2.0 Alternatives

This chapter summarizes the process through which alternative approaches for the proposed action were developed and screened, and describes the alternatives analyzed in this EA. It also provides brief descriptions of the alternatives that were eliminated from EA analysis and briefly discusses the reasons for their elimination.

2.1 Alternatives Development Process

Alternatives for the proposed action were developed and screened through the NPS's value analysis (VA) process, which is a systematic method of weighing the anticipated benefits and risks of various possible solutions to a defined problem. The VA process consists of four phases.

- **Predesign Phase:** Identify project objectives and formulate potential approaches.
- **Creativity Phase:** Conduct free-ranging evaluation of potential outcomes associated with approaches identified in predesign phase.
- **Evaluation Phase:** Systematically evaluate and screen alternatives to narrow the field and, ultimately, identify a preferred alternative for implementation.
- **Implementation Phase:** Modify the preferred alternative to fine-tune it based on results of evaluation phase and environmental review; implement.

During the predesign phase for the proposed action, NPS and their consultant team performed a range of studies aimed at identifying and evaluating the feasibility of a range of approaches to restoration at the three selected sites. Early work included analyses of erosion and sediment delivery at the Muddy Hollow Pond and Glenbrook Crossing sites (Jones & Stokes and NHC 2003a, 2003b). Additional work for each of the sites (summarized in NHC 2004) included analyzing historic and existing hydraulic/hydrologic and habitat conditions; identifying factors with the potential to constrain successful design and implementation of restoration; and estimating the capital cost of alternative restoration approaches.

Once substantial progress had been made in the predesign phase, the VA team for the proposed action convened. The meeting, which took place at Point Reyes National Seashore on June 3–5, 2003, focused on (1) further evaluating various options for construction methods and materials that had been identified in the predesign phase, and (2) selecting an alternative for further refinement during project design. The following sections provide additional detail on the evaluation process used during this meeting, which encompassed the creativity and evaluation phases of the VA process (National Park Service 2003).

Creativity Phase

The creativity phase of the project VA meeting was dedicated to a speculative (free-ranging or brainstorming-style) analysis that first addressed the risks associated with various possible approaches to coastal stream restoration, and then turned to the function and purpose of the system. Based on the results of these first two tasks, the team then reviewed the alternatives developed in the predesign phase and brainstormed to identify other possible approaches.

Evaluation Phase

During the evaluation phase, the VA team conducted a systematic analysis of all alternatives considered and/or developed in the creativity and predesign phases, in order to eliminate those that were not expected to be feasible or were judged unsuitable for other reasons. Principal guidance for the evaluation came from the project objective of repairing or removing facilities that limit or impair the natural hydrologic function in the Drake's Estero watershed, in order to allow reintroduction and enhancement of threatened aquatic populations, including steelhead and coho salmon. Additional guidance was derived from the following priorities or factors for the protection of cultural and natural resources, which are based on the NPS Mission and Strategic Goals.

- **Factor 1:** Prevent loss of cultural resources.
- **Factor 2:** Maintain and improve condition of natural resources.
- **Factor 3:** Provide visitor services, educational opportunities, and recreational opportunities.
- **Factor 4:** Protect the health, safety, and welfare of the public.
- **Factor 5:** Improve operational efficiency, sustainability, and constructability.
- **Factor 6:** Protect employee health, safety, and welfare.
- **Factor 7:** Provide cost-effective, environmentally responsible, and otherwise beneficial development of the NPS.

Table 2-1 summarizes the evaluation criteria used in the VA process. Additional information is provided in the VA report prepared for the project (National Park Service 2003).

Table 2-1. VA Evaluation Criteria for Project Alternatives

Evaluation Focus	Evaluation Criteria
Floodplains	■ Preserve floodplain values. ■ Minimize potentially hazardous conditions associated with flooding. ■ Comply with the NPS Organic Act and all other federal laws and Executive Orders related to the management of activities in flood-prone areas, including Executive Order 11988 (Floodplain Management), NEPA, and applicable provisions of the Clean Water Act and the Rivers and Harbors Appropriation Act of 1899.

Watershed and stream processes	■ Manage watersheds as complete hydrologic systems. ■ Minimize human disturbance to the natural upland processes that deliver water, sediment, and woody debris to streams, including runoff, erosion, and disturbance to vegetation and soil caused by fire, insects, meteorologic events, and mass movement. ■ Manage streams to protect stream processes that create habitat features such as floodplains, riparian systems, woody debris accumulations, terraces, gravel bars, riffles, and pools. ■ Achieve protection of watershed and stream features primarily by avoiding impacts to watershed and riparian vegetation, and by allowing natural fluvial processes to proceed unimpeded. ■ When conflicts between infrastructure (such as bridges and pipeline crossings) and stream processes are unavoidable, consider relocating or redesigning facilities, rather than manipulating streams. ■ Where stream manipulation is unavoidable, use techniques that are visually non-obtrusive and that protect natural processes to the greatest extent practicable.

The geomorphic criteria shown in Table 2-1 were based on NPS Management Policies requiring that structures and facilities be designed consistent with the intent of the National Flood Insurance Program's standards and criteria (44 CFR Part 60). In addition, screening of facilities for the Glenbrook Crossing site and the trail reroute section of the Muddy Hollow site, that are located in a designated wilderness area, was guided by NPS policies pursuant to the federal Wilderness Act of 1964, which include the following.

> … Authorizations of NPS administrative facilities located in wilderness will be limited to the types and minimum number essential to meet the minimum requirements for the administration of the wilderness area. A decision to construct, maintain, or remove an administrative facility will be based primarily on whether or not such a facility is required to preserve wilderness character or values, not on considerations of administrative convenience, economic effect, or convenience to the public or park staff. Maintenance or the removal of historic structures will also comply with cultural resource protection and preservation policies and directives, and with the concept of minimal requirement management techniques for wildernesses.

2.2 Alternatives Analyzed in this EA

The following sections describe the alternatives identified through the predesign and VA process as meriting detailed analysis and consideration. Alternatives analyzed in this EA include two "build" alternatives (Alternative 1 and Alternative 2) and the "no-build" alternative or No Action Alternative. The two build alternatives incorporate the approaches evaluated during the VA process as most likely to be successful at each of the three project sites. To achieve the most complete analysis of potential environmental effects, the build alternatives analyzed in this document represent a spectrum from a "full-build" approach with more extensive earthwork and construction at all sites (Alternative 1) to a less intensive "partial-build" approach (Alternative 2). To provide the greatest flexibility in implementation, the alternatives were designed to be modular, such that each site-specific component could be implemented independently, depending on what is identified as most likely to be both successful and cost-effective for each site.

For all alternatives, site preparation and construction would occur between August 1 and October 31. For work to begin on site prior to August 1, nest surveys would need to be conducted one week prior to implementation to insure nests are no longer present at the site. The construction window is intended to avoid disturbance of migratory bird nesting, and closes early enough to avoid the beginning of the November–April storm season. In addition, to the extent feasible, work in the channel and tidal marsh plain areas at Limantour Beach and Muddy Hollow would be timed during neap tides, when tidal range is at a minimum and the potential for water quality impacts related to tidal remobilization of soils and sediments disturbed by construction is reduced.

The sections below provide additional information on each build alternative and the No Action Alternative, including likely construction scenarios and estimated costs. Descriptions provided in this document represent the progress of the design phase as of June 2004; further modifications based on ongoing geologic and engineering investigations and materials costs are possible, although these would not change the objectives of the restoration, nor the impact footprint or results described in this document.

Alternative 1: Full-Build Approach

Alternative 1 consists of the following components.

- Partial removal of the culverted embankment crossing at Limantour Beach Marsh, and replacement with single bridge span.
- Removal of the existing earthen dam at Muddy Hollow Pond.
- Removal of the existing earthen embankment at Glenbrook Crossing and restoration of stable channel and floodplain geometry.

Construction of Limantour Beach Bridge Span and Restoration of Marsh Channel

Features and Construction Requirements

At Limantour Beach Marsh, Alternative 1 would entail removing a substantial portion of the existing crossing and replacing it with a single bridge span. The lower berm and a substantial portion of the secondary beach access embankment would also be removed (Figure 2-1; Figure 2-2).

Construction, delivery, and haul vehicles would access the site via Limantour Road and the existing visitor parking area. Construction equipment and materials would be staged in the portion of the parking area closest to the crossing, with public access to the staging area restricted by temporary construction fencing and signage.

Dewatering Pond and Channel

The freshwater pond upstream of the culvert is likely to be dry or nearly dry during the construction period. If water is present either in the pond above or the spillway channel downstream of the culvert, it would be necessary to drain the area before removing the existing crossing. A silt fence–type dewatering barrier would be installed below the crossing, and a portable gasoline-powered pump would be placed on the embankment crossing. The barrier would likely consist of heavy-gauge plastic sheeting mounted on untreated wood stakes and secured along the base with sand bags.

Water pumped from the pond and channel would be conveyed via flexible high-density polyethylene (HDPE) pipe with an approximate diameter of 6 inches to a temporary outfall located outboard of the present location of the lower berm (see Figure 2-2). The pump intake would be equipped with appropriate screening to prevent it from drawing in wildlife and fish species. Depending on the amount of water in the pond and channel, and the pumping rates necessary to drain them in a timely manner, it might be necessary to implement flow dissipation measures to prevent erosion and sediment mobilization at the pump outfall. The most likely approach would be to armor the bed and bank temporarily with sand bags or bales of sterile, weed-free straw.

Once the pond is substantially drained, a stream bypass structure consisting of flexible 6-inch HDPE pipe would be installed to convey any remaining flow in the channel around the construction area and discharge it to the temporary outfall site. The bypass structure would be installed before any earthwork or other construction activity begins. Erosion control would remain in place at the outfall to manage potential effects of concentrated flow.

Removal of Lower Berm

Before excavation to remove the lower berm begins, silt fences would be installed across the tidal marsh plain to contain any remobilized sediment. An excavator and/or scraper would be used to remove the berm embankment. It would work from south (seaward side) to north (landward side), operating from the embankment top to avoid the need for heavy equipment on the marsh plain or in the channel. Excavated materials would be handled as described below for removal of the existing crossing.

Removal of Existing Crossing

Approximately 100 linear feet of the northern (landward) end of the existing crossing embankment and much of the secondary beach access spur would be removed to accommodate bridge construction. The rest of the crossing and the easternmost part of the secondary beach access embankment would remain in place (Figure 2-2), although the pavement would be entirely removed. To the extent feasible, shrubs in the area slated for removal would be mowed or grubbed and incorporated into the topsoil.

The existing crossing embankment would be removed using an excavator and/or scraper. As described above, it would operate from the embankment top, and work would begin at the far (east) end of the secondary beach access trail, proceeding west and then from south to north on the crossing embankment. This would enable the excavator to operate entirely from the embankment, avoiding the need for heavy equipment to enter the marsh plain or channel. Removal would be phased as follows, so formwork for the southern bridge abutment (see below) could be placed by equipment operating from the embankment top.

1. Remove pavement and approximately 200 linear feet of road prism from secondary beach access trail.
2. Remove southern (seaward) end of crossing embankment.
3. Excavate for southern bridge abutment.
4. Place formwork for southern bridge abutment, as described in following section.
5. Remove remainder of embankment, working from south to north.
6. Excavate and place formwork for northern bridge abutment, as described in following section.

Material excavated during removal of the existing embankment would be loaded into dump trucks and removed from the immediate vicinity of the channel and transported to the spoils management area adjacent to the Muddy Hollow Trail, approximately 800 feet northwest of the site, where a

conspicuous cut slope likely represents the original borrow area from which materials used to construct the embankment were obtained. Any salvaged topsoil would be stockpiled separately for use in revegetation. Pavement debris and nonnative aggregate would be disposed of as appropriate. If the excavated materials are too wet for immediate placement as fill, a temporary drying basin would be established at the spoils management area, and they would be dried until ready for placement. Some of the clean excavated materials would be reserved for reuse as fill during bridge construction. The remainder would be placed as engineered fill in the spoils management area. The resulting fill slope would be contoured and terraced to restore the area to a more natural appearance. Depending on site conditions at the time of construction, the upper foot below finished grade could be left uncompacted and stabilized with soil stabilizers approved for use adjacent to surface waters until revegetation is completed. An alternative would be to compact the surface and then disc immediately prior to topsoil application and revegetation (see *Revegetation* below).

Once the existing spillway culvert, which consists of an approximately 50-foot long section of 36-inch corrugated metal pipe (CMP), is exposed by excavation, it would be removed and offhauled for recycling or disposal at an appropriate facility. The excavated area would be refilled and compacted within the access corridor to the new bridge span.

Construction of New Bridge Span

The new bridge would be approximately 8 feet wide and would consist of a single 100 to 120 foot–long span. The frame would be constructed of Cone 10 or equivalent weathering steel. The deck would consist of 3 x 12 timbers selected to maximize strength and longevity, and would be constructed with a finished elevation of approximately 8 feet above mean sea level, allowing 2 feet of freeboard above the highest recorded tide elevation in Drake's Bay.

The bridge foundation is expected to consist of cast concrete spread footings, each supported by driven steel pipe piles. The piles would be seated using an excavator with a crane attachment and would be driven with a hydraulic pile driver. The footings would be cast in place. Formwork components and rebar would be placed by an excavator with a crane attachment, operating from the embankment top and/or existing roadway. As described above, embankment removal would be phased to allow formwork for the southern bridge abutment (see below) to be placed from the embankment top. Concrete would be pumped into the formwork from a concrete truck on the existing roadway.

Materials required for bridge construction would be delivered via flatbed trucks and would be staged along with construction equipment in the temporary laydown area established in the existing Limantour Beach parking area.

Red Legged Frog Habitat Enhancement

Proposed restoration actions would result in direct impacts to documented California red-legged frog breeding habitat. While the proposed actions are intended to restore natural hydrologic process, which would mainly be tidal, there will be freshwater resources that remain adjacent to the site. In order to mitigate impacts to frog breeding habitat, excavation of appropriate sites would be conducted as part of the project to hold freshwater that could act as breeding habitat. East of, and adjacent to the current marsh, staff would excavate pits that would be potential breeding habitat for the frogs. In addition, areas east of the current channel leading to the Limantour Beach Pond would be excavated to hold water. These areas would be isolated from the tidal areas and would not affect connectivity of the system. Instead, these areas would be located in low-energy areas and not expected to fill up with large amounts of sediment. Digging closer to the groundwater table would allow these systems to remain wet. Freshwater would be available making this breeding habitat viable.

The NPS is currently in the process of assessing frog pond conditions within the wilderness areas adjacent to the project area. This assessment would also inform the implementation process.

Revegetation and Erosion Control

After bridge construction is complete, the marsh channel would be allowed to revegetate by natural recruitment.

Following fill placement and slope recontouring, the spoils management area adjacent to the Muddy Hollow Trail would be topsoiled as feasible, using the topsoil collected during removal of the embankment crossing. If a need is identified, the surface would also be seeded with a locally native mix and mulched. As shown in Table 2-2, appropriate species include coastal bush lupine (*Lupinus arboreus*), California sagebrush (*Artemisia californica)*, coyote brush (*Baccharis pilularis*) and bush monkeyflower (*Diplaudicus aurantiacus*). Poison-oak (*Toxicodendron diversilobum*) would likely recruit to the site naturally.

Table 2-2. Seed Specifications for Use in Revegetation, by Habitat

Habitat	Appropriate Seed Mix
Marsh channel	Natural recruitment
Marsh plain	Natural recruitment
Stream channel and adjacent floodplain	Natural recruitment
Riparian and terrace slopes	Sterile, fast-growing erosion control mix (Regreen or equivalent)
Upland slope	Locally native seed mix[a] including ■ bush monkeyflower (*Diplaudicus aurantiacus*) ■ blue blossom (*Ceanothus thrysiflorus*) ■ Coyote brush (*Baccharis pilularis*) ■ coastal bush lupine (*Lupinus arboreus*)

[a] All seed should be collected from the Drake's Estero watershed.

Mulch would consist of sterile, weed-free straw. Revegetation would not take place at the spoils management area until excavated materials from both the Limantour Beach Marsh site and the Muddy Hollow site have been accommodated. Coir logs and other erosion control measures would be installed as needed on the slope and at the toe of the slope to prevent excessive sediment runoff until vegetation reestablishes. If necessary, the area could also be seeded with a sterile, fast-growing erosion control mix that would germinate quickly to provide added stabilization, but would not reproduce and thus would not impede establishment of the desired native species.

Topsoiled and/or seeded areas would be monitored following standard NPS protocols to ensure that vegetation establishes successfully. Topsoiling would provide a natural seedbank and if used is expected to foster rapid establishment of vegetation.

Construction Closures

For the Limantour Beach Marsh site, Alternative 1 would require closure of approximately half of the north Limantour Beach parking lot for the duration of the construction window (3–4 weeks), to

provide the necessary area for staging of construction equipment and materials. The other half of the parking area, and the restroom facilities, would remain open for use by the public. Temporary construction fencing and signage would be used to restrict public access to the staging area and the active construction area beyond. The north Limantour Beach access trail and the lower Muddy Hollow Trail would probably also be closed throughout the construction window; signage would also redirect visitors to the south Limantour Beach access 0.5 mile to the south. It may be necessary to close Limantour Road briefly during delivery of some bridge components; in this event, the construction contractor would be required to coordinate delivery(ies) with county, state, and NPS law enforcement staff as appropriate.

During construction, the south Limantour Beach access would remain open, providing recreational access to the beach outboard of the active construction area. If necessary, grassy areas at the south access point would be mowed to provide additional parking.

Removal of Muddy Hollow Dam

Features and Construction Requirements

At Muddy Hollow, Alternative 1 would entail draining the reservoir (Muddy Hollow Pond) and removing the existing earthen dam to restore full hydraulic connectivity between the upper portion of the watershed and the Estero proper (Figure 2-3). Dam removal would take place within a single construction season. Channel geometry and function are expected to evolve and readjust by natural processes following the restoration of drainage connectivity. A check structure or structures would be installed on the former reservoir floor to trap coarse sediment and assist the development of floodplain areas for revegetation. The Estero Trail, which now crosses Muddy Hollow via the dam embankment, would be rerouted.

Construction, delivery, and haul vehicles would access the site via the Lower Muddy Hollow Trail, so the lower portion of the trail would be closed during construction. Construction materials and equipment would be staged at the north end of the existing Limantour Beach parking lot, with public access to the staging area restricted by temporary construction fencing and signage.

Construction of Alternative 1 would be followed by an adaptive management phase as the restored system readjusts and moves to a new equilibrium. It should be noted that only the Estero Trail reroute portion of the project would be conducted within the Wilderness Boundary. All proposed work upstream of the dam including adaptive management monitoring and implementation would be conducted in the Environmental Protection—Natural Environment.

Reservoir Dewatering and Streamflow Bypass

Before removing the existing dam, it would be necessary to drain the reservoir and isolate the tidal channel reaches immediately below the dam. Multiple siphon tubes would be set up at this site to initiate the pond dewatering process. A likely method for draining the reservoir (approximately 20 acre-feet of water) would be initially to use portable gasoline-powered pumps placed on the dam top to lower the water below the spillway. Water pumped from the reservoir would be conveyed via 6-inch flexible HDPE pipes to a temporary outfall located on the largest existing tidal channel, downstream of the reach slated for recontouring. Dewatering barriers similar to those described above for the Limantour Beach Marsh site would be positioned downstream of the channel reaches to be recontoured, and an additional pump would be used to dewater any channels containing water, discharging to the same temporary outfall. Pump intakes would be equipped with screening to prevent them from drawing in wildlife. In addition, flow dissipation measures would be implemented to prevent erosion and sediment mobilization at the pump outfall. The most likely approach would be to armor the bed and bank temporarily with sand bags or bales of sterile, weed-free straw.

Once the reservoir is substantially drained, a stream bypass structure consisting of flexible 18- to 24-inch HDPE pipe would be installed to convey remaining low flow in the stream channel around the construction area and discharge it into the upper Estero below the dam site. Park biologists would survey the habitat to recover and move fish and aquatic species to existing suitable habitat. Silt fences would be installed on the tidal marsh plain below the dam site to prevent sediment and soil disturbed during dam removal or other construction activities from entering the Estero system. The bypass structure and silt fences would be installed before any earthwork or other construction activity begins.

Removal of Existing Dam

Before excavation begins, trees would be removed from the dam embankment and stockpiled for reuse in the construction of check structures (see following section). To the extent feasible, shrubs would be mowed or grubbed and incorporated into the topsoil. Any salvageable topsoil would then be removed and stockpiled separately at the spoils management site (adjacent to the Muddy Hollow Trail, approximately 1,000 feet south of the site) for use during revegetation.

Dam removal would begin with excavation of sufficient material from the top of the dam to backfill the existing spillway. The dam would then be removed by an excavator and/or scraper operating from the dam top, working from the west abutment back toward the east abutment. Filling the existing spillway would enable complete removal of the dam without the need for heavy equipment to enter the channel or marsh plain area.

Excavated materials would be moved to the spoils management area, where they would be placed as engineered fill. The total volume of material removed from the dam embankment and placed as fill in the spoils management area is expected to be approximately 9,700 cubic yards.

If excavated materials are too wet for immediate placement as fill, a temporary drying basin would be established at the spoils management area, and they would be dried until ready for placement. As described above, the new fill slope would be contoured and terraced, restoring the original borrow area to a more natural appearance. Depending on site conditions at the time of construction, the upper foot below finished grade could be left uncompacted and stabilized with soil stabilizers approved for use adjacent to surface waters until revegetation is completed. An alternative would be to compact the surface and then disc immediately prior to topsoil application and revegetation (see *Revegetation* below).

Construction of Check Structure(s)

Following dam removal, a check structure or series of check structures would be constructed across the former reservoir floor, approximately transverse to flow, as shown in Figure 2-4. The check structure(s) would foster the development of channel meanders and would also serve to trap coarse sediment except at high flood stages, contributing to the development of a functional fluvial drainage and buffering sediment loading to tidal environments downstream.

The check structures are envisioned as roughened, low-relief features with some degree of permeability. They could be constructed as brush check dams anchored by keying into the substrate, or could consist of tied and anchored trees, cruciforms, or driven posts or piles and rails. Construction would rely primarily on hand techniques, and most if not all of the materials would be obtained from the immediate project site. This “low-tech” approach to constructing the check structures is intended to result in structures that would gradually degrade following channel readjustment, releasing sediment in limited amounts over an extended period of time.

A check structure would be constructed across the former pond bottom near the end of the Muddy Hollow Delta (see Figure 2-4). Installation of additional check structures may be required in the future based on site performance and monitoring as described in the adaptive management section below.

Estero Trail Reroute

Because the Estero Trail alignment now crosses the Muddy Hollow drainage via the dam embankment, it would be necessary to reroute a portion of the trail to keep it in service following dam removal. The proposed new alignment is shown as a 200 foot–wide planning corridor in Figure 2-5. The new alignment is located primarily within the Philip Burton Wilderness, and the trail would be designed and constructed to be a sustainable facility that requires a minimum of maintenance by hand crews only, compatible with NPS policies for wilderness uses.

The new trail is proposed to cross Muddy Hollow Creek in the developed area at the Muddy Hollow pump station. A wet crossing (similar to Muddy Hollow Trail crossing) or bridge would be installed at this site to ensure that fish passage is maintained on the restored system. In the case of a bridge, footings would be installed on the terrace benches above the ordinary high water mark, avoiding the need to place fill in jurisdictional wetlands or waters. In the case of a wet crossing, an alignment across the creek that minimizes delivery of upland sediment to the creek would be implemented.

Trail design would be consistent with NPS and State park guidelines for hiker/equestrian trail uses, which recommend a 3-4 foot–wide trail tread. Based on the geology and soils in the area, it is recommended that a full bench-cut be used on steep slopes and a one-half to three-quarters bench cut on gentler slopes. Because the trail is expected to accommodate heavy use by hikers and equestrians, a compacted gravel surface with geotextile fabric or an equivalent may be needed to protect against excessive wear and erosion in certain areas.

Construction methods are evaluated in light of the minimum tool requirement for work in wilderness areas (Appendix B). Proposed construction techniques include vegetation clearing by mower and by hand, followed by the combination of specialized trail construction equipment such as a Sweco dozer and hand crew work, to establish the new trail tread. Proposed construction requirements are informed by localized experience related to vegetation density, soil types, and slope stability. These methods are consistent with recommendations within the Seashore and the Trail Inventory and Condition Assessment Report (NPS 2003).

Revegetation and Erosion Control

Areas disturbed by earthwork or any other construction activity would be topsoiled as feasible, using the topsoil salvaged during dam removal. If necessary, an area may also be seeded with a locally native mix and mulched. Appropriate seed species are shown in Table 2-2. Mulch would consist of sterile, weed-free straw.

Following fill placement and slope recontouring, the spoils management area adjacent to the Muddy Hollow Trail would be topsoiled and/or seeded with a locally native mix and mulched, as described above. Revegetation would not take place at the spoils management area until excavated materials from both the Limantour Beach Marsh site and the Muddy Hollow site have been accommodated. Coir logs and other erosion control measures would be installed as needed on the slope and at the toe of the slope to prevent excessive sediment runoff until vegetation reestablishes. If necessary, the area could also be seeded with a sterile, fast-growing erosion control mix that would germinate quickly to provide added stabilization, but would not reproduce and thus would not impede establishment of the desired native species.

Following revegetation, topsoiled and/or seeded areas would be monitored following standard NPS protocols to ensure that vegetation establishes successfully. Topsoiling would provide a natural seedbank and if used is expected to foster rapid establishment of vegetation.

Construction Closures

Facilities closures for removal of the Muddy Hollow Dam would be the same as those described above for work at the Limantour Beach Marsh site, since both sites are accessed via the same parking lot and trails. Under Alternative 1, construction at Muddy Hollow would require 2–3 weeks.

Adaptive Management

The purpose of the adaptive management program at Muddy Hollow is to monitor channel adjustments and allow NPS to take action when necessary to slow rates of channel incision and erosion through the delta and reduce annual sediment delivery to Muddy Hollow Creek and the tidal marsh downstream.

NPS expects the stream system to be highly dynamic in the first years following restoration, particularly before vegetation is fully reestablished, so an active program of adaptive management treatments would likely be needed. Potential treatments would be based on observed needs and would employ locally harvested materials such as willow (*Salix* spp.) and alder (*Alnus* sp.) wood and debris. Treatments could be implemented either by NPS staff, or by a contractor. If a contractor is used, the preference would be to retain the same contractor who is responsible for restoration construction to support monitoring and adaptive management, in order to provide continuity of vision and capitalize on the contractor's experience with the sites.

Monitoring and adaptive management are expected to proceed in three phases: initial development, incision management, and channel widening management. Each phase would be initiated based on the restored system's geomorphic development, so different reaches of the system are expected to undergo the various monitoring phases at different times, as they develop progressively. Table 2-3 presents the nature and duration of each monitoring phase, identifies action triggers, and summarizes the corrective actions expected to be appropriate.

Table 2-3. Monitoring and Adaptive Management Program for Muddy Hollow Site

Monitoring Phase	Anticipated Duration	Factor(s) Evaluated	Action Triggers and Corrective Measures
Initial development	Post-construction, until the channel is deep enough that any needed works can be constructed inchannel without forcing flow out of the channel (4–5 feet near dam site, 2–3 feet upstream).	Development of a single channel through the aggraded sediment prism, starting at downstream end.	No substantial works are anticipated, although some clearing of woody brush or debris may be needed if the channel avulses excessively.

Monitoring Phase	Anticipated Duration	Factor(s) Evaluated	Action Triggers and Corrective Measures
Incision management	Following initial development, until channel bed has stabilized	Location of knickpoint in channel monitored for initial development; effectiveness of previously constructed measures in slowing channel incision and trapping sediment; potential for previously constructed measures to act as fish passage barriers.	If the knickpoint migrates too rapidly upstream (i.e., channel incision is too rapid), grade control structures should be constructed at the knickpoint; recommended structures include branch layers or branch packing structures, anchored by poles keyed into the banks. Sediment trapping structures may also be needed downstream of the knickpoint; recommended structures would be similar to pole palisades or live palisades. More substantial structures constructed of poles backfilled with native bed material may be used if palisades prove to be ineffective. Previously constructed measures identified as ineffective should be replaced or modified. If barriers to fish passage are identified, structures should be replaced or modified.
Channel widening management * *this is the most intensive measure and would only be used in extreme cases.	1–2 years following completion of incision management phase	Channel bank stability; channel width	If bank erosion occurs as a result of lateral scour around structures installed to manage incision, the original structure(s) should be modified. If bank erosion results from scour around logjams, the logjam should be removed or modified and the woody material laid along the eroding bank with rootwads in the channel at the bank toe and opposite ends anchored to stable trees in place along the bank. If sediment delivered to downstream areas by bank erosion appears to be important to channel development, bank erosion should be allowed to continue, and ■ existing riparian trees should be cut and used to stabilize the bank, as described above; or ■ existing trees should be anchored while still in place such that they would protect the bank when they fall.

Each adaptive management phase would entail the following steps.

- **Conduct Monitoring—**Inspect the channel following significant storms to determine whether management intervention is required, and if so, what actions are appropriate and where they should be applied.
- **Implement Adaptive Measures—**Construct management measures with materials harvested in the Muddy Hollow watershed, primarily using hand labor and hand tools. As with the check structures included in the initial phase of project construction, this "low-tech" approach to constructing the check structures is intended to result in structures that would degrade over time following channel readjustment, gradually releasing impounded sediment back into transport.
- **Continue Monitoring—**Inspect the constructed measures and the progress of incision and erosion along the new channel; determine whether additional

maintenance or measures are required, and if so, what actions are appropriate and where they should be applied.

- **Implement Additional Measures, as Needed—**Based on the results of monitoring, modify existing measures (check structures, etc.), replace with alternative designs, and/or construct additional measures in other locations, if needed. Any additional structures should be constructed using materials harvested in the Muddy Hollow corridor, and hand techniques.

Creation of Stable Channel and Floodplain Geometry at Glenbrook Crossing Site

The Glenbrook Crossing site is a non-conforming structure located entirely within the Philip Burton Wilderness Area. Alternative 1 would entail removing the existing culverted Glenbrook crossing, and recontouring the channel and floodplain via excavation and fill placement to approximate a geomorphically stable condition (Figure 2-6, Figure 2-7). The Muddy Hollow trail would be rerouted where it crosses Glenbrook Creek. Construction, delivery, and haul vehicles would access the site from Limantour Road via the existing Muddy Hollow trail (Figure 2-8). A temporary construction access crossing would be required to cross Muddy Hollow Creek adjacent to the Muddy Hollow Parking area, to avoid disturbance of channel and streambank habitat. If necessary, sections of the road would be graded to accommodate construction vehicles; level of effort would not exceed standard fire road maintenance procedures for Point Reyes National Seashore.

Construction materials and equipment would be staged approximately 1,000 feet east of the crossing site, on the south side of the road. Public access to the staging area would be restricted by temporary construction fencing and signage.

Specific measures would be implemented at the Glenbrook Crossing site to mitigate for impacts to wilderness associated with this proposed restoration action. Workers would stage at the Lower Muddy Hollow Parking Lot and take a shuttle into the work area. Trips along the Muddy Hollow Trail corridor would be minimized to the greatest extent possible. Within the construction area, activities and equipment should be appropriate to accomplish the objectives of the project in the best manner and shortest time possible. Analysis of Wilderness Minimum Requirements and Minimum Tool is included as Appendix B of this Environmental Assessment.

Features and Construction Requirements

Streamflow Bypass and Water Quality Protection

Before construction begins, a bypass consisting of flexible 24-inch HDPE pipe would be installed to convey streamflow around the construction area, beginning approximately 700 feet upstream of the crossing site and discharging at a temporary outfall approximately 850 feet downstream of the crossing, below the construction area. Depending on the amount of flow in the channel, it might be necessary to implement flow dissipation measures to prevent erosion and sediment mobilization at the outfall. As described for the Limantour Beach Marsh and Muddy Hollow sites, the most likely approach would be to armor the bed and bank temporarily with sand bags or bales of sterile, weed-free straw.

Following installation of the bypass, the channel reaches up- and downstream of the crossing would be coffer-dammed and dewatered, using equipment similar to that described above for Muddy Hollow and Limantour Beach dewatering. Park biologists would survey the stream reaches during dewatering, to recover and move fish and aquatic species to existing suitable habitat. Water pumped from the channel would be discharged to the creek at the temporary outfall described above.

Subsurface flows of shallow groundwater are considered likely after diversion of surface flow, especially during the early part of the construction season. Consequently, it may be necessary to supplement the surface bypass by installing additional dewatering facilities to control subsurface flows in the vicinity of the construction area and enable heavy equipment to operate in lowland areas. Information on subsurface conditions and likely dewatering needs is being collected as part of the engineering geologic and geotechnical studies in progress for the project.

Removal of Existing Road Embankment and Culvert

The existing road embankment, except for the easternmost portion, would be removed using an excavator and/or scraper operating from the embankment top. Removal would begin on the west abutment and proceed toward the east, enabling equipment to work entirely from the embankment top and adjacent roadway, without entering the channel area. The east end of the embankment would be recontoured to create an access ramp for equipment entering the area upstream from the crossing (see *Channel and Floodplain Recontouring* below).

Existing concrete riprap and any other imported material removed during excavation would be offhauled for appropriate recycling or disposal. A small volume of the clean excavated material would be placed as engineered fill to backfill the side gully downstream of the crossing. The remainder would be transported to the designated spoils management area, approximately 1,000 feet east of the site on the south side of Muddy Hollow Road. There, it would be placed as engineered fill along the toe of the existing cut slope, adjacent to the trail. This area is believed to have been the original borrow site for material used to construct the embankment and nearby dams; fill would be contoured to restore the slope to a more natural-appearing topography, and the slope would be topsoiled and/or revegetated with a locally native seed mix (see *Revegetation* below). Coir logs and other erosion control measures would be installed as needed on the slope and at the toe of the slope to prevent excessive sediment runoff until vegetation reestablishes. If it is necessary to stockpile excavated materials temporarily to allow them to dry before they are placed and compacted, a temporary drying basin would be established in the spoils management area.

Once the culvert is exposed by excavation, it would be removed and offhauled for recycling or disposal at an appropriate facility.

Channel and Floodplain Recontouring

Following removal of the existing embankment and culvert, the drainage up- and downstream of the crossing would be recontoured to create a channel and floodplain geometry appropriate to the gradient, size, and discharge of the overall system, allowing natural hydraulic function to resume. This would include the following activities.

1. Excavating accumulated sediment upstream of the crossing to create an inset floodplain with a total width of approximately 45 feet, consistent with NHCs (2004) modeling results and the characteristics of other similar drainages in the area.
2. Within the inset floodplain, excavating to create a low-flow channel approximately 10 feet wide, with a thalweg depth of 2 feet and a gradient of approximately 2%, designed to contain flows up to and including the 2-year flood.
3. Creating a 2:1 (horizontal:vertical) slope connecting the excavated floodplain to the existing upper portion of the floodplain or terrace along Glenbrook Creek. (The old terrace and floodplain are typically 5–8 feet above the excavated floodplain, and would rarely be flooded.)

Downstream of the crossing site, onsite fill would be placed in approximately 850 linear feet of the channel to raise the bed and reduce the invert gradient to a slope of approximately 2%. As a

result of fill placement, the invert elevation immediately below the crossing site would be increased by 8 feet.

Several mature red alders (*Alnus rubra*) would be removed to permit channel and floodplain recontouring. Some of the resulting woody material would be left in place on the newly contoured floodplain for natural recruitment into the stream system. Additional large pieces of woody material, or a combination of woody debris and boulders (Flosi et.al. 1998), would be used to construct eight grade control structures designed to resemble buried debris jams below the crossing site, and another nine upstream. The grade control structures would be installed at intervals of approximately 100 feet along the channel, with drops of less than 2 feet between the crests of adjacent structures. Following channel reconstruction, erosion control measures such as coir fiber logs would be installed in the newly created channel to reduce sediment entrainment and erosion.

Glenbrook Crossing Trail Reroute

Restoration at the Glenbrook Crossing site would require realigning a portion of the Muddy Hollow Trail, which now crosses Glenbrook Creek via the embankment slated for removal. The proposed alignment is shown as a 200 foot–wide planning corridor on Figure 2-8. It would leave the existing alignment near the intersection with the Bucklin trail, immediately east of the spoils management area, and would follow contours, descending gradually towards the floodplain area and cross Glenbrook Creek near the original crossing area. The new alignment would be located entirely within the Philip Burton Wilderness, and the trail would be designed and constructed to be a sustainable facility that requires a minimum of maintenance by hand crews only, compatible with NPS policies for wilderness uses.

The trail would cross Glenbrook Creek using either a bridge or wet crossing upstream of the former site. The bridge crossing is proposed to ensure fish passage on this perennial creek and to minimize the effects of heavy trail usage on creek and riparian habitats. In the case of a bridge, footings would be installed on the terrace benches above the ordinary high water mark, avoiding the need to place fill in jurisdictional wetlands or waters. In the case of a wet crossing, an alignment across the creek that minimizes delivery of upland sediment to the creek would be implemented.

Trail design would be consistent with NPS and State park guidelines for hiker/equestrian trail uses, which recommend a 3-4 foot–wide trail tread. Based on the geology and soils in the area, it is recommended that a full bench-cut be used on steep slopes and a one-half to three-quarters bench cut on gentler slopes. Because the trail is expected to accommodate heavy use by hikers and equestrians, a compacted gravel surface with geotextile fabric or an equivalent may be needed to protect against excessive wear and erosion in certain areas.

Construction methods are evaluated in light of the minimum tool requirement for work in wilderness areas (Appendix B). Proposed construction techniques include vegetation clearing by mower and by hand, followed by the combination of specialized trail construction equipment such as a Sweco dozer and hand crew work, to establish the new trail tread. Proposed construction requirements are informed by localized experience related to vegetation density, soil types, and slope stability. These methods are consistent with recommendations within the Seashore and the Trail Inventory and Condition Assessment Report (NPS 2003).

Revegetation and Erosion Control

After channel and floodplain recontouring is complete, the channel and adjacent floodplain area would be allowed to revegetate by natural recruitment. A sterile, fast-growing erosion control mix would be applied to the terrace slopes if judged necessary.

Following fill placement and slope recontouring, the spoils management area adjacent to Muddy Hollow Road would be seeded with a locally native mix and mulched. If feasible, topsoiling could also be implemented at Glenbrook Crossing, as described above for the other two sites. Appropriate seed species are shown in Table 2-2. Mulch would consist of sterile, weed-free straw. Erosion control would be installed as needed, and could include coir logs, fabrics, or use of a sterile, fast-growing erosion control seed mix. Any additional areas disturbed by staging, earthwork, or other construction activities would be similarly treated.

Following revegetation, seeded and/or topsoiled areas would be monitored following standard NPS protocols to ensure that vegetation establishes successfully.

Construction Closures

Work at Glenbrook Crossing would require closure of the Muddy Hollow Trail and reduction of available parking at the Muddy Hollow Trailhead for the duration of construction, expected to be a total of 3–4 weeks. As discussed above, the site is located in a designated wilderness area, so wilderness treatment procedures would apply during trail closures.

Adaptive Management

The measurable result of adaptive management at the Glenbrook Crossing site is to slow rates of channel incision and erosion, matching the sediment volumes resulting from incision and widening as closely as possible to sediment transport capacity, and controlling sediment loading to lower Glenbrook Creek. As at Muddy Hollow, adaptive management at the Glenbrook Crossing site would proceed in three phases: initial development, incision management, and channel widening management, summarized in Table 2-4. NPS expects the system to be highly dynamic in the first years following restoration, particularly before vegetation is fully reestablished, so an active program of adaptive management measures would likely be implemented. Treatments would be based on observed needs and would employ locally harvested materials such as willow and alder wood and debris.

Table 2-4. Monitoring and Adaptive Management Program for Glenbrook Crossing

Monitoring Phase	Anticipated Duration	Factor(s) Evaluated	Action Triggers and Corrective Measures
Initial development	Post-construction, until the channel is deep enough that any needed works can be constructed within the channel without forcing flow out of the channel (4–5 feet near crossing site, 2–3 feet upstream).	Development of channel through the aggraded sediment prism, starting at downstream end.	No substantial works are anticipated, although it may be necessary to clear brush or remove woody debris if the channel avulses.
Incision management	Following initial development, until channel bed has stabilized	Location of channel knickpoint; effectiveness of previously constructed measures in slowing channel incision and trapping sediment; potential for previously constructed measures to act as fish passage barriers.	If the knickpoint migrates too rapidly upstream (i.e., channel incision is too rapid), grade control structures should be constructed at the knickpoint; recommended structures include branch layers or branch packing structures, anchored by poles keyed into the banks. Sediment trapping structures may also be needed downstream of the knickpoint; recommended structures would be similar to pole palisades or live palisades. More substantial structures constructed of poles backfilled with native bed material may be

Monitoring Phase	Anticipated Duration	Factor(s) Evaluated	Action Triggers and Corrective Measures
			used if palisades prove to be ineffective. Previously constructed measures identified as ineffective should be replaced or modified. If barriers to fish passage are identified, structures should be replaced or modified.
Channel widening management	1–2 years following completion of incision management phase	Channel bank stability; channel width	If excessive bank erosion or lateral channel migration occurs, measures should be installed to control scour. Recommended measures include woody debris structures constructed of individual trees placed in an overlapping configuration along the bank, with their rootwads at the bank toe. Riparian trees can also be anchored so that as the bank retreats, they fall over to protect the bank from further erosion.

Each adaptive management phase at Glenbrook Crossing would entail the following steps.

- **Conduct Monitoring—**Inspect the channel following significant storms to determine whether management intervention is required, and if so, what actions are appropriate and where they should be applied.
- **Implement Adaptive Measures—**Construct management measures with locally harvested materials, using hand labor and hand tools. This "low-tech" approach to constructing management works is intended to result in structures that would degrade over time following channel readjustment, gradually releasing any impounded sediment back into transport.
- **Continue Monitoring—**Inspect the constructed measures and the progress of incision and erosion along the restored channel; determine whether additional maintenance or measures are required, and if so, what actions are appropriate and where they should be applied.
- **Implement Additional Measures, as Needed—**Based on the results of monitoring, modify existing measures (check structures, etc.), replace with alternative designs, and/or construct additional measures in other locations, if needed. Any additional structures should be constructed using locally harvested materials and hand techniques.

Alternative 2: Partial Build Approach

Alternative 2 consists of the following components.

- Replacement of the culverted crossing at Limantour Beach Marsh with a boardwalk.
- Phased removal of the Muddy Hollow Dam, with stream and tidal channel function restored over time as a result of natural processes.
- Removal of the existing earthen embankment at the Glenbrook Crossing, followed by balanced excavation and fill to restore the creek channel.

Construction of Boardwalk at Limantour Beach Marsh

Features and Construction Requirements

At Limantour Beach Marsh, Alternative 2 would entail draining the freshwater pond, spillway, and channel immediately downstream of the spillway, if water is present; removing the lower berm; removing the existing embankment crossing and culvert; and constructing a new boardwalk to provide pedestrian access to the beach. As described for Alternative 1, equipment and materials would be staged from the portion of the parking lot closest to the crossing; public access to the staging area would be restricted by temporary construction fencing and signage.

Dewatering Pond and Channel

Pond and channel dewatering at Limantour Beach Marsh would be the same under Alternative 2 as those described above for Alternative 1.

Removal of Lower Berm

Removal of the lower berm at Limantour Beach Marsh would be the same under Alternative 2 as those described above for Alternative 1.

Removal of Existing Crossing

The existing crossing embankment would be removed to accommodate boardwalk construction (Figure 2-1). Most of the secondary beach access trail embankment would also be removed.

Before earthwork to remove the crossing begins, shrubs would be mowed or grubbed and incorporated into the site topsoil as feasible. As much topsoil as possible would be salvaged for use during revegetation.

An excavator would be used to remove the crossing and trail embankments. As described for Alternative 1, it would operate from the embankment top, beginning at the far end of the secondary beach access trail and working first west (toward the crossing embankment) and then north (from the seaward end of the crossing toward the landward end). This would enable the excavator to operate entirely from the embankments, avoiding the need for heavy equipment to enter the marsh plain or channel. Removal would be phased as follows, so formwork for the southern bridge abutment (see below) could be placed by equipment operating from the embankment top.

1. Remove pavement and approximately 200 linear feet of road prism from easterly spur.
2. Remove existing crossing and culvert, working from south to north.

Material excavated during removal of the existing embankment would be handled as described above for Alternative 1. Culvert removal would also proceed as described for Alternative 1.

Boardwalk Construction

The new boardwalk would be 270 feet long and 8 feet wide, and would be equipped with a 3-foot-high safety railing consistent with ADA standards on each side. It would be constructed of sustainable materials and supported on driven steel pipe, wood or recycled plastic piles. Boardwalk piles would be driven with a hydraulic pile driver. Boardwalk construction would proceed at the level of the deck, and would avoid placement of equipment within the wetland areas.

Over the active tidal channel, the finished elevation of the boardwalk deck would be approximately 8 feet above MSL, about 2 feet above the level of the highest tide recorded in

Drake's Bay; the deck would curve gently upward to the south to follow the contour of the dune surface. Although public access would be restricted to pedestrian and equestrian use, the boardwalk would be designed to support limited vehicle traffic (all-terrain vehicles or small pick-up trucks) to allow NPS staff access for maintenance and management activities.

Red Legged Frog Habitat Enhancement

Red-legged frog habitat enhancement would be the same under Alternative 2 as those described above for Alternative 1.

Revegetation and Erosion Control

Revegetation and Erosion Control at Limantour Beach Marsh would be the same under Alternative 2 as those described above for Alternative 1.

Construction Closures

Construction closures for work at Limantour Beach Marsh would be the same under Alternative 2 as those described above for Alternative 1.

Phased Removal of Muddy Hollow Dam

At the Muddy Hollow site, Alternative 2 would entail phased removal of the existing dam, rather than removal in a single construction year as described under Alternative 1. During the first year (Phase 1) of the project, a low-level outlet would be installed to permit the reservoir to drain except during flood periods. Following an adjustment period, during which the reservoir bottom would be allowed to revegetate and the channel system would adjust to restored tidal exchange, the dam would be completely removed (Phase 2). As described under Alternative 1, the lower Muddy Hollow Trail would be rerouted.

Phase 1: Installation of Low-Level Outlet and Reservoir Dewatering

Water Quality Protection and Culvert Installation

The low-level outlet would consist of a culvert equipped with a slide gate. It would be sited to discharge into the largest tidal channel downstream of the existing dam.

Before culvert installation begins, it would be necessary to dewater the portion of the reservoir adjacent to the work area, as well as the adjacent downstream tidal channel reach. Coffer dams or silt fences would be installed around the work area in the reservoir and across the tidal channel downstream of the reservoir. The coffer-dammed portion of the reservoir would be drained using portable gasoline-powered pumps located on the dam top. Water pumped from the reservoir would be conveyed via 6-inch flexible HDPE pipes to a temporary outfall located on the largest existing tidal channel, downstream of the work area. The same system would then be used to dewater the channel reach. As described for Alternative 1, pump intakes would be equipped with NPS-approved screening to prevent them from drawing in wildlife. In addition, flow dissipation measures would be implemented to prevent erosion and sediment mobilization at the pump outfall. The most likely approach would be to armor the bed and bank temporarily with sand bags or bales of sterile, weed-free straw.

Silt fences would be installed on the tidal marsh plain below the dam site to prevent sediment and soil disturbed during construction activities from entering the Estero tidal system. The silt fences would be installed before any earthwork or other construction activity begins.

Following dewatering, the portion of the existing embankment in the work area would be excavated, using an excavator operating from the embankment top. The culvert for the temporary low-level outlet would then be placed, using an excavator with a crane attachment or a crane. The culvert would consist of CMP and would be sized to carry flows up to and including those expected from the 1-year storm event, and to cause backwater in the reservoir area during larger storms. Based on modeling by NHC (2002), this would require a working diameter of 48 inches. The culvert would be installed with approximately 1 foot of the culvert barrel buried below finished grade; consequently, the actual diameter of the culvert pipe would likely be on the order of 60 inches. The finished invert elevation would be consistent with that of the immediately adjacent downstream tidal channel reach.

Following culvert placement, the excavation would be backfilled with onsite materials temporarily stockpiled in the spoils management area for reuse. Fill would be compacted with walk-behind pneumatic compactors and/or rollers. The surface of the dam would be seeded with an appropriate locally native seed mix and mulched with sterile, weed-free straw.

Reservoir Dewatering

The reservoir would be dewatered via the low-level culvert outlet, using the slide gate to regulate flow and prevent excessive erosion or channel migration. To ensure that dewatering is proceeding as expected, and that no adverse changes in downstream channel function or sediment mobility have occurred, NPS intends to monitor the site on a monthly basis and following large storm events.

Construction of Check Structure(s)

Like Alternative 1, Alternative 2 would entail construction of a check structure or series of check structures across the former reservoir floor after dam removal, to develop channel meanders and trap coarse sediment, buffering effects on the downstream system. Construction of check structures would likely begin in the upstream portion of the former reservoir area in Year 1, following partial dewatering, and continue as the system evolves in subsequent years. Check structures would be similar under Alternative 2 to those described above for Alternative 1, and would be designed to degrade over time following channel readjustment, releasing sediment in small amounts over an extended duration.

Estero Trail Reroute

Under Alternative 2, the trail reroute (Figure 2-5), trail design, and trail construction methods, would be the same as those described above for Alternative 1. The trail reroute would be constructed during Phase 1, to avoid potential hazards associated with recreational use around the temporary dewatering outlet, and to minimize interruption and possible degradation of the recreational experience.

Phase 2: Removal of Dam

Phase 2 would be implemented following a one-year adjustment period, during which the reservoir bottom would be allowed to revegetate and the channel system would adjust to restored tidal exchange. Under Phase 2, the dam would be completely removed.

Channel Dewatering and Streamflow Bypass

Before dam removal begins, a stream bypass structure consisting of 18- to 24-inch flexible HDPE pipe would be installed to convey remaining low flow in the stream channel around the construction area and discharge it into the upper Estero below the dam site. Dewatering barriers similar to those described above for Limantour Beach Marsh would be installed up- and downstream of the construction area, and the channel reaches adjacent to the dam would be

dewatered; discharge would be conveyed via 6-inch HDPE pipe to a temporary outfall located downstream of the construction area. Pumps would be placed on the top of the dam. Pump intakes would be equipped with NPS-approved screening to prevent them from drawing in wildlife. In addition, flow dissipation measures would be implemented to prevent erosion and sediment mobilization at the pump outfall. The most likely approach would be to armor channel bed and banks temporarily with sand bags or bales of sterile, weed-free straw.

Silt fences would be installed on the tidal marsh plain below the dam site to prevent sediment and soil disturbed during dam removal or other construction activities from entering the Estero tidal system. As described above for Year 1, the bypass structure and silt fences would be installed before any earthwork or other construction activity begins.

Removal of Existing Dam

As described for Alternative 1, dam removal would begin with excavation of a sufficient amount of material from the top of the dam to fill the existing spillway. The dam would then be removed by an excavator and/or scraper working from the top of the dam, moving from the west abutment back toward the east abutment. Filling the existing spillway would enable complete removal of the dam without the need for heavy equipment to enter the channel or tidal marsh plain areas.

As with Alternative 1, excavated materials would be transported to the spoils management area adjacent to the Muddy Hollow Trail, approximately 1,000 feet south of the site, where they would be placed as engineered fill. If materials require drying before they can be placed as fill, a drying basin would be established at the spoils management area. As described above, the new fill slope would be contoured and terraced, restoring the original borrow area to a more natural appearance. Depending on site conditions at the time of construction, the upper foot below finished grade could be left uncompacted and stabilized with soil stabilizers approved for use adjacent to surface waters until revegetation is completed. An alternative would be to compact the surface and then disc immediately prior to topsoil application and revegetation.

Construction of Check Structure(s)

As described above, construction of check structures would continue under Phase 2, following complete dewatering of the reservoir. Check structures would be similar under Alternative 2 to those described above for Alternative 1.

Revegetation and Erosion Control

Revegetation and erosion control would be the same under Alternative 2 as described above for Alternative 1.

Construction Closures

During Phase 1, the Lower Muddy Hollow Trail and Estero Trail would be closed during construction to install the low-level outlet (approximately 2 weeks). Closures during Phase 2 dam removal activities would be the same as those described above for Alternative 1 at Muddy Hollow.

Adaptive Management

The purpose of the adaptive management program at Muddy Hollow is to monitor channel adjustments and allow NPS to take action when necessary to slow rates of channel incision and erosion through the delta and reduce annual sediment delivery to Muddy Hollow Creek and the tidal marsh downstream. As described for Alternative 1, the system is expected to be highly dynamic in the first years following implementation of Alternative 2. Although the need for adaptive intervention could be greater under Alternative 2, the adaptive management component

for Alternative 2 would be operate in the same way as that described above for Alternative 1. As with Alternative 1, adaptive management would proceed in three phases under Alternative 2: initial development, incision management, and channel widening management. Each phase would be initiated based on the restored system's geomorphic development, so different reaches of the system are expected to undergo the various monitoring phases at different times, as they develop progressively. Treatments would be based on observed needs and would employ locally harvested materials such as willow and alder wood and debris.

Limited Channel Restoration at Glenbrook Crossing Site

At the Glenbrook Crossing site, Alternative 2 provides for removal of the existing culverted embankment crossing and limited channel grading to enable readjustment of the channel via natural processes of erosion and transport. The proposed treatment reduces the areal extent of treatment activities from those described under alternative 1, focusing on removal of the features that impede natural process, and balancing cut and fill actions in the channel to reconnect the system through the project area. The extent of treatment under Alternative 2 is 600 feet downstream and 200 feet upstream (Figure 2-9). Log and boulder structures would be installed within the zone as described in Alternative 1, to moderate the grade and provide habitat in the restored channel.

The Muddy Hollow Trail would be rerouted in the same manner as described under Alternative 1. Construction access, staging, and wilderness mitigations would be the same under Alternative 2 as under Alternative 1.

Features and Construction Requirements

Streamflow Bypass and Water Quality Protection

Before construction begins, a bypass consisting of 24-inch flexible HDPE pipe would be installed to convey streamflow around the construction area, beginning approximately 400 feet upstream of the crossing site and discharging approximately 850 feet downstream of the crossing. The channel reaches up- and downstream of the cross would then be isolated and dewatered, as described above for Alternative 1. Water pumped from the channel would be discharged to the creek downstream of the construction area. As with Alternative 1, the channel bed and bank would be protected from excessive erosion through placement of sand bags or bales of sterile, weed-free straw.

As described above, it might be necessary to install additional dewatering facilities to control subsurface flow of shallow groundwater in the vicinity of the Glenbrook crossing construction area and enable heavy equipment to operate in lowland areas. Dewatering facilities would be designed based on the results of engineering geologic and geotechnical investigations now in progress.

Removal of Existing Road Embankment and Culvert

As described for Alternative 1, the existing road embankment, except for the easternmost portion, would be removed using an excavator and/or scraper operating from the embankment top. Removal would begin on the west abutment and proceed toward the east, enabling equipment to work entirely from the embankment top and adjacent roadway, without entering the channel area. The east end of the embankment would be recontoured to create an access ramp for equipment entering the area upstream from the crossing (see *Channel and Floodplain Recontouring* below).

As with Alternative 1, existing concrete riprap and any other imported material removed during excavation would be offhauled for appropriate recycling or disposal. A small portion of the clean excavated material would be placed as engineered fill to fill the side gully downstream of the

crossing. The remainder would be transported to the spoils management area, east of the site on the south side of Muddy Hollow Road, where it would be placed as engineered fill along the toe of the existing cut slope, restoring the original borrow site to a more natural-appearing topography. The slope would then be revegetated with a locally native seed mix (see below). It may be necessary to stockpile excavated materials temporarily to allow them to dry before they are placed and compacted; if so, a temporary drying basin would be established in the spoils management area.

Once the culvert is exposed by excavation, it would be removed and offhauled for recycling or disposal at an appropriate facility.

Channel and Floodplain Recontouring

Following removal of the existing embankment and culvert, sediment stored above the crossing would be removed and placed downstream in the reconstructed channel section. This balanced cut and fill approach would minimize excavation upstream approximately 100-200 linear feet. Upstream, the channel would be recontoured, with the invert elevation at the crossing site adjusted by as much as 8 feet.

Material recovered from the aggraded upstream area would be used for channel recontouring below the crossing site, where onsite fill would be placed in approximately 600 linear feet of the channel, reducing the invert gradient to a slope of approximately 2% and increasing the invert elevation immediately below the crossing site by about 8 feet. While the intent of the site treatment is to balance cut and fill, any excess spoils would be managed as described above for embankment removal.

To stabilize the recontoured portion of the channel, grade control structures designed to resemble buried debris jams would be installed at intervals of approximately 100 feet, with drops of 2 feet or less between the crest of adjacent structures. Grade control structures would be installed over the entire length of the recontoured reach downstream of the crossing site. The design would integrate two additional structures to be placed in the short recontoured reach upstream of the crossing site. To the extent feasible, they would be constructed using woody materials from the site. It is likely that boulders would need to be imported from approved quarries for use in this area.

Several mature alders would likely be removed to accommodate channel earthwork. The resulting large woody material would be left in place for natural recruitment into the stream system.

This approach to restoration of a more natural channel gradient would more closely balance excavation upstream of the crossing site with fill placement downstream than Alternative 1, and would result in a smaller volume of excess spoils requiring placement in the spoils management area. Because it would reduce upstream excavation, it would also minimize intrusion into the mature, established riparian forest upstream of the crossing, allowing this living community to continue to provide channel stability as natural hydrologic and hydraulic process is reintroduced to the system.

Glenbrook Crossing Trail Reroute

Under Alternative 2, the trail reroute (Figure 2-8), trail design, and trail construction methods, would be the same as those described above for Alternative 1.

Revegetation

Once channel recontouring has been completed, revegetation would proceed as described above for Alternative 1. The channel area would be allowed to revegetate by natural recruitment; other areas disturbed by construction would be topsoiled and/or seeded with an appropriate mix and mulched. The volume of spoils placed in the spoils management area would be less than for Alternative 1, but the area would be contoured and topsoiled an/or seeded and mulched, and erosion control would be installed, as described above.

Construction Closures

Construction closures for Alternative 2 at the Glenbrook Creek crossing site would be the same as those described above for Alternative 1.

Adaptive Management

As described above for Alternative 1, the purpose of adaptive management at the Glenbrook Crossing site is to slow rates of channel incision and erosion, matching the sediment volumes resulting from incision and widening as closely as possible to sediment transport capacity, and controlling sediment loading to lower Glenbrook Creek. As at Muddy Hollow, adaptive management at the Glenbrook Crossing site would proceed in three phases: initial development, incision management, and channel widening management, summarized in Table 2-4, presented above. Although the mature riparian vegetation left in place under Alternative 2 would provide an additional degree of channel stability by comparison with Alternative 1, NPS nonetheless expects the system to be dynamic in the first years following restoration, such that vigilant monitoring and an active program of adaptive management treatments would likely be needed. Treatments would be based on observed needs and would employ locally harvested materials such as willow and alder wood and debris.

Alternative 3: No Action Alternative

Under the No Action Alternative, no construction or earthwork would take place at any of the three sites. Existing management and use would continue unchanged, with management limited to activities required to preserve public health and safety. The potential for catastrophic or unplanned failure at any of these sites would remain a possibility. The following sections provide details for each site.

No Action at Limantour Beach Marsh

At Limantour Beach Marsh, the No Action Alternative would leave the existing culverted embankment crossing, secondary beach access spur, and lower berm in place. Remnants of paving would continue in place on the beach access trail and secondary beach access spur. The lower berm would continue to impede natural tidal hydraulics and marsh plain/channel dynamics below the culverted crossing. The culvert would continue to exclude tidal exchange in the freshwater pond except during high storm tides, when natural current and sediment transport processes would nonetheless be severely restricted. No slope restoration would take place in the spoils management area.

Under the No Action Alternative, management activities at Limantour Beach Marsh would include removal of debris from the culvert, and maintenance and repair of the beach access trail, as needed.

No Action at Muddy Hollow

At Muddy Hollow, the No Action Alternative would leave the existing dam embankment in place. The existing freshwater impoundment would remain unchanged, and the Estero Trail would continue to cross the Muddy Hollow drainage via its current alignment along the embankment top. The dam would continue to truncate natural hydrologic/hydraulic connectivity between the Muddy Hollow stream drainage and the tidal and estuarine habitats below the dam. Historic steelhead and coho passage up Muddy Hollow would remain impeded. No slope restoration would take place in the spoils management area.

Under the No Action Alternative, the NPS would remain responsible for ongoing monitoring and maintenance of the dam facility which is identified by the Bureau of Reclamation in 2001 as in "seriously deficient condition." Management activities at Muddy Hollow would include spillway cleaning to remove trash and debris; maintenance and repair of the Muddy Hollow and Estero Trails; and removal of shrubs and trees from the dam embankment. However, no large-scale repair or upgrade of the dam would be implemented.

No Action at Glenbrook Crossing

At Glenbrook Crossing, the No Action Alternative would leave the existing culverted embankment crossing and Muddy Hollow trail alignment in place. There would be no alteration of existing vegetation, including the mature riparian forest upstream of the crossing. Natural sediment transport and channel and floodplain processes would continue to be interrupted by the presence of the embankment and culvert, which would also continue to prevent fish passage into the headwaters of Glenbrook Creek. No slope restoration would take place in the spoils management area.

Under the No Action Alternative, management activities at Glenbrook Crossing would include maintenance and repair of existing roads and trails, and removal of debris from the culvert. Because the culvert is failed, it is likely that no action would eventually require in-kind replacement of the structure. This would be problematic considering the culvert and embankment crossing would continue to represent nonconforming structures in the Philip Burton Wilderness Area. No other major alterations or repairs are planned,.

2.3 Environmental Commitments

Environmental commitments refers to measures and practices adopted by a project proponent to reduce or avoid adverse effects that could result from construction or operation of the proposed features.

NPS is committed to ensuring that actions implemented at Point Reyes National Seashore proceed in the most environmentally sensitive manner possible. Consequently, a number of Best Management practices have been adopted for the proposed action, and would be incorporated into construction documents (plans and specifications), providing a contractual requirement that any contractor retained for any phase of the action would abide by the conditions and procedures identified.

The following sections describe the environmental commitments that would be implemented for the proposed action. They apply to all build alternatives selected for implementation.

Engineering Geologic/Geotechnical Measures

NPS would retain qualified geologic and geotechnical personnel to perform engineering geologic and geotechnical studies at each site during the design and construction phases of the proposed action, in order to ensure appropriate design for existing substrate conditions. Design recommendations would be presented to NPS in the form of written soils engineering and engineering geologic reports. The geologic and geotechnical personnel would also be responsible for monitoring earthwork and construction to ensure compliance with applicable codes and standards and with the recommendations of the soils and engineering geologic reports.

Design and Construction Commitments

NPS will ensure that design and construction of project features, including earthwork and infrastructure, proceeds in accordance with the appropriate codes and standards. Applicable codes are as follows.

- Restoration and spoils disposal earthwork: *Caltrans Standard Specifications* (California Department of Transportation 1999).
- Structural features for water conveyance, such as Alternative 2 low-level outlet at Muddy Hollow: relevant guidance of the American Waterworks Association.
- Other structural features, such as bridge or boardwalk: *Uniform Building Code* (International Conference of Building Officials).

Measures to Protect Water Quality

Seashore staff and NPS contractors will implement the preferred alternative to abide by the following stipulations in order to protect Water Quality at and downstream of the Project Sites:

- Conduct construction activities during the dry season.
- Conduct construction work in accordance with site-specific construction plans that minimize the potential for increased delivery of sediment to surface waters.
- Ensure that concentrated runoff and concentrated discharge are diverted away from channel banks.
- Minimize removal of and damage to native vegetation.
- Install temporary construction fencing to identify areas that require clearing, grading, revegetation, or recontouring, and minimize the extent of areas to be cleared, graded, recontoured, or otherwise disturbed.
- Grade and stabilize spoils sites to minimize erosion and sediment input to surface waters and generation of fugitive dust (see discussions under *Measures to Protect Air Quality* below).
- As appropriate, implement erosion control measures to prevent sediment from entering surface waters, including the use of silt fencing or fiber rolls to trap sediments and erosion control blankets on slopes and channel banks.

- Avoid operating equipment in flowing water by using temporary cofferdams and/or other suitable structures to divert flow around the channel and bank construction area.

Measures to Protect Wildlife

Measures for Migratory Birds

To prevent disturbance of migratory birds—protected under the federal Migratory Bird Treaty Act, the California Fish and Game Code, and CEQA—no project-related activities will take place during the migratory bird nesting season (February 15–August 1). To provide additional assurance, the NPS will conduct preconstruction surveys for migratory birds and their nests at the project site no more than 1 week prior to the initiation site preparation, staging, or construction activity planned before August 1. If preconstruction surveys identify active nests belonging to common migratory bird species, a 100-foot exclusion zone will be established around each nest to minimize disturbance-related impacts on nesting birds. If active nests belonging to special-status migratory birds are identified, a no-activity buffer zone will be established around each nest. The radius of the no-activity zone and the duration of exclusion will be determined in consultation with the U.S. Fish and Wildlife Service.

Measures for Aquatic Species

Before de-watering activities begin at the project site, NPS will ensure that native aquatic vertebrates and larger invertebrates are relocated to a flowing channel segment by a qualified fisheries biologist. NPS will work with NOAA Fisheries to identify or develop the most appropriate relocation protocol. Construction activities will be prohibited from unnecessarily disturbing aquatic habitat.

To ensure against adverse impacts on California red-legged frog (*Rana aurora draytonii*), NPS will conduct preconstruction clearance surveys for this species. The construction will occur during a period of time when frog use of these areas would be low. A biologist will survey the construction area on a daily basis to insure that frogs or other species have not moved in during the night. Frogs that have moved into the area would be captured and relocated to habitat outside of the construction area.

For large scale habitat projects, water levels would be lowered to manageable levels using methods outlined in the specific site description, prior to aquatic species recovery activities.

Measures to Protect Vegetation and Prevent the Introduction and Spread of Invasive Plant Species

BMPs to protect riparian vegetation during construction will be incorporated into construction documents (plans and specifications) for the proposed action. They will include, but may not be limited to, the following:

- Requiring the use of temporary construction fencing to delimit work areas. Requiring that fencing be installed before site preparation work or earthwork begins.

- Excluding foot and vehicle traffic from particularly sensitive areas by delimiting exclusion areas with temporary construction fencing and flagging tape in a conspicuous color.

- Washing off the tires or tracks of trucks and equipment entering and leaving project sites to prevent seed transport.

Spill Prevention and Response Plan

The NPS and its contractors will prepare a spill prevention and response plan that regulates the use of hazardous and toxic materials, such as fuels and lubricants for construction equipment. NPS or designated representatives would oversee implementation of the spill prevention and response plan. Elements of the plan will ensure that:

- workers are trained to avoid and manage spills;
- construction and maintenance materials are prevented from entering surface waters and groundwater;
- spills are cleaned up immediately and appropriate agencies are notified of spills and of the cleanup procedures employed;
- staging and storage areas for equipment, materials, fuels, lubricants, solvents, and other possible contaminants are located at least 100 feet away from surface waters;
- no vehicles are fueled, lubricated, or otherwise serviced within the normal high-water area of any surface water body;
- vehicles are immediately removed from work areas if they are leaking; and
- no equipment is operated in flowing water (suitable temporary structures are installed to divert water around in-channel work areas).

Measures to Protect Natural Quiet and Soundscapes

Seashore staff and NPS contractors will implement the following measures to reduce construction noise and lessen the impacts of noise that cannot be avoided.

Construction equipment will be required to have sound-control devices at least as effective as those originally provided by the manufacturer, and no equipment will be operated with an unmuffled exhaust. In general, construction will take place between 7:00 a.m. and 7:00 p.m., Monday through Saturday.

In addition, NPS will post signs at each restoration site and on the park website providing the name and contact information for an NPS staff member the public can contact with noise concerns. This person will be responsible for recording and monitoring complaints related to construction noise, and for ensuring that logged complaints are mitigated to the maximum extent possible. Construction times and contact information for noise concerns will also be publicized in the park newsletter.

Measures to Protect Air Quality

The NPS and its contractors will implement the following measures to control the generation of fugitive dust during site preparation and construction activities. These measures are contained in

the Bay Area Air Quality Management District's (BAAQMD's) Feasible Control Measures for PM10 Emissions[1] from Soil Removal Activities (BAAQMD 1996).

- Limit the area subject to excavation, grading and other construction activity at any one time.
- Water unpaved access roads, parking areas, and staging areas as necessary, or stabilize them with nontoxic soil stabilizers approved for use adjacent to surface waters.
- Apply (nontoxic) soil stabilizers to inactive earthwork areas (previously graded areas inactive for 10 days or more).
- Enclose, cover, water, or apply nontoxic soil stabilizers to exposed stockpiles as necessary.
- Maintain properly tuned equipment and limit idling time to 5 minutes.
- Cover trucks hauling soil, sand, or other loose materials, or require them to maintain at least 2 feet of freeboard.
- Replant vegetation or topsoil disturbed areas as quickly as possible.
- Limit traffic speeds on unpaved roads to 10 mph.

Measures to Address Effects on Traffic

NPS will require the construction contractor to prepare and implement a traffic safety plan. The traffic safety plan would address appropriate vehicle size and speed, travel routes, closure plans, detour plans (if any), flagperson requirements (if any), locations of turnouts to be constructed (if any), coordination with law enforcement and fire control agencies, measures ensuring emergency access, and any additional need for traffic or speed-limit signs. Delivery and haulage access, including contractor mobilization and demobilization, will be scheduled to minimize impacts on traffic on area roadways, including US-101. Construction worker parking and access would be managed to avoid impeding access for park visitors and emergency vehicles.

Measures to Protect Recreational Use

NPS will take feasible measures to minimize the effects of project construction on recreational use. Information on upcoming closures, including closure dates and arrangements for alternate parking, restroom facilities, and trail access points will be posted on the park website, distributed at the Bear Valley Visitor Center, and posted at each construction site. Information on alternate recreational opportunities will be publicized on the park website, in the park newsletter, and in signage at the construction sites where closures are necessary.

The project includes trail reroutes providing access to all existing trails along improved routes.

NPS is committed to working with the birding community to develop informational signage that explains the reasons for the change and identifies other nearby birding opportunities.

[1] *PM10* refers to particulate matter with a diameter of 10 microns or less. Material of this size is small enough to be drawn deep into the lungs when inhaled and thus poses a human health hazard.

Measures to Protect Wetland Resources

BMPs to protect wetland resources during construction will be incorporated into construction documents (plans and specifications) for the proposed action. They would include, but may not be limited to, the following.

- Where possible, construction access and staging shall occur in uplands and non-riparian habitat.
- If construction access or staging must occur in wetlands and riparian habitat, access within these areas shall be kept to the minimum road width and acreage possible. Contractors will work with NPS personnel to minimize impacts to wetlands and riparian habitat.
- Construction access routes will be flagged to ensure that construction equipment does not detour from authorized entry points and access routes.
- Where possible, construction equipment will work from upland locations to minimize impacts to wetlands and riparian habitats.
- Any temporary "fill" or staging material placed in wetlands will be removed to upland locations at the earliest possible date.
- Construction equipment will be cleaned prior to construction start to ensure that no seeds or vegetative fragments of invasive, non-native species are introduced into the Project Areas.

Measures to Protect Wilderness Values

Minimum Requirements and Minimum Tool

Work in designated wilderness areas must comply with the minimum tool requirements as designated in the Wilderness Act. Appendix B of this document presents findings of Minimum Requirements and Minimum Tool determination for the aspects of the project that occur within the Philip Burton Wilderness boundary.

Access and Construction

In addition, to ensure that wilderness values are protected, park staff would brief construction crews on procedures for operations in wilderness areas and concerns related to the wilderness, and would monitor to ensure that operations minimize impacts on wilderness values and resources. The briefing and monitoring are intended to provide an increased level of vigilance during wilderness construction.

At the work site, the crew will establish a construction center where refueling and overnight storage will occur. This site will be within the construction zone, but at a minimum distance of 100 feet from surface water and wetland resource areas. At the construction center, a temporary containment zone would be lined with impermeable material. This material would be removed at the closeout of the construction activities at this site.

Measures to Protect Cultural Resources

The NPS will coordinate with the Federated Indians of Graton Rancheria (FIGR) to insure that either an NPS or FIGR representative is on-call or on-site during the construction activities. While the project has been designed exclude work in documented resource areas, the NPS employee will be on site to insure that this is indeed the case. In the case that resources are discovered during the course of construction, the NPS will act immediately and appropriately as documented in 36 CFR 800.13 "Post-review discoveries" (http://www.achp.gov/regs.html#800.13).

2.4 Alternatives Eliminated from Further Consideration

This section presents the alternatives that were considered in the VA process but were dismissed from detailed analysis because they did not effectively meet the principal project goals. Table 2-5 briefly describes each alternative eliminated and summarizes the reasons it was not carried forward.

Table 2-5. Summary of Approaches Eliminated from Further Consideration

Site	Approach	Advantages	Reasons Eliminated from Further Consideration
Limantour Beach Marsh	Replacing existing culvert with larger box culvert.	Would improve tidal exchange/flushing in freshwater marsh area.	Would not meet objectives of removing existing infrastructure and restoring natural stream processes. Channel would still be confined and would not evolve naturally.
	Replace existing culvert with several parallel box culverts.	Would have the potential to substantially improve tidal exchange/flushing in the freshwater marsh area.	Would not meet objectives of removing existing infrastructure and restoring natural stream processes. Channel would remain confined, and flow would be divided and disrupted by passage through culverts. Sediment would likely accumulate in culvert inverts, and downstream erosion would probably continue, maintaining or worsening the existing scour pool below the crossing.
	Remove existing crossing and terminate pedestrian and equestrian access to Limantour Beach from this point.	Could meet all project objectives.	Would violate NPS mission and mission of Point Reyes National Seashore to provide recreational access to Seashore lands.
Muddy Hollow	Remove existing dam	Would restore connectivity	Outcome very uncertain;

Site	Approach	Advantages	Reasons Eliminated from Further Consideration
	without additional treatment.	between upper and lower reaches of system. Depending on how the channel evolved, would probably restore fish passage.	substantial adverse effects on water quality and tidal channel habitat likely during first 10 years following dam removal.
	Leave dam in place and increase maintenance activities to minimize vegetation on dam embankment. Install fish ladder.	Would meet objective of restoring fish passage. Would likely be cost-effective; initial cost would be comparatively low, and continuing costs would be distributed over a period of years.	Would not meet objectives of removing existing infrastructure and restoring natural hydrologic processes; the dam would continue to impede stream and shoreline processes. Because of dam's unsafe condition, could also pose safety hazards to the public, and risks to water quality and tidal habitat; risk of failure would remain.
	Remove a portion of the existing dam and replace with a culvert; leave remainder of dam in place.	Costs would be low. Depending on culvert design, could partially achieve objective of restoring connectivity between upper and lower reaches of Muddy Hollow.	Would not meet objectives of removing existing infrastructure and restoring natural stream processes.
Glenbrook Crossing	Remove existing crossing embankment without additional treatment.	Costs would be low. Would restore connectivity between upper and lower creek reaches.	Would not meet objective of restoring natural stream processes. Because substantial erosion and sediment transport would be required to eliminate the "drop" at the crossing site, would be slow to meet objective of restoring fish passage, and final success would be uncertain. Substantial adverse effects on water quality and inchannel habitat likely for first 10 years following restoration.

Site	Approach	Advantages	Reasons Eliminated from Further Consideration
	Divert flow to a new, created channel, routing Glenbrook Creek around the existing crossing site at a more natural gradient.	Would meet objectives of restoring connectivity and restoring fish passage.	Would not meet objective of restoring natural processes. Depending on design for treating existing creek channel, could have adverse effects on visual quality in wilderness area. Inconsistent with NPS commitment to minimally invasive solutions in wilderness areas.

2.5 Comparison of Alternatives and Identification of Preferred Alternative

This Environmental Assessment covers three specific sites, and project alternatives have been grouped and analyzed according to "full-build" and "partial build." The NPS has identified a combination of treatments from Alternatives 1 and 2 as the *preferred alternative.* The NPS preferred alternative for each site is one that best achieves the stated purpose and need of the project, in a manner that is compatible with the spatial and ecological context of the project site.

Table 2-6 presents an overview of the three alternatives evaluated in this EA and compares their anticipated success in meeting the objectives identified for the proposed action. Based on the environmental analysis in this EA (summarized in Table 2-6), NPS has elected a combination of Alternative 1 and Alternative 2 as its preferred alternative. The components of the preferred alternative are summarized below and highlighted in Table 2-6. They include the following.

- **Full build at Limantour Beach Marsh.** This approach would entail replacing the existing culvert with a bridge crossing as described for Alternative 1. It would meet the project's hydrologic and ecological objectives, including restoration of full tidal exchange at Limantour Beach Marsh, while maintaining and enhancing the area as a visual gateway to Limantour Beach.
- **Full build at Muddy Hollow.** This approach would entail complete removal of the existing dam and spillway during a single construction season, as described for Alternative 1. It would meet all of the project's hydrologic and ecological objectives, while removing a structure identified as unsound and "deficient" from a heavily used and ecologically important area of the Seashore. Completing dam removal during a single phase would reduce the environmental impacts associated with demolition and construction and would minimize the duration of impacts on visitor use and access.
- **Limited channel earthwork at Glenbrook Crossing.** This approach would entail excavation of the crossing facility and balanced channel excavation and fill placement to restore connectivity and channel gradient, as described for Alternative 2. It would meet all of the project's hydrologic and ecological objectives, while minimizing construction activities in a wilderness area, and maximizing the preservation of existing established native vegetation in the riparian area upstream of the crossing.

Generally, the preferred alternative treatments at each site reflect the location and land use management in the area. The full-build treatments at Muddy Hollow Pond and Limantour Beach Pond involve equal levels of work and result in similar function as the partial build treatments. However, under Alternative 1, they are timed for a single treatment (Muddy Hollow Pond) or would involve a different type access to the beach (Limantour Beach Marsh). In the case of Glenbrook Crossing, the limited treatment was selected over the full-build (fully engineered) solution because of its location within the Philip Burton Wilderness. The limited treatment is intended to remove the anthropogenic impediments to natural function and set the stage for natural process ultimately to shape the final outcome and function of the project area.

2.6 Environmentally Preferred Alternative

The *environmentally preferred alternative* is the alternative that would best promote the national environmental policy expressed in NEPA (Sec. 101[b]). It represents the alternative that would cause the least damage to the biological and physical environment while best protecting, preserving, and enhancing historic, cultural, and natural resources.

Table 2-6 presents an overview of the three alternatives evaluated in this EA and compares their anticipated success in meeting the objectives identified for the proposed action. Based on the environmental analysis in this EA (summarized in Table 2-6), NPS has elected a combination of Alternative 1 and Alternative 2 as its preferred alternative. The components of the preferred alternative are highlighted in Table 2-6 and summarized below. They include the following.

- **Full build at Limantour Beach Marsh.** This approach would entail replacing the existing culvert with a bridge crossing as described for Alternative 1. It would meet the project's hydrologic and ecological objectives, including restoration of full tidal exchange at Limantour Beach Marsh, while maintaining and enhancing the area as a visual gateway to Limantour Beach.
- **Full build at Muddy Hollow.** This approach would entail complete removal of the existing dam and spillway during a single construction season, as described for Alternative 1. It would meet all of the project's hydrologic and ecological objectives, while removing a structure identified as unsound and "deficient" from a heavily used and ecologically important area of the Seashore. Completing dam removal during a single phase would reduce the environmental impacts associated with demolition and construction and would minimize the duration of impacts on visitor use and access.
- **Limited channel earthwork at Glenbrook Crossing.** This approach would entail balanced channel excavation and fill placement to restore connectivity and channel gradient, as described for Alternative 2. It would meet all of the project's hydrologic and ecological objectives, while minimizing construction activities in a wilderness area, and maximizing the preservation of existing established native vegetation in the riparian area upstream of the crossing.

Table 2-7 summarizes the impacts associated with each of the proposed alternatives. It should be noted that in the impact topics discussion (Section 4), site specific impact descriptions, as well as tables summarizing impacts at each of the sites, under each of the alternatives are included.

Table 2-6. Anticipated Success in Meeting Project Goals and Objectives, by Alternative* * Shaded cells represent components of the preferred alternative.

Objective	Alternative 1			Alternative 2			No Action		
	Limantour	**Muddy Hollow**	**Glenbrook**	**Limantour**	**Muddy Hollow**	**Glenbrook**	**Limantour**	**Muddy Hollow**	**Glenbrook**
	Replace most of existing culverted crossing with bridge span; remove pavement from remainder. Remove secondary beach access trail embankment.	Remove dam and recontour channels to establish more natural hydraulic function. All project earthwork complete in one construction season.	Remove existing crossing and culvert; recontour channel extensively to create "stable" geometry.	Replace culverted crossing with boardwalk. Remove most of secondary beach access trail embankment.	Phase dam removal over a period of several years, relying on natural processes to adjust channel geometry.	Remove existing crossing and culvert; perform limited channel grading and fill, relying on natural erosion to fully adjust channel once flow is restored.	No earthwork or construction. Continue existing maintenance and management unchanged.	No earthwork or construction. Clean spillway and remove vegetation from dam face and top; otherwise, continue existing maintenance and management.	No earthwork or construction. Continue existing maintenance and management unchanged.
Reduce or remove long-term operations and maintenance requirements; create sustainable visitor access, including a visual gateway to Limantour Beach	High	High	Moderate to high	High	High, although complete removal of dam would take longer than under Alt 1	Moderate to high	No improvement	No improvement Risk of catastrophic failure with damage or loss to existing resources	No improvement Risk of catastrophic failure with damage or loss to existing resources
Improve hydrologic function; restore natural hydrologic processes, including surface water connectivity	High	High	High Initial channel gradient likely more stable than Alt 2, but riparian vegetation would be removed from channel and floodplain in restored area; denuded areas would require management until revegetation establishes	High	High, although complete restoration of natural processes would take longer than under Alt 1	Moderate to high Adjustment would be more protracted than under Alt 1, but established riparian growth would remain in place upstream of crossing site, and would likely provide additional channel stability in this area	No improvement	No improvement Risk of catastrophic failure with damage or loss to existing resources	No improvement Risk of catastrophic failure with damage or loss to existing resources
Improve ecological function in general; increase ecological sustainability	High	High	High Earthwork impacts would be substantially greater than Alt 2	Moderate Boardwalk would be less protective of habitat than bridge	Moderate to high Outcome more uncertain than under Alt 1	Moderate to high Depending on stabilization offered by riparian growth left in place, adjustment could result in more prolonged water quality effects than under Alt 1	No improvement	No improvement Risk of catastrophic failure with damage or loss to existing resources	No improvement Risk of catastrophic failure with damage or loss to existing resources

Table 2.7- Summary of Impacts of Alternatives

	Alternative 1: Full-Build	Alternative 2: Partial -Build	Alternative 3: No Action
Visual Resources	Under Alternative 1, short-term adverse minor impacts to visual resources would occur as a result of construction activities. The installation of signs describing the restoration activities and intent, as well as distribution of flyers and education at the Visitors Centers would mitigate some of these impacts. With these outreach activities in place, the long-term impacts would be beneficial as visitors are educated about restoration and natural process. Interpretation of the restoration activities and the ecological recovery is a unique education opportunity for visitors.	Actions under Alternative 2 would be extended over a period of two years. This alternative would result in short-term adverse minor impacts to visual resources would occur as a result of construction activities in both construction years. The installation of signs describing the restoration activities and intent, as well as distribution of flyers and education at the Visitors Centers would mitigate some of these impacts. With these outreach activities in place, the long-term impacts would still be beneficial as visitors are educated about restoration and natural process. Interpretation of the restoration activities and the ecological recovery is a unique education opportunity for visitors.	Under Alternative 3, no effects to visual resources would occur as a result of direct park actions. In the long-term, ongoing maintenance activities would result in negligible adverse effects to visual resources. No additional outreach and education opportunities would be available to park visitors.
Wilderness	Under Alternative 1, localized short-term adverse impacts to wilderness resources are considered adverse moderate. In the long-term, the proposed actions would result in benefits to the wilderness by restoring natural process to a confined system. This would also provide for visitor recognition that structures are not consistent with wilderness. Interpretation of the restoration activities and the ecological recovery is a unique education opportunity for visitors.	Under Alternative 2, localized short-term adverse impacts to wilderness resources are considered adverse minor. In the long-term, the proposed actions would result in benefits to the wilderness by restoring natural process to a confined system. This would also provide for visitor recognition that structures are not consistent with wilderness. Interpretation of the restoration activities and the ecological recovery is a unique education opportunity for visitors.	Under Alternative 3, no direct effects to wilderness resources would occur as a result of direct park actions. However, the presence of non-conforming structures (at Glenbrook) and the maintenance requirements of the trails are considered minor adverse short-term impacts. In the long-term, catastrophic failure or maintenance activities to replace a culvert would result in localized moderate adverse effects at the Glenbrook site. No additional outreach and education opportunities would be available to park visitors.

Air Quality	Under both action alternatives, production of emissions and associated dust would be similar. NPS would require contractors to adhere to the BAAQMD's Feasible Control Measures for PM10 and to ensure that earthwork equipment is properly tuned and meets applicable emissions standards. The analysis concludes that Alternative 1 and Alternative 2 would result in short-term minor adverse impacts to air quality. The project would not result in long-term effects to air resources.	Same as Alternative 1	Under Alternative 3, no construction emissions or dust generation would take place as a result of direct actions. Alternative 3 would result in no effect to park air resources.
Geology, Geologic Hazards, and Soils	Under alternative 1, structures are removed from Muddy Hollow and Glenbrook Crossing sites, reducing the potential of failure under evaluated risks factors. The resulting conditions, including the constructed bridge facility at the Limantour Marsh area would be designed with potential risk under consideration. Restoration of natural hydrologic and shoreline process would change existing slope and local soil conditions, resulting in potential short-term negligible adverse effects. In the long-term, however, removal of existing unengineered earthen facilities would reduce site susceptibility to failure in association with geologic hazards. The long-term effect of actions proposed under Alternative 1 are considered beneficial.	Under Alternative 2, structures are removed from Muddy Hollow and Glenbrook Crossing sites, reducing the potential of failure under evaluated risks factors. The resulting conditions, including the constructed boardwalk at the Limantour Marsh area would be designed with potential risk under consideration. Restoration of natural hydrologic and shoreline process would change existing slope and local soil conditions, resulting in potential short-term negligible adverse effects. In the long-term, removal of existing unengineered earthen facilities would reduce site susceptibility to failure in association with geologic hazards. The long-term effect of actions proposed under alternative 2 are beneficial.	Under Alternative 3, existing unengineered structures would remain, pooling excessive water or sediment behind these aged facilities. Alternative 3 would not result in short term effects to existing slope and local soil conditions. In the long-term, however, the existing unengineered earthen facilities would remain susceptible to failure in association with geologic hazards. In the long-term, the risk of failure associated with no action would result in localized moderate adverse effects.

Hydrology, Hydraulics, and Water Quality	Evaluation of potential impacts to hydrology, hydraulics and water quality under Alternative 1 shows the likelihood of short-term minor to moderate localized adverse impacts as hydrologic configurations and conditions adjust as a result of the restoration activities. Shifts in water regime, channel and estuarine configuration would occur, but be muted in scale through proposed adaptive management measures including installation of passive grade control, adaptive monitoring and management actions. In the long-term, the actions identified under Alternative 1 would be considered beneficial as natural hydrologic and estuarine process are restored to a new, functional dynamic equilibrium at these sites. The restoration actions would facilitate sustainable, naturally functioning hydrologic systems that would not require continued maintenance.	Evaluation of potential impacts to hydrology, hydraulics and water quality under Alternative 2 shows the likelihood of short-term minor adverse impacts as hydrologic configurations and conditions adjust as a result of the restoration activities. Shifts in water regime, channel and estuarine configuration would occur, but be muted in scale through proposed adaptive management measures including installation of passive grade control, adaptive monitoring and management actions. The longer construction window proposed under Alternative 2 for Muddy Hollow would extend potential effects, and delay natural recovery and revegetation at the site. In the long-term, the actions identified under Alternative 2 would result in minor to moderate benefits as natural hydrologic and estuarine process are restored to a new, functional dynamic equilibrium at these sites. The restoration actions would facilitate sustainable, naturally functioning hydrologic systems that would not require continued maintenance.	Evaluation of potential impacts to hydrology, hydraulics and water quality under Alternative 3 would not lead to short-term effects as a result of direct construction activities. In the long-term, the actions identified under Alternative 3 could potentially result in minor to moderate adverse impacts to water resources. At Muddy Hollow and Glenbrook, inaction could facilitate catastrophic failures leading to moderate adverse impacts to the adjacent water resources and associated habitats. Such events would lead to large-scale complete changes in habitat, and require longer periods of time to recover. Such events, occurring in association with unnatural features, result in impacts to the stream channel or ecosystem that are not within the range of natural variability, thereby increasing the time required to recover dynamic equilibrium.
Vegetation and Wildlife	Alternatives 1 and 2 would result in similar impacts to vegetation, wildlife, and habitat as a result of the direct construction activities, short-term and long-term habitat changes. Overall the changes to vegetation and wildlife habitat are considered adverse minor in the short term, with recovery, however, the long-term effects are considered beneficial.	Same as Alternative 1	Under Alternative 3, there would be no effect to existing vegetation and wildlife within the project area during the short term. In the long-term, potential failure of these earthen facilities under either flood flow or geologic hazard scenarios would result in minor adverse effects to vegetation and wildlife resources. Recovery time of these resources as a result of potential uncontrolled (catastrophic) failure would be more protracted and could prevent these areas from reaching stable physical or ecological equilibrium.

Wetland Resources	Overall, Alternative 1 would result in minor short-term adverse impacts associated with conversion or direct impacts as a result of construction. In the long-term, the recovery or conversion to more ecologically sustainable wetlands and habitat is considered a benefit to wetlands and wetland functionality at all the Project Sites.	Alternative 2 would result in minor short-term adverse impacts associated with conversion or direct impacts as a result of construction. The extended duration associated with Muddy Hollow and the smaller impact area at Glenbrook do not change the overall impacts to wetlands between Alternative 1 and 2. In the long-term, the recovery or conversion to more ecologically sustainable wetlands are considered beneficial to wetlands and wetland functionality at all the Project Sites.	Overall, the No Action Alternative would have adverse, negligible impacts in the short-term and localized minor to moderate, adverse impacts on wetlands and wetland functionality in the long-term. The severity of impact for each Project Site depends to a large degree on the potential for and consequences of catastrophic failure of the existing infrastructure. Limantour Beach Marsh has the lowest potential for catastrophic failure of the culverted berm, and failure would have the least impact on Project Site and downstream and upstream wetlands. Conversely, the potential for catastrophic failure, and associated impacts are much higher at Glenbrook Creek and Muddy Hollow, and should these structures fail, these and adjoining areas would be likely to incise and thereby cause more extensive losses of wetlands and wetland functions.
Special Status Plant Species	The project would not result in impacts to federally threatened or endangered plant species. The project would, to the greatest extent possible, avoid direct impacts to special status plants, but deconstruction activities could result in short-term minor adverse effects associated with changes to circulation and depositional patterns. The project build alternatives would result in smoothing of physical and ecological gradients, and in the long-term would result in expansion of habitat beneficial to special status plants in the area.	Same as Alternative 1	Alternative 3 would not result in impacts to special status plant species in the short-term or in the long-term.

Special Status Fish Species	Restoration actions under the build alternatives would result in increased sediment loading following deconstruction, but would restore habitat and access to habitat available to the fish in the long-term. Based on this analysis, the project build alternatives would result in short-term minor effects to special status fish (namely steelhead) and EFH within the project watersheds. The proposed actions, intended to restore hydrologic connectivity and access to the Muddy Hollow and Glenbrook watersheds would result in long-term beneficial effects to steelhead, potential coho salmon habitat, and EFH.	Same as Alternative 1	Under the no action alternative, there would be no effect on special status fish species and EFH in the short term. In the long-term, the potential for catastrophic failure would result in minor to moderate adverse impacts to steelhead and EFH in the project area.
Special Status Amphibians	The effects of changing habitat associated with the proposed restoration activities would result in localized short-term moderate adverse effects on the California red-legged frogs and the critical habitat at Limantour Beach Pond and Muddy Hollow Pond. In the long-term, enhancement actions adjacent to Limantour Beach Pond are expected to offset long-term impacts, resulting in minor adverse effects to the individuals. At the Glenbrook Crossing, non-breeding habitat would be effected, and only temporarily. The actions at Glenbrook Crossing would result in localized minor adverse effects in the short-term, with long-term beneficial effects as the system moves towards natural equilibrium. The proposed action alternatives would not result in impairment of park special-status amphibian species. The build alternatives would not jeopardize the persistence of California red-legged frogs in the project area or within the park.	Same as Alternative 1	Under the no action alternative, there would be no effect on special status amphibians in the short term. In the long-term, the potential for catastrophic failure would result habitat loss similar to that described for the build alternatives, and therefore minor to moderate localized adverse impacts at these sites.

Special Status Reptiles	The build alternatives would result in indirect impacts on the northwestern pond turtle through changes in habitat at Muddy Hollow and Limantour Beach Pond. These changes represent a localized moderate adverse impact in the short-term and minor adverse impacts in the long-term within the project area. The project actions at Glenbrook Crossing would not effect the northwestern pond turtle.	Same as Alternative 1	In the short-term the no action alternative would not result in direct or indirect impacts on the northwestern pond turtle within the project area. In the long-term, potential catastrophic failure could result in minor long-term impacts to the special status reptile species. The project actions at Glenbrook Crossing would not effect the northwestern pond turtle.
Special Status Avian Species	Analysis of Alternatives 1 and 2 indicates that there would not be impacts to bird reproduction and nesting, associated with project construction window. For resident birds, construction noises would persist for a period of 2-3 weeks at each site, but construction would avoid direct impacts. Standard mitigations to avoid impacts to the western snowy plover would include morning surveys adjacent to the work area. If snowy plovers are encountered, equipment would not be started until after the plovers fly away from the area. The project would result in negligible short-term effects on special status birds, and as a result of restoration of marsh habitat at Limantour Beach Pond and Muddy Hollow, potential black rail, salt marsh common yellowthroat, and sora habitat would expand in the local area. The long-term effects therefore would be beneficial to the special status bird species and their habitat. Because of the timing of the project, the actions at Glenbrook crossing would not result in impacts to special status bird species in the short or long-term.	Same as Alternative 1	Analysis of Alternatives 3 indicates that there would not be impacts to bird reproduction and nesting as the result of construction activities. In the long-term, the potential for catastrophic failure would result in minor impacts to the habitat of special status bird species.
Special Status Mammal Species	The build alternatives would result in the potential for indirect impacts, and would be negligible in the short term, but in the long-term no effect on Point Reyes mountain beaver is likely. Alternative 1 or Alternative 2 would not result in impairment of park special-status mammal species.	Same as Alternative 1	The no action alternative would not result in the potential for direct or indirect impacts, and would be no effect to special status mammal species in the short or long-term. Alternative 3 would not result in impairment of park special-status mammal species.

Special Status Invertebrate Species	The build alternatives would result in the potential for indirect impacts, and would be minor in the short term, but in the long-term no effect on special status invertebrates is likely. For this reason, it is concluded that the proposed build actions would result in minor short-term impacts to special status invertebrate species. In the long-term, restoration of more natural conditions and processes would result in beneficial effects to special status invertebrate species, specifically the globose dune beetle.	Same as Alternative 1	Under no action, there would be no short or long-term effects on special status invertebrate species as a result of direct action
Cultural Resources	Under Alternatives 1 and 2, the proposed restoration designs would avoid impacts to documented cultural resource areas. The analysis concludes that the project would result in no short-term or long-term effects on cultural resources. If operations reveal previously undocumented resources, the NPS would implement management measures described above to ensure that resources are preserved and protected in an appropriate manner. Alternative 1 or Alternative 2 would not result in impairment of park cultural resources.	Same as Alternative 1	Under Alternative 3, no action would take place within the project area therefore, no effect on cultural resources would occur as a result of this project. Alternative 3 would not result in impairment of park cultural resources.
Soundscape	Under either Alternative 1 or Alternative 2, and in combination with the proposed environmental commitments, short-term adverse minor effects would occur on the natural soundscape. Following construction, no additional operations at the site would affect the soundscape, therefore there is no effect in the long-term. The action alternatives would not result in impairment of the park soundscape resource.	Same as Alternative 1	Under Alternative 3 no construction would occur, therefore there would be no effect to the soundscape in both the short-term and long-term. Alternative 3 would not result in impairment of the park soundscape resource.

Public Health and Safety	Both Alternative 1 or Alternative 2 would result in the removal of facilities that pond water. Based on the analysis above, the action alternatives would result in short term minor impacts to public health and safety as a result of construction activities and closures, and beneficial long-term effects with the removal of these structures. Alternative 1 or Alternative 2 would not result in impairment of park public health and safety.	Same as Alternative 1	Alternative 3 would result in no effect in the short-term, and the potential for minor adverse effects to public health and safety in the long term. Alternative 3 would not result in impairment of park public health and safety.
Recreational Use	Either Alternative 1 or Alternative 2 would change existing habitat features requiring new trail access corridors and shifts to current recreational uses. In the short-term, minor adverse impacts to recreation would occur as a result of temporary construction closures. In the long-term, changes to the trail network and habitat would result in new and different recreational opportunities and are considered beneficial.	Same as Alternative 1	Alternative 3 would not result in temporary closures and therefore there would be no effect to recreational resources in the short term. In the long-term, potential failure of facilities without plans to repair or replace them would result in minor to moderate adverse impacts to recreational uses, including trail access as well as wildlife viewing.
Transportation and Traffic	Alternative 1 would result in short-term minor adverse effects to traffic during the period of construction. However, once construction is completed, the resulting restoration is not expected to change the traffic loading patterns to or within the park, therefore no long-term effects would occur to traffic.	Alternative 2 would result in short-term minor adverse effects to traffic during the period of construction, but would include 2 construction years rather than one (Muddy Hollow phasing). However, once construction is completed, the resulting restoration is not expected to change the traffic loading patterns to or within the park, therefore no long-term effects would occur to traffic.	Alternative 3 would result in short-term or long-term effects to traffic. Alternative 3 would not result in impairment to park resources as a result of traffic.

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