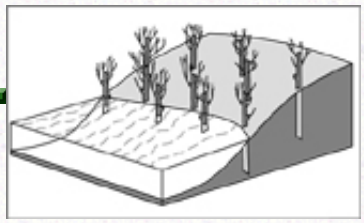
WILLOW POSTS AND POLES



1. CATEGORY

1.0 – River Training

2. DESIGN STATUS

Level II

3. ALSO KNOWN AS

Pole Planting, Dormant live posts

4. DESCRIPTION

Willow (*Salix* spp.) trees and shrubs may be propagated by planting cuttings. Although smaller (<4 cm (1.5 in)) diameter cuttings (stakes) grow more vigorously than older, larger materials (posts and poles), larger materials provide mechanical bank protection during the period of plant establishment.

5. PURPOSE

Dense arrays of posts or poles reduce velocities near the bank or bed surface, and long posts or poles reinforce banks against mass instabilities occurring in shallow failure planes.

6. PLANNING

Useful for Erosion Processes:

- Toe erosion with upper bank failure
- ✓ Scour of middle and upper banks by currents
- ✓ Local scour
- ✓ Erosion of local lenses or layers of noncohesive sediment
- Erosion by overbank runoff
- General bed degradation
- Headcutting
- Piping
- ✓ Erosion by navigation waves
- ✓ Erosion by wind waves
- Erosion by ice and debris gouging
- General bank instability or susceptibility to mass slope failure

Spatial Application:

- Instream
- Toe
- ✓ Midbank
- Top of Bank

Hydrologic / Geomorphic Setting

- Resistive
- Redirective
- Continuous
- Discontinuous
- Outer Bend
- Inner Bend
- Incision
- Lateral Migration
- Aggradation

Conditions Where Practice Applies:

Willow posts and poles can be used in most areas in need of revegetation. Those most conducive to this practice are midbank areas on banks with a 1V:2H slope or shallower. Although posts and poles can be planted in the toe and upper bank areas, vigorous growth is rare, due to drowning and desiccation of the poles, respectively.

Complexity:

Low.

Design Guidelines / Typical Drawings:

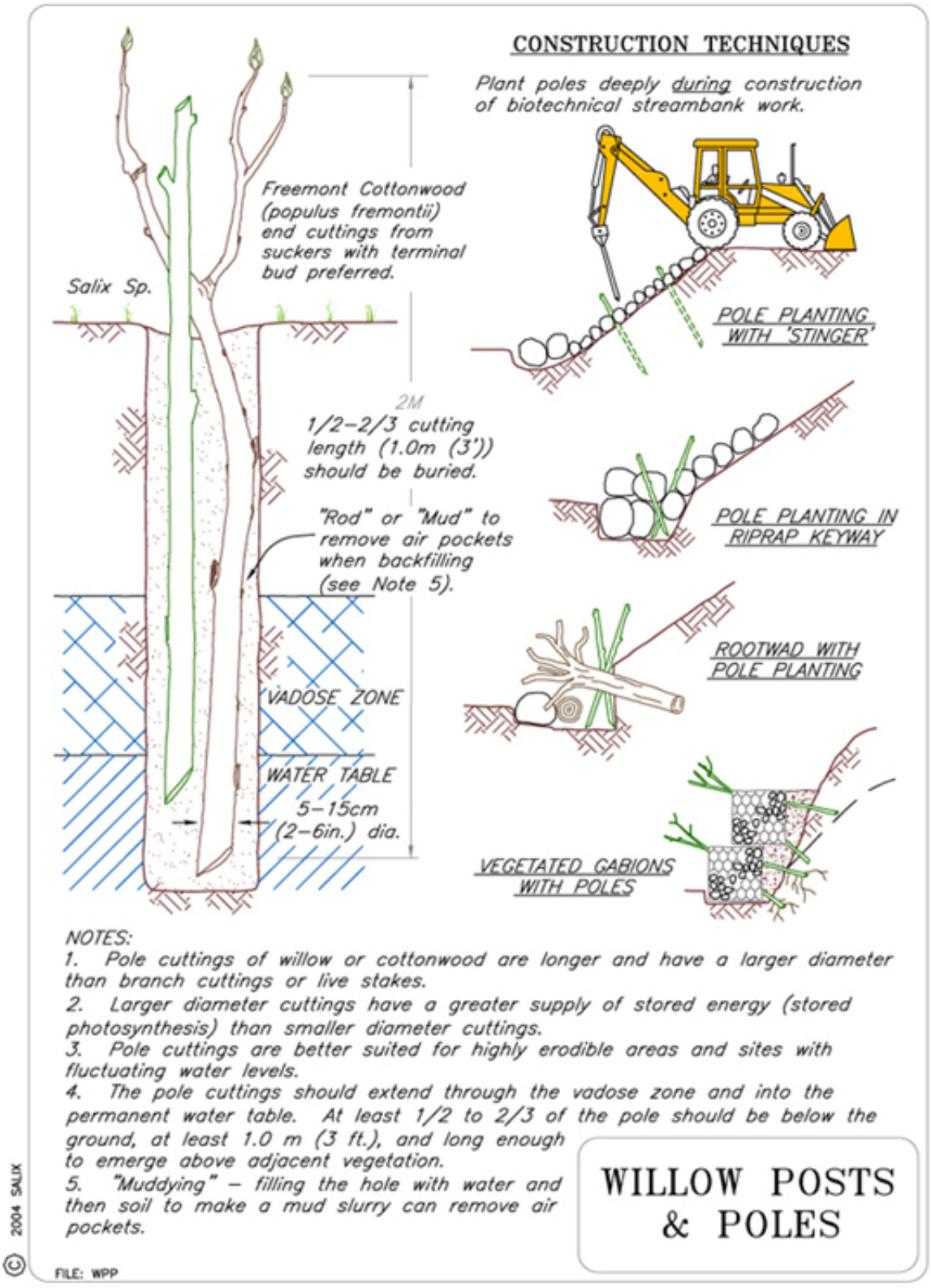
Willow cuttings should be planted while dormant, and care should be taken to prevent desiccation or dormancy break of cuttings between harvest and planting. Basic considerations for harvest, handling, and contracting for installation of plant materials are available from several sources, including Federal Interagency Stream Restoration Working Group (1998) and the Special Topic: **Harvesting and Handling of Woody Cuttings**.

Poles and posts should be deeply (1 to 2 m (3 to 7 ft)) planted in holes created using an auger or metal "stinger" mounted on a hydraulic hoe, or an excavator bucket. Poles should be planted to such a depth that desiccation does not occur during summer (for sites with water tables lower than the stream) and poles are not undermined by local scour during high flows. Augered holes offer the advantage that soils adjacent to the planted stem are not compacted. Good contact between the plant stem and soils is essential, so holes that do not collapse must be refilled with compacted soil to prevent desiccation of the plants due to air pockets. High flows that occur shortly after planting can ensure collapse of the holes and filling of air pockets. Water jetting, in which stems are rapidly inserted into soils that are locally liquefied using a high-pressure stream of water, offers many advantages over other planting techniques when applied to sandy soils (Drake and Langel, 1998).

Only a small portion of the pole should remain above the surface of the ground – about 80% of the cutting should be buried, to prevent desiccation and ensure good stem to soil contact.

Willow success is governed by soil texture and moisture regime (Pezeshki et al. 1998). Workers in drier climates have stressed the importance of planting Willow posts deeply enough to maintain contact with groundwater throughout the growing season (Swenson and Mullins, 1985). Evaluation of a large-scale Willow planting project in northwest Mississippi highlighted the success of Willow posts planted in middle-bank elevations (Watson et al., 1997), while those at the bank toe died due to excessive moisture and those at top bank experienced low survival due to droughty conditions (Shields et al., 1998). Although the cuttings need moisture for survival, evidently they lack the arenchymous tissue found in wetland plants grown from seed, and any level of soil moisture leading to oxidation-reduction potential (Eh) less than about 200 mV is extremely detrimental. Ideal conditions for survival and growth involve abundant soil moisture, but well-drained conditions that produce levels of soil Eh > 350 mV.

Willow planting schemes must specify a standard spacing. Generally, cuttings are planted in denser arrays than those typical of mature plants, in order to reduce near-bank velocities to non-erosive levels. Accordingly, only 40 to 50% survival may provide acceptable performance if the spatial distribution of survivors is fairly uniform. Laboratory flume experiments indicate that near-bed velocities and shear stresses within an array of erect, emergent posts will be reduced about 50% by a density in which the average distance between adjacent posts is equivalent to the square root of 20 times the stem diameter (Lopez and Garcia 1997, Wilkerson and Watson 2000). Staggered patterns apparently do not offer any greater reduction than uniformly-arranged rows (Wilkerson and Watson 2000).



Willow Posts and Poles Typical Drawing

[.dwg]() [.dgn]()

7. ENVIRONMENTAL CONSIDERATIONS / BENEFITS

Willow species are lead pioneers in riparian zones throughout much of North America. Once established, they provide cover and create microhabitat conditions conducive to colonization by endemic native species that comprise the riparian community. Functional riparian zones provide habitats for a wide range of aquatic and terrestrial plants and animals, generally improve bank stability, mediate water quality, and improve visual resources.

8. HYDRAULIC LOADING

Allen and Leach (1997) report velocities of 2 m/sec (6.6 ft/sec) sustained by Willow cuttings.

9. COMBINATION OPPORTUNITIES

Willow posts and poles are excellent additions to any technique that requires excavation, particularly when the depth and location of the excavation intercepts soils conducive to Willow growth. Willow posts and poles may be inserted into stone or soil backfill and thus become incorporated with the structure as they root. They can also be incorporated into many techniques during construction (See Techniques: **Vegetated Riprap**, **Vegetated Gabions**), and can be planted in the keyways of many structures. When placed along a channel with perennial flow, Willows generally will not survive when planted at the toe, but may serve as short-term sacrificial protection for plantings at higher elevations. If permanent protection is needed, however, structural measures like stone toe are recommended.

10. ADVANTAGES

- Willow posts and poles are inexpensive to acquire, install, and maintain.
- Willow posts and poles provide long-term protection .
- Willows generally do not grow into the stream or above the top of bank.
- The mature willows provide canopy cover for aquatic and terrestrial fauna, which also lowers stream temperatures.
- Aquatic and terrestrial habitat is provided and/or improved.
- Willows act as pioneer species, and allow other plant species to colonize the area after the Willows have become established.

11. LIMITATIONS

- Willow posts and poles have higher survival rates when planted during their dormant season, so planning should be adjusted accordingly when possible.
- Optimum stabilization is not achieved until the Willows become established, typically at least one season after installation, although they provide some reinforcement immediately following installation.

12. MATERIALS AND EQUIPMENT

Willow poles, approximately 5-15 cm (2-6 in) in diameter, and 1.8-3 m (6-10 ft) in length. Equipment for digging planting holes; optimum equipment is a backhoe with "Waterjet Stinger," normal Stinger or auger, but an excavator bucket can also be used effectively.

13. CONSTRUCTION / INSTALLATION

Poles and posts should be deeply (1 to 2 m (3 to 7 ft)) planted in holes created using a metal "stinger" mounted on a hydraulic hoe, or an auger.

14. COST

Reported costs range from $2 to $8 per pole or post, including harvesting, transporting, and installing plant materials. Cost will depend on cost of labor in your area, and distance from Willow harvesting area to your site.

15. MAINTENANCE / MONITORING

Willow posts should be inspected for vigor, dehydration, and animal browsing problems, and remedial action taken as necessary.

16. COMMON REASONS / CIRCUMSTANCES FOR FAILURE

Dessication and browsing are the two biggest reasons for failure. Often, Willow post installations need to be fenced for a year or so, especially in agricultural areas, to allow the Willows to get established. Willows that are not planted deeply enough, have too much of their stem exposed, or do not have good stem to soil contact can dry out and die before getting established.

17. CASE STUDIES AND EXAMPLES

Cedar Creek

Scour was occurring on an outer bend of Cedar Creek in Northern California , which was causing serious erosion that had the potential to impact Highway 299. Riprap was used to armor the bank, and 9 bendway weirs were used to redirect flow away from the sensitive bank. Live stakes were installed at the toe, and willow posts were planted into and around all structures.

Little Topashaw

Little Topashaw Creek is a fourth-order stream in the Yalobusha River watershed in Chickasaw County, north central Mississippi. A geomorphic evaluation performed immediately prior to construction indicated that the downstream end of the reach was in the aggradational stage V of the of incised channel evolution conceptual model, while the middle part of the reach was stage IV, and the upstream fourth of the reach was still degrading (stage III). In general, concave banks on the outside of meander bends were caving, and sand was accreting on large point bars opposite failing banks. On the outside of bends, eroding banks frequently invaded adjacent cultivated fields, while inside bends and abandoned sloughs were vegetated with a diverse mixture of hardwood trees and associated species. This project was designed to accelerate evolution of the

existing system toward a sinuous two-stage channel with wooded berms that could be classified as Stage VI. Bank stabilization structures made from large woody debris instead of stone were placed along the toe of eroding banks.

Old 99 Creek

Two old homesites and a large concrete culvert were obstructing Old 99 creek and had accumulated an estimated 5,000 yd^3 of sediment in the creek bottom. This project removed the homesites, culvert, and sediment down to the historic creek bottom, and stabilized the restored channel with a series of 4 rock cross vanes and liberal willow post planting. A second component of this project was the removal of 2 undersized metal culverts and replacement with 3 larger concrete culverts. The upstream bank of the creek was treated with vegetated riprap, as it had been experiencing severe erosion due to scour during high flows.

Please visit the **Photo Gallery** for more pictures.

18. RESEARCH OPPORTUNITIES

None identified.

19. REFERENCES

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