APPENDIX B

BEST MANAGEMENT PRACTICES - STANDARD DESIGNS & PROCEDURES

This appendix includes standard designs and procedures for many of the structural and physical Best Management Practices (BMPs) that are referred to in the Manual (Chapters 3 through 9). The best drawings and procedures were gleaned from a variety of manuals, guidelines, handbooks, and other references. Users of these designs are encouraged to refer to the original source for more detailed specifications of the particular BMP.

B-1 TABLE OF CONTENTS

B-1 TABLE OF CONTENTS

B-2 USEFUL REFERENCES

1. Association of Bay Area Governments (ABAG). 1995. Manual of Standards for Erosion & Sediment Control Measures. 2nd edition. Oakland CA. [(510)464-7900; //www.abag.ca.gov]

2. California Dept. of Fish and Game (CDFG). 1998. California Salmonid Stream Habitat Restoration Manual. By Gary Flosi, et al. Inland Fisheries Div., 3rd edition. Sacramento, CA. [(916)654-5997]

3. Furniss, M., et al. 2000. FishXing: An interactive CDROM. FishXing Development Team and Humboldt State Univ. Courseware Development Center. Arcata CA.

4. Humboldt County. 2000. "Ordinance for Grading, Excavation, Erosion and Sedimentation Control." July Draft. Prepared by Oscar Larson Assoc., Eureka CA.

5. King County. 2000. Regional Road Maintenance Endangered Species Act Program Guidelines. Prepared by the Regional Road Maintenance Technical Working Group. Final Draft. Seattle, WA. [//www.metrokc.gov/roadcon/bmp/pdfguide.htm]

6. McCullah, J. 1992. Erosion and Sediment Control Standards Design Manual – County of Shasta. Prepared for the Western Shasta Resource Conservation District (RCD). Redding CA. 187 p.

7. Robison, E., A. Mirati, and M. Allen. 1999. Oregon Road/Stream Crossing Restoration Guide. Advanced Fish Passage Training Version. Salem OR. [//www.4sos.org/wssupport/ws_rest/OregonRestGuide/index.html]

8. Salix Applied Earthcare. *Erosion Draw 3.0* / *BioDraw 1.0*. Redding CA. [(530) 247-1600; //www.salixaec.com]

9. USDA Forest Service (USFS). 2000. Water/Road Interaction Technology Series: "Diversion Potential at Road-Stream Crossings"; "Response of Road-Stream Crossings to Large Flood Events in Washington, Oregon, and Northern California" By M. Furniss et al., Technology and Development Program. San Dimas, CA. [(909)599-1267]

10. USDA Natural Resources Conservation Service. 1996. *Watershed Technology Electronic Catalog*. [//www.wcc.nrcs.usda.gov/wtec/wtec.html]

11. USDA Natural Resources Conservation Service. 1996. Engineering Field Handbook – Streambank and Shoreline Protection. Part 650, Chapter 16. [local NRCS office]

12. Washington Dept. of Fish and Wildlife. 1999. Fish Passage Design at Road Culverts: A design manual for fish passage at road crossings. Olympia WA. [//dfw.wa.gov]

13. Weaver, W.E. and D.K. Hagans. 1994. Handbook for Forest and Ranch Roads. Mendocino County Resource Conservation District, Ukiah CA. [(707)468-9223]

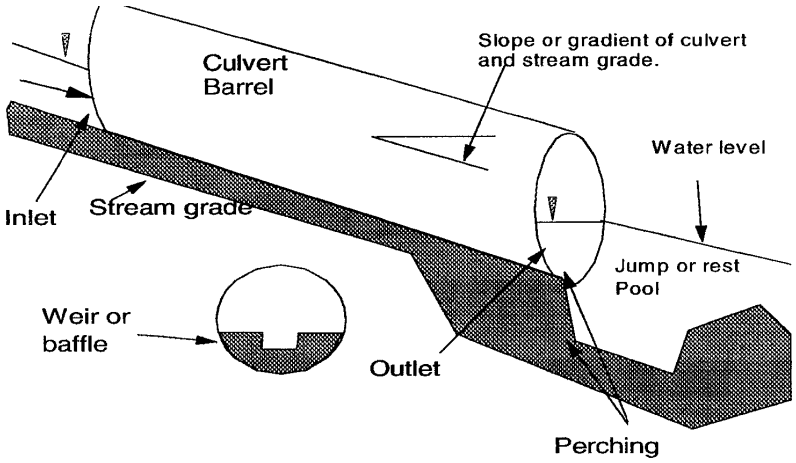
B-3 CULVERT BMP DESIGNS

These designs for practices at or within culverts are for the purposes of:

- Erosion control
- Fish passage improvement
- Water runoff control
- Sediment control

List of Culvert BMP Designs:	**Design #**
Culvert Hydraulics - Definition of Terms Diagram	B-3.1
Plugging Hazards Diagram	B-3.2
Back-Flooding Weirs	B-3.3
Baffles – Fish Passage	
When to Use & Types	B-3.4
Washington Baffles	B-3.5
Ditch Relief Culvert	B-3.6
Energy Dissipator	B-3.7
Culvert Inlet Sediment Trap	B-3.8

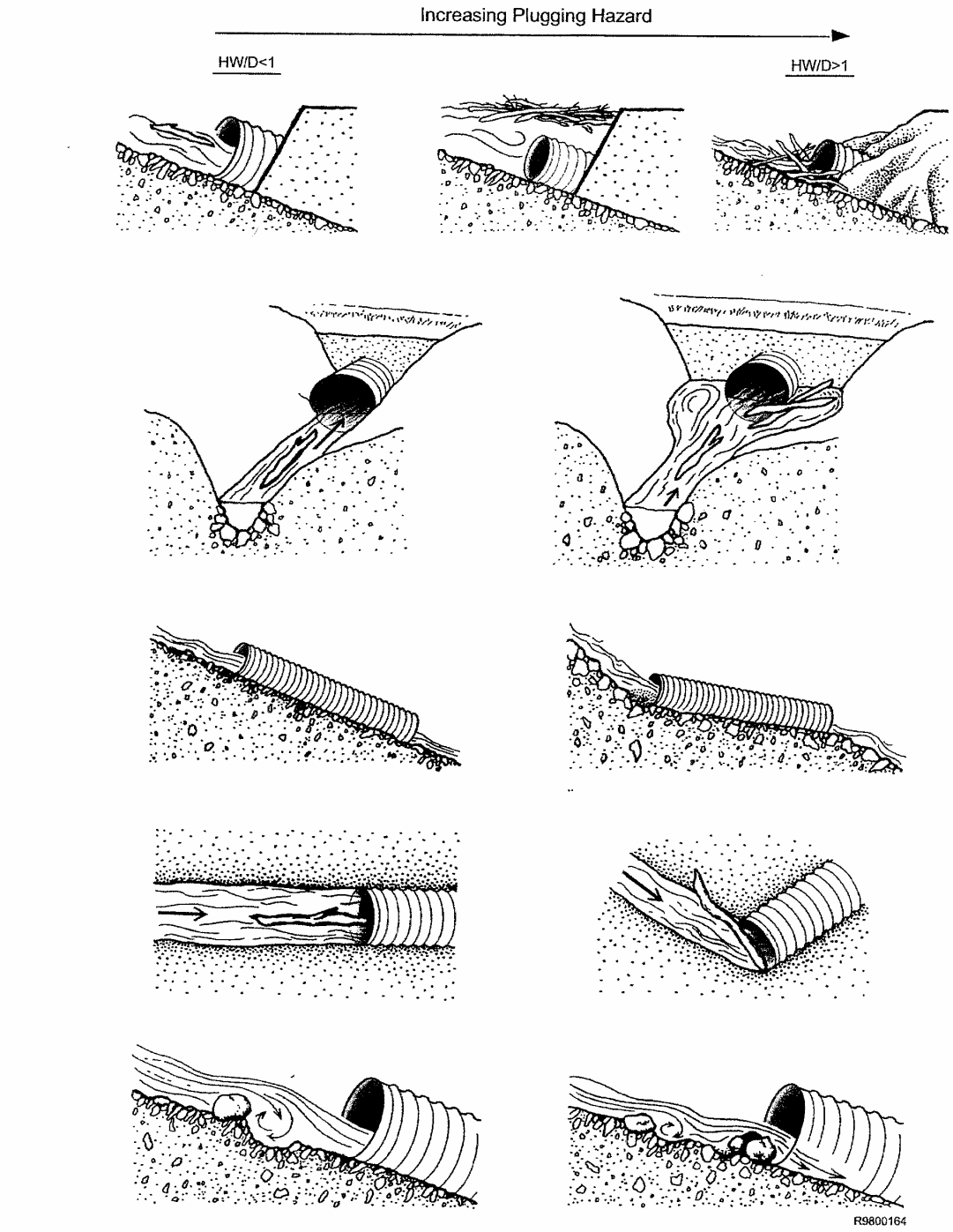
Culvert Hydraulics B-3.1
Definition of Terms



Perched Outlet: A condition in which a culvert's outlet is suspended over the immediate downstream pool, requiring fish to leap into a culvert (DFG).

Source: Robison, E., A. Mirati, and M. Allen. 1999. Oregon Road/Stream Crossing Restoration Guide. Advanced Fish Passage Training Version. Salem OR.

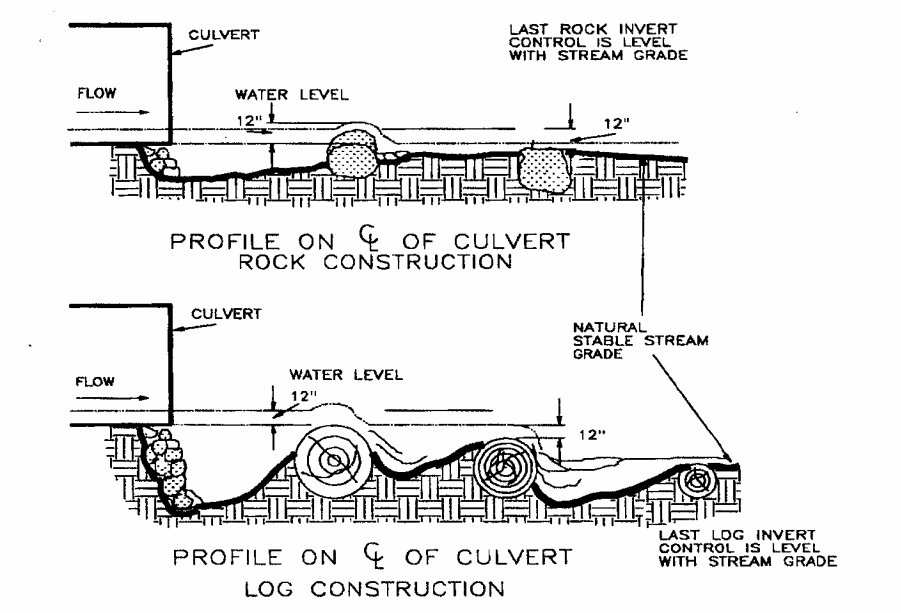
Culvert Plugging Hazards B-3.2



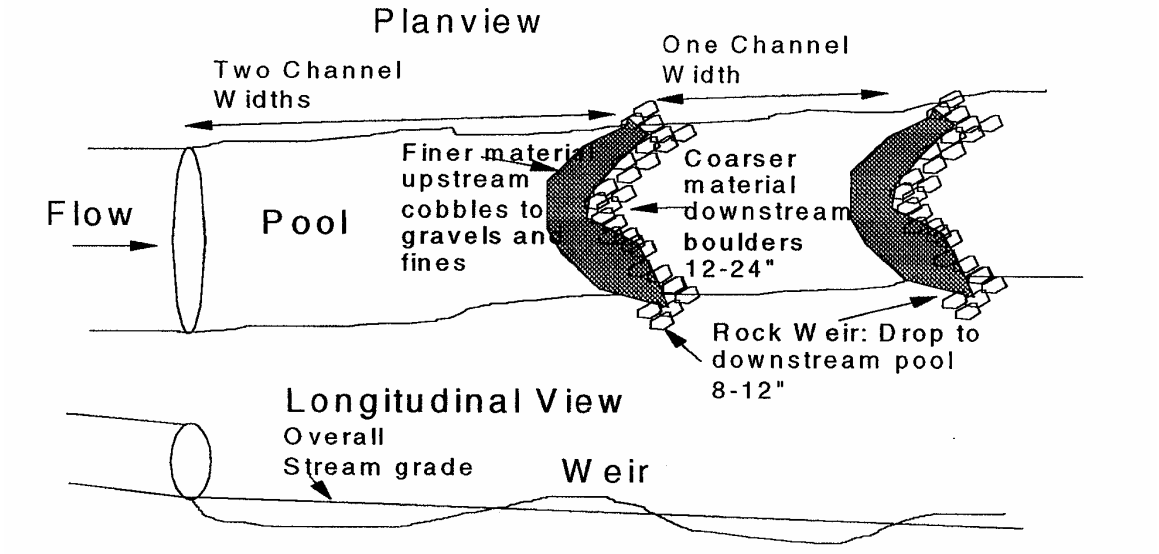
Source: USDA Forest Service (USFS). 2000. Water/Road Interaction Technology Series: "Diversion Potential at Road-Stream Crossings", By M. Furniss et al., Technology and Development Program. San Dimas, CA.

Back-Flooding Weirs B-3.3

When to use: When culvert is not installed with at least ¼ of its diameter at or below stream grade. Purpose is to help pass adult and juvenile fish where a jump barrier was created by scour at the downstream end of culverts.



Source: California Dept. of Fish and Game (CDFG). 1998. California Salmonid Stream Habitat Restoration Manual. By Gary Flosi, et al. Inland Fisheries Div., 3rd edition.



Source: Robison, E., A. Mirati, and M. Allen. 1999. Oregon Road/Stream Crossing Restoration Guide. Advanced Fish Passage Training Version. Salem OR.

Baffles: When to Use & Types B-3.4

Definition: A feature added to a culvert to increase the hydraulic roughness of the culvert and therefore reduce the average cross-section velocity. The purpose is to improve fish passage, mainly for adults.

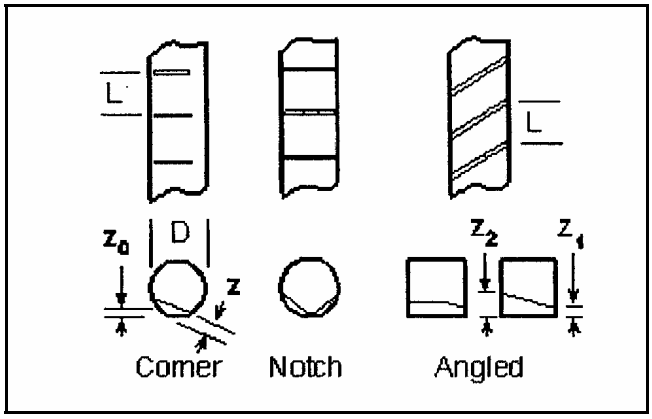
When to Use: To provide for adult fish passage in an existing culvert in a low gradient stream with good habitat upstream, and where funding is not available to replace with a bridge or open bottomed culvert. Cost and maintenance usually make this choice a last resort.

When Not to Use: Baffles within a culvert are not a desired solution to meeting velocity criteria and are not appropriate for new culvert installations. Baffles should not be installed in culverts with: 1) less than 5 feet of headroom; 2) high gradient streams (>3.5% slope) with large bedload and debris moving through. Culverts with baffles are more prone to clog with debris and sediment. Baffles can rip out and damage the culvert or cause it to fail.

Baffle Styles: The figure below depicts 2 styles for round culverts and 1 for box culverts. They are all designed with a continuous alignment of notches along one wall rather than alternating back and forth. This design allows less resistance to high flows and an uninterrupted line of fish passage along one or both sides. This feature is particularly important for weak fish which would be forced to cross the high velocity zone at every baffle in an alternating baffle design.

Two details of angled baffles are shown for box culverts; the continuously sloped baffle is generally used for juvenile passage situations and in culverts 6 feet wide and less. The notch baffle style is especially useful in large culverts and can be applied to slopes of 2.5-3.5%. Corner baffles generally apply to culverts with slopes from 1.0-2.5%.

To avoid reducing the culvert capacity, the upstream baffle should be placed at least one culvert diameter downstream of the inlet and should be high enough to ensure subcritical flow at the inlet at the high design flow. A modification of the culvert, such as a mitered end or wingwalls, may also be required to improve its hydraulic efficiency.



Source: Washington Dept. of Fish and Wildlife. 1999. Fish Passage Design at Road Culverts: A design manual for fish passage at road crossings. Olympia WA.

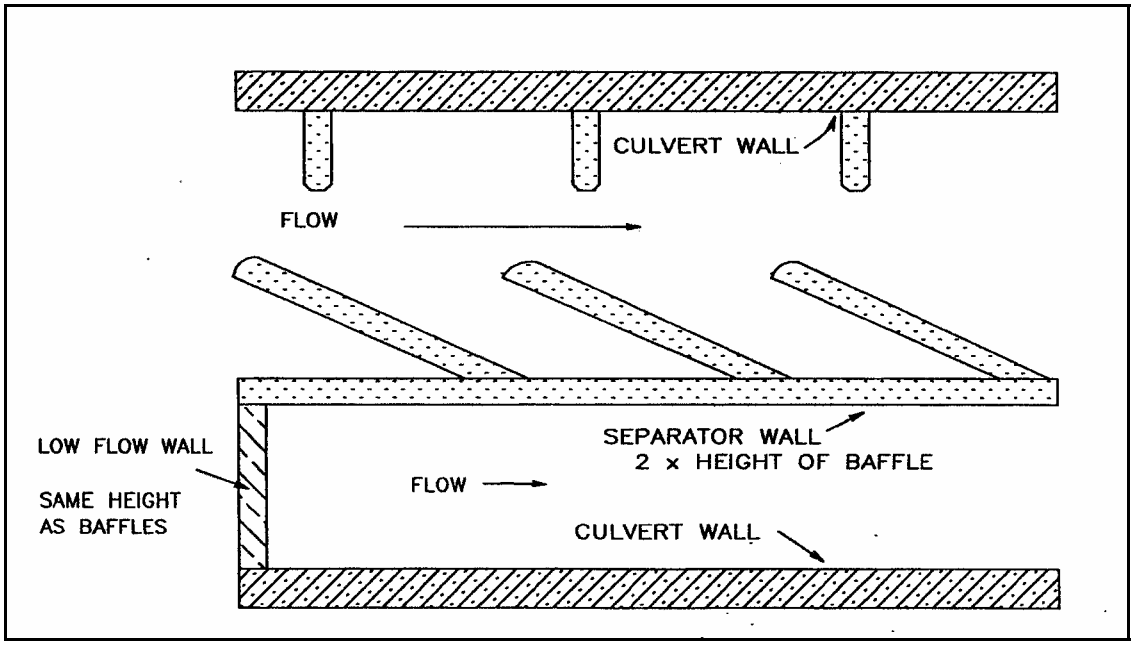


Figure 1. Washington Baffles with a separator wall – for culverts > 7 ft. width. (CDFG 1998)

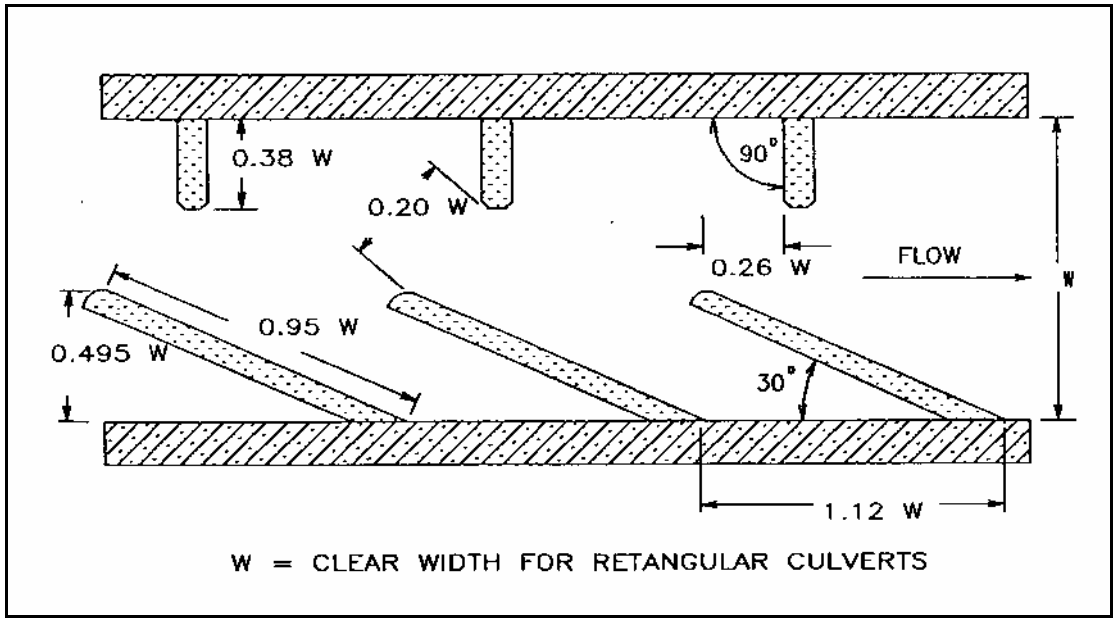


Figure 2. Washington baffles. (CDFG 1998)

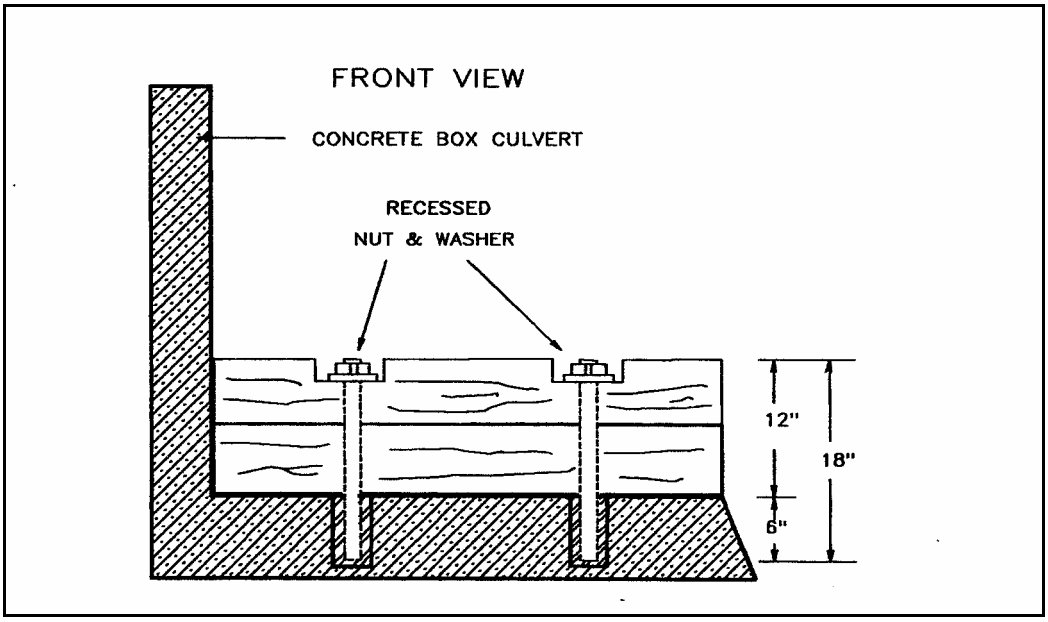


Figure 3. Redwood Washington baffle construction. (CDFG 1998)

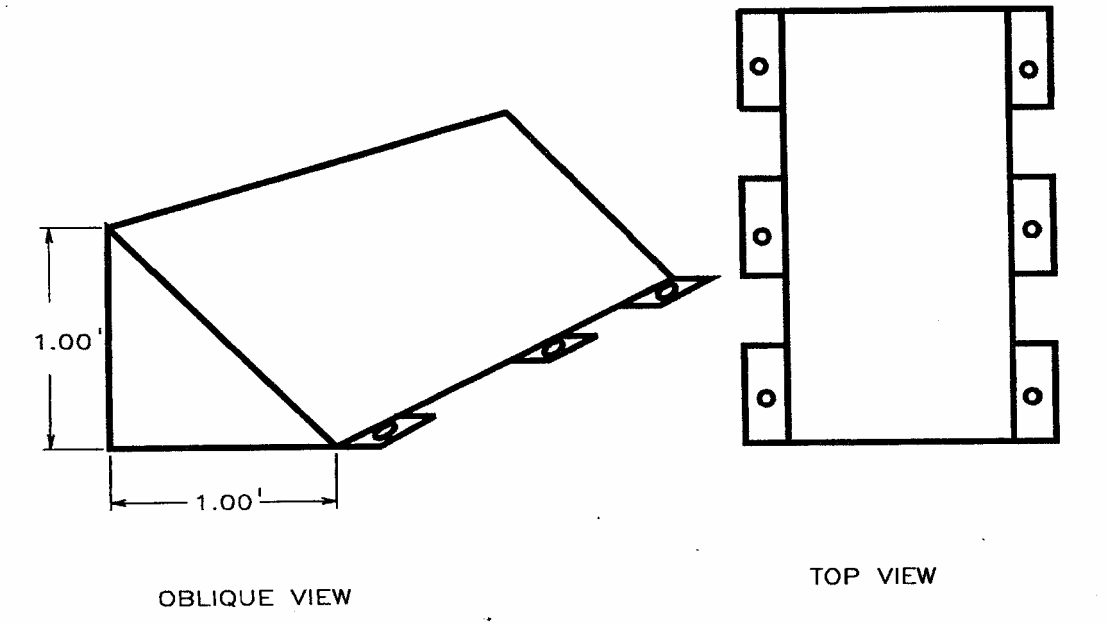


Figure 4. Steel Washington baffle. (CDFG 1998)

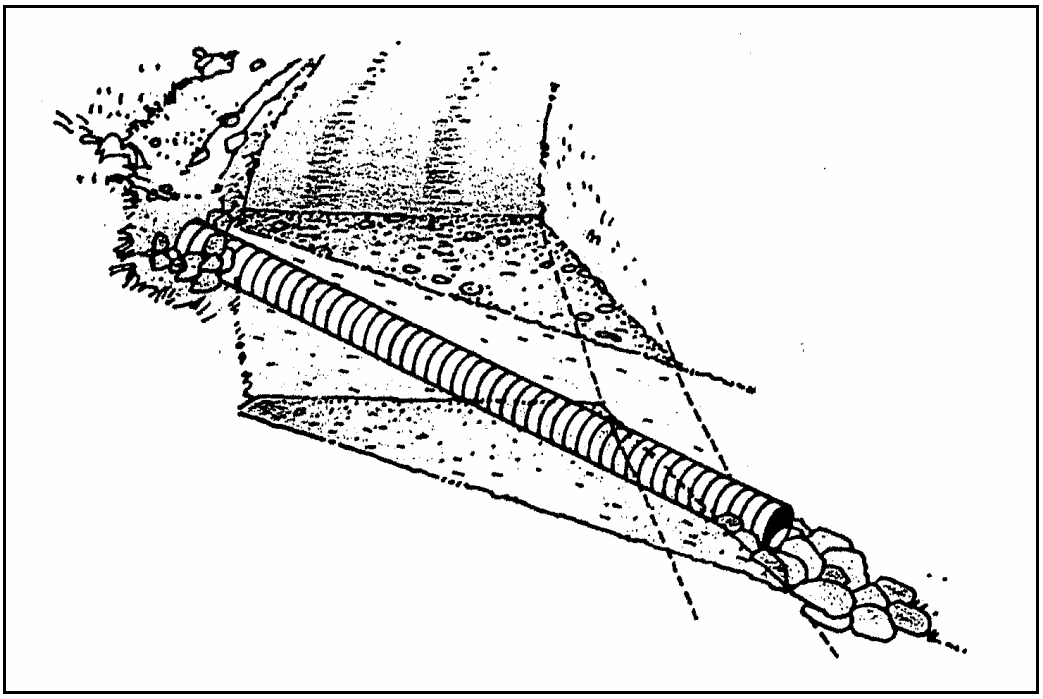
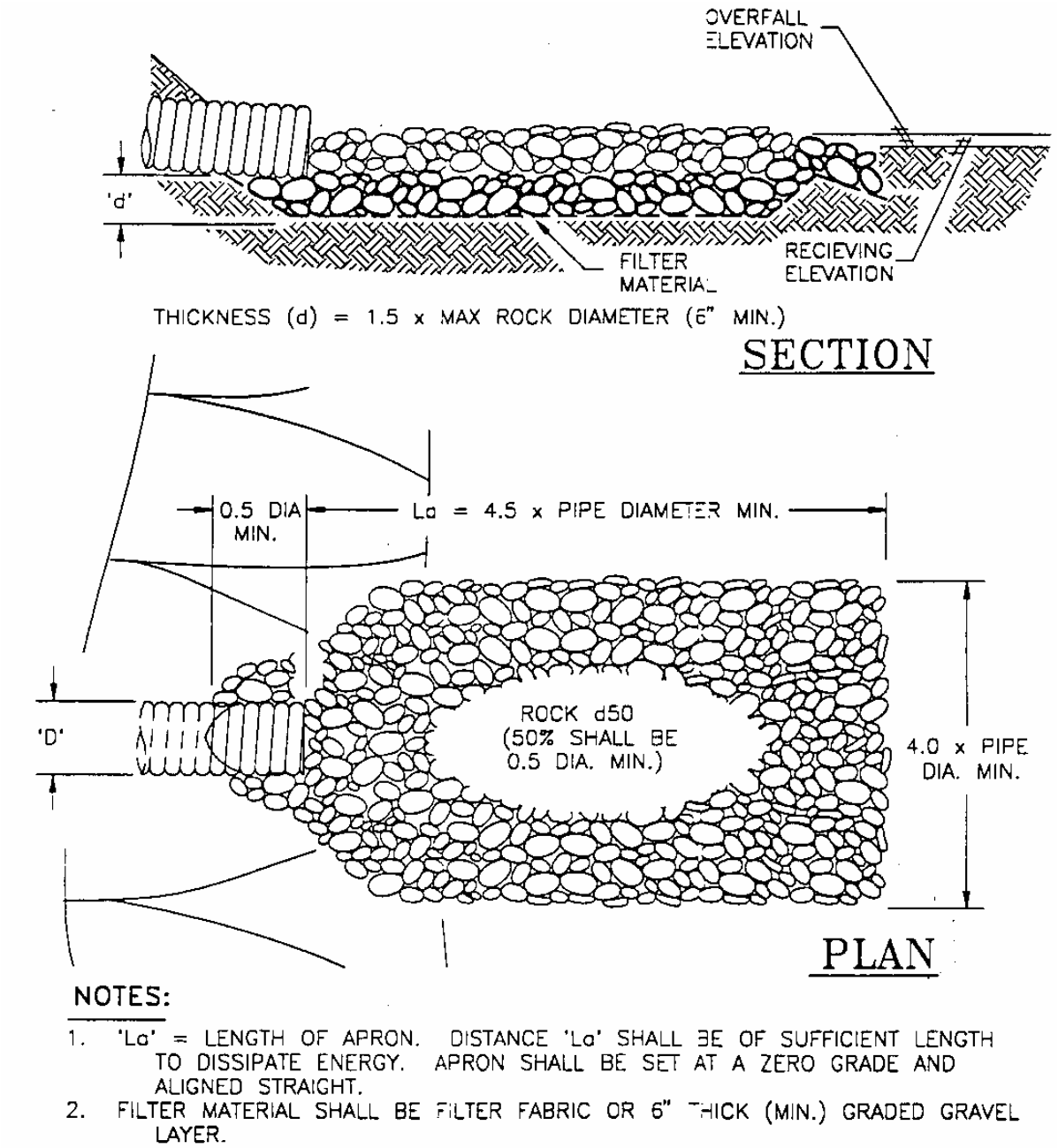


Figure 1. Like stream crossing culverts, ditch relief culverts should be installed at the base of the road fill, with armoring at the inlet and some type of energy dissipation at the outfall. If the culvert is placed higher in the fill, a downspout should be used to carry flow from the outlet downslope past the base of the fill.

Source: Weaver, W.E. and D.K. Hagans. 1994. Handbook for Forest and Ranch Roads. Mendocino County Resource Conservation District, Ukiah CA.

Energy Dissipator B-3.7

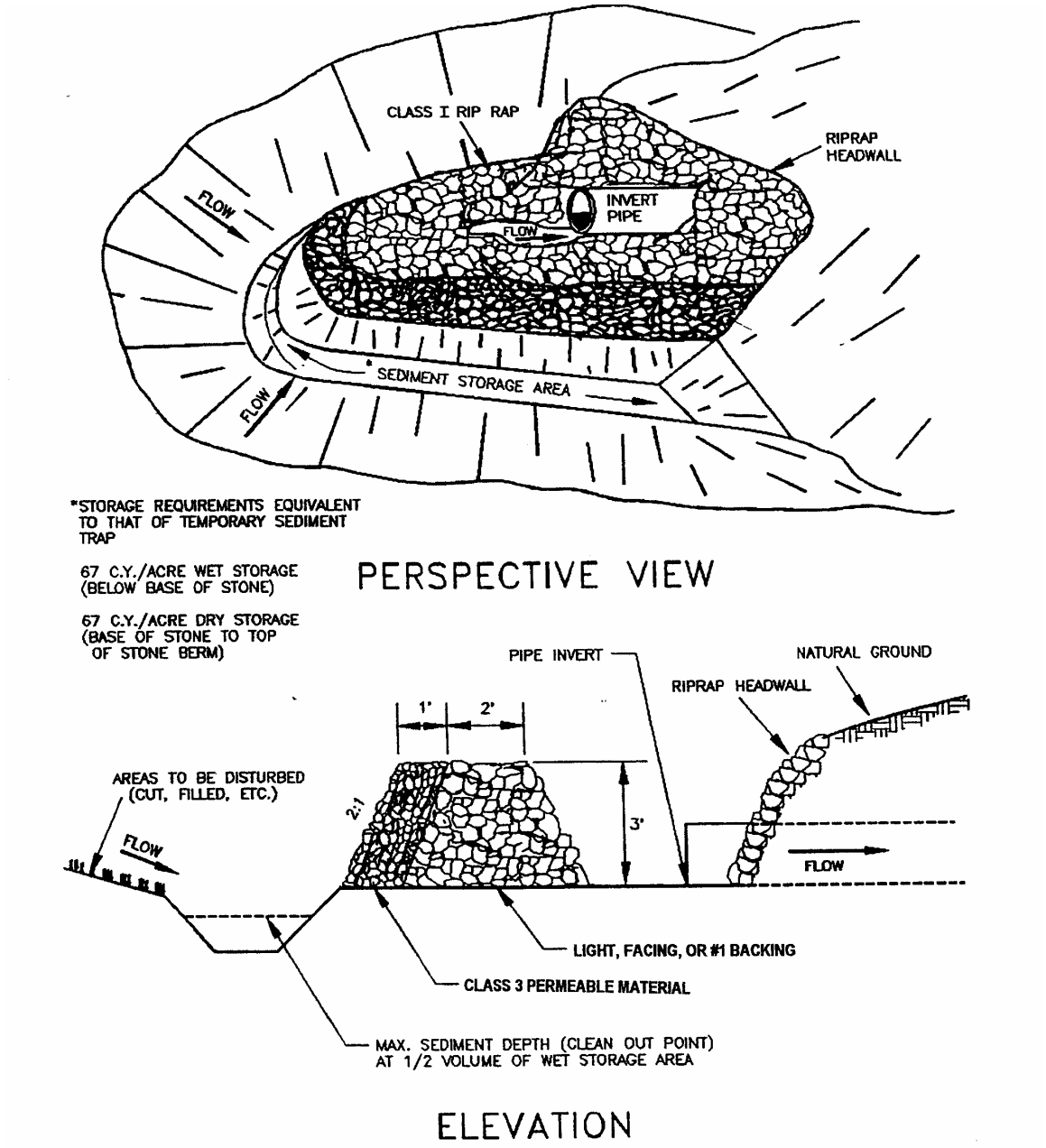


NOTES:

1. 'La' = LENGTH OF APRON. DISTANCE 'La' SHALL BE OF SUFFICIENT LENGTH TO DISSIPATE ENERGY. APRON SHALL BE SET AT A ZERO GRADE AND ALIGNED STRAIGHT.
2. FILTER MATERIAL SHALL BE FILTER FABRIC OR 6" THICK (MIN.) GRADED GRAVEL LAYER.

Source: McCullah, J. 1992. Erosion and Sediment Control Standards Design Manual – County of Shasta. Prepared for the Western Shasta Resource Conservation District (RCD). Redding CA. 187 p.

Culvert Inlet Sediment Trap B-3.8



Source: Association of Bay Area Governments (ABAG). 1995. Manual of Standards for Erosion & Sediment Control Measures. 2nd edition. Oakland CA.

B-4 EROSION CONTROL – UPSLOPE

EROSION CONTROL BLANKETS B-4.1
GEOTEXTILE FABRICS

Description: Soil stabilization can be done through the installation of a protective blanket (covering) or mat on a prepared planting area, steep slope, or channel.

Purpose: The purpose is to resist the forces of soil erosion during storm events, reinforce steep slopes, and help promote vegetation establishment as a mulch substitute. These blankets can be made out of short-term biodegradable to control temporary erosion or long-term non-biodegradable materials for permanent reinforcement for vegetation during high flow or runoff events.

Other terms include Rolled Erosion Control Products, Erosion Control Netting, Turf Reinforcement Mats, and Geotextiles or Geosynthetics.

Types of Materials:

Biodegradable Products: Natural fibers

- Coconut Fiber or coir
- Jute
- Straw
- Wood fiber (excelsior)

Non-biodegradable Products: Synthetic fibers and filaments

- Nylon (polyamides)
- Propylene and Ethylene (polyolefins)
- PVC (polyvinylchloride)

Composites: A degradable filler between a temporary layer of netting and a permanent layer of a synthetic "matrix".

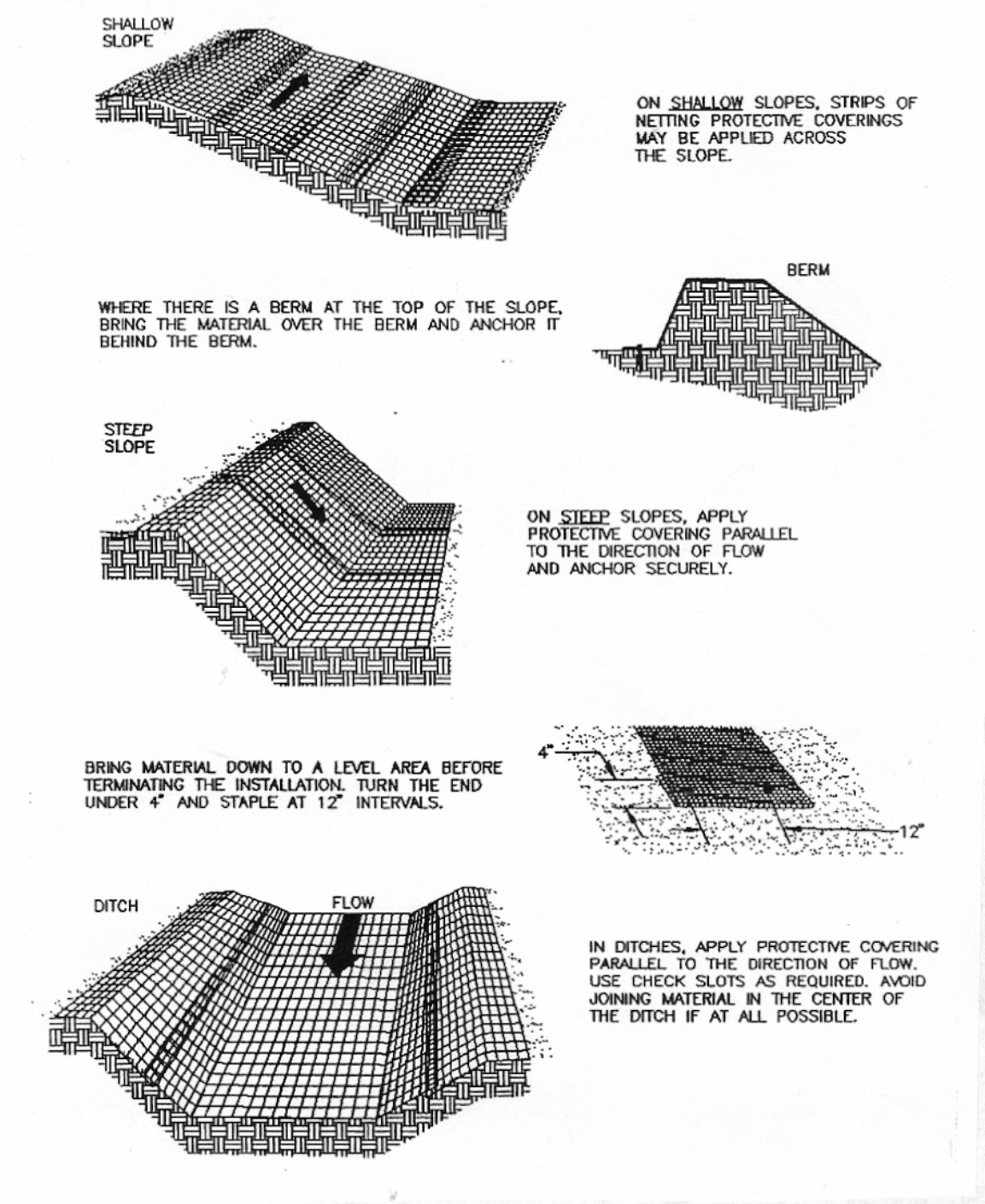
Filter Fabric: A permeable material made with synthetic fibers. It may be woven or non-woven fabric and is usually packaged in roll form.

- Woven filter fabric should only be used for soil separation, road reinforcement and soil separation.
- Non-woven filter fabric should only be used for drainage filtration but may be used under unpaved roads in certain circumstances.

For guidance in selection, refer to NRCS Design Note 24, *Guide to Use of Geotextile*, available at a local NRCS office.

EROSION CONTROL BLANKETS B-4.2
PLACEMENT & INSTALLATION

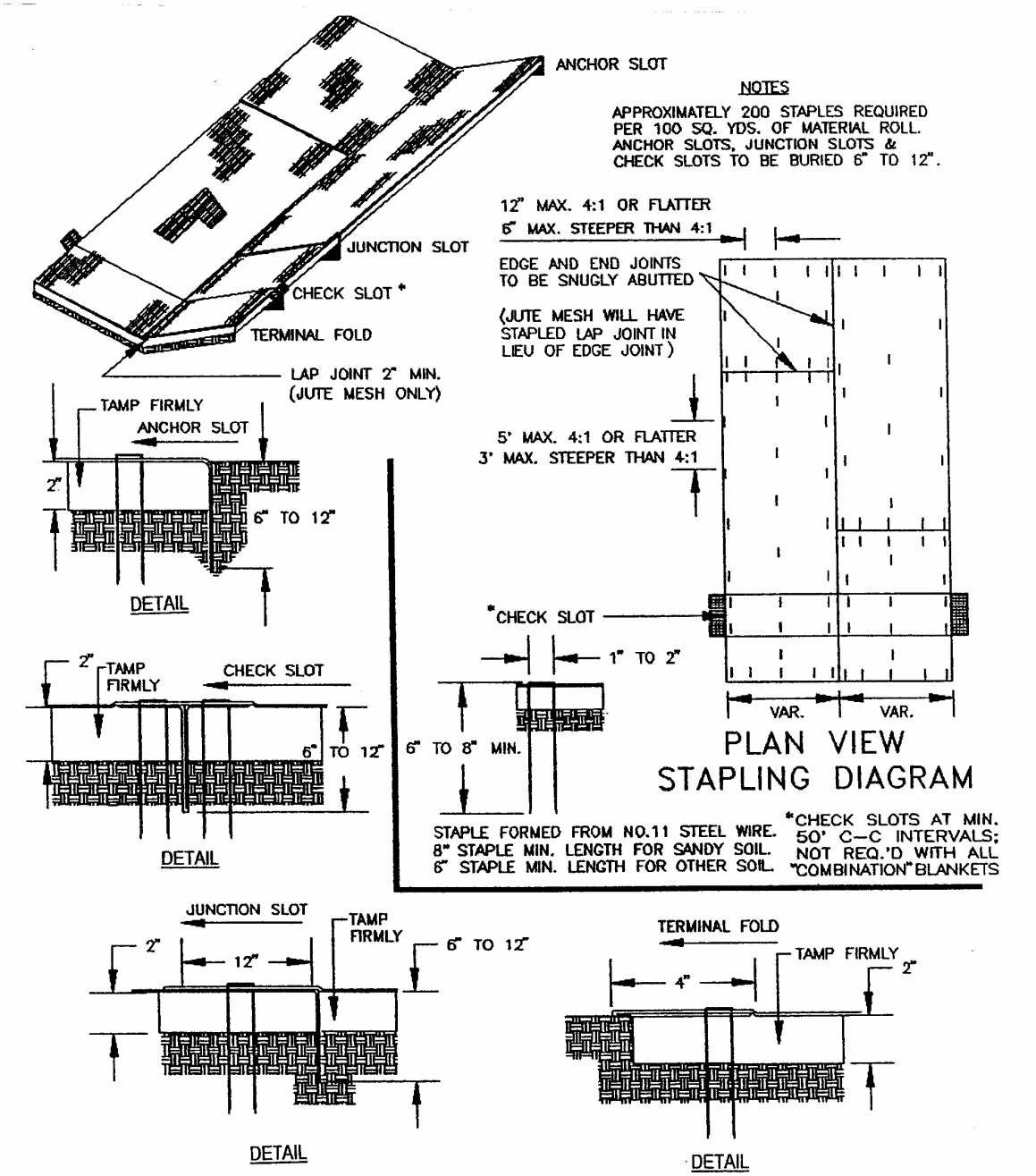
Figure 1. Placement of Biodegradable Blankets



(Source: ABAG. 1995. Manual of Standards for Erosion & Sediment Control Measures.Oakland CA.)

EROSION CONTROL BLANKETS B-4.2 PLACEMENT & INSTALLATION

Figure 2. Installation of Biodegradable Blankets

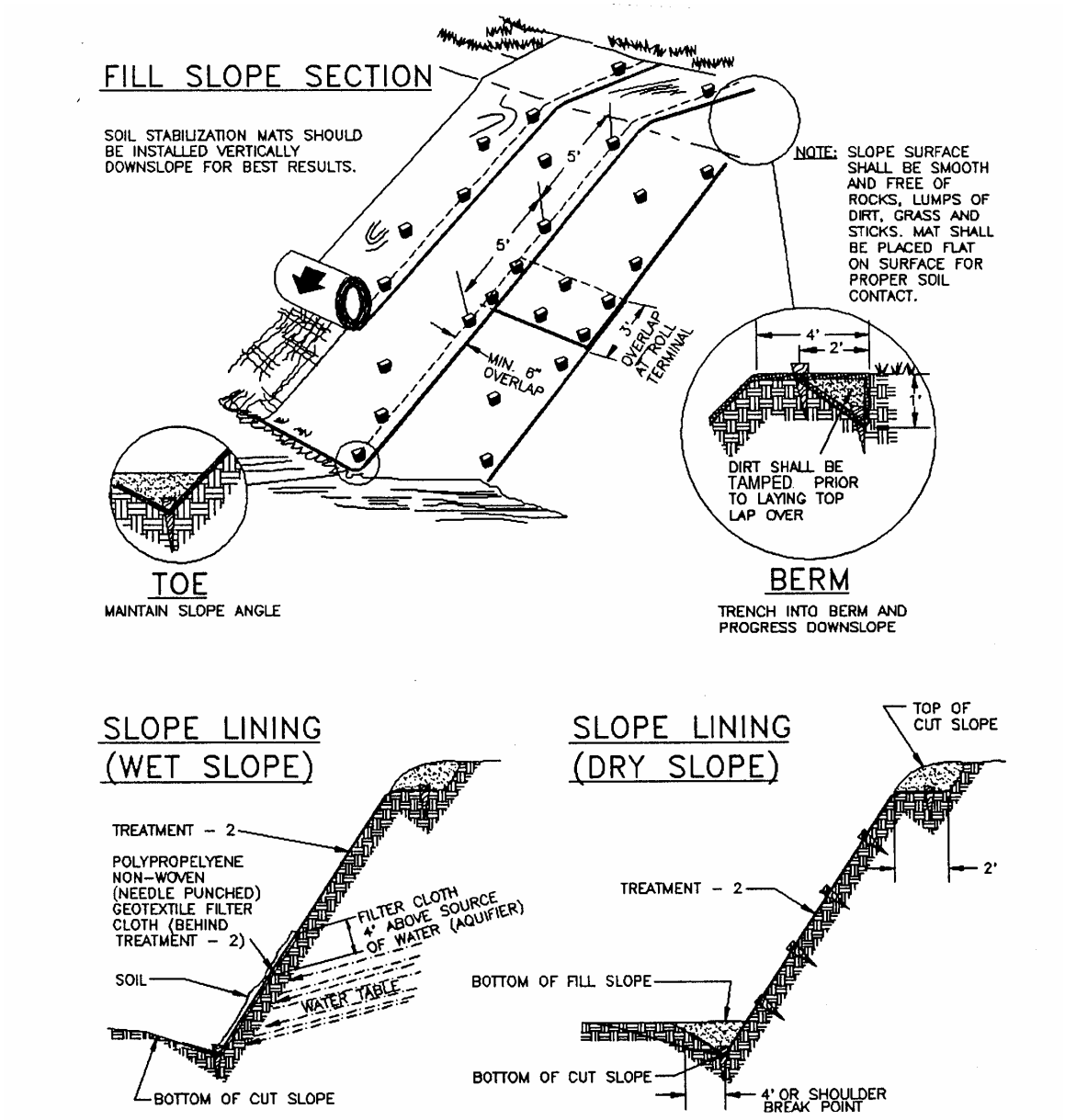


NOTE: Follow Manufacturer's recommended installation procedures.

Source: ABAG. 1995. Manual of Standards for Erosion & Sediment Control Measures.Oakland CA.

EROSION CONTROL BLANKETS B-4.2
PLACEMENT & INSTALLATION

Figure 3. Placement of Non-biodegradable Blankets



(Source: ABAG. 1995. Manual of Standards for Erosion & Sediment Control Measures.Oakland CA.)

Figure 4. Anchoring of Blankets

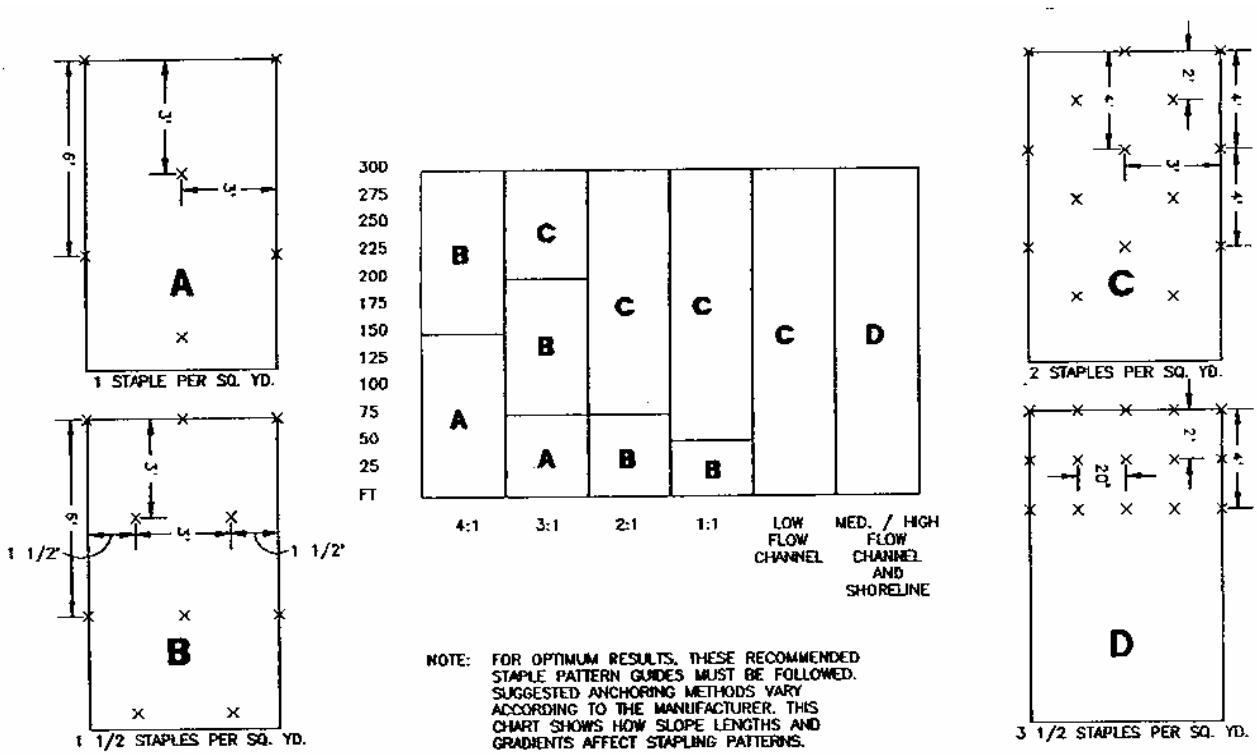
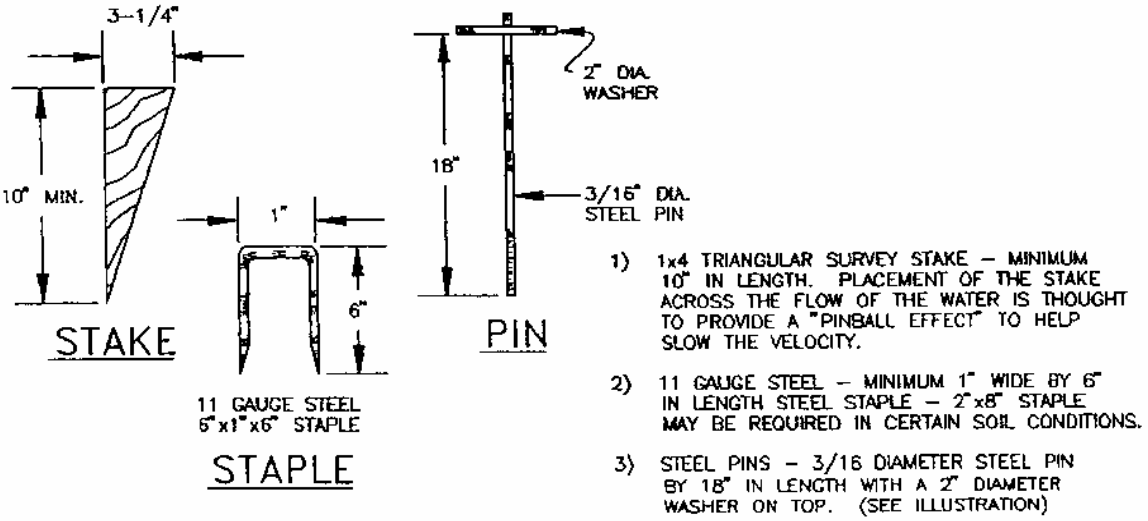


Figure 5. Installation Anchors

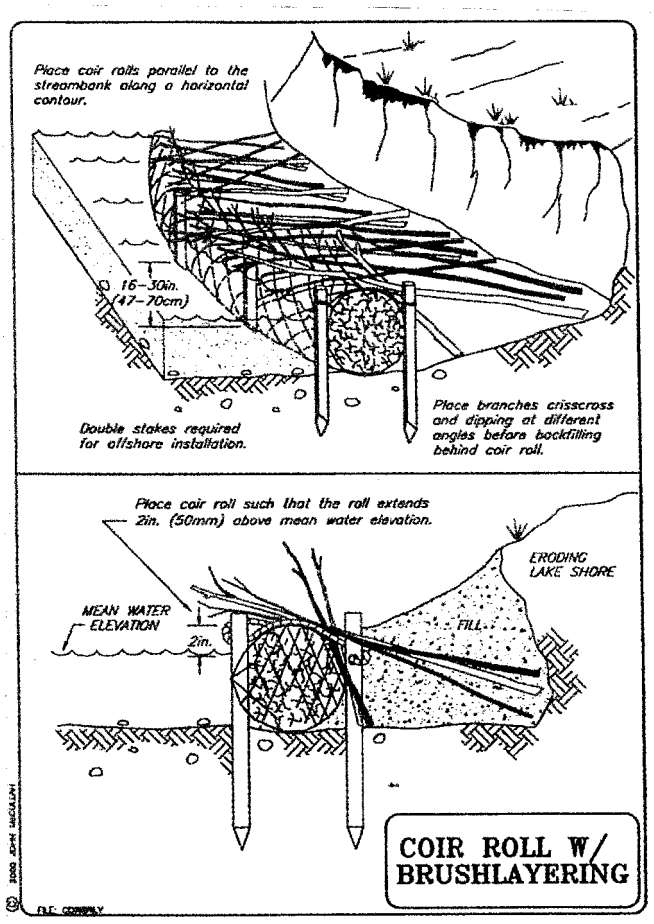


(Source: ABAG. 1995. Manual of Standards for Erosion & Sediment Control Measures.Oakland CA.)

Possible Uses:

- Temporary check dams in ditches
- Temporary spoil stockpile protection
- Drop inlet protection
- Temporary interceptor dike and swale
- Streambank stabilization with brushlayering

Figure 1. Coir Roll with Streambank Brushlayering



Sources: Sloan, R. 2001. "Coir rolls with brushlayering for successful streambank and shoreline stabilization." *Erosion Control* (March/April): p. 80. Drawing copyrighted by John McCullah. King County. 2000. Regional Road Maintenance ESA Program Guidelines. Seattle WA.

MULCHING B-4.4

Description: Mulching is the application of straw, wood chips, or other suitable materials on the soil surface applied manually or by machine. Plant-made materials will eventually decompose (biodegrade).

Purpose:
- Helping as a temporary, short-term practice
- Reducing erosion by protecting the soil surface from raindrop impact
- Decreasing surface water or wind velocity impacts
- Fostering the growth of vegetation by increasing available moisture and providing insulation against extreme heat and cold.

How to Use:
- Apply over areas already seeded or planted to provide soil protection and insulation.
- Cover soil sufficiently to allow seeds to germinate but thicker where seeding germination is not an issue.
- Nets and matting may be used in combination with mulch, and can help keep mulch from blowing away.
- Various types and sizes of mulch are available.
- Apply additional mulch where erosion or scouring occurs.
- Repair if a tear in the cover netting or matting occurs.
- Inspect weekly during construction or immediately after rainstorms.

When NOT to Use:
- On slopes steeper than 2 horizontal to 1 vertical
- In watercourses and streams
- In ditches where water flow is continuous.

Source: King County. 2000. Regional Road Maintenance Endangered Species Act Program Guidelines. Seattle WA. p. 2.103.

PLANTING B-4.5

Description: This practice includes the planting of appropriate species of trees or shrubs on bare slopes (such as the road cut or fill slope), along a ditch or channel, or adjacent to streams.

Purpose:

- Helping provide long-term stabilization of slopes through the plants' roots and leaf litter
- Providing shade and riparian cover near streams to provide better aquatic habitat. Trees may eventually contribute large woody debris (LWD) to the stream for instream benefits.

What to Do:

- Correct choice of plant species and proper planting technique are critical to good plant survival.
- Obtain container–grown or bare-root stock of native species found in the vicinity of the planting site from a nursery in the region. Large quantities (>100 plants of 1 species) may need to be special ordered (grown under contract) with the nursery at least 6-12 months in advance.
- For moist areas, an option is to collect willow sprigs from a grove of willows near the area when dormant: sprigs should be at least ½ inch in diameter and 18 inches long, with 2-3 inches diameter and 3-4 feet long being the best.
- Handle seedlings carefully and ensure they are kept sufficiently watered (soil mixture is damp, not dry or soggy) and shaded until site is ready to plant. In cool, damp weather, seedlings are vulnerable to mold. Plant willow sprigs same day as cut.
- Clear away loose organic material, such as leaves and grasses, from the planting spot to expose mineral soil.
- Dig hole with shovel or hoedad to be deep and wide enough for the roots to be fully extended. Fill hole, being sure soil falls around roots, and tamp soil firmly around base of plant with heel. Willow sprigs need to be 75-80% buried into the soil.
- Add slow-release fertilizer tablet into hole, especially on poor soils.
- Water site - if possible – immediately after planting and weekly during dry periods of the first year. An attachment from a water truck can be used to hand irrigate near roads.

What NOT to Do:

- Plant in the summer months and where watering is not available.
- Plant trees within the safety clear zone areas that could become hazards.
- Plant willow sprigs upside down (avoid this by making sure buds are pointing up)

Sources: King County. 2000. Regional Road Maintenance Endangered Species Act Program Guidelines. Seattle WA. ; CDFG. 1998. California Salmonid Stream Habitat Restoration Manual.

PLASTIC COVERING B-4.6

Purpose:

- Covering exposed areas needing immediate temporary protection from soil erosion that cannot be covered by mulching
- Helping protect bare soil areas during winter months before grass seed can germinate
- Covering steep slopes, construction sites, and on stockpiles where surface runoff can be controlled from the plastic covered area.

How to Use:

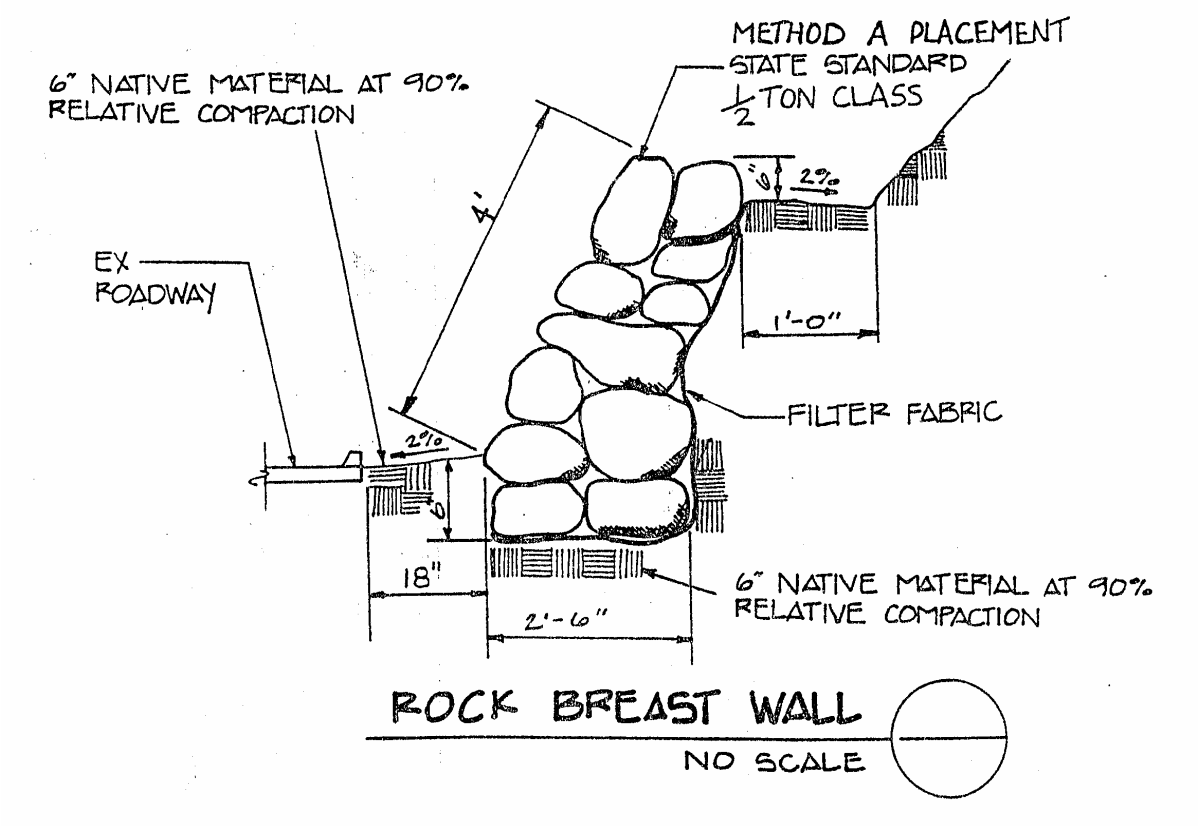
- Secure plastic by staking or using weight (e.g., sandbag or tires) to prevent movement. Rebar must not be used as a staking mechanism
- Key plastic covering in at the top of the slope.
- Apply additional BMPs, such as a berm or sediment control, to control surface water runoff from plastic.
- Inspect weekly and make any needed repairs or replacements.
- Remove plastic when area has stabilized or there is no longer the potential for sediment runoff from the site.

Source: King County. 2000. Regional Road Maintenance Endangered Species Act Program Guidelines. Seattle, WA.

ROCK BREAST WALL B-4.7

Description: A rock breast wall is a low retaining wall (usually 10 feet or less in height) constructed against the base of a slope. The wall is usually built by stacking rocks atop one another in a single, one-rock width course.

Purpose: To defend the toe of the slope and to prevent slope damage by erosion, especially piping and spring sapping as a result of seepage exiting from the face of the slope.



Source: Caltrans – Lake Tahoe district office (1994).

SEEDING B-4.8

Description: This practice spreads grass and forb seeds on disturbed or bare soil by the dry method (e.g., hand broadcasting, a hand -seeding device, blower) or hydraulic method (slurry mix of seed, fertilizer, water and mulch applied under pressure).

Purpose: To establish vegetative cover on exposed soil areas that will help decrease soil erosion. Seeding can be done for temporary or permanent purposes.

What to Do:

- Prepare site by removing weeds and debris, then loosening and roughening seedbed with a rake to 2-4" deep, if possible. Follow by raking smooth to a depth of ½ inch.
- Select seed mix carefully. Species or variety selection should be based on:
  - Performance (high survival rate) under local climate conditions
  - Protection of native grass communities
  - No tendency to spread (be "non-invasive") or become a weed if an exotic
  - Need for annual (short-term) and/ or perennial (long-term) mix of species
  - Commercial availability of seed (see Chapter 12-D Supplies).
  - Examples of Effective Native Seed Mixes: (a) Blue wildrye, California Brome, Idaho fescue, Squirreltail – for hot, dry sites; (b) Slender hairgrass, tufted hairgrass, red fescue, and California meadow barley – for moist sites
- Spread seed at appropriate time of year (Sept. 1- Oct. 15 best) and application rates (ranging from 15-80 lbs/acre). A hand-seeding device can apply more uniformly than hand broadcasting. Hydromulch may be better for applying to steeper slopes.
- Apply a slow-release fertilizer (such as ammonium phosphate 16-20-0) at recommended rate (e.g., 100 lb/acre). Re-apply in the second growing season to get full establishment.
- Rake lightly after seeding to cover seeds with a ½ to 1 inch layer of soil.
- Cover with certified weed-free (see County Agriculture Commissioner) straw (rye, barley, rice) mulch as needed to protect the surface during germination. [Note: "Organic" straw mulch is not the same thing and may contain many weed seeds.] Application rate varies at 2,000 -3,000 lbs/acre. See B-4.4 Mulching
- Only use tackifiers on very steep slopes, if needed to hold down mulch. Be sure the type selected is non-toxic (e.g., not the asphalt-type).
- Irrigate if rainfall is insufficient to keep soil moist during seed germination and establishment.
- Re-seed if established grass cover is inadequate after one growing season.

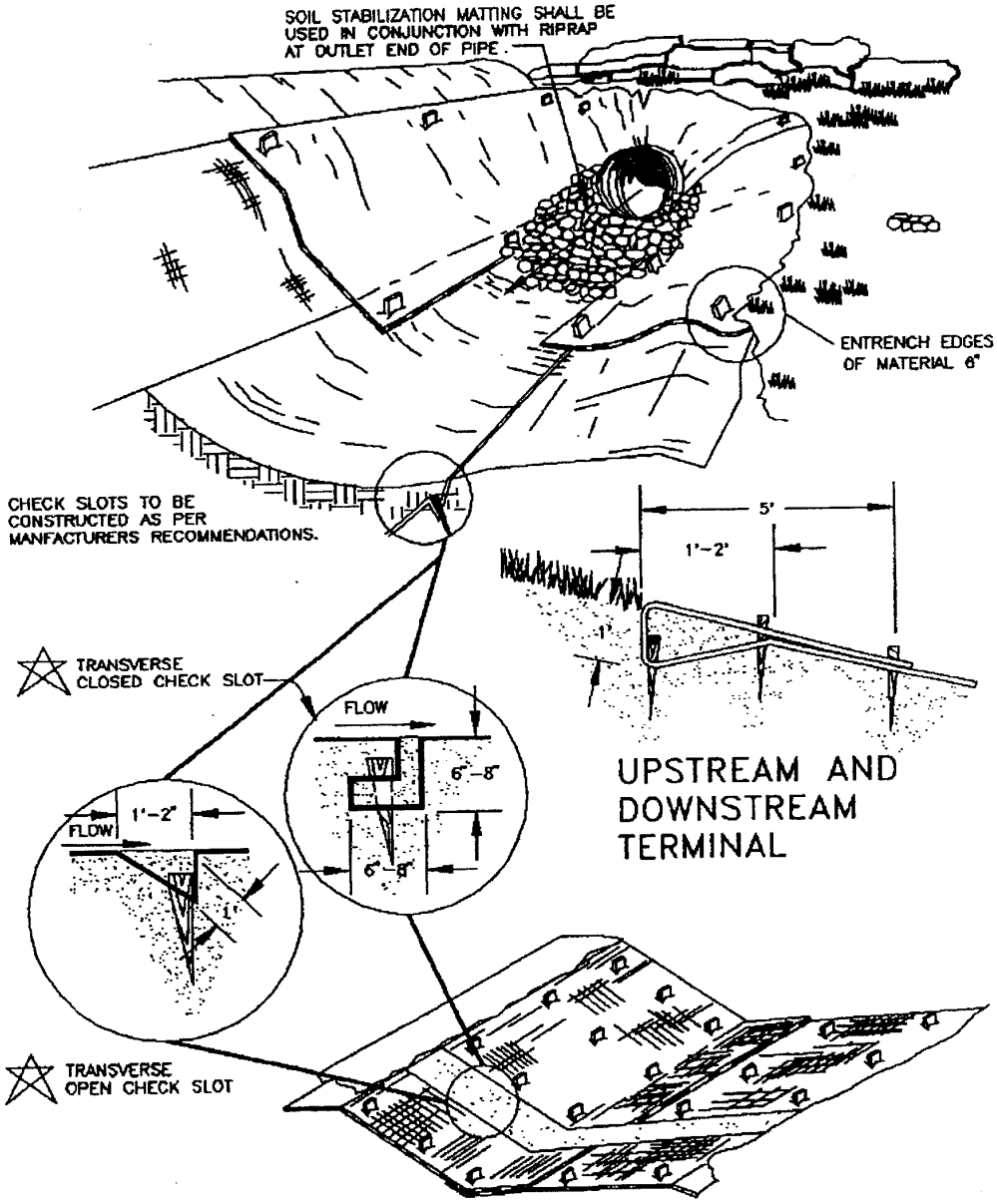
What NOT to Do:

- Do not cause more harm than good by introducing new invasive weeds into an area that can compete with the native grasses.
- Do not skimp on the amount of mulch during the first year of seed establishment.

Sources: Trinity County RCD, Native Grass mixes; McCullah, J. 1992. Erosion and Sediment Control Standards Design Manual – County of Shasta.; King County. 2000. Regional Road Maintenance Endangered Species Act Program Guidelines. Seattle, WA.;; Klamath National Forest, Seeding Specifications.

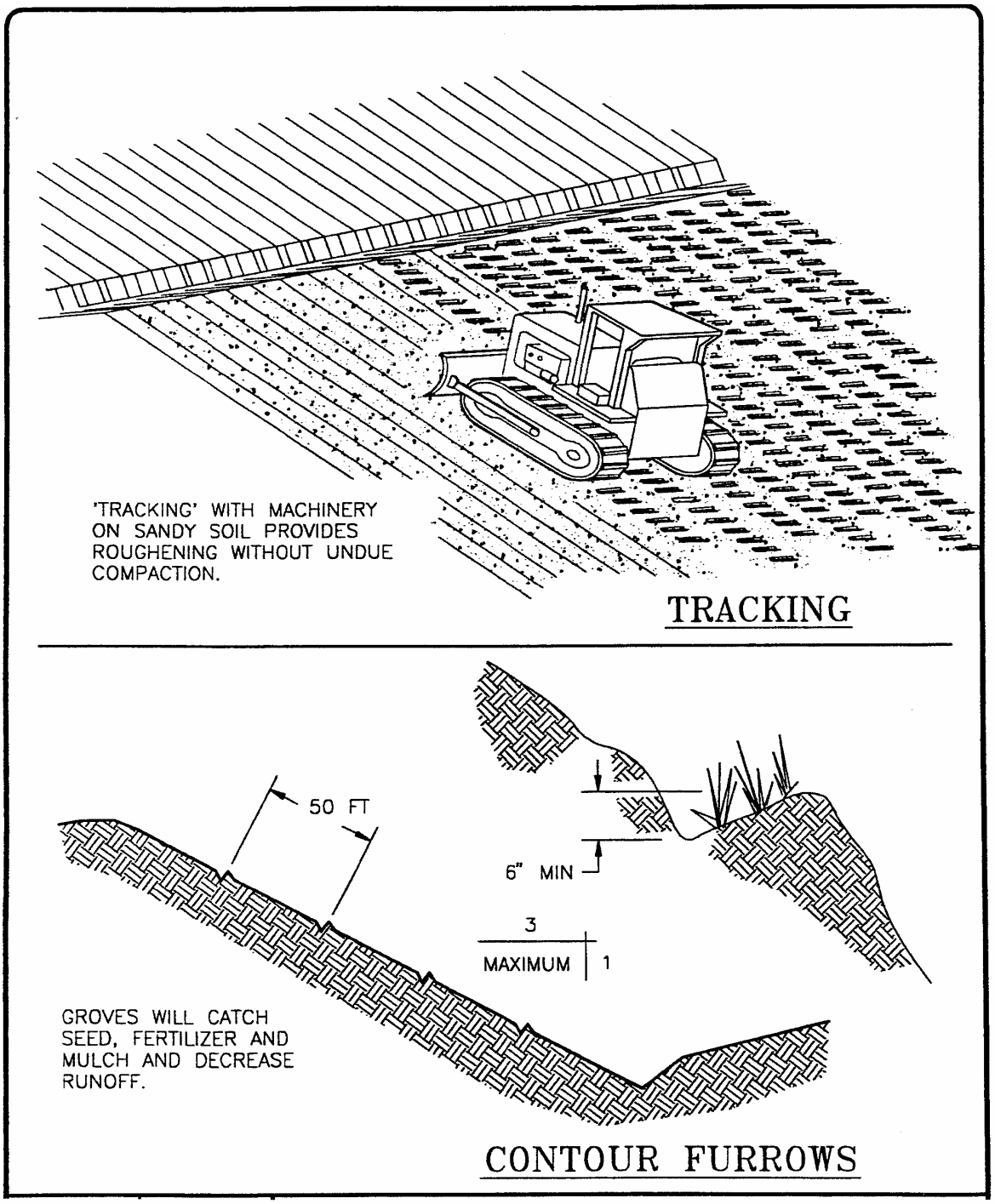
SILT MAT B-4.9

Purpose: To capture sediment and prevent erosion at culvert discharge points where there are no high flow rates.



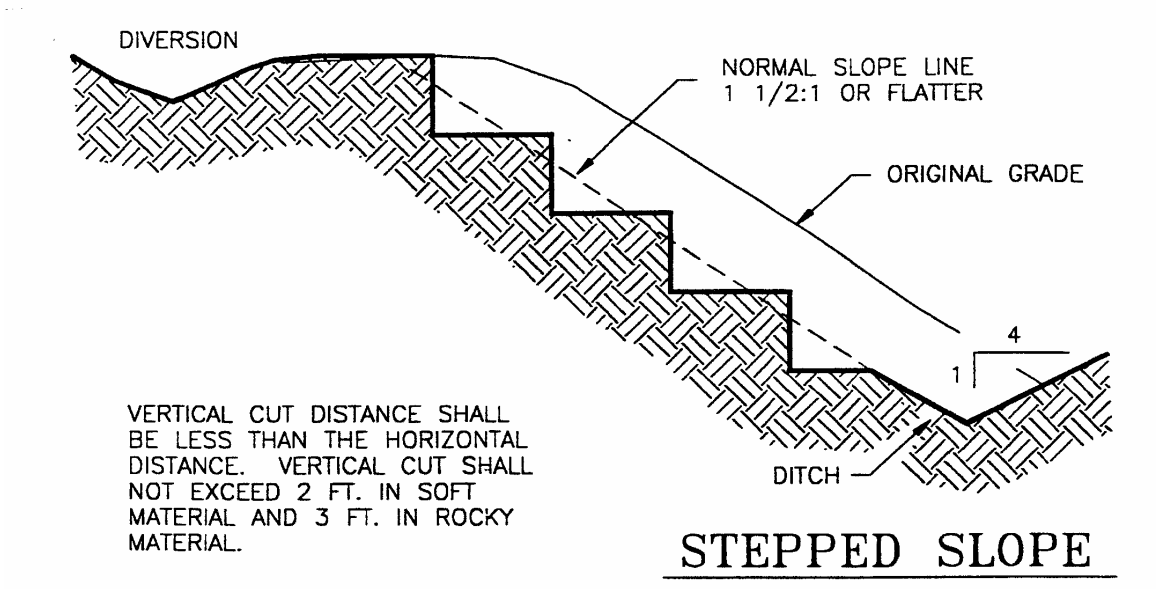
Source: King County. 2000. Regional Road Maintenance Endangered Species Act Program Guidelines.

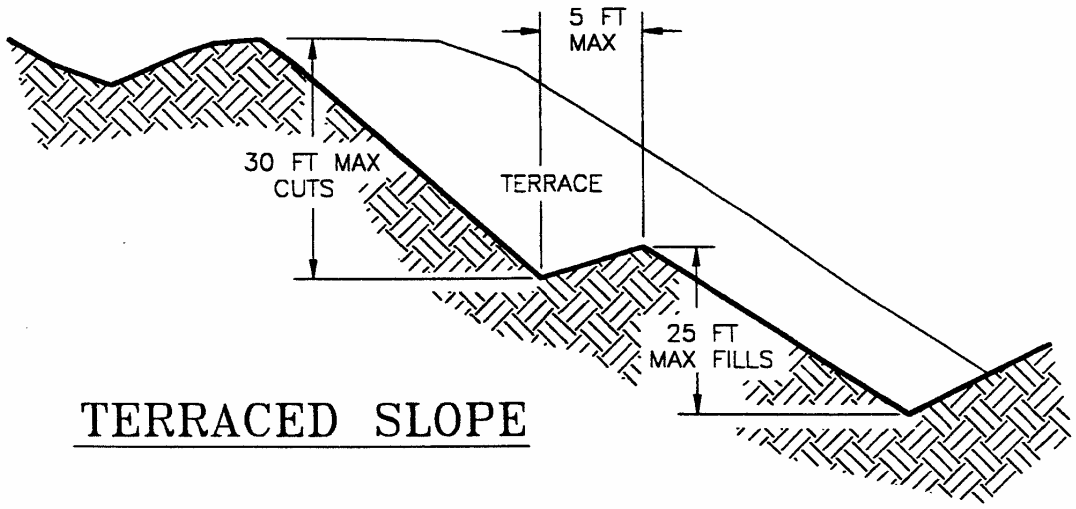
SLOPE TREATMENTS: B-4.10
SURFACE ROUGHENING & TRACKING



Source: McCullah, J. 1992. Erosion and Sediment Control Standards Design Manual – County of Shasta. Western Shasta RCD.

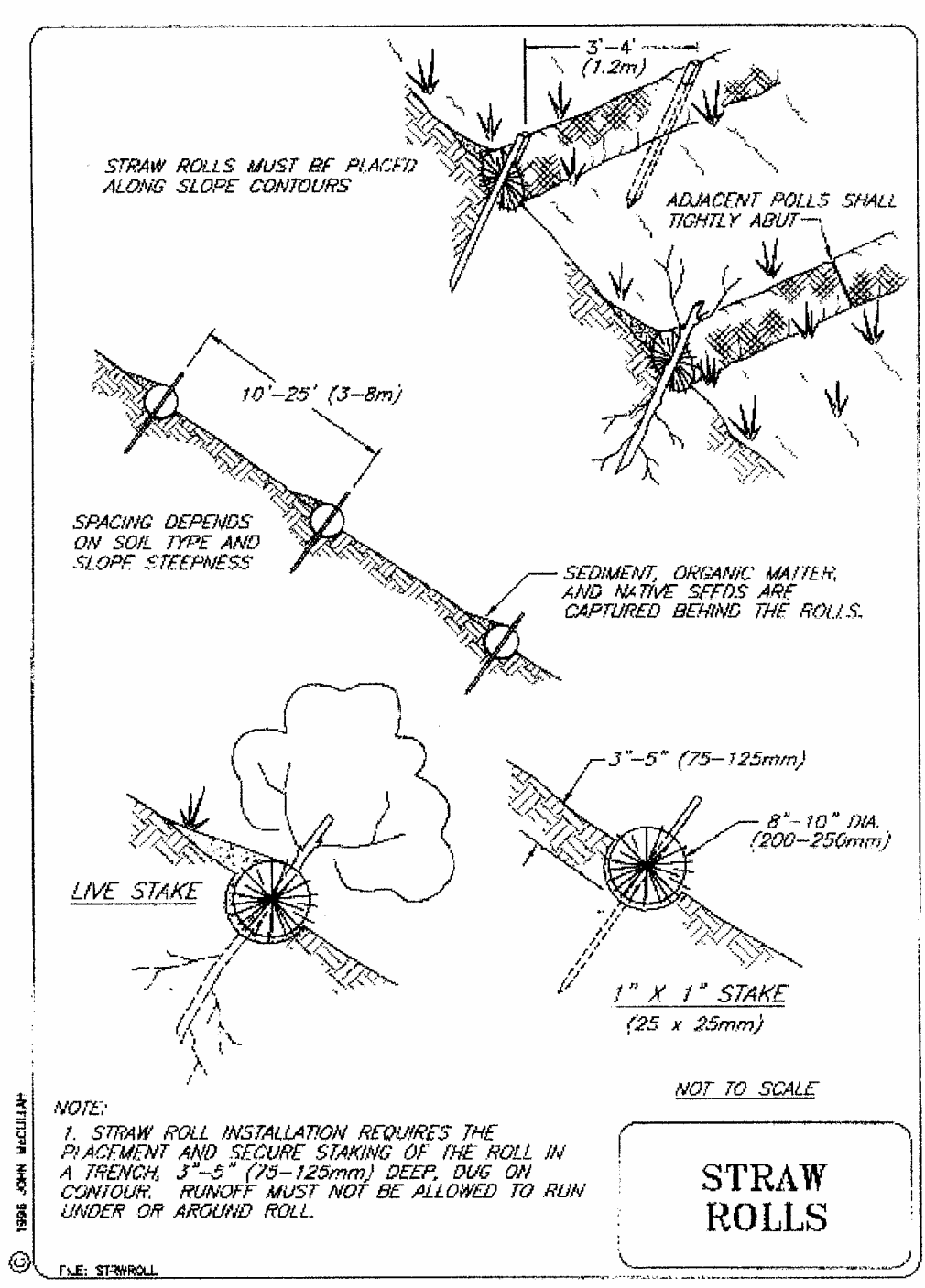
SLOPE TREATMENTS: B-4.11
STEPPED OR TERRACED SLOPE





Source: McCullah, J. 1992. Erosion and Sediment Control Standards Design Manual – County of Shasta. Western Shasta RCD.

STRAW LOG OR ROLL B-4.12



Sources: John McCullah copyright. Found at: //www.strawwattle.com Or //www.earth-savers.com

B-5 FISH EXCLUSION

Description: Road maintenance activities may require work within streams that contain salmonids. Some of these activities require the site to be temporarily dewatered with the fish removed, relocated upstream of the work area, and excluded from the work site until work is completed. See also: Chapter 4-F Temporary Stream Diversions

Purpose: BMPs are used to minimize or reduce deleterious impacts to aquatic resources for the dewatering action. Fish exclusion from the work site prior to dewatering must be done in accordance with the protocols set forth in the "Incidental Taking Permit" from the National Marine Fisheries Service (NMFS) and the California Dept. of Fish and Game (for state-listed species). Fish exclusion is done only under the supervision of a qualified fishery biologist with such a permit.

When Fish Exclusion May be Needed:

- **Stream Crossings:** Repair, maintenance, cleaning, installation or replacement / upgrade of stream crossing facilities such as pipes, arch pipes, culverts, fish ladders, weirs, sediment pools, and bridges.
- **Bridge Maintenance:** Repair, replacement, and maintenance of bridge components such as the superstructure, footings, piers, supports, abutments, and ramps.
- **Watercourses and Streams:** Repair, replacement, installation, and maintenance tasks such as structural repair/ replacement, slope stabilization, sediment removal, vegetation management, debris removal, or habitat maintenance / improvements.

Sequence of Fish Exclusion Procedures:

1. Isolate the area (block nets).
2. Remove as many fish as possible using seine or dip nets.
3. Gradually dewater work area.
4. Remove as many remaining fish as possible using dip nets, and relocate upstream.
5. Electroshock, if required by permit, to avoid any stranding.
6. Keep records of fish exclusion activities.

What to Do:

- Consult with a qualified fishery biologist with an Incidental Taking Permit from NMFS and CDFG. A copy of the permit must be in possession of the person(s) authorized to collect the fish at the time of the fish exclusion activity.
- Obtain any needed training from the qualified fishery biologist.
- Only assist the supervising fishery biologist in the officially approved "incidental take permit" procedures when requested.
- Help clean fish screens twice a day of leaves and debris, and report any dead fish to the supervising biologist.

What NOT to Do:

- Do not "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect" a threatened or endangered species (i.e., "take") without the above procedure.

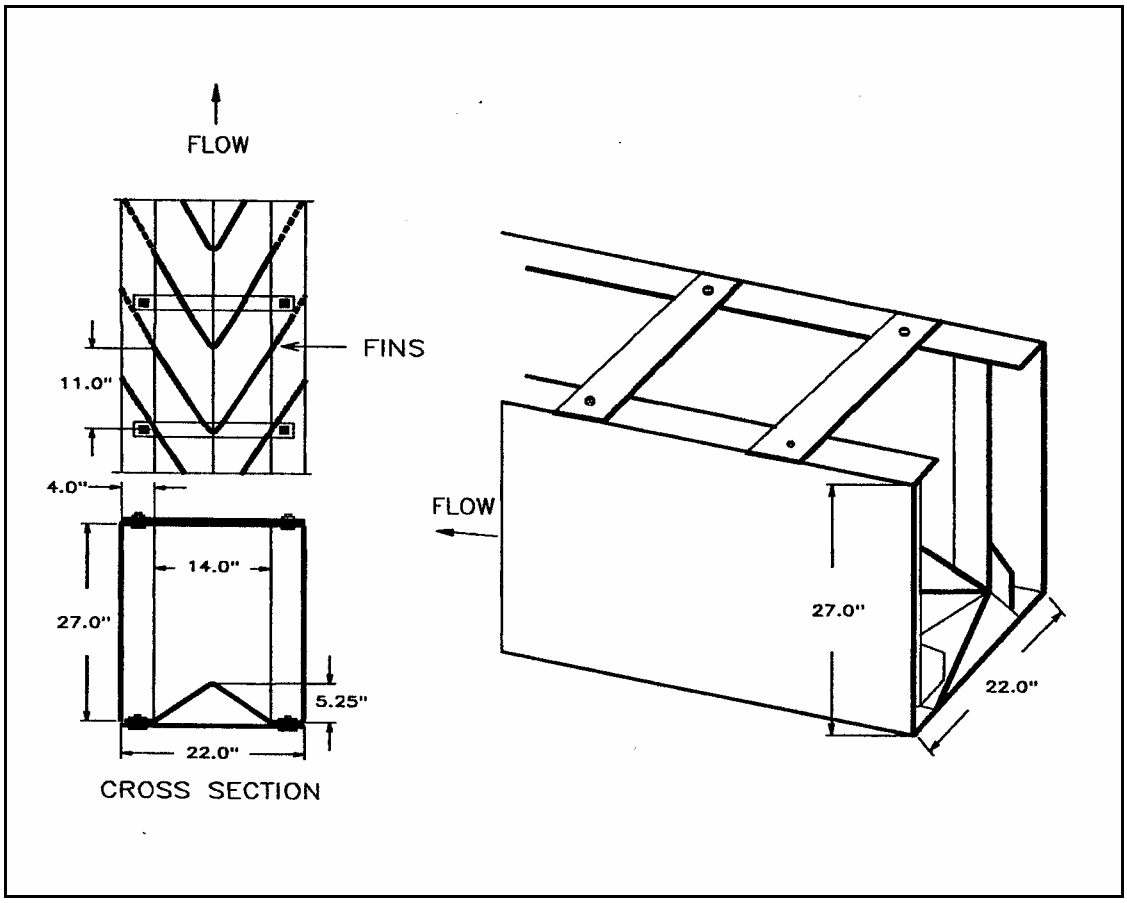
Sources: King County. 2000. Regional Road Maintenance Endangered Species Act Program Guidelines. Seattle, WA; Jan Smith, Trinity County DOT; Ross Taylor, Ross Taylor & Associates, Arcata CA.

B-6 FISH LADDERS

List of BMP Designs	Design #
Alaskan Steep-pass	B-6.1
Denil Fishway	B-6.2
Step-and-Pool Fishway	B-6.3

FISH LADDER: ALASKAN STEEP-PASS

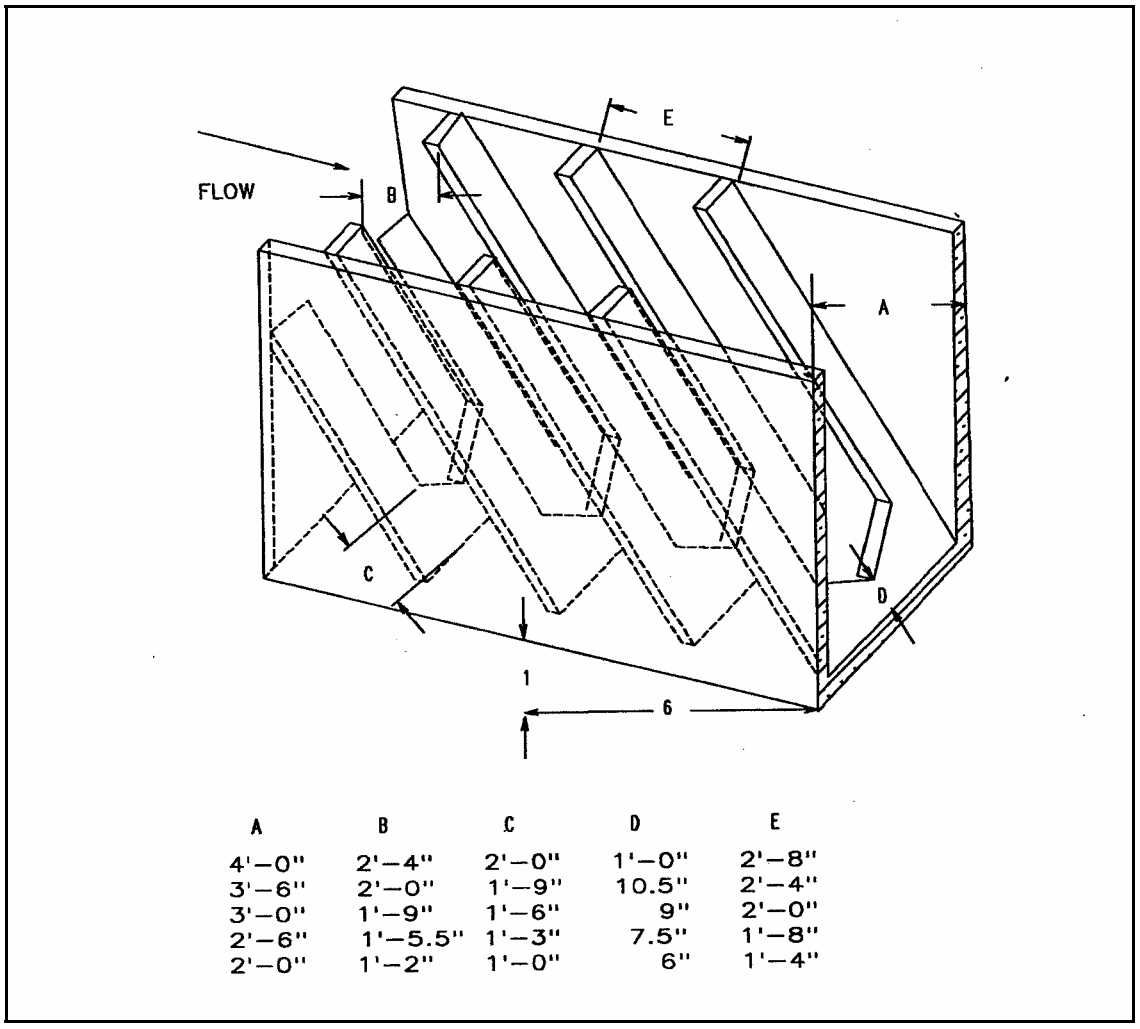
B-6.1



Source: California Dept. of Fish and Game (CDFG). 1998. California Salmonid Stream Habitat Restoration Manual. By Gary Flosi, et al. , 3rd edition. Sacramento, CA.

FISH LADDER: DENIL FISHWAY

B-6.2

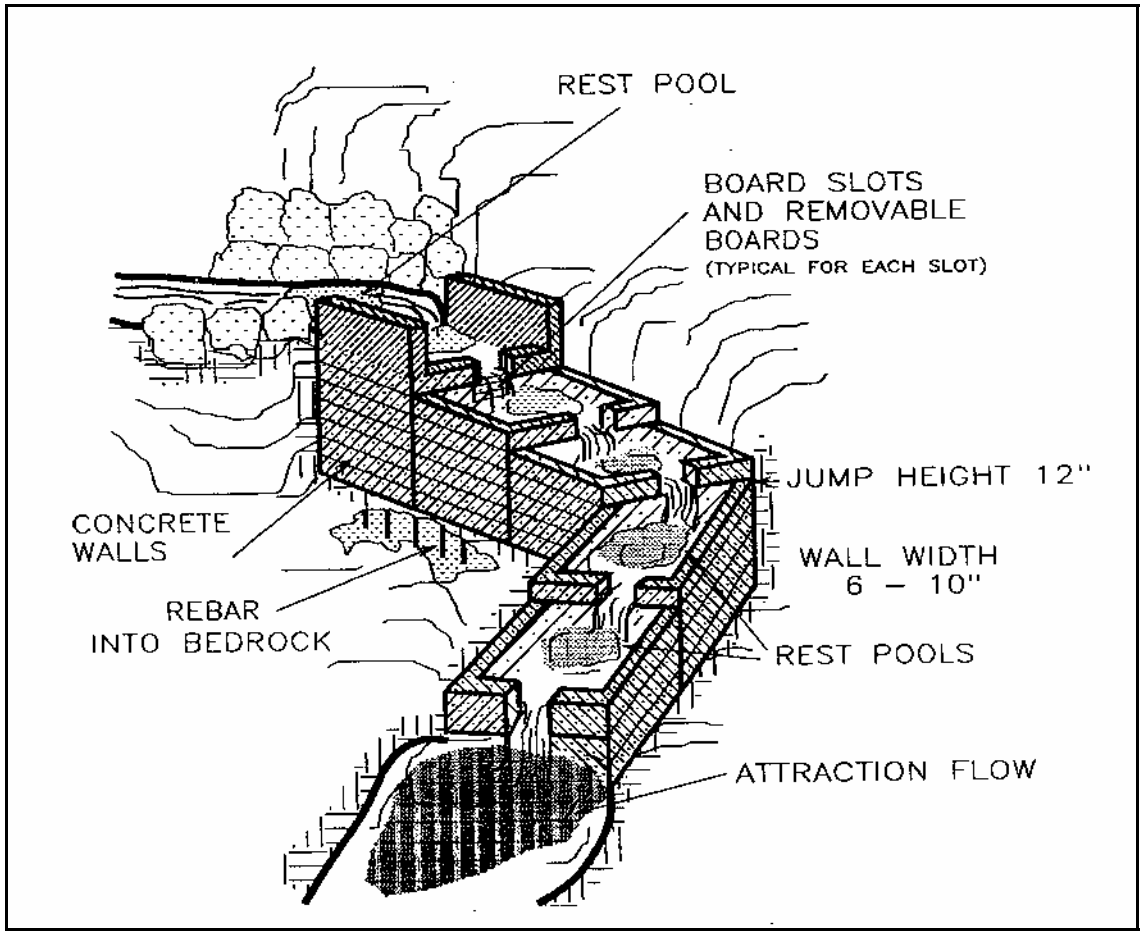


A	B	C	D	E
4'–0"	2'–4"	2'–0"	1'–0"	2'–8"
3'–6"	2'–0"	1'–9"	10.5"	2'–4"
3'–0"	1'–9"	1'–6"	9"	2'–0"
2'–6"	1'–5.5"	1'–3"	7.5"	1'–8"
2'–0"	1'–2"	1'–0"	6"	1'–4"

Source: California Dept. of Fish and Game (CDFG). 1998. California Salmonid Stream Habitat Restoration Manual. By Gary Flosi, et al. , 3rd edition. Sacramento, CA.

FISH LADDER: STEP-AND-POOL FISHWAY

B-6.3

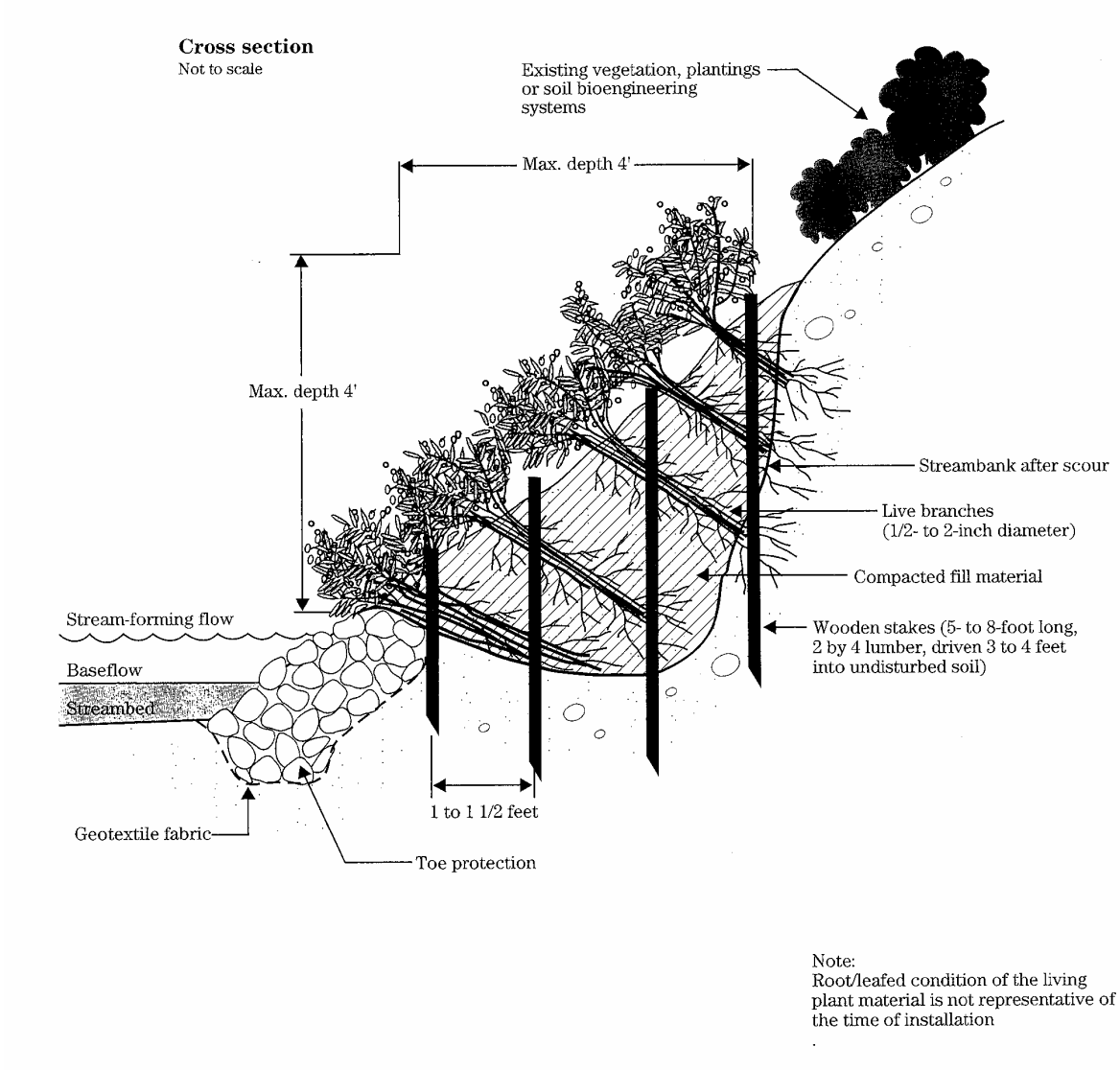


Source: California Dept. of Fish and Game (CDFG). 1998. California Salmonid Stream Habitat Restoration Manual. By Gary Flosi, et al. , 3rd edition. Sacramento, CA.

B-7 STREAMBANK PROTECTION / CHANNEL IMPROVEMENT

BIOENGINEERING: BRANCHPACKING

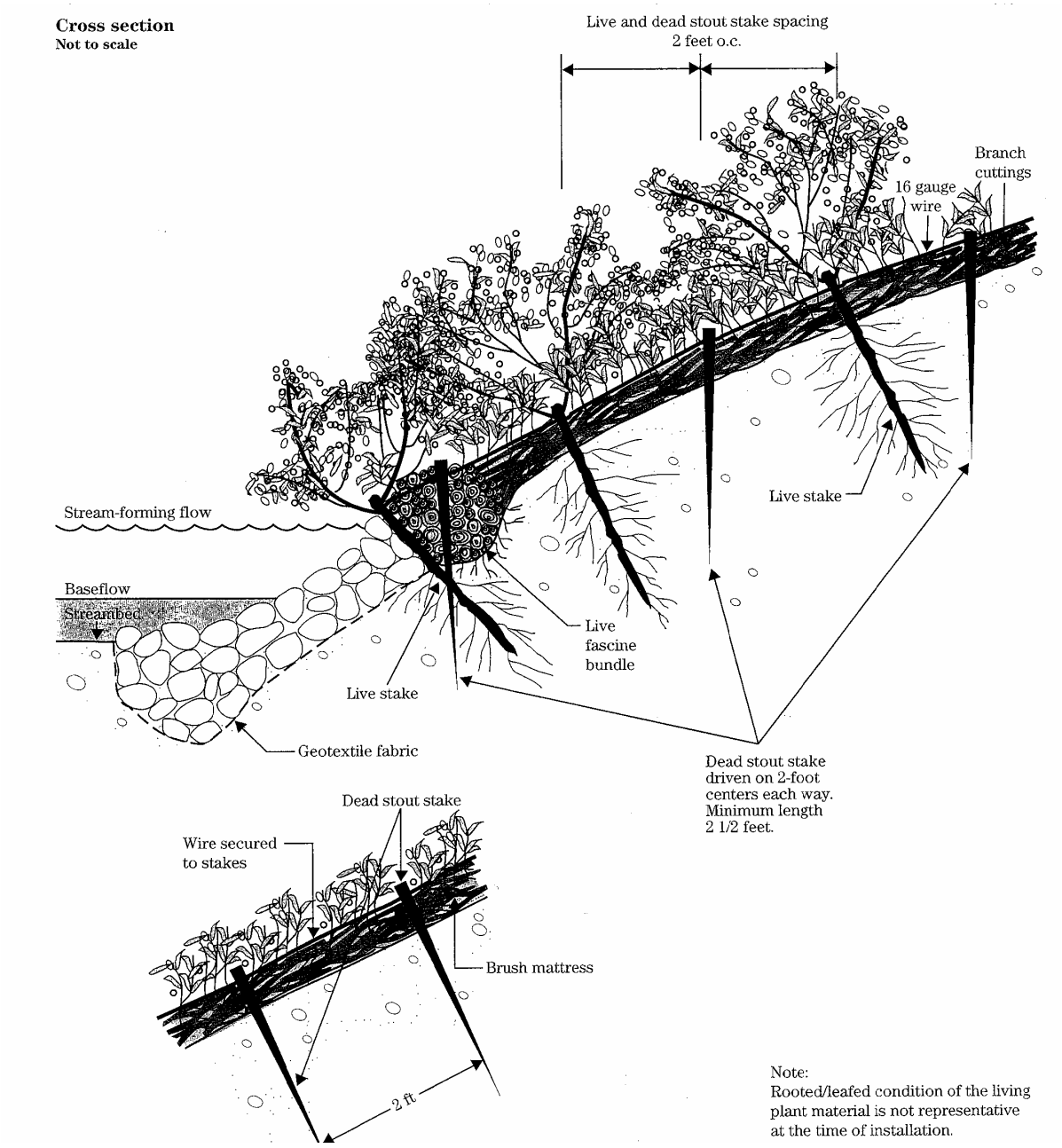
B-7.1



Note: CDFG encourages planting to below bankfull elevation and the addition of large woody debris (see B-7.4).

Source: USDA Natural Resources Conservation Service. 1996. Engineering Field Handbook – Streambank and Shoreline Protection. Part 650, Chapter 16.

BIOENGINEERING: BRUSHMATTRESS B-7.2

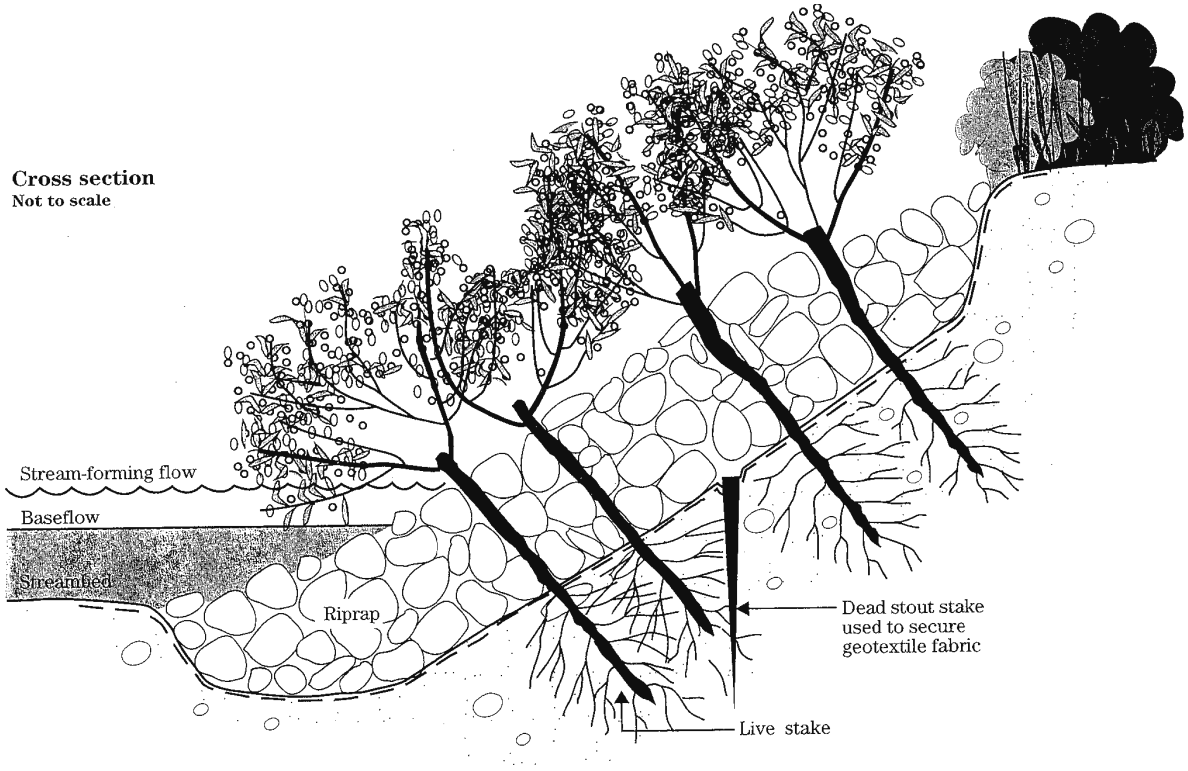


Note: CDFG encourages planting to below bankfull elevation and the addition of large woody debris (see B-7.4).

Source: USDA Natural Resources Conservation Service. 1996. Engineering Field Handbook – Streambank and Shoreline Protection. Part 650, Chapter 16.

BIOENGINEERING: JOINT PLANTING

B-7.3



Source: USDA Natural Resources Conservation Service. 1996. Engineering Field Handbook – Streambank and Shoreline Protection. Part 650, Chapter 16.

BIOENGINEERING: B-7.4
LARGE WOODY DEBRIS - LWD

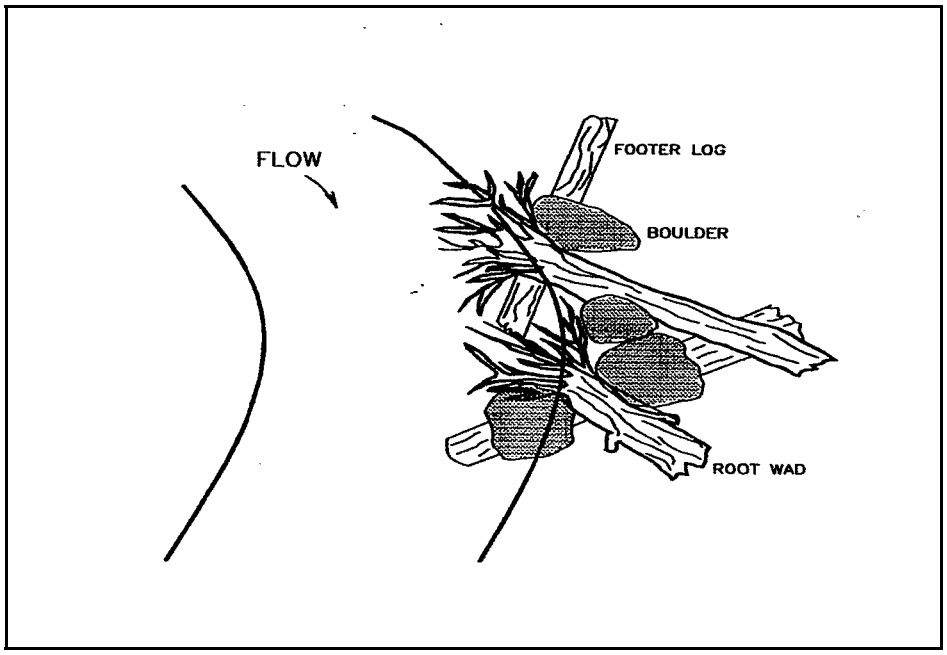


Figure 1. Native material revetment – Plan View. (After Rosgen, 1993)

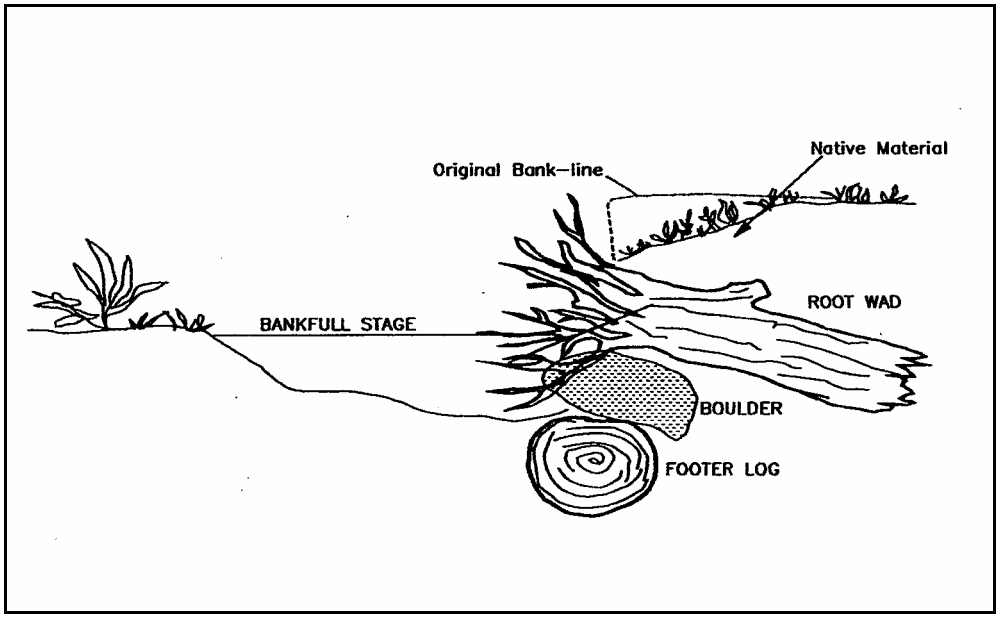
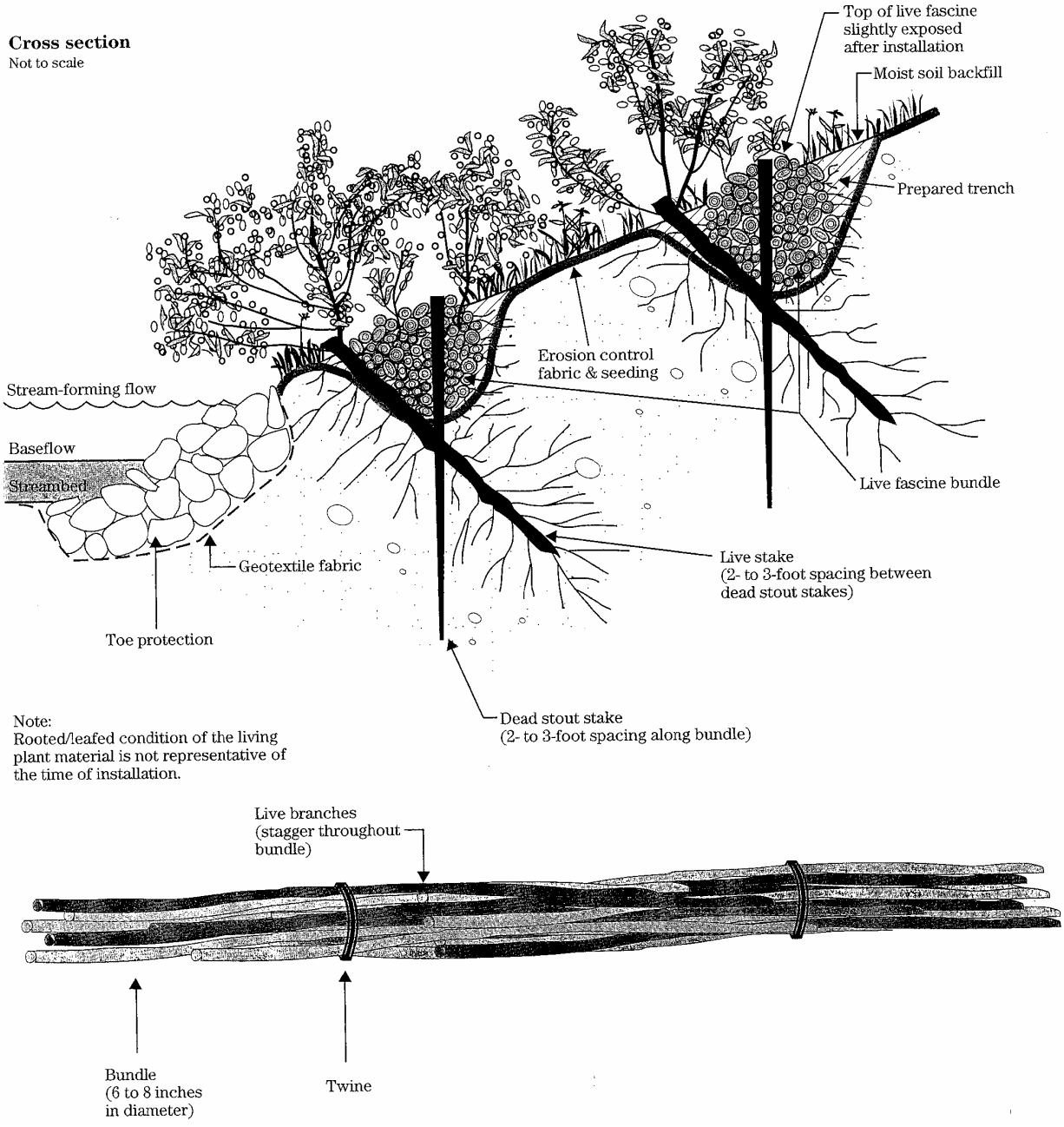


Figure 2. Native material revetment – Side View. (After Rosgen, 1993).

Source: California Dept. of Fish and Game (CDFG). 1998. California Salmonid Stream Habitat Restoration Manual. By Gary Flosi, et al. 3rd edition. Sacramento, CA.

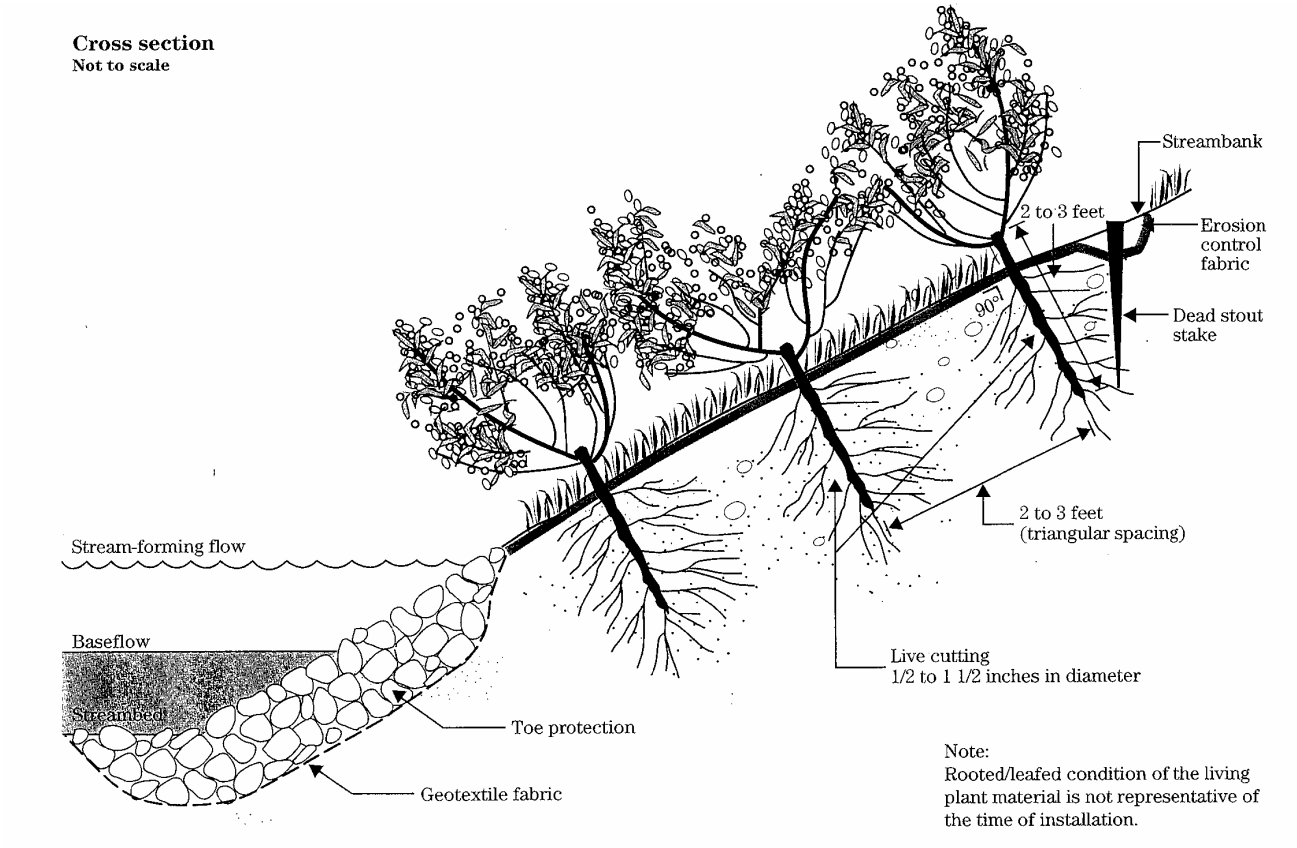
BIOENGINEERING: LIVE FASCINE

B-7.5



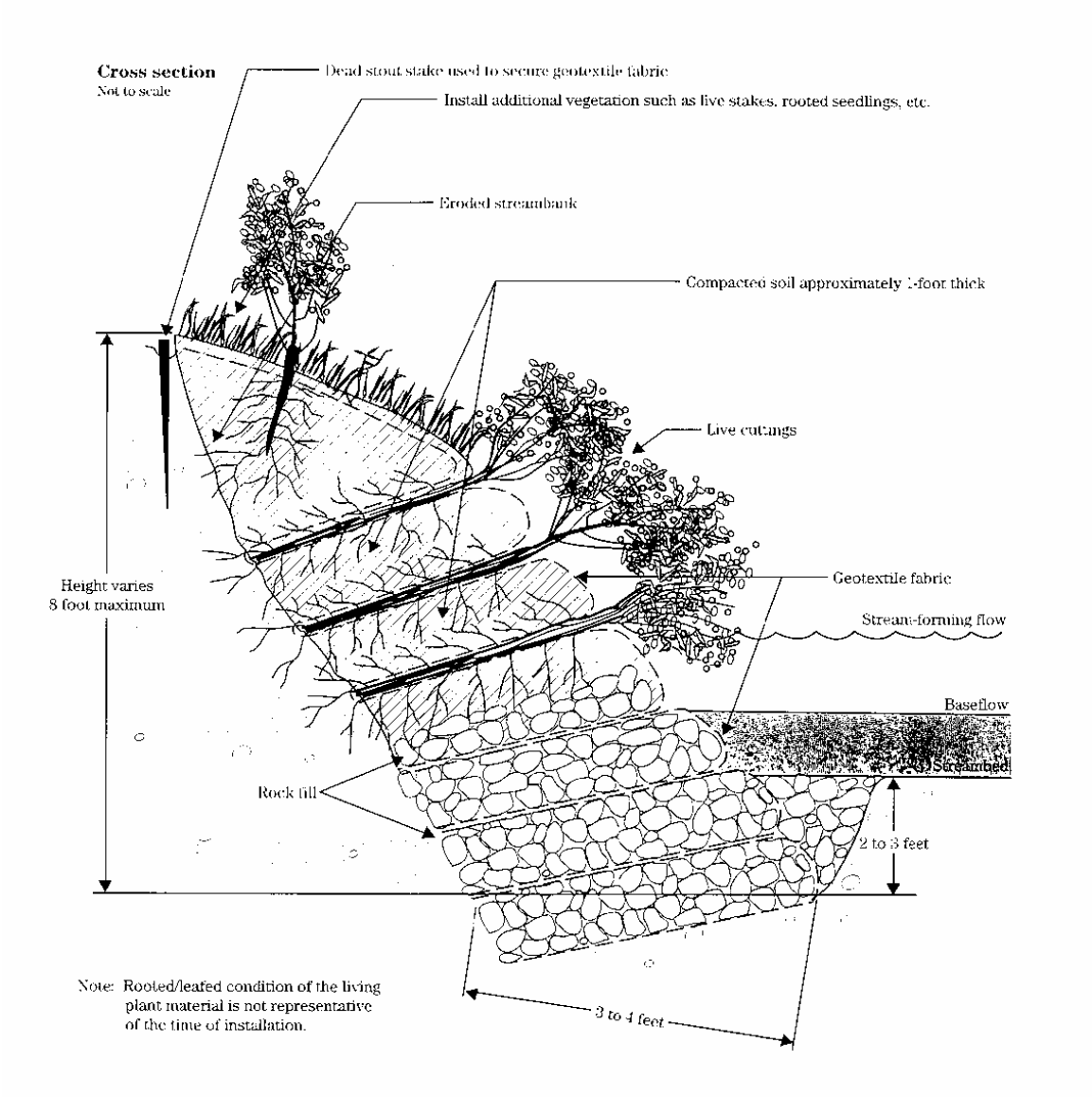
Source: USDA Natural Resources Conservation Service. 1996. Engineering Field Handbook – Streambank and Shoreline Protection. Part 650, Chapter 16.

BIOENGINEERING: B-7.6
LIVE STAKE



Source: USDA Natural Resources Conservation Service. 1996. Engineering Field Handbook Streambank and Shoreline Protection. Part 650, Chapter 16.

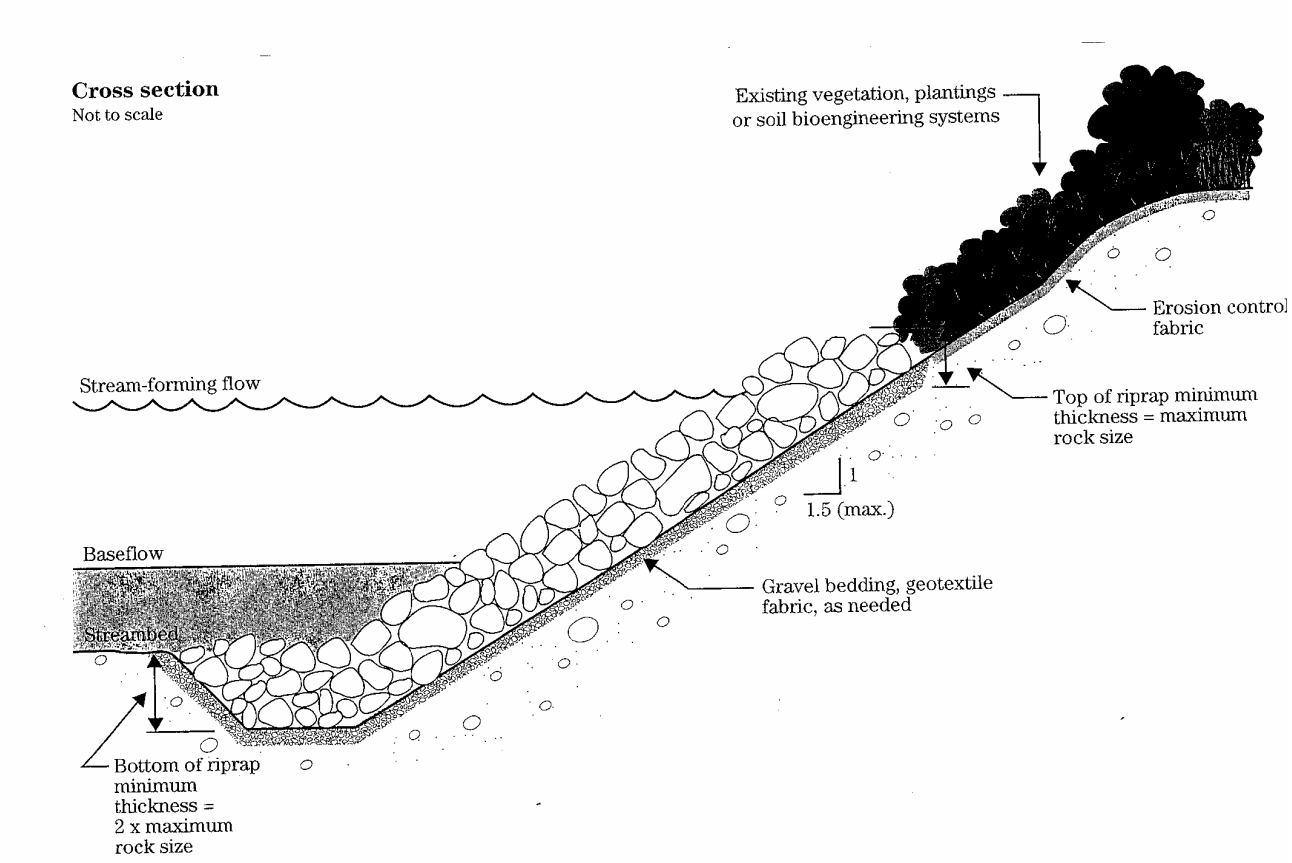
BIOENGINEERING: VEGETATED GEOGRID B-7.7



Source: USDA Natural Resources Conservation Service. 1996. Engineering Field Handbook Streambank and Shoreline Protection. Part 650, Chapter 16.

ROCK RIPRAP DESIGN DETAILS

B-7.8



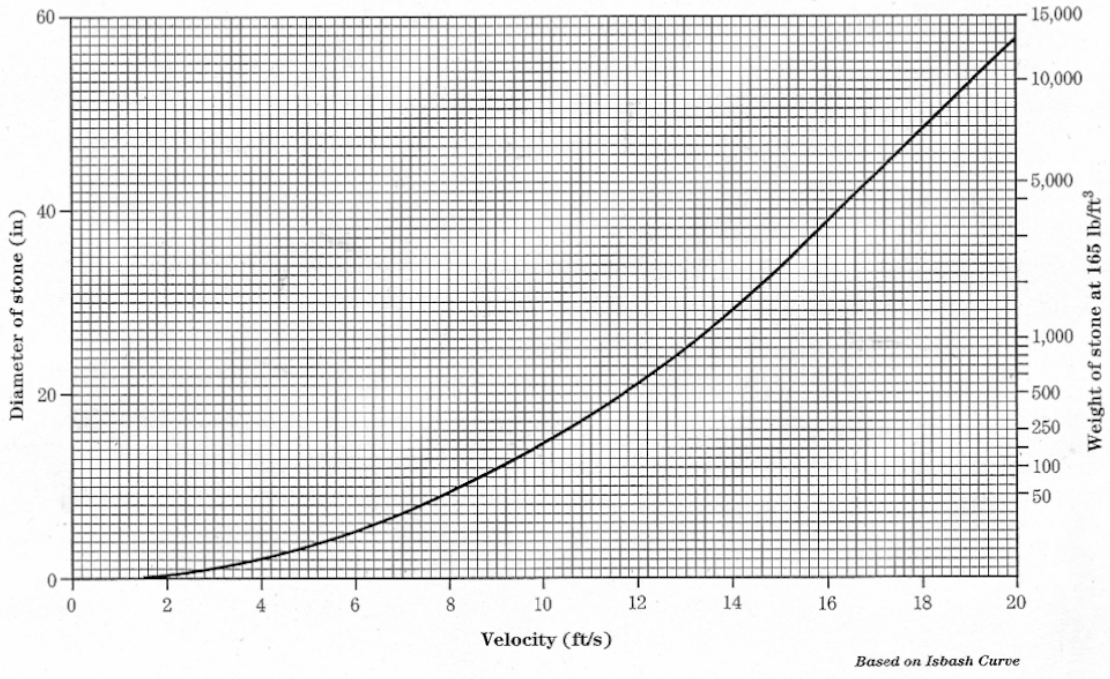
Source: USDA Natural Resources Conservation Service. 1996. Engineering Field Handbook Streambank and Shoreline Protection. Part 650, Chapter 16.

From NRCS Manual:

Isbash Curve

The Isbash Curve, because of its widespread acceptance and ease of use, is a direct reprint from the previous chapter 16, Engineering Field Manual. The curve was developed from empirical data to determine a rock size for a given velocity. See figure 16A–1. The user can read the D_{100} rock size (100 percent of riprap ≤ this size) directly from the graph in terms of weight (pounds) or dimension (inches). Less experienced users should use this method for quick estimates or comparison with other methods before determining a final design.

Figure 16A–1 Rock size based on Isbash Curve



Procedure
1. Determine the design velocity.
2. Use velocity and fig. 16A-1 (Isbash Curve) to determine basic rock size.
3. Basic rock size is the D_{100} size.

Source: USDA Natural Resources Conservation Service. 1996. Engineering Field Handbook Streambank and Shoreline Protection. Part 650, Chapter 16, Appendix 16A.

Figure 16A–2 Rock size based on Far West States (FWS)-Lane method

$D_s = \frac{3.5}{CK} w D S$ $D_s = D_{75}$ size rock in inches

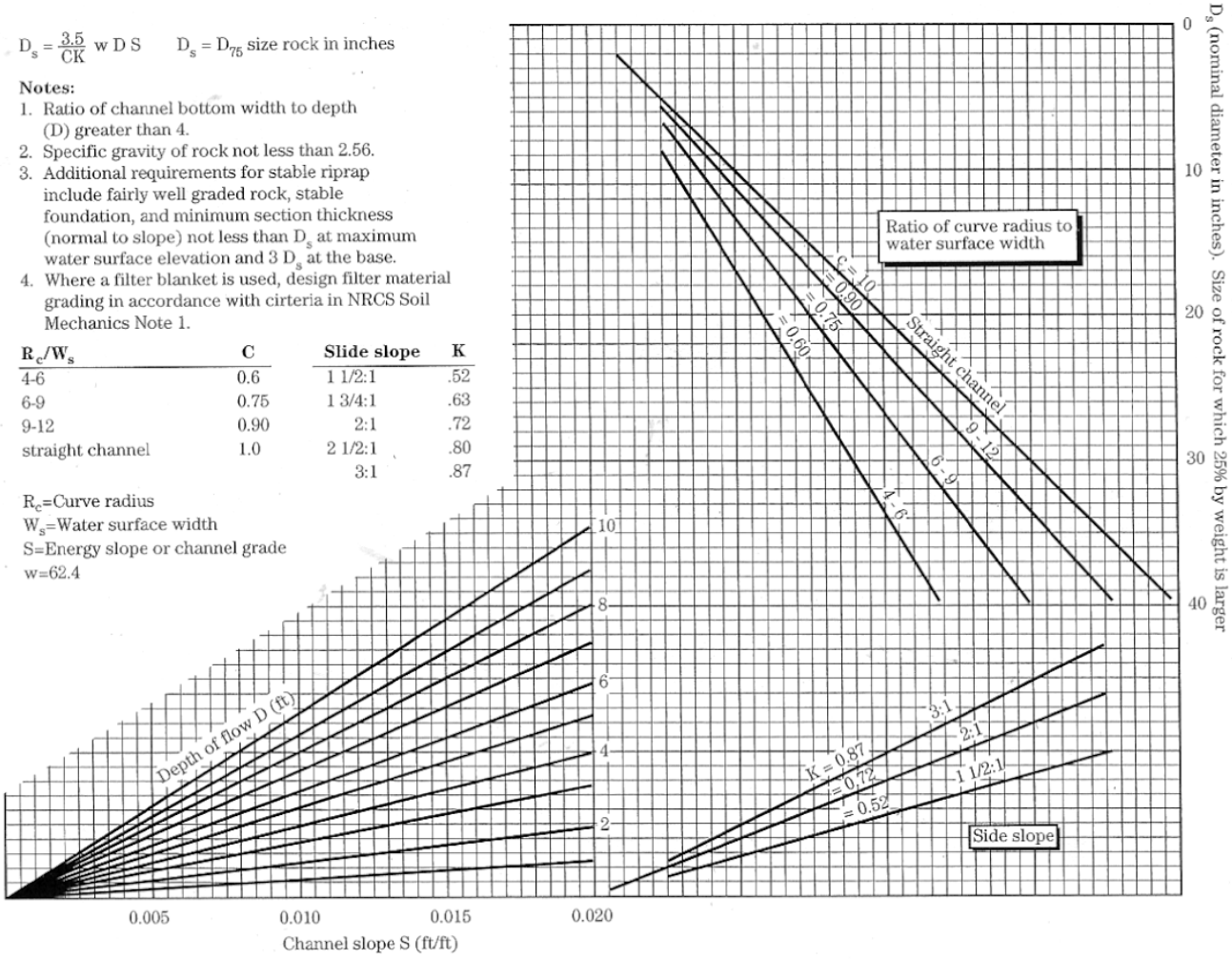
Notes:

1. Ratio of channel bottom width to depth (D) greater than 4.
2. Specific gravity of rock not less than 2.56.
3. Additional requirements for stable riprap include fairly well graded rock, stable foundation, and minimum section thickness (normal to slope) not less than D_s at maximum water surface elevation and 3 D_s at the base.
4. Where a filter blanket is used, design filter material grading in accordance with cirteria in NRCS Soil Mechanics Note 1.

R_c/W_s	C
4-6	0.6
6-9	0.75
9-12	0.90
straight channel	1.0

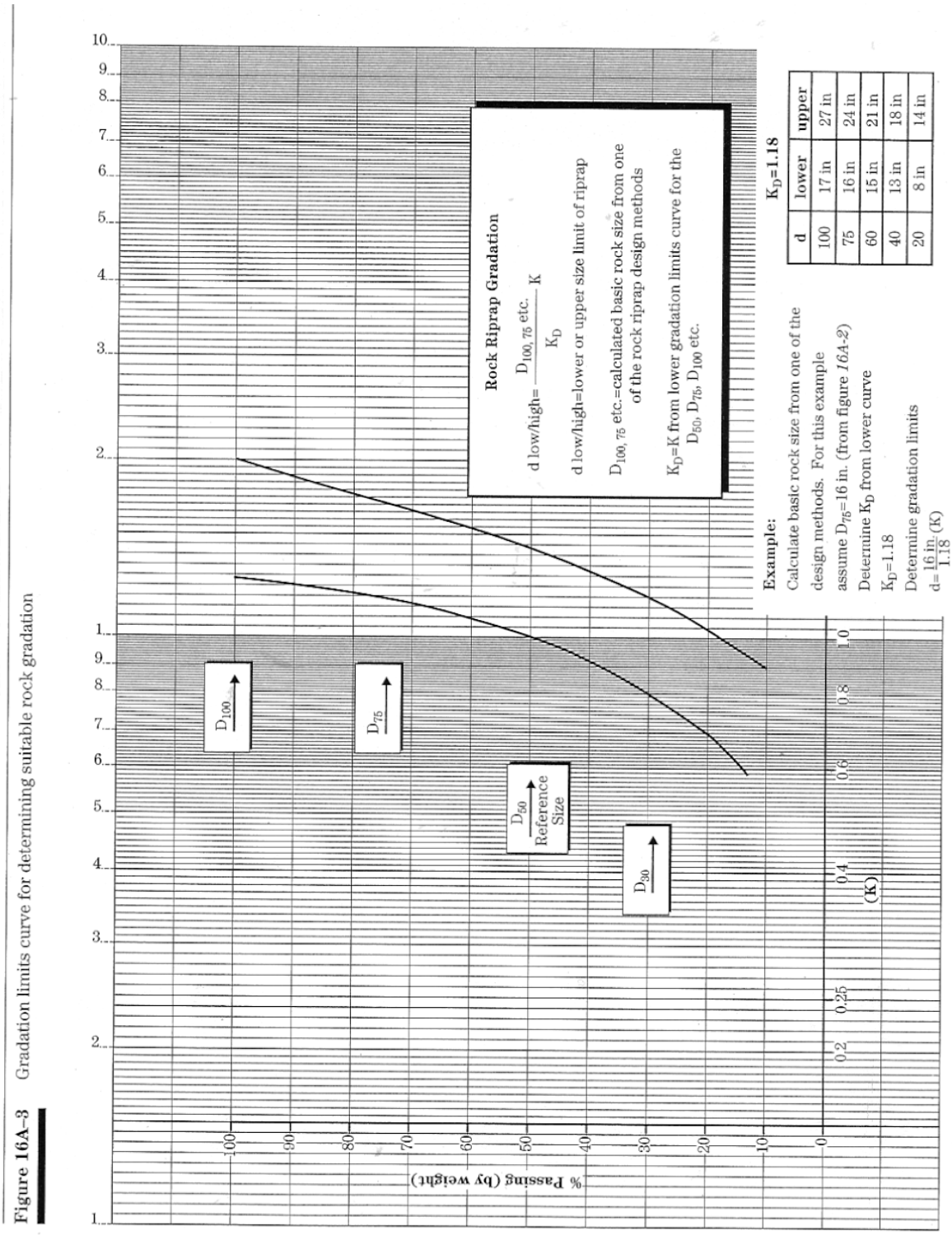
Slide slope	K
1 1/2:1	.52
1 3/4:1	.63
2:1	.72
2 1/2:1	.80
3:1	.87

R_c=Curve radius
W_s=Water surface width
S=Energy slope or channel grade
w=62.4



Procedure

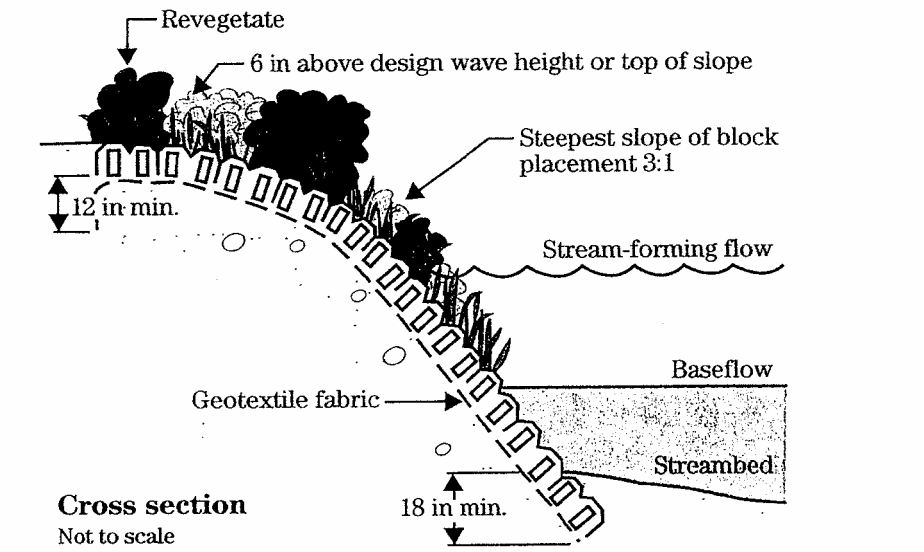
1. Determine the average channel grade or energy slope.
2. Enter fig. 16A-2 with energy slope, flow depth, and site physical characteristics to determine basic rock size.
3. Basic rock size is the D_{75} size.



d	K_D=1.18 lower	upper
100	17 in	27 in
75	16 in	24 in
60	15 in	21 in
40	13 in	18 in
20	8 in	14 in

Figure 16A–3 Gradation limits curve for determining suitable rock gradation

CONCRETE CELLULAR BLOCK B-7.10



Source: USDA Natural Resources Conservation Service. 1996. Engineering Field Handbook Streambank and Shoreline Protection. Part 650, Chapter 16.

STREAMBED GRAVEL B-7.11

Description: Streambed gravel is sediment-free, non-angular (smooth) gravel of variable sizes used for habitat protection and maintenance, or sometimes in culvert replacements (which may be in watercourses or streams).

Purpose:
- Providing a natural substrate for fish
- Minimizing siltation in ditches and /or stormwater facilities

What to do:
- Place gravel in accordance with applicable design and permit conditions.
- Check gravel gradation to ensure it meets design specifications.
- If gravel has excessive fines, wash rock off-site (at a location where washed water cannot enter watercourses, streams or wetlands) until it runs clear.
- Haul material in clean truck bed.
- Dump cleaned rock onto tarped area on-site.
- Place a cover and berm around clean rock stockpiles. Re-wash rock before using if it becomes dirty.

What NOT to do:
- Use gravel that does not meet design specifications.

Source: King County. 2000. Regional Road Maintenance Endangered Species Act Program Guidelines. Seattle, WA.

B-8 WATER & RUNOFF DIVERSIONS

List of BMP Designs	Design #
Aqua Barrier	B-8.1
Coffer Dam	B-8.2
Dewatering	B-8.3
Diversion Berm	B-8.4
Diversion Channel	B-8.5
Rolling Dip	B-8.6
Sandbag	B-8.7
Slope Drain - Temporary	B-8.8
Slope Drain – Overside	B-8.9
Stream Bypass	B-8.10

AQUA BARRIER B-8.1

Description: An aqua barrier is a manufactured vinyl tube filled with water to provide a temporary / portable dam or barrier positioned to contain or divert the movement of water. It is a type of cofferdam.

Purpose:

- Providing a dry construction area in a stream or waterway.
- Providing a bypass for a stream or waterway.
- Creating a temporary reservoir for water storage.
- Excluding waters from work area under and around bridges or piers.

What to Do:

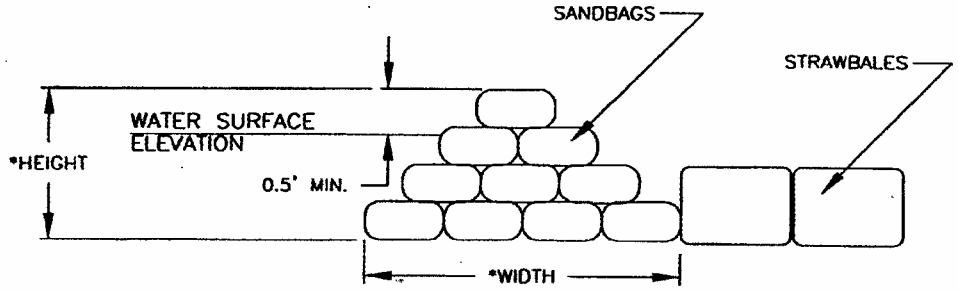
- Use in accordance with the permit requirements.
- Refer to Fish Exclusion procedures (B-5).
- Follow manufacturer's recommendations and guidelines for installation and safety measures.
- Wear knives so workers can deflate in an emergency.
- Keep a repair kit on site in case of small punctures.
- Remove any visible rocks or sharp objects before installing barrier.
- Barriers can be used on dry ground, or in standing or flowing water.
- If needed, join multiple aqua barriers with connections.
- Inspect several times daily and make any needed repairs immediately.
- Allow to dry before rolling up for storage.

What NOT to Do:

- Do not cross more than 2/3 of the main flow of any salmonid-bearing water at the time of the year when any life stage of the fish is expected to be present.

Source: King County. 2000. Regional Road Maintenance Endangered Species Act Program Guidelines. Seattle, WA.

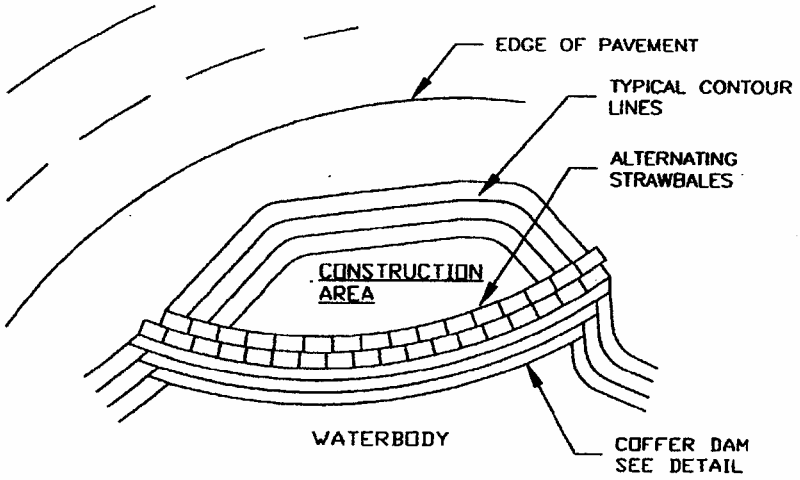
COFFERDAM B-8.2



* HEIGHT AND WIDTH OF COFFER DAM SHALL BE DETERMINED BY THE WATER SURFACE ELEVATION AT THE TIME OF CONSTRUCTION.

NOTES:

1. SANDBAGS SHALL BE USED IN ACCCORDANCE WITH APPLICABLE PERMITS.
2. INSTALL COFFER DAM AND DEWATER SITE PRIOR TO CONSTRUCTION
3. PROVIDE ADEQUATE FREEBOARD.



Source: King County. 2000. Regional Road Maintenance Endangered Species Act Program Guidelines. Seattle, WA.

DEWATERING B-8.3

Description: Dewatering can be used to keep water from a work area by using any or all of the following: pump, barrier, vactor, or bypass culvert.

Purpose:
- Allowing work to be performed in dry conditions
- Reducing the transport of soil particles by flowing water
- Reducing the liquefaction of soils.
- Used in ditches, watercourses, streams, channels, swales, and excavations.

What to Do:
- Determine if the project will require continuous dewatering.
- Schedule pumping, monitoring, and maintenance activities accordingly.
- Dewatering must be used in accordance with applicable design and permit conditions.
- Refer to "Fish Exclusion" procedures in B-5.
- Install dewatering devices.
- Install site-specific barrier before dewatering to prevent exterior water from entering construction area.
- Ensure water discharged from the site is not allowed to cause erosion.
- Dewatered water must be discharged to:
  - A containment device
  - A sanitary sewage system
  - Other BMPs to remove sediment before reintroducing to watercourse.
- Inspect daily and make any required repairs immediately.
- Check for erosion at discharge and repair or move as necessary.
- Provide adequate fuel supply and backup pumps in the event of a mechanical failure.

What NOT to Do:
- Do not use where flows are greater than pump capacity.

Source: King County. 2000. Regional Road Maintenance Endangered Species Act Program Guidelines. Seattle, WA.

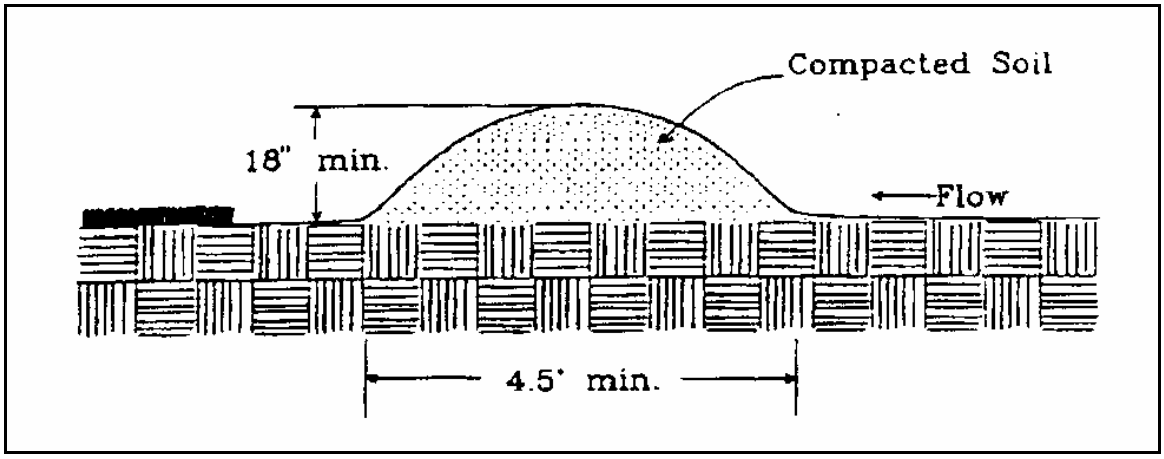
DIVERSION BERM B-8.4

Description: A diversion berm is a temporary ridge of compacted soil constructed at the top or base of a disturbed slope. These structures generally have a life expectancy of 18 months or less.

Purpose:
- Diverting storm runoff from upslope drainage areas away from unprotected disturbed areas and toward a stabilized outlet.
- Diverting sediment-laden runoff from a disturbed area to a sediment-containment facility such as a sediment trap or a sediment basin.

What to Do:
- Install as a first step in the land-disturbing activity.
- Compact adequately to prevent failure.
- Have a minimum freeboard of 0.3 feet.
- Apply temporary seeding and mulch following construction of the berm.
- Clear plastic may be used as an additional erosion control method (B-4.9).
- Inspect daily and make any required repairs.
- When no longer needed, remove sediment build-up and the berm. Revegetate area disturbed by berm removal (if applicable).

What NOT to Do:
- Do not use if water flow is likely to erode the berm.
- Do not use if there is indequate space for construction.



Source: King County. 2000. Regional Road Maintenance Endangered Species Act Program Guidelines. Seattle, WA.

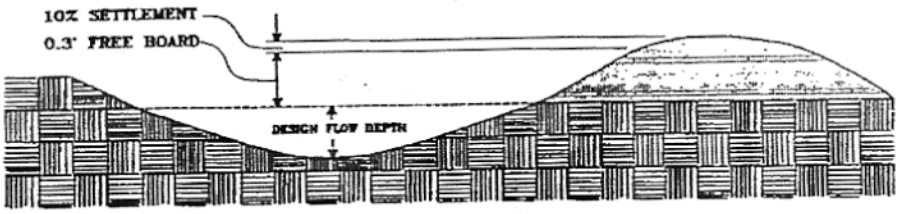
DIVERSION CHANNEL B-8.5

Purpose:

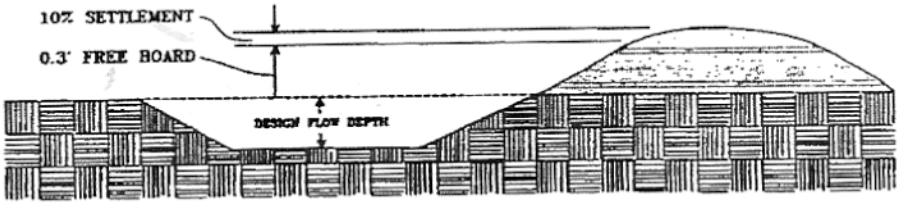
- Reducing slope length
- Intercepting and diverting stormwater runoff to stabilized outlets at non-erosive velocities
- Intercepting sheet flow
- Decreasing down slope sheet flow velocity

What Not to Do:

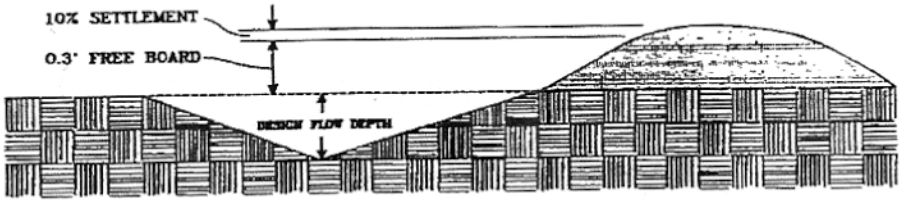
- Do not use if the downslope is greater than 2 horizontal to 1 vertical.
- Do not use if water flow is likely to erode the channel.



TYPICAL PARABOLIC DIVERSION



TYPICAL TRAPEZOIDAL DIVERSION



TYPICAL VEE-SHAPED DIVERSION

Source: King County. 2000. Regional Road Maintenance Endangered Species Act Program Guidelines. Seattle, WA.

ROLLING DIP B-8.6

Description: Rolling dips are breaks in the grade of a road. The dips are sloped either into the inside ditch or to the outside of the road edge to drain and disperse road surface runoff. Rolling dips are most frequently used on outsloped roads.

Purpose:

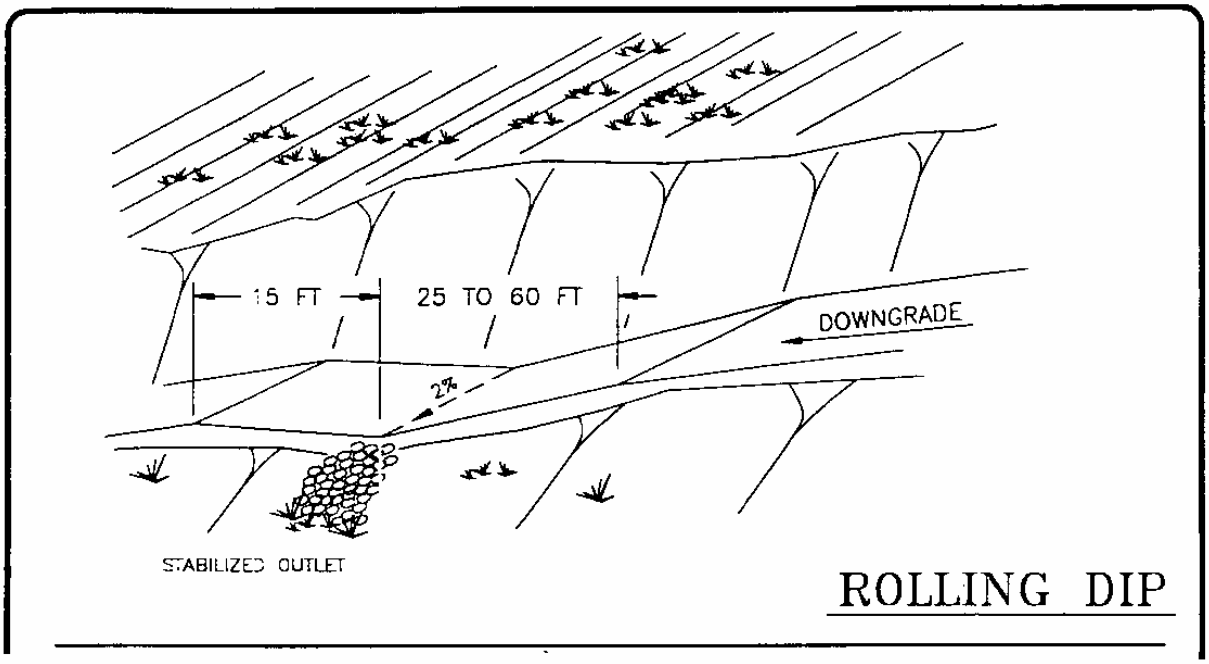
- Draining and dispersing road surface runoff to prevent rilling and surface erosion.
- Improving surface drainage on existing roads with low volume traffic and lower speeds.

What to Do:

- Excavate the entire rolling dip into the roadbed; do not create any fill.
- Angle the axis of a rolling dip about 30 degrees to the road alignment.
- Make sure that the down-road side of the dip has a higher slope than the original grade below it, to ensure that runoff cannot continue down the road surface.
- As a road becomes steeper, make dips deeper and place at a steeper angle to adequately capture and divert road runoff.

What NOT to Do:

- Grader operators should not fill the depressions with soil or cut deeply into the lower part of the rising section, which would remove the important grade change.



Sources: McCullah, J. 1992. Erosion and Sediment Control Standards Design Manual – County of Shasta. Prepared for the Western Shasta RCD. Redding CA. 187 p.; Weaver, W.E. and D.K. Hagans. 1994. Handbook for Forest and Ranch Roads. Mendocino County RCD, Ukiah CA.

SANDBAG B-8.7

Description: A sandbag is a pre-manufactured cloth or plastic bag (polypropylene) filled with sand or gravel. Sandbags can be used to keep water from the work area, for settling and reduction in water velocity and erosive forces.

Purpose:
- Serving as a cofferdam
- Providing filtering for sediment (when used with clean pea gravel)
- Decreasing water velocity, such as in a ditch
- Protecting areas from flooding

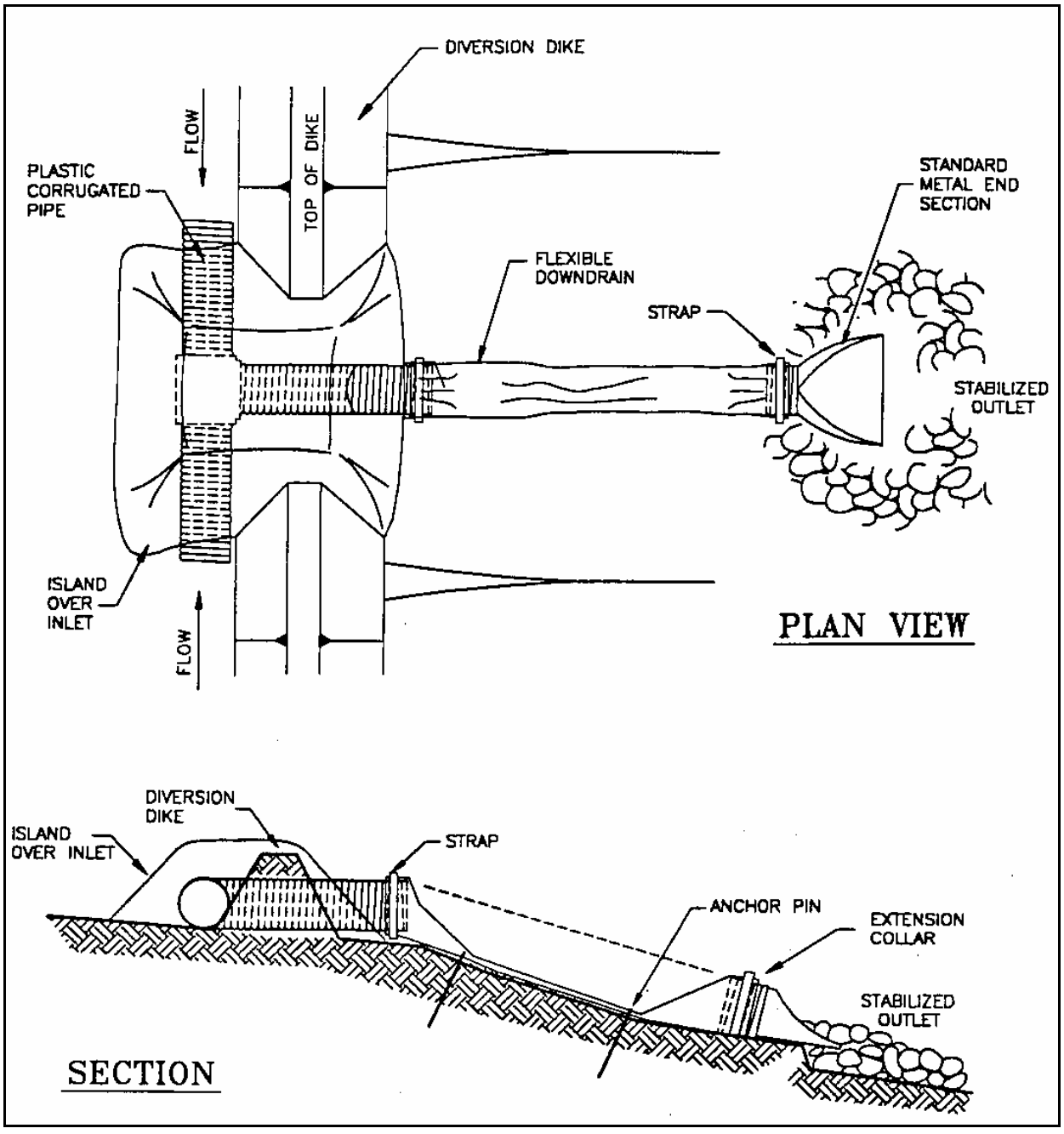
What to Do:
- Apply in accordance with permit requirements
- Refer to Fish Exclusion procedures in B-5
- If sandbag filling is used as streambed gravel, it must be washed before filling bags and appropriately sized according to design or permit conditions. Wash rock off-site (at a location where washed water can not enter watercourses, streams or wetlands) until water runs clear.
- Secure ends of sandbags to ensure material does not scatter.
- When used as a barrier, stack bags tightly together and in alternating, brick-layer fashion.
- Inspect daily during workweek and replace any damaged sandbags.
- Remove sediment when deposits reach ½ the height of the bags.
- Release contents of gravel-filled bags on site, in streams, when so stated in the specific permit conditions. Remove bags from job site.

What NOT to Do:
- Do not use when permit conditions state not to.

Source: King County. 2000. Regional Road Maintenance Endangered Species Act Program Guidelines. Seattle, WA.

SLOPE DRAIN - TEMPORARY

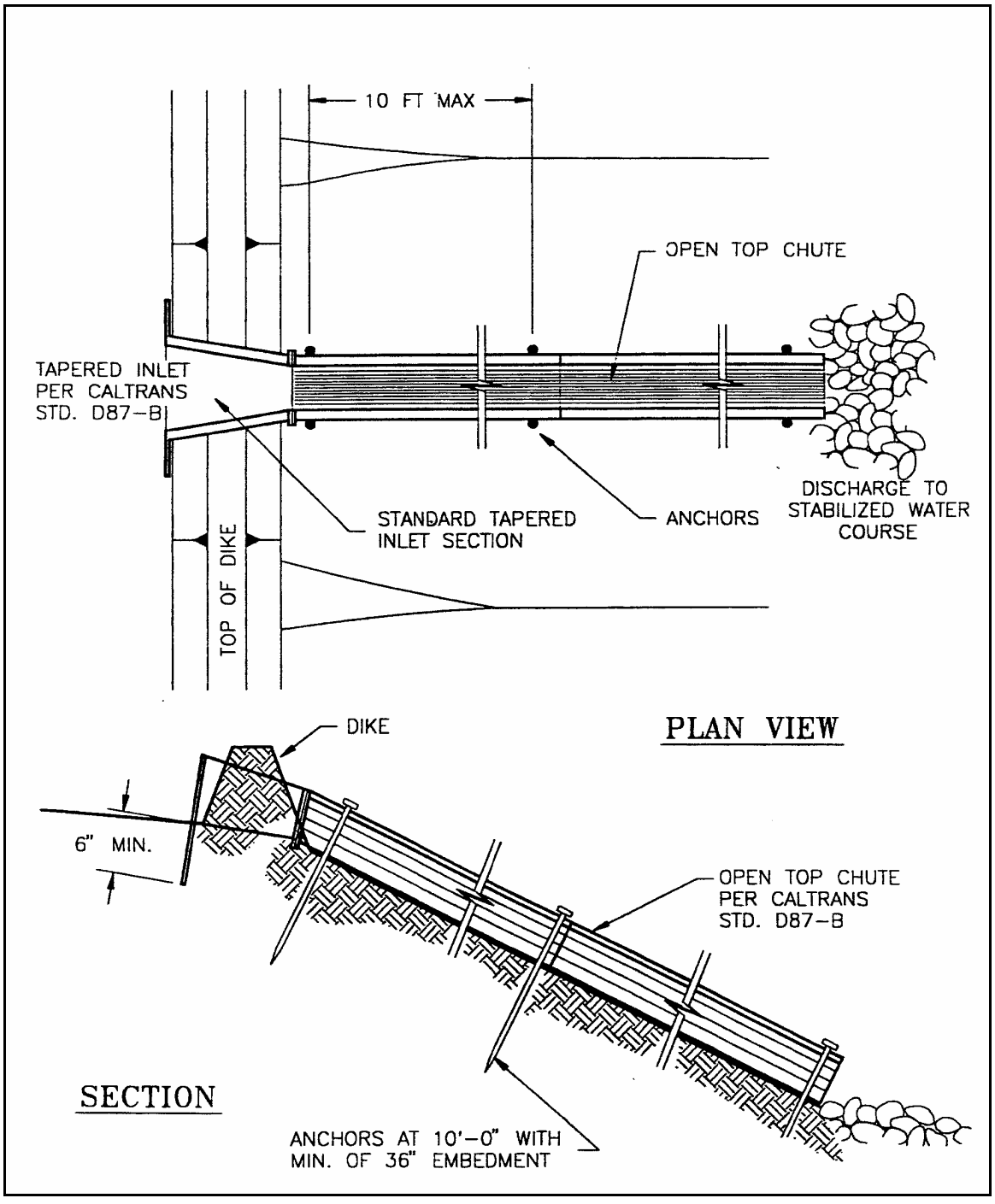
B-8.8



Source: McCullah, J. 1992. Erosion and Sediment Control Standards Design Manual – County of Shasta. Prepared for the Western Shasta RCD. Redding CA. 187 p.

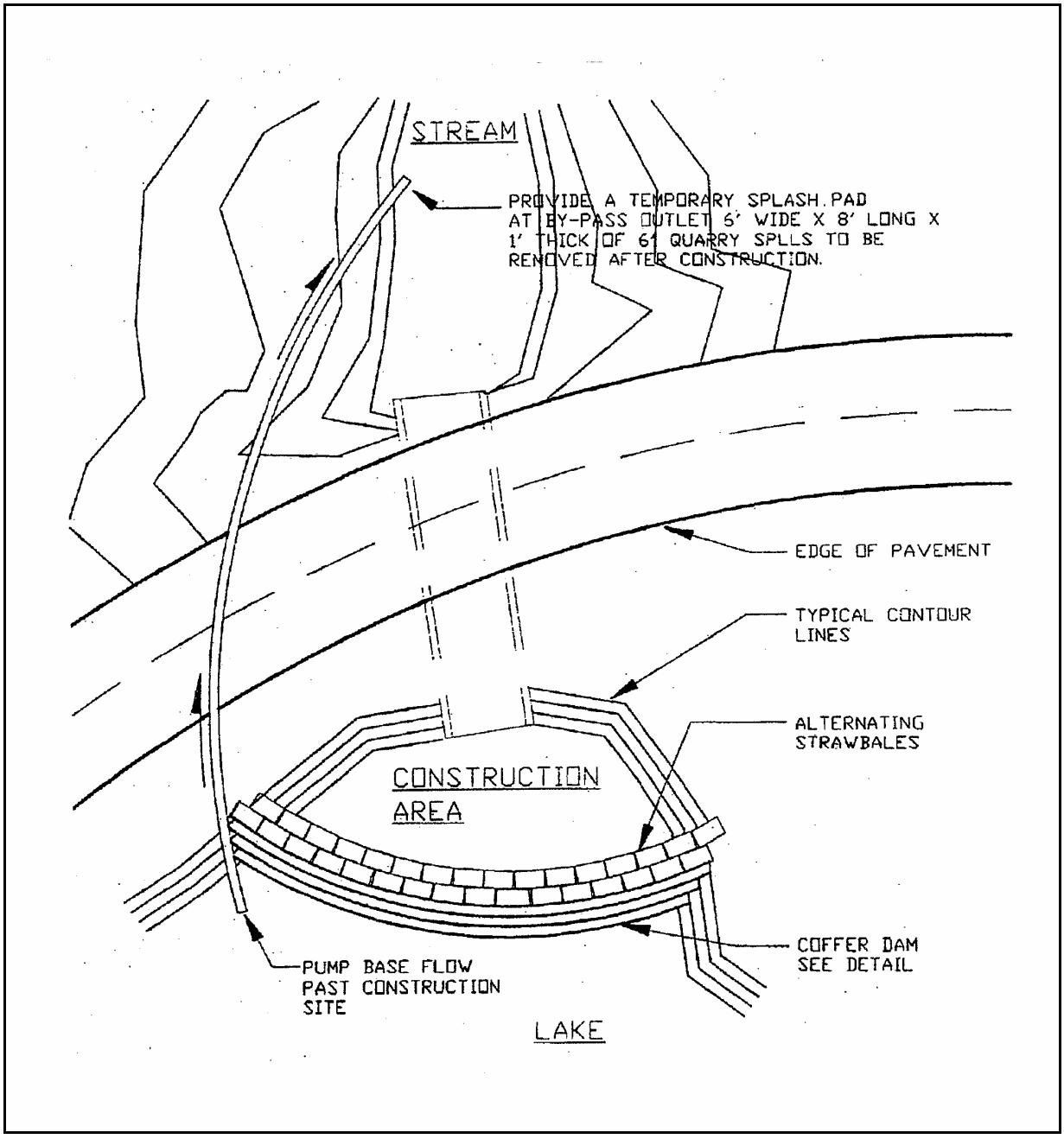
SLOPE DRAIN - OVERSIDE

B-8.9



Source: McCullah, J. 1992. Erosion and Sediment Control Standards Design Manual – County of Shasta. Prepared for the Western Shasta RCD. Redding CA. 187 p.

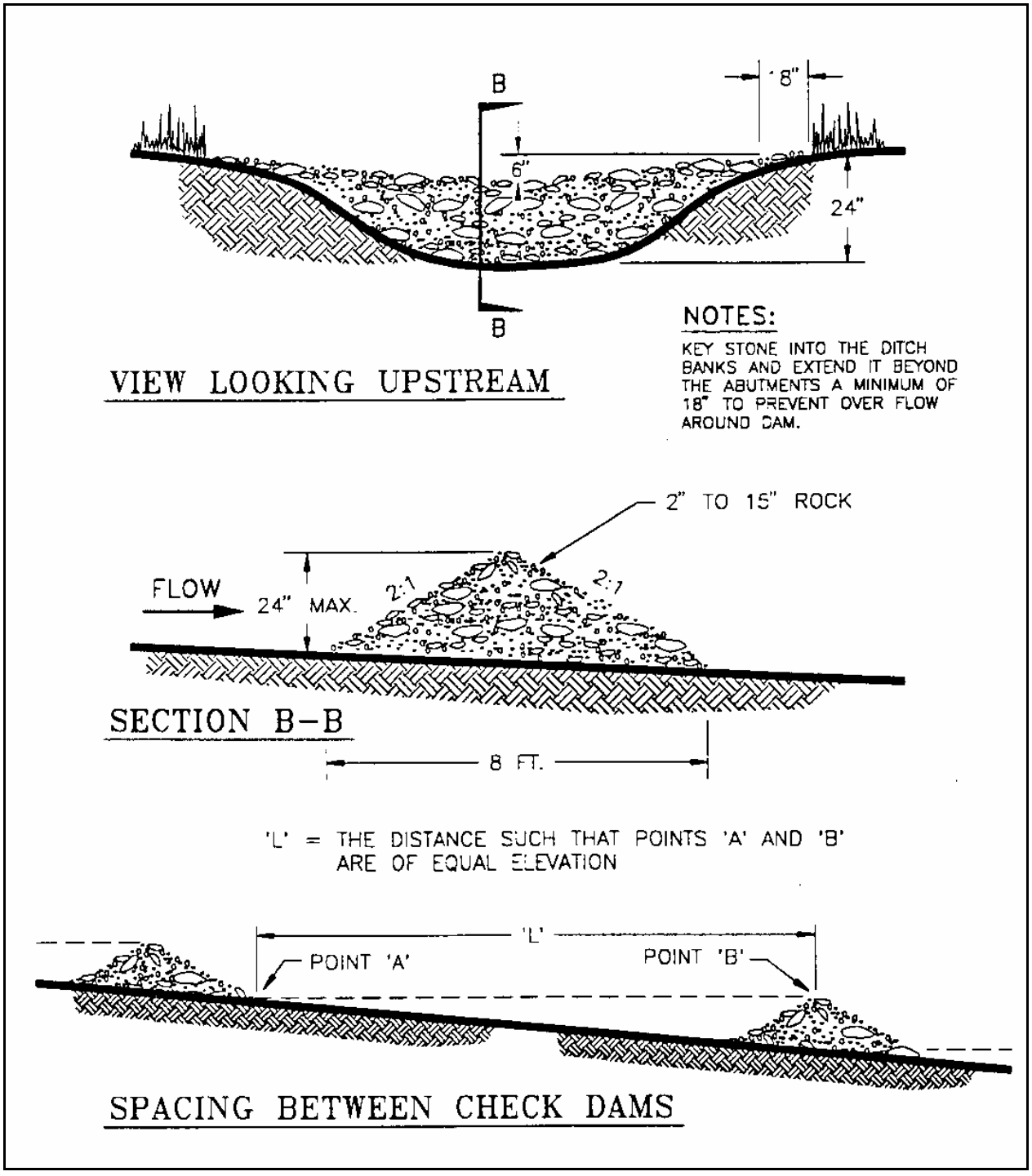
STREAM BYPASS B-8.10



Source: King County. 2000. Regional Road Maintenance Endangered Species Act Program Guidelines.

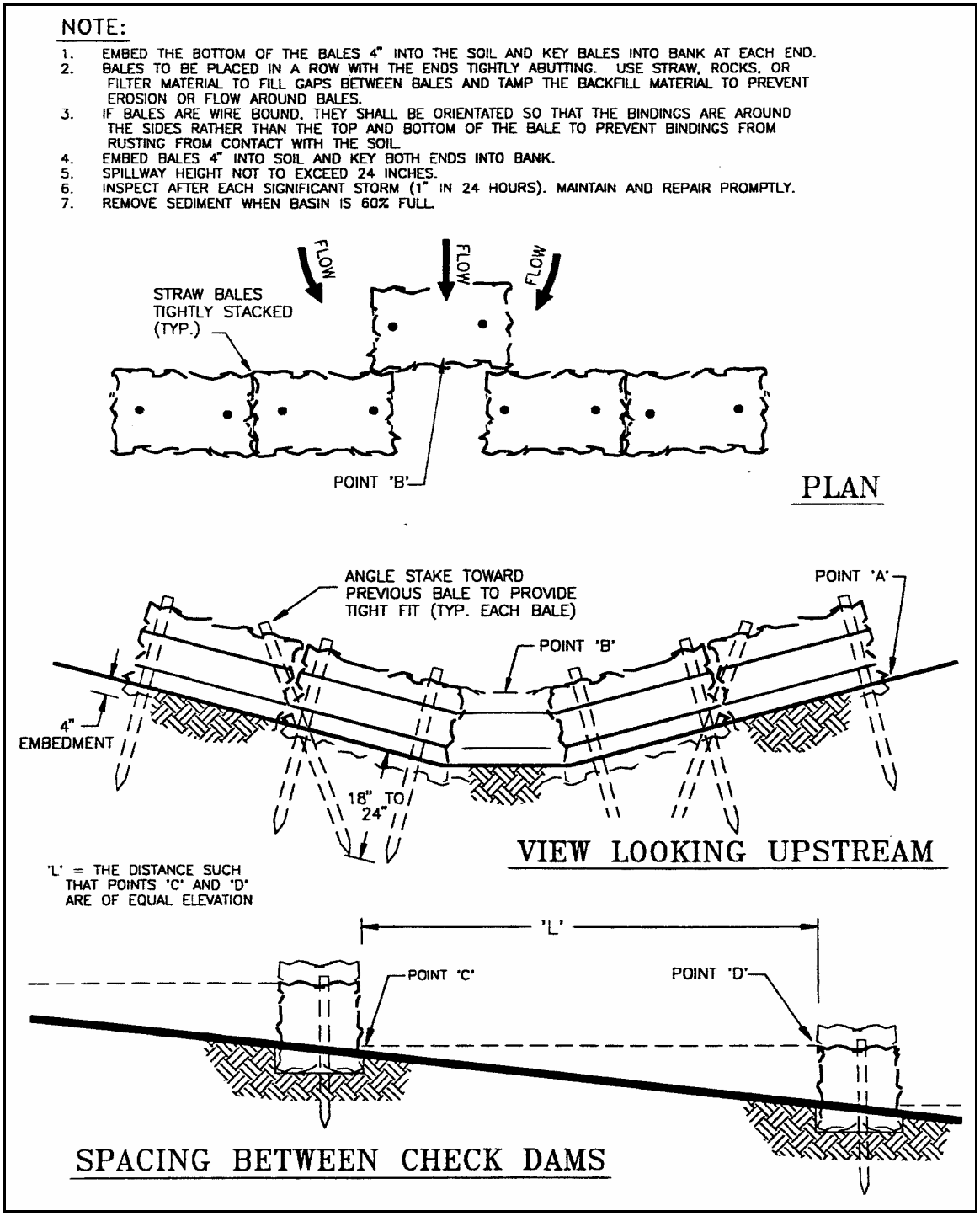
B-9 WATER QUALITY PROTECTION & SEDIMENT CONTROL

CHECK DAM –ROCK B-9.1



Source: McCullah, J. 1992. Erosion and Sediment Control Standards Design Manual – County of Shasta. Prepared for the Western Shasta RCD. Redding CA. 187 p.

CHECK DAM – STRAW BALE B-9.2

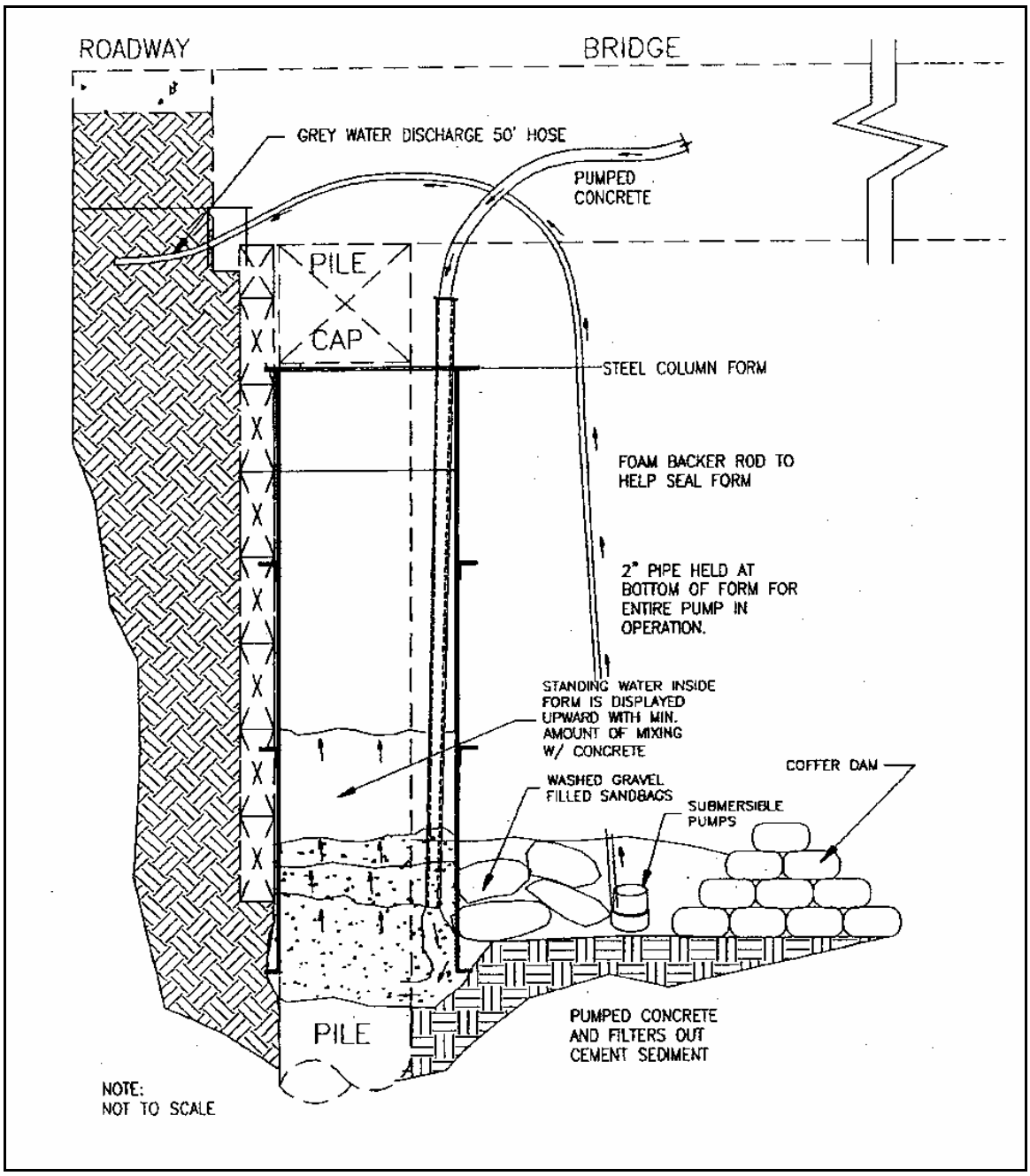


Source: McCullah, J. 1992. Erosion and Sediment Control Standards Design Manual – County of Shasta. Prepared for the Western Shasta RCD. Redding CA. 187 p.

CONCRETE CONTAINMENT B-9.3

Purpose:

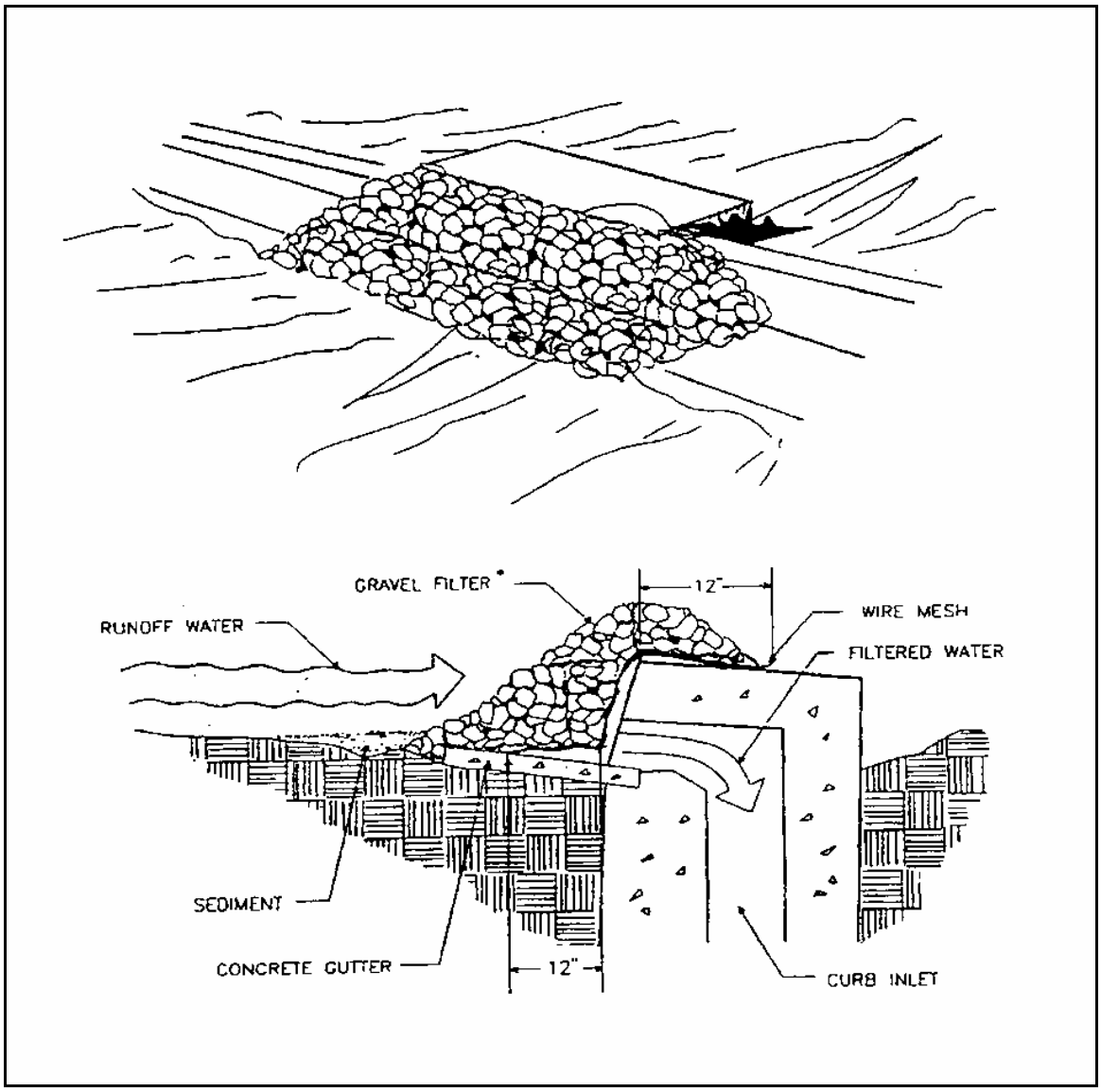
- Preventing uncured concrete and chemicals from leaving the work site and entering the adjacent body of water
- Used when dewatering is not possible for bridge repair work



Source: King County. 2000. Regional Road Maintenance Endangered Species Act Program Guidelines.

CURB OR DROP INLET SEDIMENT TRAP B-9.4

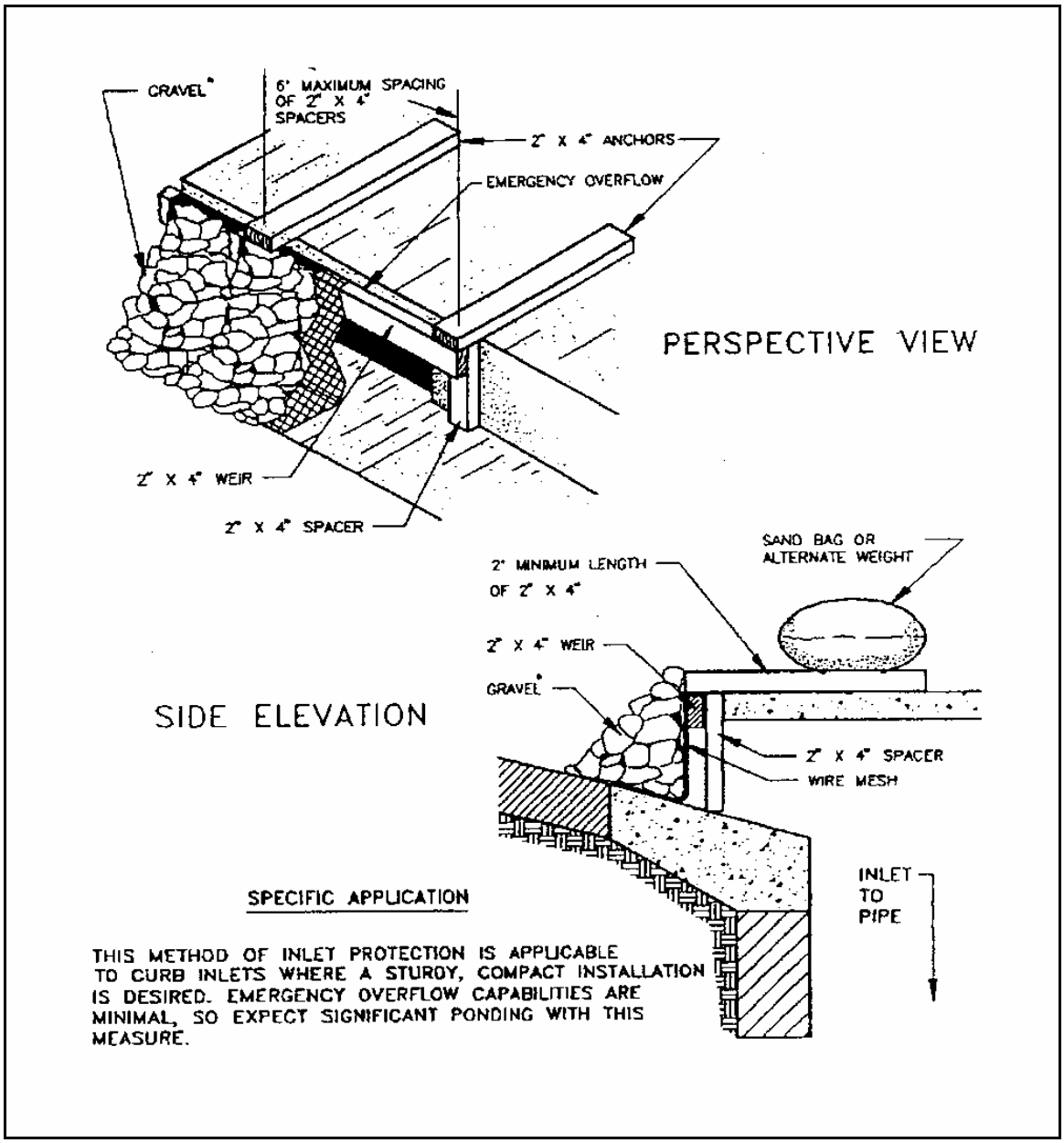
Figure 1. Design A - Curb inlet sediment trap detail



Source: King County. 2000. Regional Road Maintenance Endangered Species Act Program Guidelines.

CURB OR DROP INLET SEDIMENT TRAP B-9.4

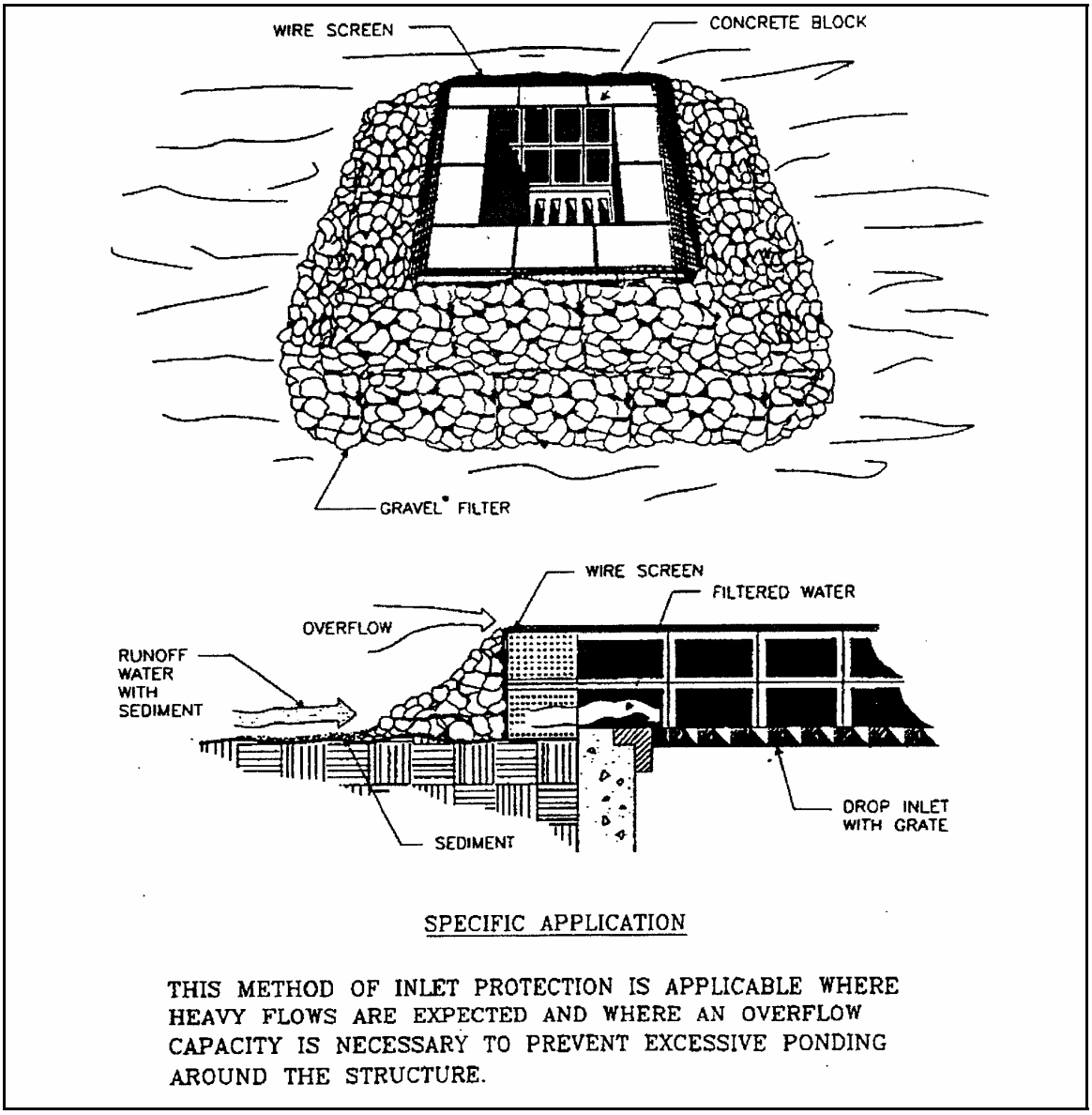
Figure 2. Design B – For curb inlets where a sturdy, compact installation is required.



Source: King County. 2000. Regional Road Maintenance Endangered Species Act Program Guidelines.

CURB OR DROP INLET SEDIMENT TRAP B-9.4

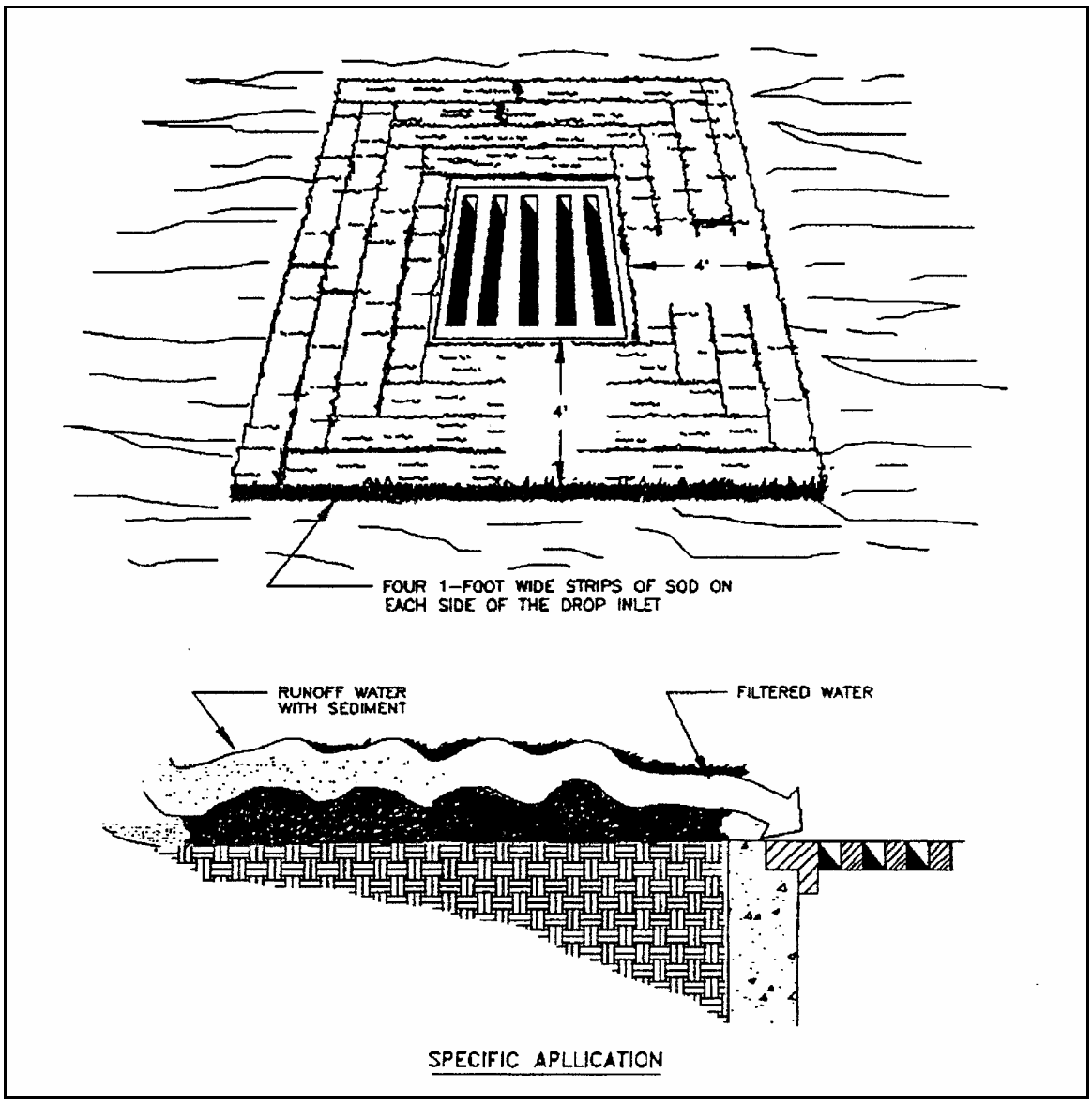
Figure 3. Design C - Block and gravel drop inlet with sediment filter.



Source: King County. 2000. Regional Road Maintenance Endangered Species Act Program Guidelines.

CURB OR DROP INLET SEDIMENT TRAP B-9.4

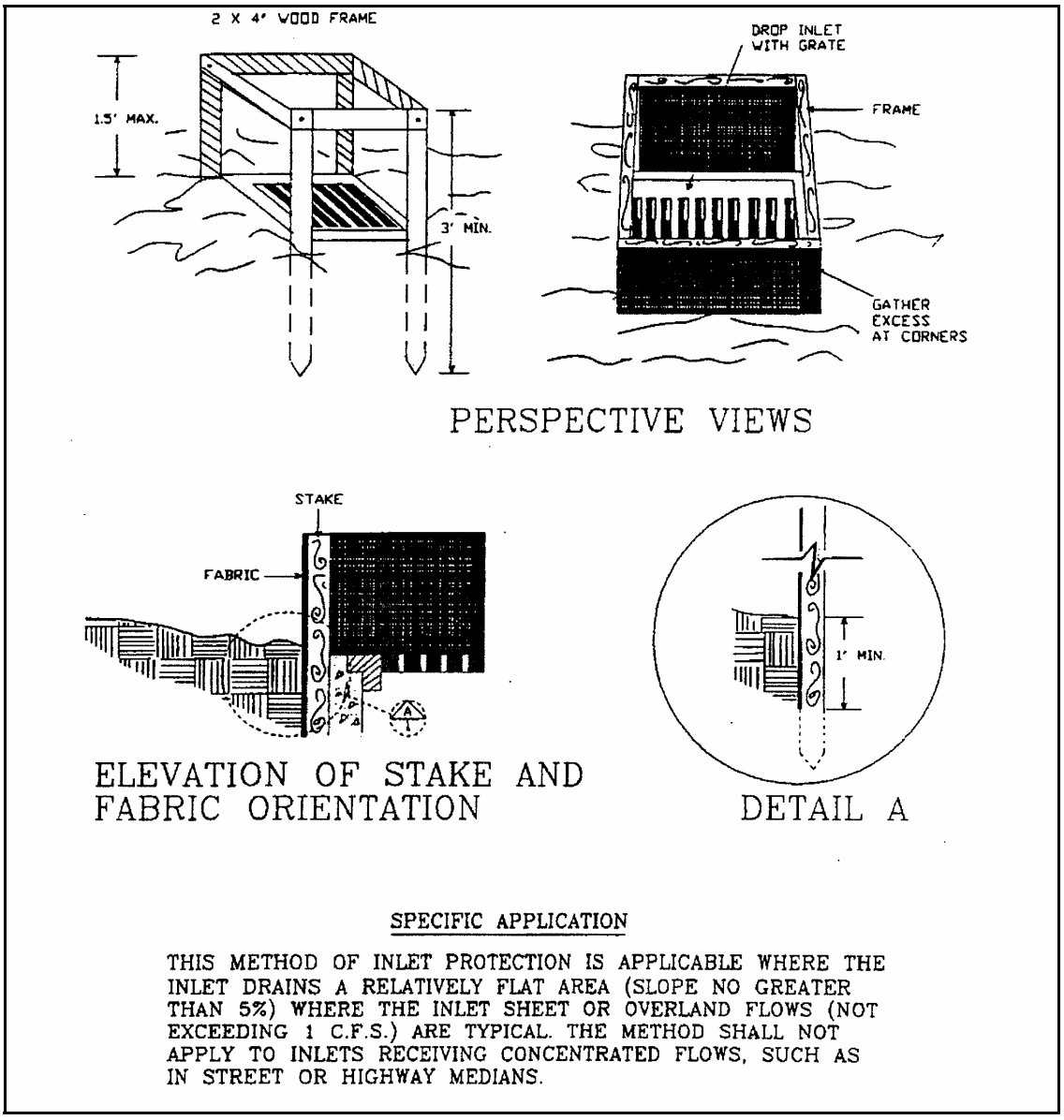
Figure 4. Design D – Drop inlet with Sod sediment filter.



Source: King County. 2000. Regional Road Maintenance Endangered Species Act Program Guidelines.

CURB OR DROP INLET SEDIMENT TRAP B-9.4

Figure 5. Design E – Silt Fence drop inlet protection.



Source: King County. 2000. Regional Road Maintenance Endangered Species Act Program Guidelines.

SEDIMENTATION SUMP B-9.5

Description: Sedimentation sumps provide a sump within the flow line of ditches, swales, or channels to allow soil particles to collect and settle.

Purpose:

- Collecting soil particles by settlement in areas where water quantity or velocities are transporting sediment and impacting structures or habitat.

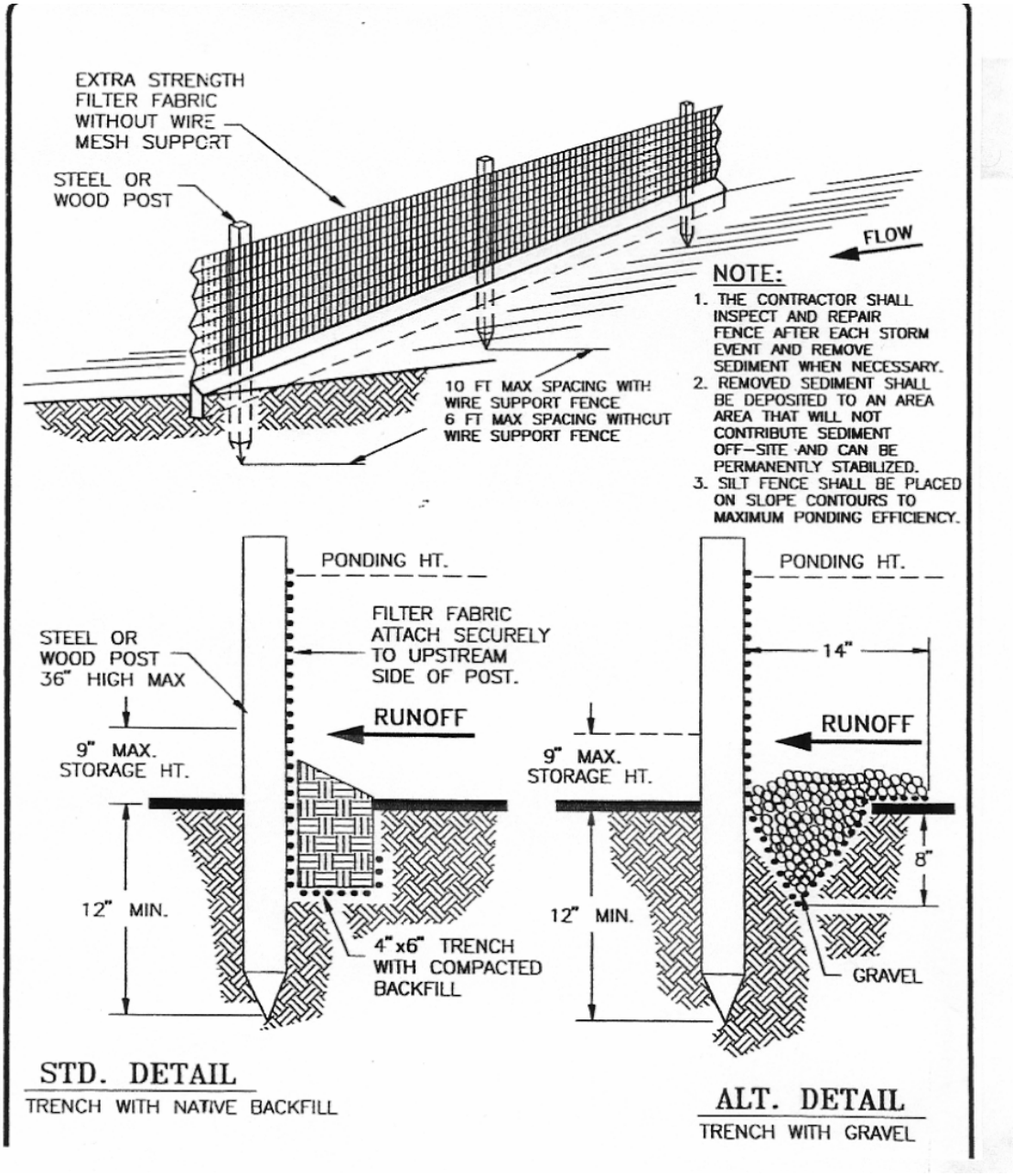
What to Do:

- Place rim of structure at flow line elevation.
- Size structures based on the quantity of sediment and space availability within the transport facility.
- Place structures with other BMPs, such as ditch linings.
- Locate structures in transport facilities where they can collect sediment prior to pipe crossings into streams, wetlands, sensitive areas, or structures that easily plug with sediment.
- Monitor after rainfall events to determine the needed cleaning schedule and frequency.
- Clean when needed using vactor truck (used in cleaning of catch basins), if affordable.

What NOT to Do:

- Do not use to remove excessive fines.

Source: King County. 2000. Regional Road Maintenance Endangered Species Act Program Guidelines.



Source: McCullah, J. 1992. Erosion and Sediment Control Standards Design Manual – County of Shasta. Prepared for the Western Shasta RCD. Redding CA. 187 p.

SILTATION POND / SETTLING TANK B-9.7

Description: A siltation pond, or settling tank, is a temporary containment structure or area for silt-laden water to be initially discharged. After sufficient settling, the water may be discharged to a sanitary sewer, storm drainage system, or other BMP.

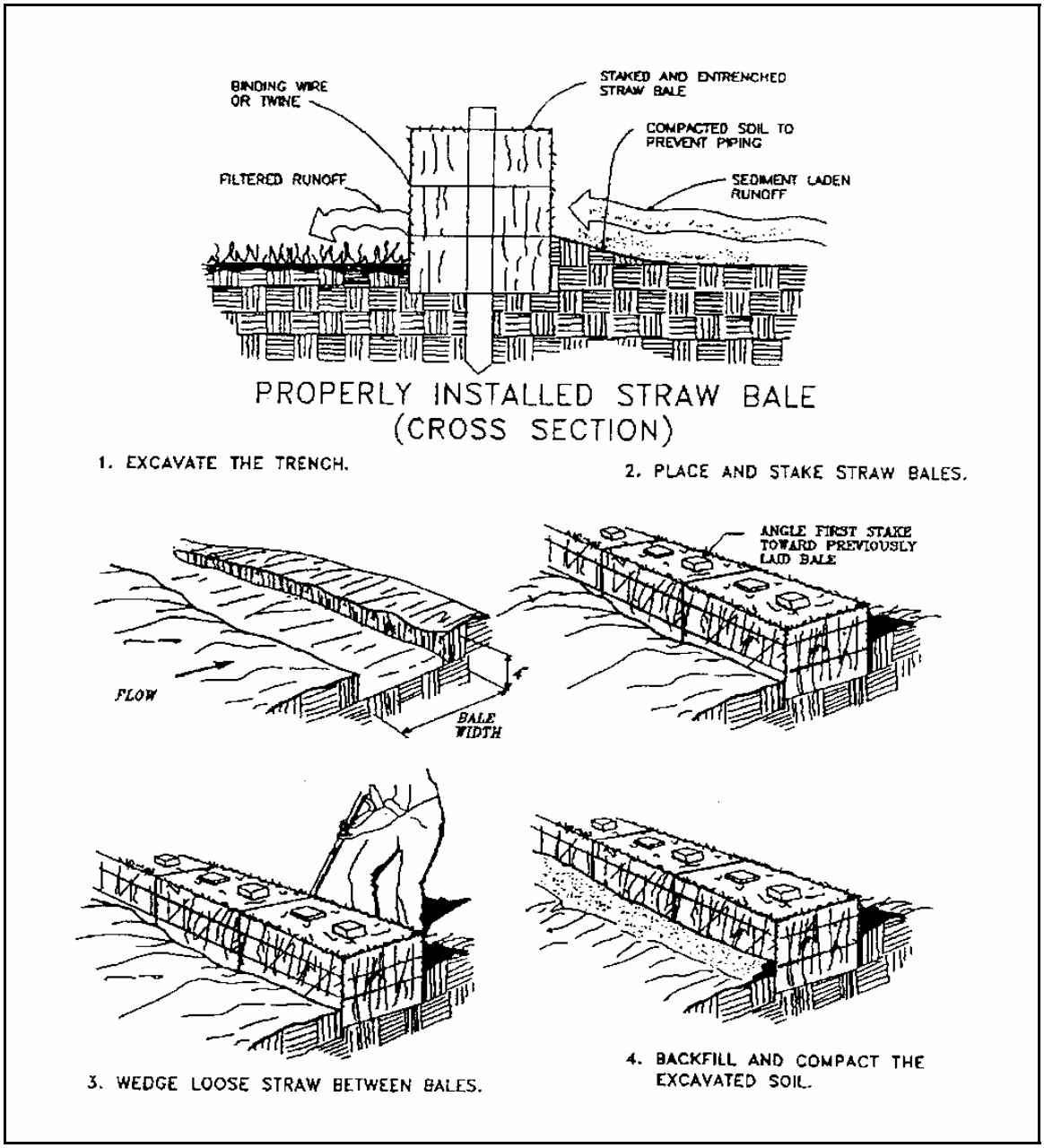
Purpose:
- Allowing soil particles to settle before being discharged off-site
- Containing water-borne soil particle on site
- Controlling the flow of water through a control structure, such as a tee fitting, an oil–water separator, or an orifice.

What to Do:
- Install according to applicable permit requirements.
- Be sure that the quality of the water discharged from siltation pond / settling tank meets the permit requirements at the point of discharge.
- Check site to determine if there is adequate space for pond excavation.
- Use portable tanks where ponds cannot be constructed.
- Design siltation pond according to surface water design standards.
- Have geologist review soil types to ensure compatible filtration. Use line where soils are incompatible with filtration.
- Inspect daily during workweek, particularly the filtering and control devices. Repair structure and replace devices to ensure that the structure functions as designed.
- When pond/tank is no longer needed, follow engineer's recommendation for its removal. Remaining sediment shall be removed and disposed of according to permit conditions.
- Revegetate area that was disturbed by the pond /tank, if needed.

What NOT to Do:
- Do not use in soils that are not compatible for filtration, unless a liner is used.
- Do not use if there is inadequate space to process the volume of sediment-laden water.

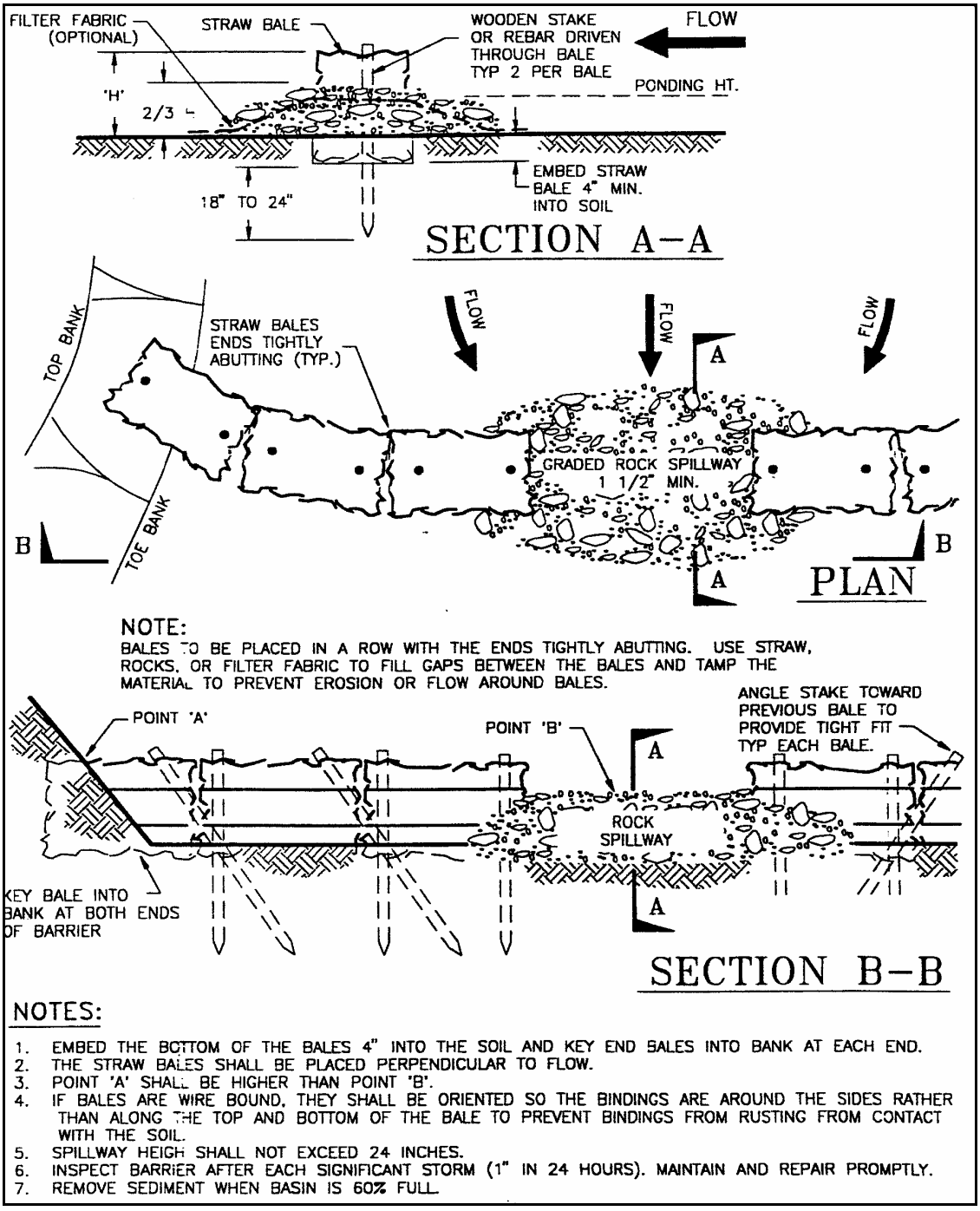
Source: King County. 2000. Regional Road Maintenance Endangered Species Act Program Guidelines.

Figure 1. Properly installed straw bale and construction of straw bale barrier.



Source: King County. 2000. Regional Road Maintenance Endangered Species Act Program Guidelines.

Figure 2. Semi-pervious straw bale sediment barrier, with sand and gravel spillway.



NOTES:

1. EMBED THE BOTTOM OF THE BALES 4" INTO THE SOIL AND KEY END BALES INTO BANK AT EACH END.
2. THE STRAW BALES SHALL BE PLACED PERPENDICULAR TO FLOW.
3. POINT 'A' SHALL BE HIGHER THAN POINT 'B'.
4. IF BALES ARE WIRE BOUND, THEY SHALL BE ORIENTED SO THE BINDINGS ARE AROUND THE SIDES RATHER THAN ALONG THE TOP AND BOTTOM OF THE BALE TO PREVENT BINDINGS FROM RUSTING FROM CONTACT WITH THE SOIL.
5. SPILLWAY HEIGH SHALL NOT EXCEED 24 INCHES.
6. INSPECT BARRIER AFTER EACH SIGNIFICANT STORM (1" IN 24 HOURS). MAINTAIN AND REPAIR PROMPTLY.
7. REMOVE SEDIMENT WHEN BASIN IS 60% FULL.

Source: McCullah, J. 1992. Erosion and Sediment Control Standards Design Manual – County of Shasta. Prepared for the Western Shasta RCD. Redding CA. 187 p.

SWEEPING B-9.9

Description: Sweeping is done by hand or mechanical means. A sweeper is a vehicle with brushes and /or a vacuum system and a water spray system used on the roadways to remove debris and soil particles.

Purpose:

- Removing soil particles and debris before entering the drainage systems, watercourses, or streams
- Suppressing dust on roadways and at construction sites
- Removing snow sand after snow and ice control operations

What to Do:

- Use pickup brooms in sensitive areas.
- Always use water with mechanical brooms.
- Schedule snow sand removal as part of the snow and ice emergency response.
- Dispose of collected material at permitted facilities.
- Do not pick up suspicious debris but instead call appropriate agency.

Source: King County. 2000. Regional Road Maintenance Endangered Species Act Program Guidelines.

TURBIDITY CURTAIN B-9.10

Description: A turbidity curtain is a pre-manufactured floating geotextile structure which minimizes turbidity transport from a disturbed area adjacent to or within a body of water. This device allows for settling of suspended solids and/or reducing water velocity.

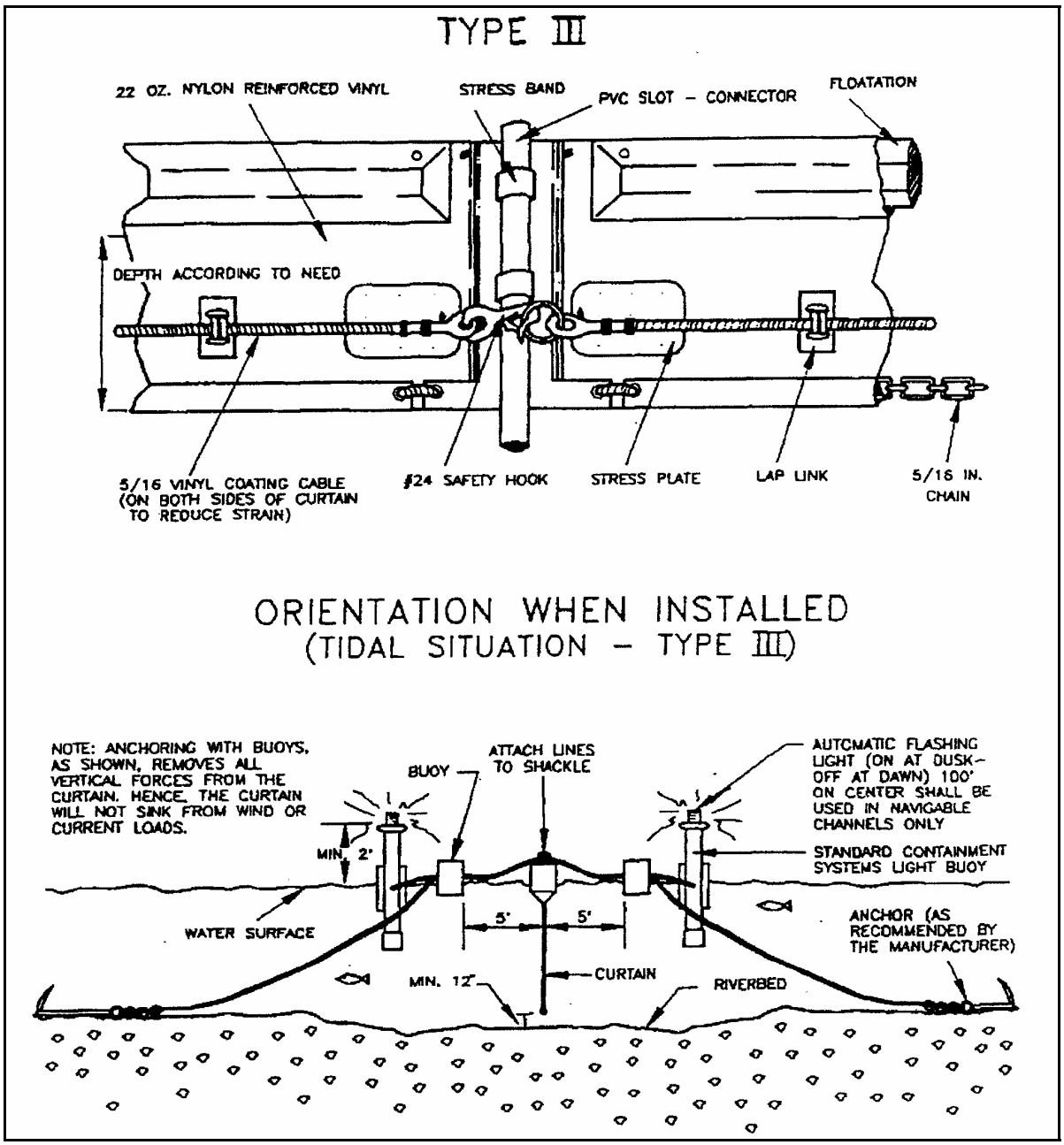
Purpose:
- Minimizing the mixing of turbid water with adjacent clean water
- Containing soil particles during construction and/or repair activities

What to Do:
- Install according to manufacturer's recommendations and guidelines and follow applicable permit requirements.
- Choose the appropriate height of the turbidity curtain. Units are preassembled in 50 foot lengths and are used by connecting the number of units required.
- Add a suitable weight or anchoring system to the bottom of the curtain.
- Remove curtain in such a manner as to minimize turbidity. Remaining soil particles shall be sufficiently settled before removing the curtain.
- Ensure that water discharged from turbidity curtain meets permit requirements at point of discharge.

What NOT to Do:
- Do not place across the main flow of a significant body of water.
- Do not cross more than 2/3 of the main flow of any salmonid-bearing water at the time of the year when any life history stage of salmonids are expected to be present.
- Do not use where flow volume or water velocity inhibits its function.
- Do not use for any purpose other than retaining silt.

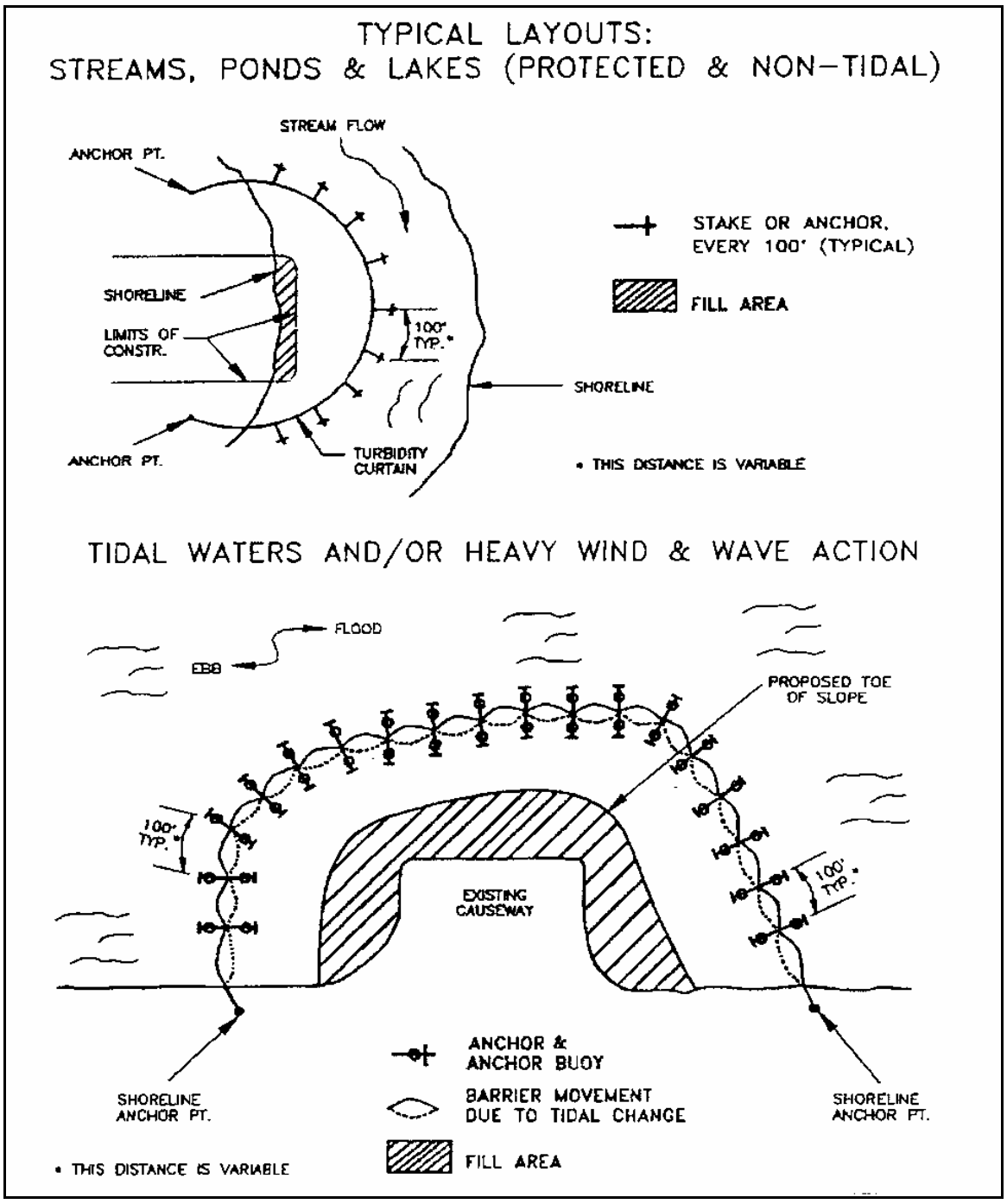
Source: King County. 2000. Regional Road Maintenance Endangered Species Act Program Guidelines. Seattle WA.

Figure 1. Turbidity Curtain – Type III, including tidal situation.



Source: King County. 2000. Regional Road Maintenance Endangered Species Act Program Guidelines.

Figure 2. Two typical layouts of a turbidity curtain.



Source: King County. 2000. Regional Road Maintenance Endangered Species Act Program Guidelines.