Trail Design and Construction for Habitat Restoration: Learning from Muir Beach (2010)

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California Trails & Greenways Conference
April 12, 2011

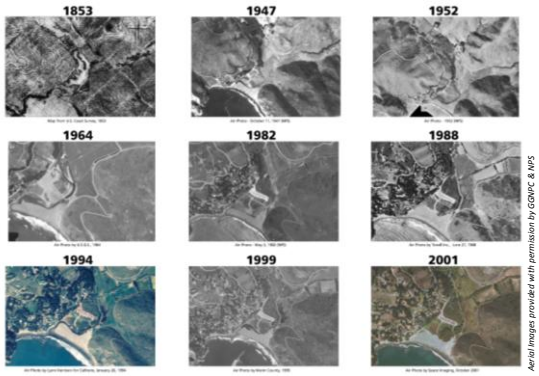
Learning from Muir Beach: Presentation Outline

1. Muir Beach Project/Site Background
2. Project's Scope of Work
3. Design Process & Construction Techniques
4. Post-Construction

Muir Beach: Project Background

- Big Lagoon – 46 acre, 5+ year Restoration Project
- Project – Year 2 – August to November 2010
- Redwood Creek (headwaters on Mt. Tamalipais)
- Habitat Restoration for Threatened Species: Salmonid Spawning (Coho Salmon & Steelhead Trout), California Red-Legged Frog
- More information visit: www.nps.gov/goga/muir-beach

Muir Beach: Historical Land Use



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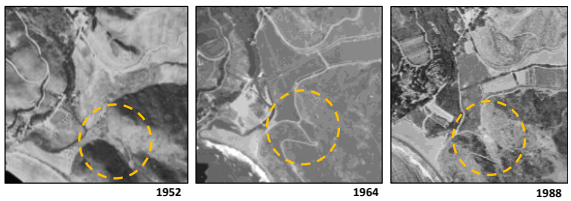
Muir Beach: Alluvial Fan's Historical Land Use (36 yrs)



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Muir Beach: Project Overview

Muir Beach: Original Scope of Work

Muir Beach: Expanded Scope of Work

Muir Beach: Watershed Restoration Goals

Restore Natural Watershed Drainage Patterns:

- Reduce Sediment Delivery
- Dewater Trails (to drain into appropriate sub-watershed)
- Slow Stormwater Run-off
- Eliminate Concentrated and Artificial Water Flows

Muir Beach: Restoration Design & Construction

New channel & Check Dams *Drain Lens* *Coastal Fire Road Decommission*

1. **Address Historical Uses/Alterations –** Decommission Gully & Fire Road, Install Step Pools & Rolling Dips
2. **Primary Design Features –** New Channel, New Road Location, Culvert Upgrade
3. **Supporting Design Features –** Drain Lenses, Wet Water Crossing and New Road Improvements
4. **Maintaining Watershed Stability After Construction –** Erosion Control & Site Maintenance

Muir Beach: Erosion Gully Decommission

Muir Beach: Coastal Fire Road Decommission

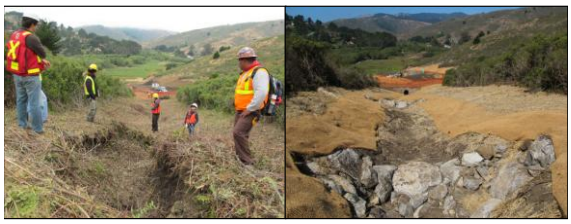
STEP 1: Rip old road bed

STEP 2: Compact & shape new fill in place

Muir Beach: Step Pool Construction

1. Work with existing contours
2. Install ¼ -½ ton rock on sides, base, and back of step pool
3. Use 3”-9” rock to check voids between larger rocks

Muir Beach: Step Pool Construction



Step Pool Area BEFORE Construction

Step Pools AFTER Construction

Muir Beach: Rolling Dip Construction

Pre-construction conditions: 2.1 miles of road was acting like a stream channel for water and sediment through the Upper Alluvial Fan into the Redwood Creek.

After construction: 25 rolling dips were installed in order to dewater the roadway into the appropriate watersheds and reduce sediment loading.

Muir Beach: Primary Design Features

Muir Beach: New Road and Channel Location

Alluvial Fan BEFORE Construction

- 6’ deep x 2’-8’ width erosion gully
- 18” diameter culvert (upper)
- 16” diameter culvert (lower)
- 10-18% trail grade

Alluvial Fan AFTER Construction

- 12”-18” deep x 6’-10’ width channel
- 48” culvert (upper)
- 30’ width wet water crossing (lower)
- 10-12% trail grade

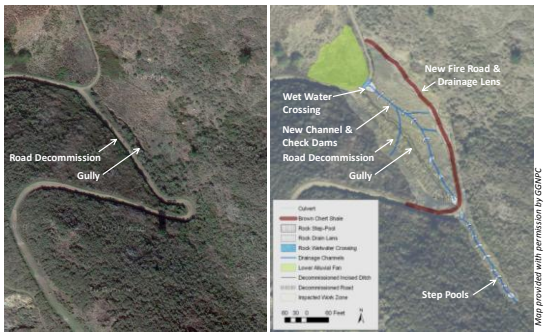
Muir Beach: New Channel Construction

Alluvial fan BEFORE construction

Constructing new channel & check dams (view from upper culvert)

Alluvial Fan AFTER Construction (view from lower wet water crossing)

Muir Beach: Alluvial Fan Before & After

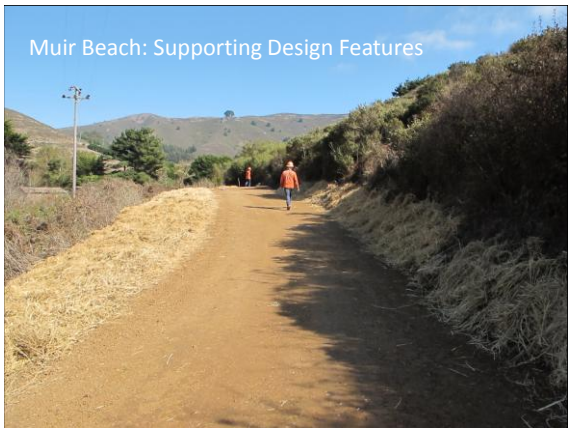


Aerial of Alluvial Fan BEFORE Construction

GPS Map of Alluvial Fan AFTER Construction

Muir Beach: Alluvial Fan Construction

Muir Beach: Supporting Design Features



Muir Beach: Drain Lenses Construction Process

STEP 1: Cut subgrade below spring/seep out flows

STEP 2: Sandwich 36"+ of drain rock between two layers of 600X stabilization fabric at seep locations

STEP 3: Place 8-12" of crushed rock for trail surface

STEP 4: Compact & smooth for finish grade

Muir Beach: Emergency Access Road Drain Lens

Muir Beach: Emergency Access Road

Access Road BEFORE Construction | Access Road AFTER Construction

1. New Compacted Crushed Rock Hiking/Driving Surface (2,000+ L.F.)
2. Out-sloped Surface Drainage (to not concentrate stormwater)
3. Drain Lenses, Armored Tread, Wet Water Crossings & Culverts (to address large seeps/spring flow)

Muir Beach: Emergency Access Road Culverts

Access Road Culverts New Construction (11/2010) | **Access Road Culverts After Heavy Rains (1/2011)**

- Replaced one 14" existing culvert with three 18" culverts
- Road previously flooded during winter rain events

Muir Beach: Alluvial Fan Wet Water Crossing

STEP 1: Excavate 30' wide x 2 ½ ' deep area for rock

STEP 2: Place 600X stabilization fabric

STEP 3: Place 3"-9" rock bedding for 4 to 6 ton rock

STEP 4: Water-jet and compact crushed rock into voids

Muir Beach: Alluvial Fan Wet Water Crossing

Completed wet water crossing after December (2010) storm event

Muir Beach: Erosion Control Methods & Design

Rice Straw Delivery | *Coir Netting Installation* | *Waddle Installation*

1. Progressively install erosion control as the project is being built
2. Place biodegradable waddles 15' on center and aligned on contours
3. 4" – 12" of weed free rice straw (depending on future planting plans)
4. 700G Coir Netting on slopes 3:1 or greater with 1"x1 ½" stakes 4' on center

Muir Beach: Erosion Control Statistics

1. Weed-free Straw – 918 bales
2. 700G Coir Netting – 135,135 s.f. (63 rolls, 3.1 acres)
3. Biodegradable Waddles – 7,400 linear feet (296 waddles, 1.4 miles)

Muir Beach: After Construction & Rain

Muir Beach: After Construction & Rain

Stormwater flow above/below the new 48" culvert (January 2011)

Muir Beach: Lessons Learned