ZEEDYK AND CLOTHIER

Let the Water Do the Work

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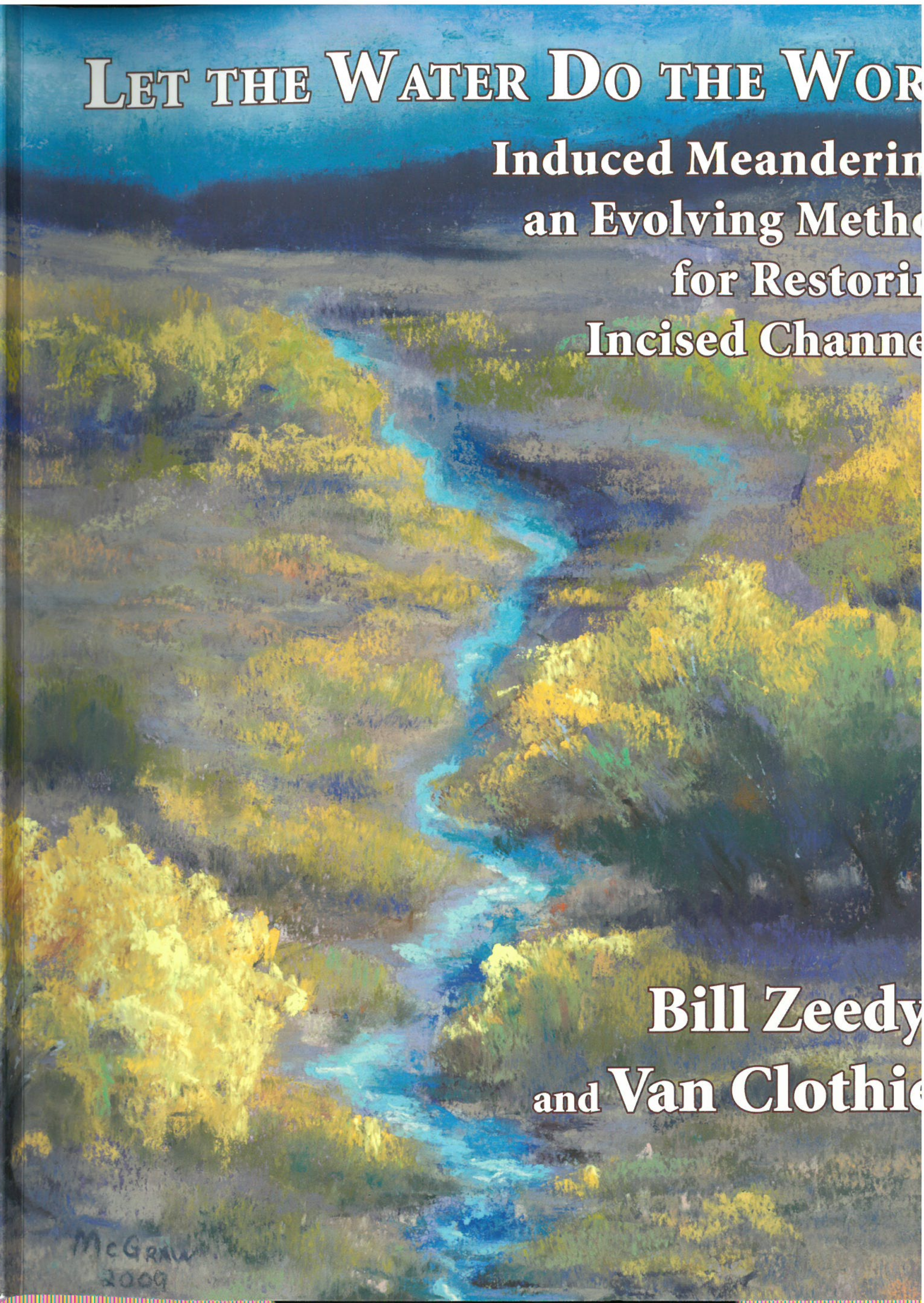

Bill Zeedy
and Van Clothie

Vanes

A vane is a type of deflector. It is an upstream-pointing barb used primarily to divert high velocity flow away from a cutbank on the outboard side of a meander bend. This will reduce erosion, prevent scrolling, and maintain the proper meander radius (Figure 5-7). Vanes can be constructed of boulders, logs, or vertical wooden posts. The vane functions by moving the zone of maximum velocity outward from the bank.

A second use of the vane, when applied in the practice of Induced Meandering, is to direct flow into the opposite bank initiating bank erosion and causing the channel to widen in that direction (Photo 5-9). This is similar to the manner in which a baffle functions. As the channel widens opposite the vane, it begins to deposit sediments along the bank adjacent to the vane where velocities decrease, thereby maintaining the channel width (Figure 5-8). As a result, a bend begins to develop, which may in turn evolve into a new meander.

Several considerations govern the design and installation of the vane. First, the angle of incidence of the vane with the bank should be 20° or less, slightly less is better (Photo 5-10, Figure 5-10, page 94). A vane with a wide angle of incidence is more apt to fail than one with a narrow angle. Second, the angle of descent (declination) from the bank at the bankfull elevation to the tip of the vane at the bed of the channel should be in the range of 2° to 7°. A vane with a steep angle of descent is more apt to fail than a shallow one. Third, the structural components must be adequate to withstand high shear stress, especially when placed in deeply incised channels with fast moving currents and cohesive banks that resist erosion (Figure 5-9). It is important that the bank end of the vane does not extend above planned bankfull level.

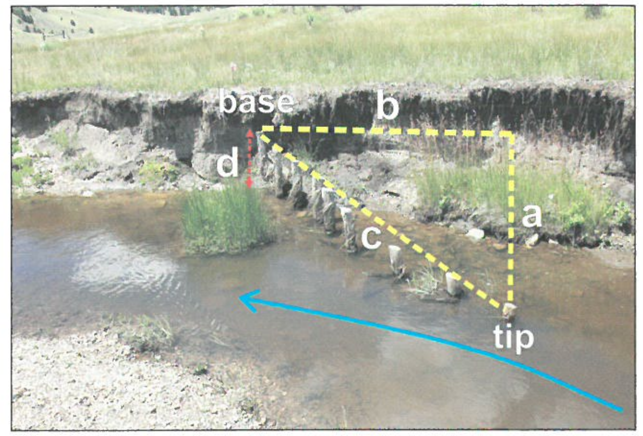

Figure 5-7. A post vane used to protect the outboard or concave bank. Comanche Creek, Carson National Forest, Taos County, N.M. (Photo by Tamara Gadzia)

Photo 5-9. The first ever post vane, 1999, used to initiate erosion of the opposite bank, Pueblo Colorado Wash, Apache County, Ariz. Note deposition upstream and downstream from the vane, downstream deposition not visable.(Photo by Bill Zeedyk)

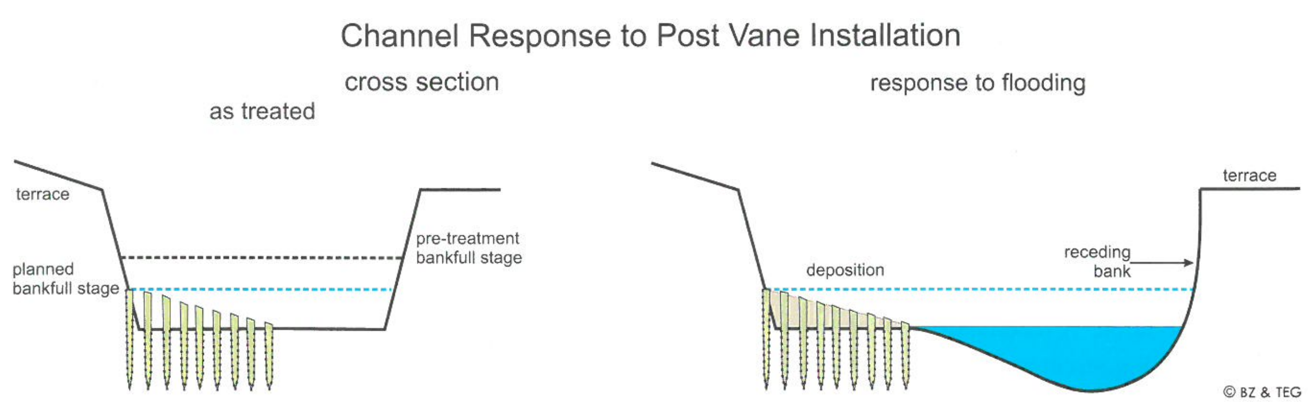

Figure 5-8. Channel response to post vane installation (Adapted from Zeedyk 2003).

Vanes can be built using a variety of materials. Most commonly, vanes are constructed with posts, but boulder and logs also work well. Heavy equipment, such as a backhoe, is needed to excavate trenches for logs and pits for boulders, and to maneuver heavy logs and boulders into place. Proper placement of logs, boulders and footer rocks is critical to structure performance.

Post vane

Because many restoration projects are initiated by individuals or groups having access to manual labor (volunteers, family, friends), but without the funding or desire to hire machinery, a feasible alternative to the use of machine-built structures was needed. Finding an alternative to mechanized equipment led to the development of the post vane, which can be built by hand. The post vane is constructed by driving posts vertically down into the stream bottom to a depth significantly deeper than the scour depth, normally three to five feet, marking the posts to the correct height to achieve the proper angle of descent from streambank, and then trimming the excess. Having first perfected the technique by building modest-sized post vanes manually, it was an easy step up to install larger post vanes in larger rivers by machine.

Post vanes were developed and first used by Bill Zeedyk for installation by hand labor at Hubbell Trading Post National Historic Site on Pueblo Colorado Wash in June, 1999. Their purpose was to withstand the high shear stress occurring within a deep, narrow channel contained by cohesive clay banks that resist erosion. Boulders were more easily displaced than posts by flood flows.

Morphologically, a post vane functions similarly to a boulder or log vane, the main difference being that a portion of the flow squeezes between the posts, rather than spilling over the surface of the structure. Because flows are moving more slowly through the vane than in the open channel, sediments drop out and point bar formation begins in the lee of the structure.

Ecologically, vanes facilitate the establishment of stream bank vegetation by providing optimum seedbed conditions and sheltering newly established plants from flood forces until they can become well rooted. As plant height and root densities increase, streambank soils become well stabilized and the plants begin to protect the vanes which initially sheltered them. Vanes may also provide resting cover near select foraging areas where fish can hide in nooks and crannies between the posts and boulders while lurking in wait for passing prey.

Caution should be observed when extending a post vane beyond mid-channel, because the erosive power of the bankfull discharge increases rapidly as a larger proportion of the total flow is temporarily detained behind the vane, which can cause the vane to fail.

A post vane is a straight-edged structure protruding from the streambank into the oncoming current at an angle from the streambank not exceeding 20°, though less is better. The top edge of the vane dips downward at an angle from horizontal, beginning at bankfull level at the streambank and ending at bed elevation at mid-channel (Figure 5-9, page 94). For post vanes, straight sturdy wooden posts 4-7 inches in diameter at the fat end and 4-6 feet long are recommended for most applications. Using a sledge hammer, posts are driven into the streambed to a depth of 3-5 feet, depending on cohesiveness of bed materials. Opening a pilot hole with a digging bar or auger may facilitate installation. Six-inch posts should be spaced on 18 inch centers, leaving a space of about 12 inches between posts. Thinner posts should be spaced closer together.

After all posts have been driven to the correct depth, the posts are marked for cutting. The bank end post is marked at bankfull elevation, and the tip end post is marked just above bed elevation. A string is stretched between these marks as a guide to marking all the other posts at the proper angle of descent (Photo 5-11, page 95). The string must be checked with a line level to make sure the angle does not ascend, which could lead to structural failure. Cut off excess post lengths with a saw and remove them from the job site. Optimally, the apex of the angle between the vane and the bank can be partially filled with rocks (Photo 5-12, page 95). The rocks should be too large to slip between the posts. The rocks ***should not*** be piled higher than half the height of the vane edge because doing so promotes turbulence and scour.

To install a vane at the proper angle to the bank, place a mark on the bank at the planned apex of the

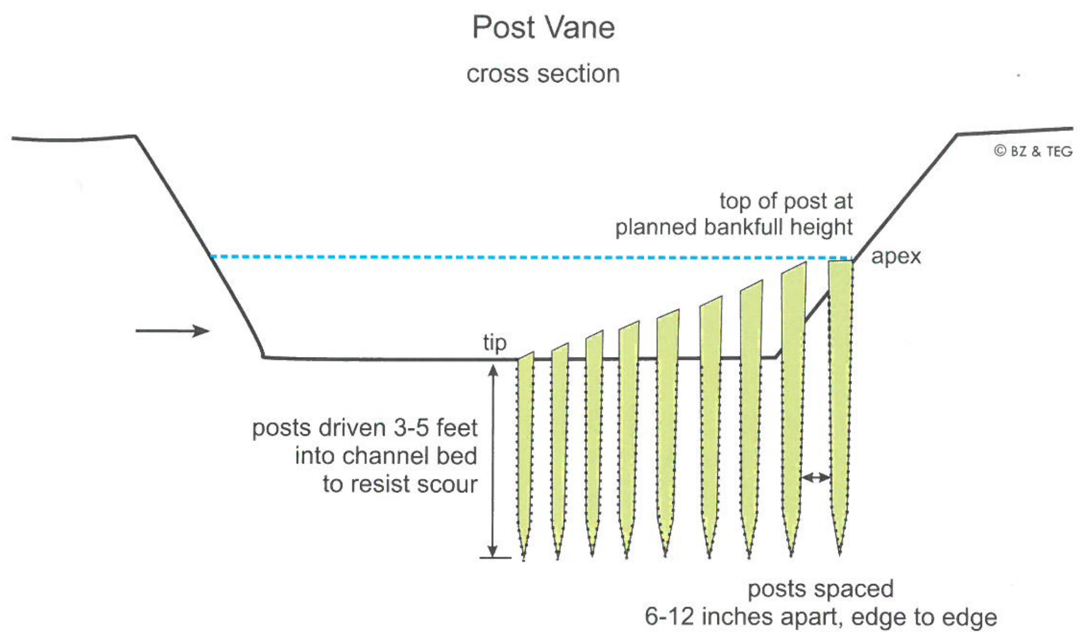

Figure 5-9. Post vane cross section schematic (Adapted from Zeedyk 2003).

Photo 5-10. A post vane, manually installed, on perennial Manuelitas Creek, San Miguel County, N.M. Note that the opposite bank is beginning to recede.
(Photo by Tamara Gadzia)

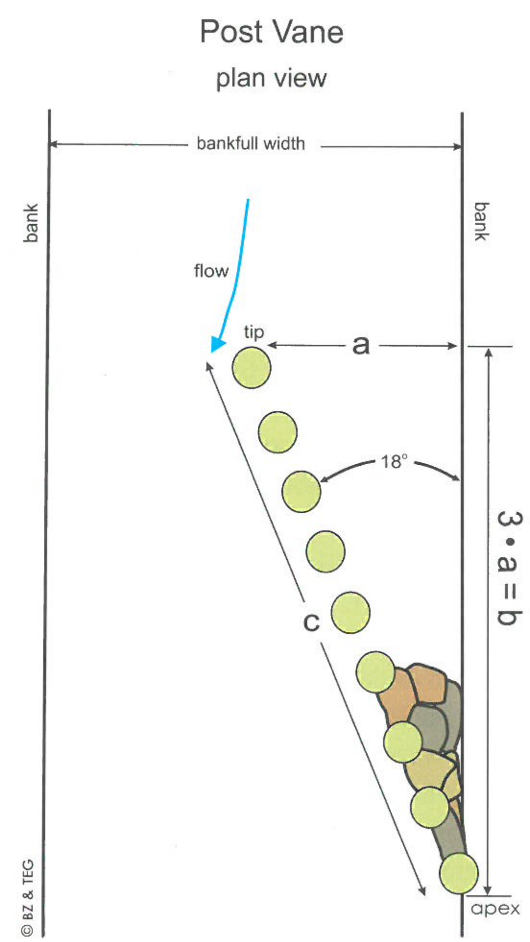

Figure 5-10. Post vane plan view schematic. Optional: fill apex with 1.0 ft diameter rock (Adapted from Zeedyk 2003).

Photo 5-11. Stretching a string to mark the line of descent on a post vane. Comanche Creek, Carson National Forest, Taos County, N.M. (Photo by Tamara Gadzia)

Photo 5-12. The vane/bank intersection is filled with rock and sedge wads to initiate the formation of a bankfull bench. Comanche Creek, Taos County, N.M. (Photo by Courtney White)

Relative Dimensions of a Vane

18° right triangle
(a) Width = 50-70% existing channel width
(b) Bank length = 3 • width
(c) Structure length (hypotenuse) = 3.24 • width
(d) Height = design bankfull max depth

Figure 5-11.

meander, measure out to mid-channel, and make a second mark there for the tip of the vane. This measurement is the width of the vane **(a)**. Multiply the width by three and take this measure from the apex to a point on the bank downstream which will be the length of the vane **(b)**. This procedure will produce an 18° right triangle (Figure 5-10, 5-11).

When the opposite bank begins to recede in response to treatment, the vane can be extended into the channel to "chase" the opposite bank. A point bar will evolve downstream from the vane on the same side. If the vane is too tall, or filled too high with rock, turbulence will prevent formation of a point bar.

Post vane installation with machinery

Post vanes can be installed with the aid of a backhoe or excavator. Where the river bed is comprised of cobble or boulder-sized material, it may be too difficult to pound posts into the bed by hand, and mechanized equipment can make the job easier.

When working on ephemeral channels, the trenching method is more efficient than hand driving. It may also be possible to bore holes using a tractor-mounted auger (Photo 5-13). Holes can be dug manually with a posthole digger and bar. Finally, where large diameter posts are used and streambeds are soft sand, gravel or muck, it may be possible to grasp the post mechanically in the jaws of an excavator and simply push the post into the streambed (Photo 5-14). On the Rio Puerco, a sand-bedded channel having a bankfull width of 56 feet, posts were pushed into the streambed

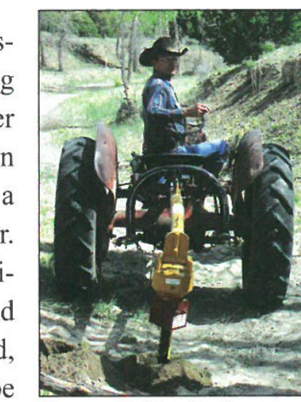

Photo 5-13. Boring post-holes with a tractor-mounted auger. (Photo by Tamara Gadzia)

Photo 5-14. Excavator with a "thumb" used to push log vanes into riverbed. Rio Puerco, Sandoval County, N.M.
(Photo by Mike Chavez)

Photo 5-15. Mechanically installed posts scribed at the proper angle for trimming. Rio Puerco, Sandoval County, N.M. (Photo by Mike Chavez)

to the appropriate depth and then cut to height using a chainsaw. These posts averaged twelve inches in diameter and twelve feet long and were placed on thirty inch centers. Vanes averaged forty-five feet along the hypotenuse with nineteen posts per vane (Photo 5-15).

Machine built post vanes were first installed by Van Clothier in 2005 on a creek in the Burro Mountains. To install a machine built post vane, dig a trench about six feet deep (Photo 5-16). Begin digging at the downstream or bank end of the vane, storing the excavated material in a pile nearby, but not on existing vegetation. When the trench is long enough, place posts butt end down in the trench, leaning them upright on the streamward edge of the trench. Place deadmen (horizontal logs pinned with boulders) along the bottom of the trench to prevent the posts from tilting during flood events. When the trench posts are all carefully set in place, fill in the trench, and put any additional material on the bank side of the vane and compact it in place (Photo 5-17). To compact the soil, roll it with the wheel of the backhoe. Once the backhoe has moved to the next site, snap a chalk line and cut the posts off at the proper design height and angle of descent (Photo 5-18).

It is desirable, especially if significant scour is expected, to backstop the posts with horizontal deadmen. Depending on cohesiveness of channel substrates, the walls of the trench may collapse soon after digging. It may be necessary to work quickly to install the posts before the walls collapse. In that case, work in segments so that posts are set as the digging progresses.

Photo 5-16. Installing a post vane in an ephemeral channel using a backhoe to dig a trench while the stream is dry.

Photo 5-17. Placing excavated material in the trench alongside the posts. Note: this sequence shows posts on bank side of trench. Placing them on the stream side of the trench is more secure.

Photo 5-18. Installed post vane. Stream is flowing after first flood. (Above photos by Van Clothier)

Place each bucket of excavated material in the trench alongside the posts and continue adding posts as the trench progresses, so that the trench is filled with posts and dirt as fast as it is being dug.

Boulder vane

A boulder vane should be built with rock footers placed in trenches beneath the structure. Trenches should be dug below scour depth and at least two times the height of the above ground boulders. For a boulder vane to survive a flood in sand bed streams, trench depth must be at least four times structure height. The proper technique is to place the footer rocks first and then install the surface rocks, beginning at the bank and working toward the tip. A **cutoff sill** is recommended to prevent overbank flows from going around the structure (Figure 5-12).

Log vane

Log vanes can be used to protect banks or to create meanders and generate point bars. Proper installation of log vanes is much more technical than post vanes. A trench is dug into the bank wide enough to accommodate the log (Photo 5-19). To insure that the log can withstand expected shear forces, approximately 60% should be in the bank (Photo 5-20). The log should be placed with the butt in the bank, and pinned down near the bank with a boulder. A footer log can be placed slightly upstream and under the vane log to plug the gap and prevent undercutting.

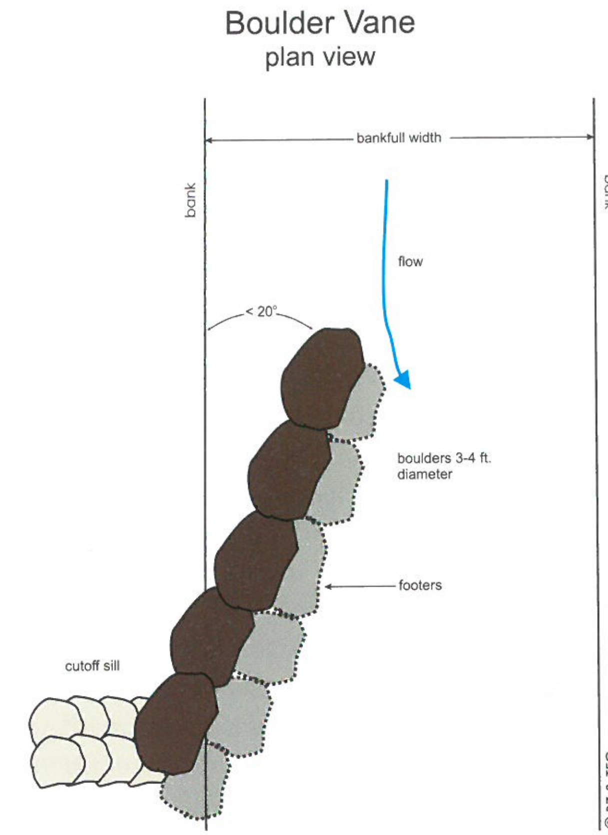

Figure 5-12. Boulder vane plan view schematic.

The angle where the log intersects the bank can be filled with rocks or a live willow clump to help stabilize the structure, but nothing should protrude above the log. The rocks will initiate development of a bankfull bench. It is recommended that a piece of

Photo 5-19. Using an excavator to install a log vane on Manuelitas Creek, San Miguel County, N.M., August 2005.

Photo 5-20. The same log vane, June 2009. Note vigor of vegetation on the bankfull bench. (Photos by Steve Reichert, Tierra y Montes Soil and Water Conservation District)