysis

3.1 Alternative approaches to controlling erosion damage

Controlling Connor Creek erosion can take four different engineering approaches. Each approach has variations, each with advantages and disadvantages, which are described below. Following the description of the engineering approach is an analysis of the structural options available to implement the approaches.

1. No Action—would require no public expenditure for construction, unless bridges were constructed for beach access. Additional property loss would be certain, and negative impact would result on the biological system that has grown in the part of Connor Creek downstream from the bend at the Chabot Road access. If a moderately high flow (roughly a 5-year flood) occurs before the mouth migrates to join with the Copalis River, a breach could occur at any of a number of low spots in the barrier, or near station 7312, which is about 3,000 feet from the mouth. If by natural high flows the creek breached at the location of the former mouth, the exposure of the area to the wave climate and salt water would have a negative impact on the wetlands located between Surfcrest and Seaview Estates. If the barrier breached in the location of Station 7132 or at any spot southward, the northward migration process would restart, exposing the right bank to further damage as the mouth migrated. If the creek connected with the Copalis River before breaching could occur, the probability of breaching in Connor Creek in the previously identified places would increase, to a greater than 50 percent chance annually, with results similar to those described previously.

2. Fix Connor Creek mouth in 1987 location—would require structures. Several variations of structural stabilization are available to accomplish this, and they are described individually below. They consist of diverting the flow from its northward path to a westward direction and preventing migration of the type experienced in the last several years. Control of migration could take the form of a confined channel or a bounded migration corridor. The action would expose Wetland E (Natural Resources Assessment) to increased wave energy and salinity. The banks would adjust to the new wave energy regime, and the mean water level in the wetland would drop slightly because of the shortened path to the ocean. All the channel length currently downstream from the proposed diversion would become filled with sand, either immediately as a result of diversion, or gradually by wave overwash and wind.

3. Fix Connor Creek mouth at some intermediate downstream position—would require structures similar to those applicable to Approach 2. This approach would preserve the wetlands located upstream of the new mouth and protect them from direct exposure to waves. The probability of natural breaching at the

previously identified upstream low spots would remain high. Preventing that breaching and eventual loss of the structures emplaced for this approach would require reinforcing and raising the elevation of the identified low spots in the barrier. The location where the mouth would be positioned would experience sustained wave exposure and would require control of resulting erosion. The investment made in controlling the mouth location would be vulnerable to loss (through upstream breaching and renewed mouth migration) and would probably justify protecting it from destruction by reinforcing the entire barrier from the bend at Chabot Road access to the new mouth. The result would be regained beach access for properties lying north of the new mouth as the former channel filled, but continued loss of access south of the mouth, except by bridges.

4. Fix Connor Creek mouth in its current location—would require structures similar to those applicable to Approach 2. This approach would prevent Connor Creek from joining the Copalis River. The approach also would preserve the wetlands located upstream of the new mouth, and would require less excavation of the barrier than for Approach 3. This approach would require erosion protection around the mouth to stabilize it, as would Approach 3, but would require a greater length of reinforcement for the barrier to prevent breaching. The County and private beach access points would remain severed, and bridges would be the only practical means of accessing the beach between Seaview Estates and Copalis Beach. Reinforcement of the barrier in the low spots would be required as a minimum, and reinforcement for the whole barrier length would likely be required.

Table 4 summarized the engineering approaches and structural features. (3.23 MB File)

3.2 Structural Alternatives

Nine alternative engineered components of solutions have been identified. A concept design was prepared for each alternative and a preliminary investigation of engineering feasibility and approximate construction cost was completed. A final design might incorporate elements from these different alternatives. For example, upland in the existing Connor Creek waterway a diversion structure may be built incorporating wooden piles, anchored woody debris and vegetation.

Across the spit, the diverted creek channel might be constrained between geotextile tubes. Closer to the shoreline, rock dike structures may provide resistance to large waves and impact from floating debris. All parts of the dike may incorporate vegetation as means to strengthen the structure and possibly enhance the environmental aspects of the project.

3.3 No Action

No Action. The trend of changes to Connor Creek that have taken place in the past several years lead to the projection that without human interference or very large floods and waves, the creek mouth will continue to migrate northward and the barrier spit will continue to lengthen. The barrier crest profile that was surveyed in March 2001 showed four locations along the barrier in the 4,000-foot distance downstream of the bend at Chabot Road that are about 15 feet elevation. The upstream-most location of one of these low spots is where the creek formerly exited to the ocean. This study showed that the annual risk of flood waters exceeding 15 feet elevation is about 5 percent in the upper 4,000 feet of the study reach with the current configuration of the creek. Figure 4 shows water surface profiles computed for three return-period events and the longitudinal profile of the barrier crest, and illustrates where overflow of the barrier could occur. If the depth and duration of overflow is sufficient to cut a new creek mouth at the overflow point, natural processes would partially fill the abandoned portion of the channel with littoral material and the new mouth would migrate northward. A specific location where a breach would relocate the creek mouth cannot be confidently predicted because of the numerous variables that make one location more vulnerable to downcutting than another. In the case of restarting the process of mouth migration, the right bank of the channel opposite the mouth would be exposed to Pacific Ocean waves entering the creek and traveling upstream. The erosional damage to properties lying east of the channel was dramatic as the channel migrated northward in the past five to eight years. Re-exposing the bank to new wave impacts could produce erosional loss equally dramatic.

If the rate of northward migration of the creek mouth continues as it has in the recent past, Connor Creek could be expected to join the Copalis River within a year or two. A higher flow event would likely trigger the capture of Connor Creek by the Copalis River. That action would cause flood elevations in Connor Creek to be higher for the same flow than with the mouth in its current location, resulting in overflow of the barrier during floods having higher occurrence probabilities than currently.

3.4 Rock Dike Confined Channel

Two parallel rock dikes would be constructed in the vicinity of the Chabot Road public access to confine Connor creek within a relatively narrow zone. Figure A-1 shows the rock dike confined channel concept design. The dikes would be on either side of new excavated channel between the existing shoreline and Connor creek. The rock dikes would prevent further migration of the new excavated channel in either the northward or southward directions. Material from the excavated channel would be used to "plug" the existing Connor Creek channel and form part of the dike structure.

Rock is the most durable construction material among the alternatives, but may be the only feasible method to resist the high energy wave conditions near the shoreline at the western end of the dikes. Locating the western ends of the dikes near the shore would prevent eventual bypassing of the creek around the northern dike and resumption of northward migration of the mouth. Relatively large rock size would be necessary to resist damage by waves. A rock dike constructed on beach sediment will require an outer layer of larger armor rock resting on smaller sized bedding material. Geotextile fabric would be used for additional foundation stability.

A preliminary cost estimate for the rock dike confined channel is approximately $2,220,000.

3.5 Geotube Dike Confined Channel

The Connor Creek entrance would be relocated as described above. A geotextile tube dike for constraining channel movement is similar in concept to the rock dike except that the structure is constructed of large, sand filled, geotextile containers. Figure A-2 shows the geotube dike channel concept design.

Individual geotubes can have lengths up to 300 feet. If additional length is required the tubes can be attached end to end. The tubes would be laid adjacent to the excavated channel on relatively even and stable ground.

Geotubes are a "softer" alternative to a rock structure. One advantage is that the geotubes can adjust to small variations in the ground level and minor foundation scour and do not require as extensive foundation preparation as do rock structures or, particularly, solid structures such as bridges.

Geotubes are relatively inexpensive and easy to construct when experienced crews perform the work. However, geotubes have a shorter design life than a rock structure and require higher maintenance. They are vulnerable to damage from the impact of wave-borne logs and debris. They are also vulnerable to vandalism. Geotubes fail rapidly after damage due to loss of material through the damaged area. Also, if differential settlement is extreme, the geotextile tube could tear due to the added stress in the fabric exceeding the design strength specification.

Geotubes may be more appropriate as a partly buried structure, further upland away from the shoreline. It may be desirable to use rock for at least part of the structure close to the shoreline if it is necessary to extend the dikes past the shoreline.

A preliminary cost estimate for the geotube dike confined channel is $910,000.

3.6 Wooden Pile Wall and Woody Debris Barrier

This alternative is similar in concept to a vertical retaining wall or bulkhead constructed across the existing Connor Creek Channel. The momentum of the creek flow would be diverted westward to the Pacific Ocean through a new excavated channel. The history of Connor Creek in the vicinity of Chabot Road shows that a wooden pile wall was successful for a number of years at diverting the creek into the ocean and preventing erosion and creek migration. The pile wall and woody debris creek diversion alternative (Figure A-3) follows this concept. The Connor Creek outlet would be relocated with initial excavation where the creek exited to the ocean during the time the former wooden pile wall structure was in place. The wall alternative would likely require relatively high maintenance. It is understood that the original pile wall eventually failed due to a lack of maintenance.

The vertical pile wall would be reinforced with large woody debris and material excavated from the channel. Monitoring and maintenance would be necessary to make timely repairs to the pile wall, and possibly extend it if Connor Creek begins to bypass the wall and resume its northward migration.

A preliminary cost estimate for the wooden pile wall is $130,000.

3.7 Vegetated Bank Confined Channel

The vegetated bank confined channel option is similar in concept to the geotubes option and rock dikes option for both the confined channel and migration zone concepts. A channel is excavated to the ocean and the banks are protected with vegetation, placed logs and woody debris to prevent channel migration beyond the desired bounds (Figure A-4). This alternative may require high maintenance, due to its exposure to high waves and sand transport rates.

The use of vegetation is desirable environmentally and helps stabilize the banks of the channel in protected environments. The vegetation is usually self-perpetuating and traps sediment in lower energy environments. Properly designed vegetation has the potential to complement the nearby wetland area and eventually become part of the wetland.

A preliminary cost estimate for the vegetated bank confined channel is $930,000.

3.8 Rock Dike Channel Migration Corridor

The rock dike channel migration corridor concept would allow the Connor Creek entrance to migrate naturally between two rock dikes spaced relatively far apart. Figure A-5 shows a migration corridor between Seaview Estates on the north and Surfcrest Condominiums to the south.

The dike design would be similar in concept to that described in the rock dike confined channel alternative. A new channel would be excavated initially and the excavated material used to plug the existing Connor Creek Channel to the north near Seaview Estates.

A preliminary cost estimate for the migration corridor alternative is $2,960,000.

3.9 Composite Migration Corridor

Two linear features would be constructed to limit the northward and southward migration of the Connor Creek mouth to a zone encompassing the 1987 creek mouth location. See Figure A-6. The northern structure would block flow from its northerly direction and divert it westward to the ocean. The southern structure would limit the extent of southern migration of the mouth. The structures would be as environmentally compliant as possible, yet durable enough to survive the wave and flow regime of the Connor Creek mouth. Geotextile sand-filled tubes would comprise the structural elements of the channel sides at more inland locations, and would serve as reinforcement of the channel embankment. Vegetation appropriate for its exposure would be planted between the layers of tubes. The entire embankment would be overgrown when the vegetation matures. The vegetation would slow the flow speed at the channel sides as well as benefit fish in the creek mouth. The western ends of the structures would need to extend seaward enough to prevent creek migration around the structures. The terminus of each structure is expected to be located near the MHHW line. Armoring the structure ends with rock would be necessary to resist wave forces and provide the required durability.

A preliminary cost estimate for the combined geotextile reinforced bioengineered migration corridor alternative is $2,070,000.

3.10 Geotube Barrier Reinforcement

Preventing breaching of the barrier is a major objective of the erosion control project, although barrier stabilization alone would not address all the potential erosion damages. A series of sand-filled geotextile containers anchored and placed to the selected elevation would control overtopping to a given recurrence interval. See Figure A-7. At lower recurrence interval floods, Connor Creek flow would be constrained to exit at the creek mouth. (The creek and the Copalis River would need to be prevented from joining in this case.) The damage associated with an uncontrolled breach and renewed northward migration of the mouth would be prevented by the barrier reinforcement, but erosion at the mouth would occur unless it was also controlled by structures.

A preliminary cost estimate for the geotube barrier reinforcement alternative is $1,090,000.

3.11 Pedestrian Bridge

A timber bridge or elevated walkway would be constructed over Connor Creek to provide access to the shoreline. Figure A-8 shows the pedestrian bridge concept design. This design incorporates a walkway supported by timber piles, pile caps and stringers, and would be a permanent structure.

This alternative is complicated by likely additional requirements for public parking, public facilities such as restrooms, and compliance with the Americans with Disabilities Act.

Temporary, removable bridges are currently in seasonal use by private property owners along Connor Creek. However, these temporary bridges are likely not suitable for a public facility because they may not meet applicable building codes and would not be designed for year round use.

A pedestrian bridge, or any other permanent structure, requires stable ground for the bridge abutments. However, the Connor Creek banks are not sufficiently stable for abutments, especially near the northern County access point. Construction of permanent bridges may not be feasible until the barrier grows higher and stability of the site would be assured.

A preliminary cost estimate for the pedestrian bridge alone is approximately $140,000.

3.12 Single Buried Rock Barrier

This alternative would be installed in anticipation of a breach occurring at one of the low spots at the southern end of the barrier spit. An uncontrolled breach there would cause northward migration of the creek mouth to resume. The rock barrier would not prevent breaching or control the creek mouth prior to a breach. The rock barrier would be constructed in a trench excavated across the barrier to control the northward limit of creek mouth migration after a breach occurred. The barrier would be placed just north of the creek outlet's 1987 position. A high flood flow could overflow the current topographic low and downcut the barrier at that location. The toe elevation would be low enough to prevent undercutting by the creek, and the top elevation of the rock would be only high enough to contain creek flows.

Breaching of the barrier is likely at the 1987 mouth location but could occur at some other location on the barrier spit already shown to be an overwash area. In either case, the freshwater habitat in the vicinity of the wetlands would be damaged by salt water and wave exposure. Breaching at the southern end of the barrier spit would necessitate excavation of a channel in the 1987 outlet to minimize erosional damage near the newly formed breach. There would likely be no opportunity to construct the rock barrier after breaching in the 1987 creek mouth location because of the normally rapid rate of mouth migration. After the new mouth location had become dominant, fill would be placed in the creek channel to direct flow westward on the south side of the rock barrier.

If seaward extension of the barrier terminus was required after operation and monitoring of the rock barrier, the extension could be constructed at that time. An extension might be needed to prevent the newly formed mouth from bypassing the tip of the rock barrier and migrating northward again.

A preliminary cost estimate for a buried rock barrier, in addition to the post-breach construction, is approximately $1,006,850.