

Afternoon Session

Alternatives Development

Construction Factors

- Site and Channel Access
- Work Conditions
- Restricted Seasons
- Mobilization and Staging Areas
- Materials Storage Areas
- Dewatering
- Limits of Work

Develop and Screen Alternatives

- Define Project Goals and Objectives
- Alternatives Screening and Project Evaluation
- Acceptable Bank Stabilization Structures
- Rock Slope Protection Design

Define Project Goals and Objectives

- Most projects should be multi-objective with property protection, bank protection, habitat enhancement, and water quality protection foremost. Common Goals and Objectives include:
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 - ⑩ 👉 **Affordability** - what is the most cost effective solution, and what are the costs relative to other alternatives and benefits?
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 - ⑩ 👉 **Acceptability** - what is acceptable to the property owner, environmental interest groups, neighbors, and local government in terms of biological and water quality impacts, loss of property, appearance, and access and recreation issues.
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 - ⑩ 👉 **Permitting** - the plans should be consistent with City and County policy and regulations and should not conflict with state and federal regulations governing activities in navigable waters, wetlands, floodplains, endangered species habitat and riparian corridors.
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 - ⑩ 👉 **Sustainability** - the project should provide the risk and hazard reduction targeted for the design flow and shear forces at the site in terms of durability and maintenance needs.
- Alternatives should be developed and evaluated with the following questions in mind:

Alternative Development

- The No Action Alternative
- The Minimum Interference Alternative
- Flexible Boundary Alternative
- Rigid Boundary Alternative
- Integrated Solution Alternative
- Short-term vs. Long-term Alternative

Alternatives Screening and Project Evaluation

- Environmental
- Cost
- Durability
- Maintenance
- Permittability
- Flow Deflection
- Channel Conveyance Effects
- Downstream Impacts

Project Alternative	Environmental	Cost	Durability	Maintenance	Flow Deflection	Conveyance	Comment
No Project							Does not meet project goals, riparian vegetation endangered some sites
Rigid, Inflexible Hard Structures (retaining walls)							Best use extreme velocities, geotechnical problems, high value property
Flexible Hard Structures (gabions, rip-rap)							Can withstand wide range of velocities and shear forces, but generally allows less vegetation than flexible liners or integrated
Flexible (soft) Approaches, including (Vegetative & Biotechnical)							limited to velocities less the 1.5 mps
Integrated Approaches (Crib walls, planted rip rap, geogrids)							Depending on toe protection, uses limited to velocities less than 2.5-3 mps

Acceptable Bank Stabilization Structures

- Vegetative and Biotechnical Approaches
- Structural and Integrated Approaches
- In-Stream Structures

Vegetated and Biotechnical Approaches

- Live Stakin and Willow Wattling
- Planted ECF
- Brush Layering
- Brush Mattress
- Fiber Rolls/Fiber Rock Rolls/Coir Fiber Rolls

Structural and Integrated Approaches

- Vegetated Geogrids
- Live crib-walls
- Planted Rock Riprap
- A-Jacks
- Rock Riprap (Grouted or not)
- Loose Rock Riprap
- Concrete Block Walls
- Live Rock Wall
- Post and Wire Fencing
- Planted Gabion Baskets
- Reinforced Concrete
- Modular Pre-cast Units
- Gunnite

In-stream Structures

- Flow Deflectors/Rock Spurs
- Log/Rootwad/Boulder Revetments
- Boulder or Grouted Rock Check Dams
- Boulder Clusters and Rock Vortex Weirs
- Lunker Structures

Rock Slope Protection

- Gradation Table??

Typical D_{50} riprap design:

$$D_{50} = C \frac{0.001 V_a^3}{d_{avg}^{0.5} k_1^{1.5}}$$

where:

D_{50} = the median riprap particle size (ft)

V_a = average velocity in the main channel (ft/s)

d_{avg} = average flow depth in the main channel (ft)

K_1 = defined as:

$$K_1 = \left[1 - \left(\sin^2 \theta / \sin^2 \phi \right) \right]^{0.5}$$

θ = the bank angle with the horizontal

ϕ = the riprap material's angle of repose

B. Blodgett's (1986) relationship (Brown and Clyde, 1989)

$$d_s = 12 \text{ ft for } D_{50} < 0.005 \text{ ft (1.5 mm)}$$

$$d_s = 6.5 D_{50}^{-0.11} \text{ for } D_{50} > 0.005 \text{ ft (1.5 mm)}$$

where:

d_s = estimated probable maximum depth of scour (ft)

D_{50} = median diameter of bed material (ft)

- 1. For natural scour and fill phenomenon in straight channels and in channels having mild bends**
- 2. Measure d_s from lowest elevation in cross section**
- 3. Assume low point in cross section may move adjacent to channel bank**
- 4. Calculated depth of scour must be added to predicted long term degradation and local scour (if any) to obtain total required toe depth**







Develop Concept Plan & Design Report

- After developing and screening project alternatives and selection of the preferred alternative, a Concept Plan and Design Report should be prepared and submitted for preliminary review.
- The objective of this step is to provide a preliminary review and confirmation of the design concept before time and effort is spent in preparing detailed construction drawings, and in permitting and project approval.
- The Concept Plan should portray graphically (through sketches, and plan, profile, and cross-section drawings) the approach to bank stabilization that deals with all of the design factors and constraints.
- The Concept Plan is best considered to be a tool for conveying ideas and information to the plan and permit reviewers, and provides the basis to guide the subsequent development of the more detailed Construction Drawings. Planning level cost estimates developed for the alternatives analyses should be refined at this stage for public projects.
- The Concept Plan should include a discussion of the site constraints, information on the geomorphic, hydraulic, and biological investigations including and recommendations, the geotechnical report, (if required), the alternatives evaluated, and the rationale for selection of the preferred alternative. This will be especially important if a purely structural approach is proposed.

Local, State, and Federal Agency Permitting and Project Approval

- U.S. Army Corps of Engineers 404 Permit
- California Department of Fish & Game
Streambed Alteration Agreement
- Regional Water Quality Control Board
Water Quality Certification & General
Stormwater Construction Permit
- California Environmental Quality Act
- Endangered Species Act