Materials Plant Program

TECHNICAL NOTES

U.S. DEPARTMENT OF AGRICULTURE NATURAL RESOURCES CONSERVATION SERVICE
PORTLAND, OREGON JULY 1997

PLANT MATERIALS TECHNICAL NOTE NO. 18

FACTORS AFFECTING SELECTION, ACQUISITION, AND USE OF PLANT MATERIALS IN A SOIL BIOENGINEERING PROJECT

Theresa R. Flessner
Conservation Agronomist
Plant Materials Center, Corvallis, Oregon

Introduction

The primary objective of this technical note is to inform readers of factors which must be considered to properly select, acquire, and use plant materials in a soil bioengineering project. A bibliography of useful references regarding this topic is provided.

Problem Statement

Appropriate plant selection, acquisition, and use is an essential component of every successful soil bioengineering project. The process of plant selection and use is complex and should be based on project objectives, a thorough site analysis, project design, and knowledge of plant species' characteristics, growth requirements, availability, and cost. The Natural Resources Conservation Service recommends the use of native plant species in soil bioengineering or other revegetation practices, whenever possible.

Plant Selection

Project Objectives

Project objectives can include plant community restoration, streambank stabilization, restoration of fish and wildlife habitat, improvement of ground and surface water quality, and control of weedy plant species. Knowledge of local native sources or a "plant community reference site" within the watershed and successional stage of these plant species can form the basis for vegetative restoration efforts. Plant species with large, fibrous root mass and high stem densities will provide greater mass stability, protect the soil surface, and decrease velocity of water. A mix of native species (trees, shrubs, grasses, forbs) will generally provide shade, cover, and food for endemic fish and wildlife species. The inclusion of large woody debris within the stream will enhance fish habitat. Finally, an effective vegetative riparian buffer will capture sediment, filter

nutrients, control certain weedy (introduced) species through shade, and reduce velocity of flood flows while trapping debris.

Site Analysis

The site analysis should include an assessment of the overall condition of the watershed, particularly in terms of current and future land use or management activities, topography, climate, vegetation, hydrogeomorphology, and soil. A thorough site analysis will narrow 1) the number of plant species that can be considered and 2) methods of utilizing these species effectively. As an example of an assessment of the overall watershed condition, the west fork of Dairy Creek (passing through Washington County, Oregon) occurs in a transitional area between forest lands and the agricultural valley floor; logging and farming are the major land uses. The topography and land uses in this watershed contribute to the excess sediment and nutrient loads of its streams and rivers. Annual precipitation ranges from 40"-80", with the majority occurring from October through March. The stream must be adequately stable to withstand the combination of these physical characteristics; often the simplest method to increase stability is with vegetation.

To narrow the list of plant species for use in a soil bioengineering project, the site analysis must also include an evaluation of specific, local site characteristics. These characteristics include composition of existing plant communities, streambank slope and uniformity, soil texture and structure, available water supply, microclimate, and fish and wildlife diversity and activity. Knowledge of local plant community composition and diversity will serve as an initial guide in selecting species for your project. Existing vegetation often includes some native species and several introduced, weedy perennial vines, forbs, and grasses, such as blackberry, thistle, and/or reed canarygrass. These weedy species are quite competitive and hinder establishment of plant materials. Thus, selection of vigorous, competitive native species is necessary.

Streambank slope and uniformity, soil texture and structure, available water supply, and microclimate influence available soil moisture and nutrients, drainage, and light intensity and duration. These factors limit the number of adapted plant species for the project.

Fish and wildlife habitat can be fostered with certain plant species, plant types, or large woody debris (debris provides cover for fish, for example), and animal predation from deer, beaver, nutria, and/or rabbits must be evaluated and protective measures provided during establishment of plant materials if necessary.

Project Design

Streambank slope and uniformity, stream size, velocity, and sinuosity must be considered when designing the project. Soil bioengineering techniques should be installed on 2H:1V slopes (or flatter), and the bank toe must be stable. Channel alignment (curve radius divided by stream width) should be greater than 6, and bank full stream velocity should be less than 8 feet per second. Some sites do not meet these slope criteria; thus, rock may be placed in select areas to stabilize the toe, and the bank should be graded back appropriately. It is important to stockpile topsoil that is removed during grading, as it is utilized in planting and certain bioengineering techniques, such as brush mattressing. However, if the topsoil seed bank consists mostly of introduced, aggressive plant species, "clean" topsoil (seed bank consisting mostly of desirable plant species) should be obtained.

The soil bioengineering technique selected will also influence selection of plant materials. For example, live stakes require plant materials that produce stout, large diameter stems, while brush mattressing utilizes species with smaller diameter, multibranched, flexible stems.

Specific plant traits to consider include type (woody or herbaceous), form, stem diameter and flexibility, phenology, growth rate, type of root system, propagation or planting requirements, competitive ability, and flood, fire, and drought tolerance. Both woody and herbaceous species are used to revegetate streambanks; woody species are primarily used in soil bioengineering techniques and in clump or mass plantings, and herbaceous species are often seeded on disturbed or bare areas. Shrubby (low-growing), flexible, smaller species are utilized at the base of the slope, and taller species are utilized upslope. Plant species with a rapid growth rate, season-long canopy cover, and fast-growing, massive fibrous root system provide excellent erosion control. The use of compatible species, or those that can survive, grow, and reproduce, together, and foster succession is ideal.

Soil bioengineering techniques utilize woody species which root easily from dormant hardwood cuttings and can tolerate both flooding and drought events. Thus, plants, cuttings, stakes, whips, or poles are generally planted or utilized in soil bioengineering techniques in late fall, winter, or very early spring in western Oregon and western Washington. Soil bioengineering projects are generally installed in early April to mid-May in eastern Oregon and eastern Washington. If projects are installed in early fall, irrigation is often required (particularly in eastern Oregon and eastern Washington) to facilitate plant establishment. Plant materials must have access to the water table during dry, hot summers to survive, especially in coarse, well-drained soils. Timing of plantings must also follow state/federal instream guidelines.

Willows (*Salix* spp.) meet most of the above criteria, as well as redosier dogwood (*Cornus stolonifera*) and Douglas spirea (*Spiraea douglasii*). Other plant species to consider for use in a soil bioengineering project in the Pacific Northwest are listed in Washington Technical Note No. 28 and Chapters 16 and 18 of the USDA Natural Resources Conservation Service Engineering Field Handbook (see bibliography). Plant materials may be utilized as live stakes, fascines, cuttings, joint plantings, in brush mattressing, brush layering, branchpacking, or other soil bioengineering techniques, and as clump plantings. Disturbed areas are generally seeded, mulched, and/or netted.

Plant Acquisition

Plant materials can be collected locally, purchased from commercial suppliers, or obtained through contract growers. Each source has distinct advantages and disadvantages. Local sources are adapted to site conditions, and utilizing these sources will maintain the genetic integrity of the area. However, local sources may be of limited quality and quantity, difficult to identify, and labor-intensive to locate, collect, store, and/or propagate. The effect of removing plant material on local wildlife must also be considered.

Commercial suppliers may provide the desired species or local stock; the quality and quantity of this stock can be determined prior to installation. Cost is often high, and plant quantities may be limited.

Contract growers are often utilized if commercial supplies are limited or unavailable, local (genetic) sources are desired, and horticultural or agronomic expertise and facilities are necessary to propagate and increase plant species. Growers need sufficient lead time (1-2 years minimum) to locate, collect, and propagate plants. As a result, plant materials provided from contract growers may be costly.

Monitoring and Maintenance

After planting and installation of soil bioengineering techniques, it is important to monitor and maintain the site as the information gained will be invaluable when designing future projects. The site should be inspected at least annually and after major high flows. Ground photopoints should be established and photographs taken both spring and fall. Plant growth and composition, erosion control, and structural stability must be evaluated. Overall, the site is considered stable and the soil bioengineering system functioning properly if there is no sign of soil erosion or sloughing, plant material is vigorous and healthy, species composition is diverse, and plantings provide adequate cover and buffer width. Improved water quality, increased shade, and enhanced wildlife and fish habitat should also be evident. In short, the goals of the project should be met.

If plant materials are dying or growing poorly and/or structures are damaged or missing, maintenance is required. Maintenance efforts are usually most intense one to three years after planting or until plant materials mature and the system is functioning properly. Maintenance may include irrigation, fertilization, pruning, replanting, and pest control (of diseases, insects, weeds, and animals). The use and application of fertilizers and pesticides near streams must follow all local, state, and federal rules, regulations, or guidelines. Structures may need repair or replacement, and the site may need to be fenced or protected from human or animal traffic. Disturbance to the site during maintenance operations should be minimized as much as possible.

Summary

Proper plant selection and use is paramount to a successful soil bioengineering project. Selection and use must be based on project objectives, a thorough site analysis, appropriate design, and knowledge of plant species traits, growth requirements, availability, and cost. Plant materials may be obtained from local sources, commercial suppliers, or contract growers. Each has distinct advantages and disadvantages. After planting and installation, periodic monitoring and maintenance are essential processes for a fully functional riparian ecosystem.

BIBLIOGRAPHY

Allen, H. H., and Klimas, C. V. 1988. Reservoir shoreline revegetation guidelines. Department of the Army, U. S. Army Corps of Engineers Tech. Rep. E-86-13. Waterways Experiment Station, Vicksburg, MS.

Carlson, J. R. 1992. Selection, production, and use of riparian plant materials for the western United States. In: Proceedings--Intermountain Forest Nursery Association. USDA Forest Service Gen. Tech. Rep. RM-211. Rocky Mountain Forest and Range Experiment Station, Ft. Collins, CO. pp. 55-67.

Carlson, J. R., Conaway, G. L., Gibbs, J. L., and Hoag, J. C. 1991. Design criteria for revegetation in riparian zones or the intermountain area. In: Proceedings--Symposium on Ecology and Management of Riparian Shrub Communities. USDA Forest Service Gen. Tech. Rep. RM-65. Rocky Mountain Forest and Range Experiment Station, Ft. Collins, CO. pp. 163-166.

Darris, D. C., T. R. Flessner, and J. D. C. Trindle. 1994. Corvallis Plant Materials Center Technical Report: Plant Materials for Streambank Stabilization 1980-1992. USDA Natural Resources Conservation Service, Portland, OR. 172 pp.

Gray, D. H., and Leiser, A. T. 1982. Biotechnical slope protection and erosion control. Van Nostrand Reinhold Company, New York.

"How to plant willows and poplars for riparian rehabilitation." Plant Materials Technical Note No. 23. USDA, Soil Conservation Service, Boise, Idaho. April 1993. 11 pp.

Johnson, A. W., and Stypula, J. M., eds. 1993. Guidelines for bank stabilization projects in the riverine environments of King County. King County Department of Public Works, Surface Water Management Division, Seattle, Washington.

"Native plants recommended for wetland/riparian plantings in the Pacific Northwest." Plant Materials Technical Note No. 28. USDA, Natural Resources Conservation Service, Spokane, Washington. January 1995. 4 pp.

R. B. Sotir & Associates and others. 1996. USDA Natural Resources Conservation Service Engineering Field Handbook Chapter 16: Streambank and Shoreline Protection. USDA Natural Resources Conservation Service, Portland, Oregon. 130 pp.

Sotir, R. B., and Gray, D. H. 1992. USDA Soil Conservation Service Engineering Field Handbook Chapter 18: Soil Bioengineering for Upland Slope Protection and Erosion Reduction. USDA Soil Conservation Service, Portland, Oregon. 53 pp.

"Streamside revegetation." Plant Materials Technical Note No. 6. USDA, Soil Conservation Service, Portland, Oregon.
March 1989. 8 pp.