Appendix C. Captioned Photographs of Selected Sites

There are few symbols and abbreviations used in photo captions. They are:

#	pounds
>	greater than
<	less than
U/S	upstream
D/S	downstream
3'V:8'H	(3 feet vertically and 8 feet horizontally)
1V:2H	without ' symbol is tangent of slope face angle, rise and run

The photographer's perspective is described to assure that readers orient themselves "within" photos and for describing features. "U/S view" means you are looking upstream, and "D/S view" means you are looking downstream. "Left and right" convention is from the viewpoint of the photographer looking through the lens, so that "left is left" and "right is right".

Author's Note. This document is Appendix C of what is often called the "Caltrans riprap report", FHWA-CA-TL-95-10. There is no significant difference in content between this version of Appendix C and any prior printed editions or "PDF" documents which you may have. However, the photo image quality is improved, as contrasted to prior versions. All of the original manuscript photos were scanned at 300 dots per inch, cropped to a uniform size, and brightened. Also, several photo captions were slightly revised for clarification, and all the captions are now "text searchable" for phrases and/or key words, which help you to quickly locate information.

When you cite images and/or captions from this improved Appendix C, in your list of references please present all the bibliographical data as shown below (authors, title, subtitle, report number, publisher, place of publication, dates of publication). Thank you.

Racin, James A., Hoover, Thomas P., and Crossett Avila, Catherine M., **California Bank and Shore Rock Slope Protection Design - Practitioner's Guide and Field Evaluations of Riprap Methods,** report number FHWA-CA-TL-95-10, California Department of Transportation, Sacramento, CA, 3rd Internet edition, October, 2000, revised Appendix C, 1 Jan 2004.

Additional note. Printed documents are not available from Caltrans of either the January 2004 version of Appendix C or the 3rd Internet version of the main body of the report through Appendix B. Individuals may download, save, and print a single copy for their own use. A printed copy of the second edition (November 1997) of the entire report may be purchased from the National Technical Information Service (NTIS) 1-800-553-6847, 5285 Port Royal Road, Springfield, Virginia, 22161. The NTIS government accession number is PB 98-106453.

Jim Racin, P. E. 1 Jan 2004 Office of Highway Drainage Design CA DOT Sacramento, CA.

Photo C-1. Parallel and impinging flow. D/S view. Abundant vegetation where flow is parallel to riprapped bank (left foreground), as contrasted to the same bank farther downstream, where flow impinges on the outside of bend. Natural sand bar (right bank) is typical of the inside of bends of rivers.
Site 1 WA Nisqually R. May 1992

Photo C-2. Bank which gets impinging flow. D/S view. Design velocity was 16 feet per second.
Seattle Corps Class V riprap 1800#-25# W50 750#.
Observer holding white z-scale: 30-inches high by 5-inches wide.
Site 1 WA Nisqually R. May 1992

Photo C-3. U/S view from top of impinged bank at 90 degree bend.
During 1989, flood debris (a tree, like a battering ram) punched a hole in the riprap, the dike breached, and flooding occurred. No riprap along U/S banks, dense tree growth provides shade and riparian habitat.
Site 2 WA Skookumchuck R. May 1992

Photo C-4. Repaired zone of impinged bank at 90 degree bend. U/S view.
Specified Seattle Corps Class II riprap 500#-25# W50 200#, but delivered riprap is about W50 50#.
z-scale: 30-inches high by 5-inches wide.
Site 2 WA Skookumchuck R. May 1992

Photo C-5. Maintained dike bank (left) and natural bank (right). D/S view. Left bank is riprapped, and vegetation volunteered among rock voids. 1989 flood overtopped dike here (left bank). Right bank is natural. Site 2 WA Skookumchuck R. May 1992

Photo C-6. Partially toppled willow. U/S view.
Willows planted at 25-foot intervals on silt-covered riprap.
1000-feet of toe was repaired in 1970. Site 3 WA Puyallup R. May 1992

Photo C-7. Toe was mounded 3-feet vertical by 8-feet horizontal. D/S view. Previous toe was 3'Vx4'H. Face slope of toe in river is 1V:1.5H. Site 4 WA Cedar R. Orchard Bend May 1992

Photo C-8. Tree toppled by current. Flow is toward right. Volunteer tree is below elevation of normal high water. In WA state some dike districts require removing vegetation when it is greater than 2-inches in diameter at chest height. Site 4 WA Cedar R. Orchard Bend May 1992

Photo C-9. Rock and tree stump retards (permeable jetties, groins) along levee, also called "fish habitat" or "fish cluster" structures. D/S view. Retards dissipate stream energy, promote oxygenation, redirect low and intermediate flows, and provide resting zones for fish. See Photo C-10.
Site 6 WA Cedar R. Rainbow Bend May 1992

Photo C-10. Fish habitat structure. Flow is toward right. Tree stump anchored by large rock projects into stream, provides eddy for fish. Tree stumps are likely to float away at high stream stage unless secured with cables. 30-inch long by 5-inch wide z-scale leaning against stump.
Site 6 WA Cedar R. Rainbow Bend May 1992

Photo C-11. Riprapped toe and plastic geogrid gabions. D/S view. Very steep lower slope 1V:1/2H and steep upper slope 1V:1H, both made with plastic geogrid gabions, which have rocky soil fill and were revegetated. Lowest 2 geogrid gabions have only rock, since they are below stage of normal high water. Site 7-B WA Green R. May 1992

Photo C-12. Close-up of plastic geogrid gabion and vegetation. Square grids are on 1-inch centers. Pencil with blue top for scale at center of image. Site 7-B WA Green R. May 1992

Photo C-13. Repaired zone where flow impinges. U/S view.
As-designed, Seattle Corps Class IV riprap 1000#-25# W50 400#,
as-constructed Class V riprap 1800#-25# W50 750#.
Site 8-A WA South Fork Skagit R. May 1992

Photo C-14. Rock hammer impact and pick, qualitative field tests.
During 1991 flood fight on North and South Skagit R, there were five different rock sources.
Occasionally, poor quality rock was placed during flood fight. When wetted, this rock softens.
Site 8-B WA South Fork Skagit R. May 1992

Photo C-15. Permeable rock jetties (fish habitat structures). U/S view from high flow impinging zone. Permeable jetties protect portion of bank at low and moderate flows on bends by deflecting current away from bank and back into the river, weir flow when submerged. Site 9 WA Skykomish R. May 1992

Photo C-16. Close-up of permeable rock jetty. U/S view.
30-inch high by 5-inch wide z-scale.
Silt-covered cobbles in foreground. Calm water at lower right, D/S of jetty.
Site 9 WA Skykomish R. May 1992

Photo C-17. RSP tied to solid rock outcrop, natural impermeable retard (jetty). U/S view. Designed slide repair encroaches in river, was okay by permit. Site 10 OR South Umpqua R. May 1992

Photo C-18. Soil-filled voids, natural vegetation. D/S view. As flood waters receded, voids filled with soil, then air and water-borne seeds sprouted and provided riparian habitat. Site 10 OR South Umpqua R. May 1992

Photo C-19. Channel cut through deposited beach sand. Layered RSP and geotextile along toe of shore protection got covered with beach sand. By wave action and storms, beaches cycle between accretion (accumulation) and scour (removal). Site 11 OR Nesika Beach May 1992

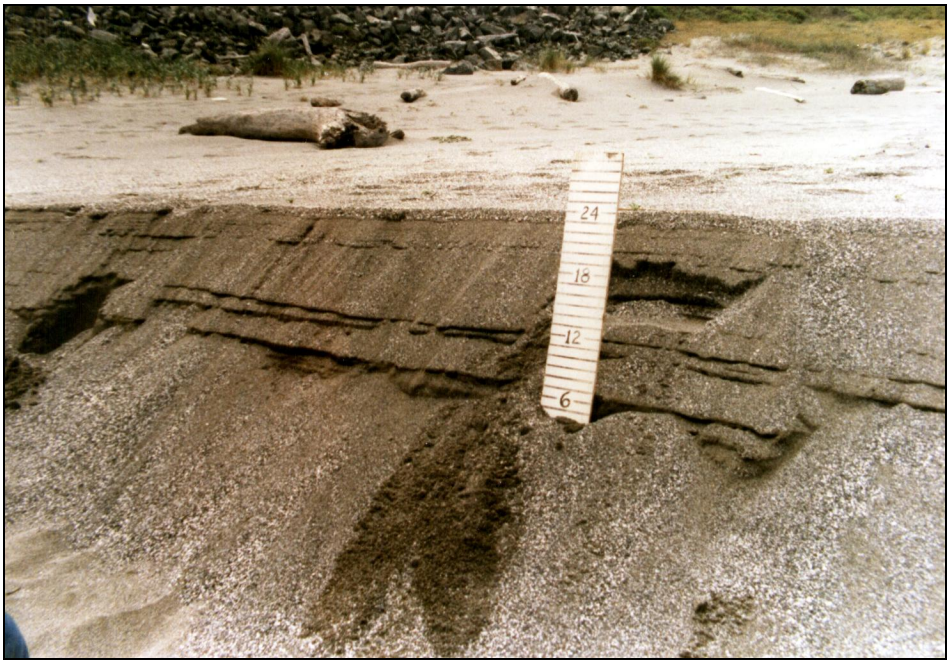

Photo C-20. Layers of deposited sand.
Side of channel shows different thicknesses of beach sand accretion.
30-inch high by 5-inch wide z-scale, inch graduations.
Site 11 OR Nesika Beach May 1992

Photo C-21. Large hydraulic opening under bridge to pass debris.
U/S view of northerly bank at low tides.
Layered RSP protects bridge abutment fill (Class 2000, Class 50, geotextile).
Site 12 OR Pistol R. and Beach 19 May 1992

Photo C-22. Layered RSP protects bridge abutment fill. Southerly abutment fill. Layered RSP is (Class 2000, Class 50, geotextile). River flows toward right at low and ebb tides. Channel to ocean on right.
Site 12 OR Pistol R. and Beach 19 May 1992

Photo C-23. Lighter rocks of well-graded mixture displaced by storm waves, 1 of 2.
View of northerly abutment fill, D/S of bridge. Class 2000 (2000#-40# W50 700#), well-graded.
Creek flows toward left at low and ebb tides. Ocean wave attack is from left.
Site 13 OR Myers Creek and Beach 19 May 1992

Photo C-24. Lighter rocks of well-graded mixture displaced by storm waves, 2 of 2.
View of northerly abutment fill, U/S of bridge. Class 2000 (2000#-40# W50 700#), well-graded.
Site 13 OR Myers Creek and Beach 19 May 1992

Photo C-25. Primary cover stone on southerly abutment fill. U/S view. Gradation of outside layer (primary cover stone) 2070#-1240# eliminated light rocks typical of "standard" gradations. Rocks in foreground are displaced Class 2000 of northerly abutment riprap seen in Photo C-23.
Site 13 OR Myers Creek and Beach 19 May 1992

Photo C-26. Outside layer (primary cover stone) 2070#-1240#. View of Southerly abutment riprap. Fewer rocks displaced as contrasted to standard Class 2000.
30-inch high by 5-inch wide z-scale and 6-foot wide folding rule.
Site 13 OR Myers Creek and Beach 19 May 1992

Photo C-27. Failed riprap on levee bank. U/S view, westerly bank just U/S of Route 58 bridge. Failure was due to round rock on oversteepened backslope, no filter layer, low and mid-range flow angles that impinged on banks due to shifting gravel bars and debris. Levee bank slopes were designed and built at 1V:2H using the parallel flow assumption. Site 14 OR Salmon Creek May 1992

Photo C-28. Gravel bar (2nd one U/S) directs impinging flow at westerly bank (left). U/S view. Degraded channel partly due to in-stream sand and gravel removal, which provided about 6-feet additional depth capacity. Route 58 westerly bridge abutment fill protected with concrete-filled fabric. Site 14 OR Salmon Creek May 1992

Photo C-29. Route 58 bridge. D/S view. Easterly abutment fill is also protected by concrete-filled fabric, which was selected for both abutment fills due to thinner than riprap cross section in relatively narrow channel under bridge, and poor past performance of rounded riprap on steep slopes.
Site 14 OR Salmon Creek May 1992

Photo C-30. Toe of rigid concrete-filled fabric is undercut about 6-inches.
U/S view at D/S join with flexible rock riprap, westerly bank Route 58 bridge. Rigid concrete-filled fabric did not drop into scoured zone yet. Site 14 OR Salmon Creek May 1992

Photo C-31. OR Keyed Riprap, overview of left bank. D/S view. Low flow path impinges at about 45 degrees on about 100 feet of riprapped bank, (arrows marked on photo). U/S training dikes, not shown, are also OR Keyed Riprap. Site 15 OR South Santiam R. May 1992

Photo C-32. OR Keyed Riprap, close-up at left bank. D/S view at impinging zone.
Class III (800#-25# W50 300#) over 1-foot Class 50 filter layer. Rock is visible below surface.
Natural siltation and vegetation about 3-feet higher than water surface.
Site 15 OR South Santiam R. May 1992

Photo C-33. Keyed riprap by Corps of Engineers, Portland. D/S view. Impinging flow on bank of Minto Brown Island. Class 700 (700#-20# W50 200#) extends up bank with natural vegetation to base of trees. Island is flooded every 2-3 years. Bank gets overtopped about 8 feet above base of trees.
Site 16 OR Willamette R. 20 May 1992

Photo C-34. Keyed riprap by Corps of Engineers, Seattle. D/S view. Impinging flow along Hansen Dike. Repaired 1991, 60-inch thick Class V (1800#-25# W50 750#) and gravel bedding. Rock keyed by pounding surface with 2-cubic yard bucket of excavator. Note rock groins for improved fish habitat.
Site 9 WA Skykomish R. 14 May 1992

Photo C-35. 88th Avenue, 1 of 4. U/S view. At end of concreted rock drop structure and hidden by vegetation in right foreground is Type L riprap (repaired washout of Very Light riprap). Right half of drop structure is stepped pools for recreational users, left half is continuously sloped for oxygenation.
Site 20 CO South Platte R. 16 Jun 1992

Photo C-36. 88th Avenue, 2 of 4. D/S view. Last pool of concreted rock drop structure. After drop structure dissipates energy, river turns sharply. Repaired zone of Type L riprap is just D/S to left, hidden by vegetation. Denver UDFCD rock size range (inches): <3 to 15, D50=9, D100=15.
Site 20 CO South Platte R. 16 Jun 1992

Photo C-37. 88th Avenue, 3 of 4. D/S view. Repaired zone at join with concreted rock drop structure is Type L riprap and willows, withstood flow rate >12,000 cfs. x and y scales: 6-foot ruler and 6-foot rod, z-scale: 30-inches high (looking at edge of ¼-inch plywood).
Site 20 CO South Platte R. 16 Jun 1992

Photo C-38. 88th Avenue, 4 of 4. D/S view. Repaired zone of Type L riprap and willows. Sandbar willow (probably Salix exigua) was selected because it bends easily and offers less flow resistance than some other tree families, when exposed to river currents during high river stages.
Site 20 CO South Platte R. 16 Jun 1992

Photo C-39. Parallel flow, bank protected with Denver UDFCD Type L riprap. D/S view. Type L range (inches): <3 to 15, D50=9, D100=15. x and y scales: 6-foot ruler and 6-foot rod. z-scale 30-inches high by 5-inches wide. Natural growth on gravel bar, mid-channel. Site 21 CO South Platte R. 16 Jun 1992

Photo C-40. Natural growth contrasted to non-revegetated riprapped dike. View: across river. Foreground growth is on gravel bar island. Riparian vegetation grows in naturally deposited soil pockets in riprap below bikeway. Bikeway built at stage of about Q5, riprapped dike built above stage of Q100. Cyclist near center of image. Site 21 CO South Platte R. 16 Jun 1992

Photo C-41. Impinging flow, bank protected with Denver UDFCD Type M riprap. D/S view. Type M range (inches): <4 to 21, D50=12, D100=21. Same scales as in Photo C-39. Debris at stage of Q5. Boaters go between pilot rocks at concreted drop structures (only right pilot rock is visible). Site 22 CO South Platte R. 16 Jun 1992

Photo C-42. Riprapped levee covered with soil and revegetated above Q5 stage. U/S view. (See Photo C-41 for D/S view). Concreted rock drop structure at right (flow is toward you), continuously sloped for oxygenation. Gravel bar (left higher by degraded river bed) deflects river and causes impinging flow on bank protected by Denver UDFCD Type M riprap. Site 22 CO South Platte R. 16 Jun 1992

Photo C-43. Denver UDFCD Type L riprap below 3-foot drop structure failed, repaired with concreted rock. U/S view. Urban multiple-use flood control: park during dry season with trickle flow, open channel for storm runoff and snowmelt. Site 23 CO Sanderson Gulch 16 Jun 1992

Photo C-44. Denver UDFCD concreted Type L transition to Type L riprap OK. D/S view. Length from headwall in Photo C-43 to end of concreted Type L is about 75 feet. No erosion at concrete to grass transition. About 100-feet D/S, there is erosion on right bank caused by impinging (not visible) tributary flow that comes from the left at 90 degrees. Site 23 CO Sanderson Gulch 16 Jun 1992

Photo C-45. Permeable rock retard (jetty) and check dam. U/S view.
Previously natural embankment was undercut by impinging flow and failed.
I-70 roadway embankment reconstructed at 1V:1.5H.
Protected with CO DOT HEAVY riprap, size ranges: 1280#-10# W50 275#.
Site 26 CO Eagle R. 17 Jun 1992

Photo C-46. CO DOT HEAVY riprap. U/S view about 200 yards D/S of check dam in Photo C-45.
Roadway embankment (left) is on outside bend of river, and it gets exposed to impinging flows.
Q100 stage about 2-feet below observer and pipe invert. 30-inch high by 5-inch wide z-scale.
Site 26 CO Eagle R. 17 Jun 1992

Photo C-47. Rough surface boundary created with riprap. U/S view. CO DOT HEAVY riprap. Rough boundary enhances habitat by providing current eddies and voids among rocks. Bikeway was built at stage of Q5. Cover soil placed over HEAVY riprap for revegetation with occasional voids where soil washed through. Site 27 CO Colorado R. 17 Jun 1992

Photo C-48. Willows growing well through concreted-RSP. View normal to riprap. Experiment by CO DOT : willows were planted among riprap voids, then concrete was placed. Result : willows grew OK. I-70 Glenwood Canyon Bikeway, Grizzly to Shoshone. Site 27 CO Colorado R. 17 Jun 1992

Photo C-49. CO DOT HEAVY riprap and one timber crib. U/S view. Arrow points to one remaining timber crib in zone of impinging flow. In 1984, flow >22,000 cfs destroyed all timber cribs U/S of arrow and CO DOT MEDIUM riprap, size range 440#-3# W50 85#. Bank repaired with HEAVY riprap. Site 28 CO Colorado R. 17 Jun 1992

Photo C-50. Observer on topmost beam of timber crib among willows. U/S view. Additional HEAVY riprap placed along toe and U/S of timber crib. The composite structure (HEAVY riprap, timber, willows) is an example of biotechnical bank protection. Site 28 CO Colorado R. 17 Jun 1992

Photo C-51. Archaeological site protection causes impinging flow. U/S view.
Concrete wall and riprap protect archaeological site, but redirect flow. Near bank, opposite the protected site (right concrete structure) received impinging flow, toe eroded, bank sloughed. Original bank protection was gap-graded rock mixture >>8-ton to 5#. Site 30 CO Colorado R. 18 Jun 1992

Photo C-52. Impinging zone D/S and opposite archeological site. U/S view. CO DOT maintenance crew added 200#-500# rock to interlock heavier rocks, which remained after lighter rocks washed away. Future repairs likely on I-70 between miles 106.5 and 108 due to gap-graded rock mixture.
30-inch high by 5-inch wide z-scale. Site 30 CO Colorado R. 18 Jun 1992

Photo C-53. Longitudinal stone toe and tieback (permeable rock retard, hard-point dike). U/S view. Longitudinal toe controls meander and parallels creek, while tie-backs are roughly perpendicular and trap sediment. USACE R200 class, maximum weight 200# W50 50#. Natural willow growth among rocks. 30-inch high by 5-inch wide z-scale. Site 33 MS Black Creek 19 May 1993

Photo C-54. Longitudinal stone toe and tiebacks. U/S view. Tiebacks (permeable rock retards keyed into damaged bank) redirect flow away from farmland banks, trap sediment, and provide zones for natural revegetation. Longitudinal toe scoured, undercut, and launched (arrow marked on photo). Site 34 MS Batupan Bogue 19 May 1993

Photo C-55. Rural county road bridge over incised streambed. D/S view. When streams flow over erosive soil, especially loess or waterborne silts, the bed gets notched and banks slough forming unstable vertical banks. Such scour results from in-stream mining, natural headcutting, and/or downcutting. If and when pile-caps are exposed, remedies at bridge and in-stream grade controls (u/s, d/s, or both) are considered. See also photos C-56, C-57, C-58 and captions. Site 38 MS Worsham Cr. 19 May 1993

Photo C-56. Baffle and modified Agricultural Research Service grade control structure with R1000 riprap. U/S view, several hundred yards U/S of bridge in Photo C-55. R1000 rock gradation (1000#-60# W50 430#) protects streambed and banks. Mid-channel baffle dissipates higher stage velocities, and prevents wave propagation. Site 38 MS Worsham Cr. 19 May 1993

Photo C-57. Grade control structure with failed R400 riprap, 1of 2.
U/S view, a few hundred yards D/S of bridge in Photo C-55. R400 (400#- 30# W50 160#) washed about 20 feet D/S of 4-foot drop structure (weir). Scour hole (downcutting and headcut migration upstream) next to weir threatens long-term stability of weir. Site 38 MS Worsham Cr. 19 May 1993

Photo C-58. Grade control structure with failed R400 riprap, 2 of 2.
D/S view, a few hundred yards D/S of bridge in Photo C-55. R400 washed about 20 feet D/S of weir. Baffle about 75-feet D/S of drop, where stream is about 2-3 times wider than normal. Naturally occurring trees on riprapped banks. Site 38 MS Worsham Cr. 19 MAY 1993

Photo C-59. Steel sheet pile grade control structure and riprap. View across crest. Banks and just D/S of drop protected with riprap, estimated W50 200#. Drop is about 1-foot. Site 47 MS North Fork Tillatoba Cr. 20 May 1993

Photo C-60. Concrete-filled, steel-pile baffle. U/S view. Baffle is about 25-feet D/S of grade control structure in Photo C-59. Randomly interlocked log snags on U/S side of baffle provide habitat and nutrient value for fish and other aquatic life. Site 47 MS North Fork Tillatoba Cr. 20 May 1993

Photo C-61. Dense vegetation naturally regenerated among riprap on impinging (left) bank. D/S view, 1/3 way up slope from low flow (non-storm) water surface, US 101 at top of slope. Recent high water indicated by debris hanging on tree. Impinging flow on this bank is caused by a protruding natural rock outcrop (not visible), upstream on opposite bank. Site 53 CA South Fork Eel River 13 Feb 1996

Photo C-62. Dense vegetation in naturally silt-filled voids of riprap. U/S view near site of Photo C-61. 30-inch high z-scale is 9 feet higher than water surface. Heights (elevation differences) : about 45 feet from US 101 to river and >50 feet to toe of riprap. RSP-class of lower half of slope : 1/2 ton as-designed, 4-ton as-built. Site 53 CA South Fork Eel River 13 Feb 1996

Photo C-63. Elevation limit of naturally deposited silt. U/S view, just above site of Photo C-62. Lower arrow (orange vest) shows limit of silt, 1/3 way up slope from river. Upper arrow (white hard hat) is near mid-slope. Site 53 CA South Fork Eel River 13 Feb 1996

Photo C-64. Zone of sparse vegetation on upper half of riprapped slope. D/S and downhill view. Same white hard hat (marked with arrow) seen in Photo C-63, near mid-slope. Upper half of slope is 1/2 ton RSP Class Method B (Caltrans standard gradation). Not much soil among rock voids, therefore little voluntary growth. Site 53 CA South Fork Eel River 13 Feb 1996

Photo C-65. Soil placed on slope over riprap above ordinary high water (OHW) for planting. U/S view. Slope cross-section of soil cover is 1V:2H, riprap is 1V:1.5H. CA layered RSP design: Type B RSP-fabric, Backing No. 1, 1/2 ton RSP. Toe embedded 8 feet below 30-inch high z-scale in ditch, extends 10 feet laterally to left. Top of RSP is 20 feet above ditch, 10-foot wide bench (nearly level break in a long slope) is 42 feet above ditch. Site 55 CA South Fork Eel River 13 Feb 1996

Photo C-66. Unstable silt deposit, 6-feet thick. D/S view of bank in Photo C-65. Triangular plan view dimensions of silt +50 feet wide x 350 feet along ditch, and top of silt is about 75 feet below US 101. "Fish-cluster rocks" buried under silt after 1 wet season. Cover-soil eroded to RSP below 36-inch culvert (upper left of image). Site 55 CA South Fork Eel River 13 Feb 1996

Photo C-67. Mad River Mouth / Pacific Ocean at low tide. Northwesterly view. River flows north (D/S to right) then turns west (left) to ocean. In 1991 northward migration of mouth >600 yards in one storm threatened Clam Beach State Park and US 101. Emergency permit obtained. Pit was dug to sea level for 8 ton layered, launchable RSP (mounded toe concept); excavated sand piled along (westerly) turn to limit erosion of Clam Beach State Park. Site 59 CA Mad River 23 Jan 1992

Photo C-68. Mad River Mouth / Pacific Ocean at ebb tide. D/S view. Surface velocity >7 fps continually scoured toe and unprotected sand banks caved-in. Temporary rock and RSP-fabric placed during low tide, helped keep water out of excavation pit (pumped). Permit later allowed armoring sand bank with 8-ton layered, launchable RSP (mounded toe concept). Site 59 CA Mad River 11 Feb 1992

Photo C-69. Loader-mounted dispenser holds 20' wide x 250' long roll of RSP-fabric. View from pit bottom. 12-oz/sqyd nonwoven needle-formed geotextile, ultraviolet stabilized, made from virgin and recycled plastics (tinted green from pop bottles). Specially designed Z-fold pattern (by Racin) on pit bottom gives extra length of RSP-fabric to fall into anticipated scour holes with rocks as undermining occurs. Site 59 CA Mad River 11 Feb 1992

Photo C-70. Four-man team positioned and sewed RSP-fabric. From top to bottom of bank, one continuous prayer seam was stitched with nylon thread. Seam strength >= RSP-fabric strength of 300-lb grab tensile strength was achieved. Stitched seams are required in this (and similar) severe setting of river currents and ocean tides. Site 59 CA Mad River 11 Feb 1992

Photo C-71. Z-folding RSP-fabric in bottom of pit. Southerly U/S view, Mad River right background. Layered design: RSP-fabric, 1.5' Backing No.2, 10'-15' high special 8 ton launch rock mixture fills pit (mounded toe). Same layers on highway slope with 10' thick launch layer. Sand dune below vista point at southerly end of permitted emergency bank protection eroded in next 2-years, see Photos C-74, C-75. Site 59 CA Mad River 11 Feb 1992

Photo C-72. Thin sand layer on Backing No. 2 protects rubber tires of equipment during turning movements, prevented rubber tires from getting chewed-up by angular rocks of backing layer. Southerly view in pit. Sand layer is not needed to protect RSP-fabric from backing or outside layers of rock, because Caltrans specifies RSP-fabrics to survive normal riprap construction, via specified toughness values. Site 59 CA Mad River 11 Feb 1992

Photo C-73. Inspecting special rock mixture, 8-ton maximum. Northerly D/S view, Mad River at left. Large launch rocks were placed individually by rubber-tired loaders. Although mixture is designed to launch, some interlock is needed. Excavated pit (at sea level) was pumped after storms due to seepage from high river stages and above-normal tides. Site 59 CA Mad River 11 Feb 1992

Photo C-74. Mad River RSP facility after 2 years. U/S southerly view. Mad River and ocean sand spit at right, Mckinleyville / US 101 vista point marked by arrow. Layered riprap built in pit : RSP-fabric, Backing No. 2, and special launchable 8 ton rock mixture (mounded toe concept). Covered with sand layer and revegetated naturally. Site 59 CA Mad River May 1994

Photo C-75. Southerly limit of 1992 RSP project and remainder of dune below vista point. View normal to bank. Vegetation did not resist erosive forces of river and ocean. Two logging railroad ties (5 feet below trees) cast shadows on vertical sand bank. Eroded dune below vista point parking lot. Second emergency permit granted to armor 1000 feet U/S of 1992 RSP project limit.
Site 59 CA Mad River May 1994

Photo C-76. Dumping rock down 14-foot bank, normally not done, sizes segregate. Northerly view. Rock berm at toe keeps RSP within limits, Backing protects RSP-fabric. Backing was placed from bottom to top of bank. Layered design: Z-folded RSP-fabric, 1.5' Backing No.2, 14' high special 4 ton launch mixture. Site 59 CA Mad River May 1995

Photo C-77. RSP leading edge notched into bank. View normal to bank. Two men are 50 feet apart, plan view length (width this view) of leading edge. Base width (directly into photo) of leading edge is 42 feet, 3x wider than rest of base. For 1995 job, 1992 launch rock sizes were reduced 1 class to 4 ton maximum. Site 59 CA Mad River May 1995

Photo C-78. Leading edge of layered, launchable 4-ton RSP after 9 months. D/S northerly view. River at low flow rate. Ebb tide 1400 PST, low at 1515 PST minus 0.7-foot. Some localized erosion at RSP-sand interface. Logs and debris drifted ashore, not due to local bank erosion. Arrow shows 30-inch high z-scale. Site 59 CA Mad River 15 Feb 1996

Photo C-79. West-turn RSP at mouth of Mad River after 3 years. Northerly view from vista point, center horizon Trinidad Head. West-turn built in 1992, same launchable layered design as in pit, see Photos C-71, 72 & 73. Moonstone Beach bluff is nearest natural rock outcrop, 3.8 miles north of vista point. Site 59 CA Mad River May 1995

Photo C-80. Trailing edge localized erosion beyond layered, launchable 8 ton RSP-sand interface. D/S northerly view beyond west-turn bank, ocean at left. Local scour limit is 100 yards D/S and 25 yards to right. After 4 years, RSP has halted northward migration of river mouth, protecting Clam Beach and US 101. Site 59 CA Mad River 15 Feb 1996

Photo C-81. RSP tied to natural rock outcrops. 1996 D/S impinging view. A, B, and C mark sites of 1993 Photos C-82, C-83, and C-84 respectively. Grizzly Creek (at bottom) flows (to left) into Van Duzen. Silhouetted fisherman (right of C) sits where Creek thalweg was in 1993, on 5-foot thick gravel bank from Creek watershed. Van Duzen turns left around point bar (shadow at left below A).
Site 56 Van Duzen River 15 Feb 1996

Photo C-82. Toe stabilized with 4 ton RSP-class, upper bank is 1 ton. U/S view, near A in Photo C-81. Arrow (near top center) marks rail of former bridge over Grizzly Creek, (replaced in 1996), gravel bar and Grizzly Creek inflow (top right of center). Van Duzen opposite bank point bar (by upper right edge).
Site 56 Van Duzen River 3 Feb 1993

Photo C-83. Leaning alders stressed by recent high water events. Normal to bank view, near B in Photo C-81, D/S is to left. Observers at join with riprapped bank (left) and natural rock outcrop (right). Ordinary high water is near base of 30-inch high by 5-inch wide z-scale, where alders are vertical. Site 56 Van Duzen River 3 Feb 1993

Photo C-84. Level line between observers' hats is near highest observed water (1964). U/S view, near C in Photo C-81. Grizzly Creek thalweg flows through gravel bar into Van Duzen (behind right observer). Grizzly Creek State Park campground (above gravel bar) was submerged about 7 feet in 1964 floods. Site 56 Van Duzen River 3 Feb 1993

Photo C-85. Failed banks and channel invert protection. U/S view. Steep channel grade, undersized CA 1/2 ton RSP-class gap-graded, no intermediate sizes for interlock, no backing material. Woven-tape geotextile (slit-film) marked with arrows, inappropriate as RSP-fabric on banks. Water behind RSP-fabrics must drain quickly back into channel.
Site 60 CA Grizzly Cr. 2 May 1995

Photo C-86. Woven-tape geotextile (slit-film), inappropriate as RSP-fabric on banks. Close-up view. Typical permittivity of this particular slit-film is about 0.06 per second (about 5 gallons per minute per square foot). Recommended minimum permittivity for RSP-fabric is 0.5 per second (about 37.5 gpm / sqft). Site 60 CA Grizzly Cr. 2 May 1995

Photo C-87. Repaired channel with CA 1-ton RSP-class and oversized rock allowed. D/S view. "ROAD GRADE" about 6 %. Channel grade transitions from 2.5% (at 30-inch high z-scale marked with arrow) to about 21% past upper (closest) downdrain. Concrete anchors for cable-stays are below the bench hinge point of the lower downdrain (left edge of image). Both downdrains are 18-inch steel pipe. Site 60 CA Grizzly Cr. 2 Feb 1996

Photo C-88. Downdrain extends below and beyond top of riprapped channel sides. U/S view of "closest" downdrain seen in Photo C-87. 1V:2H side slope. Nonwoven needle-formed RSP-fabric was wrapped over Backing No. 2 RSP-class. Soil and erosion control planting mixture held by RSP-fabric, would erode vertically down into rock voids if not there. Site 60 CA Grizzly Cr. 2 Feb 1996

Photo C-89. Sediment fan in stilling pool behind gabion weir grade control structure. D/S view just above the lower downdrain seen in Photo C-87. 6'-2" tall observer is standing on weir crest. Channel drop into dissipater / stilling pool is steeper than 21 %. Channel invert has smaller rock, about 1/4 ton RSP-class, spread on top of 1 ton RSP and oversized rock mixture.
Site 60 CA Grizzly Cr. 2 Feb 1996

Photo C-90. 6'-2" tall observer on stable +8-ton rock near end of channel. U/S view. Contrast to Photo C-85. 30-inch high by 5-inch wide z-scale (marked with arrow at bottom center of image) is D/S of lowest concrete cutoff. Site 60 CA Grizzly Cr. 2 Feb 1996