adjacent development. Plants of larger size may be necessary in urban areas to give a more immediate effect. The selection of suitable species is very important in urban areas and should be based on experience in similar areas. Street tree plantings can significantly improve the visual quality of communities. Flowering trees and shrubs and wildflowers enhance the highway environment and offer pleasant and changing scenes for the motorist and adjacent property owners.

b) Screening Undesirable Views and Objects

Screening undesirable views seen from and toward the highway can be performed with plants, earth berms, fences, and combinations of these. Plantings offer a variety of forms and combinations of forms which can be manipulated by the designer to accomplish a natural looking solution. In some cases, effective screening with plants will take several years to achieve, but this should not prevent the accomplishment of this work.

The sight lines from and toward the highway to the object to be screened should be studied. Partial screening may be acceptable in some areas to minimize attention to the undesirable scene and total screening may be required in other areas. Where a year-round screening effect is desirable, evergreen plants should predominate, with deciduous material for seasonal color, textural interest, and continuity with the surrounding area. Whenever possible, consideration should be given to the removal of the objectionable object.

4. Setback Distances for Trees

The following descriptions may vary somewhat from state to state according to a state's special experiences and safety regulations. Setback distances found in other AASHTO guides present ideal clear-zone-distance criteria. The AASHTO *Roadside Design Guide* (1989) and the AASHTO *Guide for Selecting, Locating, and Designing Barriers* (1977), represent "best practice" references.

These guidelines may be applied to new plantings of trees whose trunk diameter at maturity will be four inches or greater. Setback distances or vehicle recovery areas are related to type of slope, slope ratio, traffic volumes, and design speed of the highway. The setback is from the traveled way which is the portion of the roadway for the movement of vehicles, exclusive of shoulders and auxiliary lanes.

Given distances will not always be practical. Variations in site-specific conditions need to be considered and may warrant special treatment. Existing historic, aesthetic, or environmentally important trees may be retained within the recovery area if they are protected or are not in a target position, such as the outside of horizontal curves. Shrubs and ground cover may be planted within the recovery area for safety and aesthetic purposes.

The above guidelines should be used unless one of the following reasons will allow for a lesser distance or require a greater distance:

- The minimum distance behind guardrail depends on the deflection of the guardrail as described in the AASHTO reference cited above. Examples of this setback distance are 11 feet for cable guardrail, 2 to 3 feet for W-Beam guardrail and no minimum distance for concrete barriers.

- There is no minimum setback distance behind rigid obstructions, such as walls and concrete barriers, nontraversable backslopes, or banks. However, tree branching and tree maintenance should be considerations determining minimum distances.

- For central business districts and local streets with barrier curbs, a minimum distance of 1.5 feet should be provided beyond the face of the curb to the anticipated outside diameter of the tree trunk when mature. On urban arterials and collectors with similar curbs and usually higher speeds, the offset distances should be increased.

- Where limited right-of-way or the necessity for planting would result in less clearance, all factors in the area should be weighed to decide if a special exception is warranted. Special exceptions or conditions may include:

    1. Where exceptional or unique trees because of size, species, or historic value exist.

    2. On designated scenic roads or low-speed roads, as well as low-speed urban roads.

    3. Where the absence or removal of trees would adversely affect rare/endangered/threatened species (plant or animal), wetlands, water quality, or result in serious erosion/sedimentation effects.

    4. Locations where the cumulative loss of trees would result in a significant adverse change in character of the roadside landscape.

    5. Landscaped, park, recreation, horticultural, residential or similar areas where trees and other forms of vegetation provide significant functional and/or aesthetic value.

- Adequate sight distance for the design speed of the highway must be determined on curves, intersections, railroad crossings, and in gore areas. Trees should not be placed where they are particularly vulnerable to vehicle contact, or where significant incidences of run-off-road accidents occur.

- An east-west orientation may necessitate a greater offset from the south side of a road than the north to prevent shading and ice formation in the winter.

- Allowance should be made for the regeneration of woody growth.

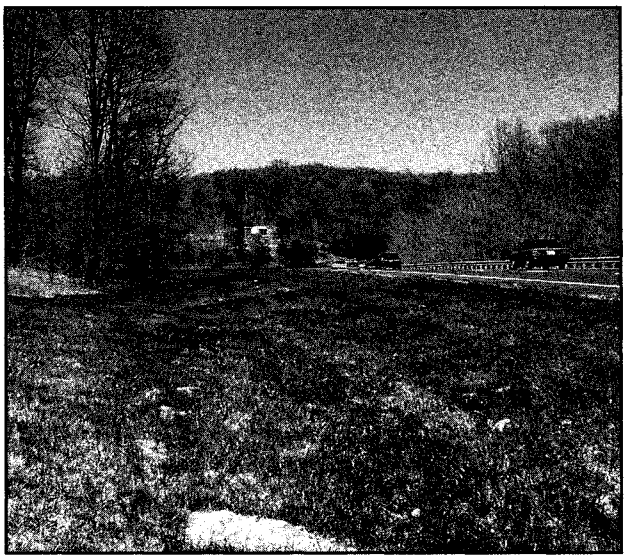

Figure IV-25. A safe and aesthetically pleasing setback distance for trees along an interstate highway.

5. Plant Establishment

Plant establishment is the care and replacement time required after plants are installed for them to adjust to and become established in the highway environment prior to normal maintenance takeover. This is a very critical stage in the planting process because of the less than optimum growing conditions within the highway right-of-way. During the plant establishment period, plants should be stimulated with necessary water and fertilizer, weeds and insects should be controlled, and pruning and plant replacements made. Depending on existing conditions and the planting function, the establishment period may be one to three year's duration. Planting contracts should include care and replacement and the date for termination of plant establishment.

L. Irrigation

Ideally, plantings are selected to be appropriate for local environmental conditions. However, in arid parts of the country, particularly in urban zones, natural rainfall or groundwater may be inadequate to support the level of planting needed for visual screening or functional purposes.

Where irrigation systems are required, they may be either temporary or permanent. Temporary irrigation systems should be installed to establish plants for a few years and then be shut down. Permanent irrigation systems are sometimes unavoidable. If they are necessary, they should be designed for long-term maintainability. Systems should effectively and efficiently supply water to the plants.

Irrigation design and planting design are closely interrelated. It is important to work out a conceptual irrigation plan before finalizing the planting plan. Where planting space is too narrow or restricted, such as gore areas or divider islands, reconsider plantings that require irrigation. For economy, restrict the use of plantings that require irrigation to areas that are visually prominent or need planting for functional reasons.

Irrigation systems should supply the appropriate amount of water to each plant, yet the systems should be as simple and straightforward as possible for maintainability. Therefore, it is essential to design planting and irrigation using a zonal concept—plants of similar water requirements, in similar soil and exposure situations should be grouped together within a valve section.

Automatic irrigation systems are usually preferred from an operational and water conservation standpoint. Automatic systems permit night watering when winds are usually low and evaporative loss of water is minimal. Safety to the motoring public

and to maintenance workers is essential. Proper design and location of sprinklers and risers can minimize the chance of water spraying on the roadway and the need to make repairs due to vehicle damage.

Wherever permanent irrigation is necessary, an effort should be made to find and make use of reclaimed water sources.

Chapter V

Construction Consideration in Design

Statement of Objectives

For the purpose of this guide, "Construction" is defined as the art and technology needed to build the outdoor human environment to facilitate a transportation system. It crosses the boundaries of many other disciplines and depends on other more established bodies of knowledge. As with maintenance, construction is strongly linked to design.

If designers are to accomplish the plans they draw, they must have a broad understanding of the actions necessary to bring the plans into being. Designers also have a responsibility to observe issues of human need and to determine how to address them.

Because of the growth and complexity of the nation's transportation system against a background of diminishing natural resources, designers no longer have total control over projects. Today, the designer may be facilitator and a manager of input from a myriad of sources as well as a specialist. Dependency upon a team of relevant resource people is important, but a liaison with construction personnel is a prerequisite for design implementation. This is particularly true when addressing the permitting process and public issues in environmentally sensitive areas.

The construction team must be well informed of any change in design rationale. A design is most successful when construction personnel are involved from the early stages of the design process through the final specifications.

Good communication during the construction phase is essential. This is evident where the construction team has taken the initiative to interact with designers and environmental specialists. Design documents are the tools used to express the level and consistency of construction techniques needed to accomplish the project. However,

unexpected conditions in the field may require adjustments of even significant design changes. For best results these circumstances should be communicated back to the designer for consideration, recommendations, and concurrence.

When a transportation improvement is located in an environmentally sensitive area or where visual impacts are a major concern, the construction engineer should have the assistance of an interdisciplinary team. For example, the landscape architect can be extremely helpful when it is necessary to fine tune the design to fit field conditions. There are decisions about the location of grading stakes for contouring, rounding and warping slopes, preservation of rock outcrops and other natural features, conservation of plants and thinning vegetation to open up frame views, application of erosion control measures, and revegetation requirements. Other disciplines with expertise in biology, forestry, agronomy, fish and wildlife management, park management, etc., can be equally as helpful to the construction engineer when the project involves streams, wetlands or other natural resources and use areas.

Design Guide

A. Erosion and Sediment Control

Under natural conditions where soils are under a protective vegetative cover and surface water courses have developed through geologic ages, weathering, including erosion, is a vital requirement for sustaining a healthy stream and is not regarded as pollution.

Unfortunately, poor land-development activities in watersheds has increased rates of soil erosion from fifty to one-thousand times that of natural amounts. This accelerated erosion is largely caused by careless earthwork operations. Sediment created from erosion is the single, greatest pollutant by volume in our waters.

Sediment causes an unhealthy habitat for fish. It destroys the balanced biological conditions necessary for a diverse aquatic community and smothers stream organisms. Sediment carries with it fertilizer nutrients which cause eutrophication of lakes and ponds. Toxic compounds which threaten life at all levels of the food chain can be transported by soil sediment.

In addition to being a pollutant to surface waters, sediment also increases flood crests, reduces the water-carrying capacity of watercourses and fills navigation channels. Sediment also causes consumptive use of water to be more costly, interferes with the assimilative capacity of waterways, and degrades the appeal of water recreation.

Sediment pollution is controlled through the timely control of soil erosion. Sedimentation causes environmental disturbances; downstream inhabitants are vulnerable to upstream development activities. To protect water flowing from upland watersheds to downstream communities, a variety of methods are integrated into an erosion and sedimentation control plan. Elements of the erosion plan include site specificity, locating protected resources, timing of execution, applying natural and man-made

devices, and establishing reliable vegetative cover. The contract plans should include pay items for temporary and permanent erosion control measures.

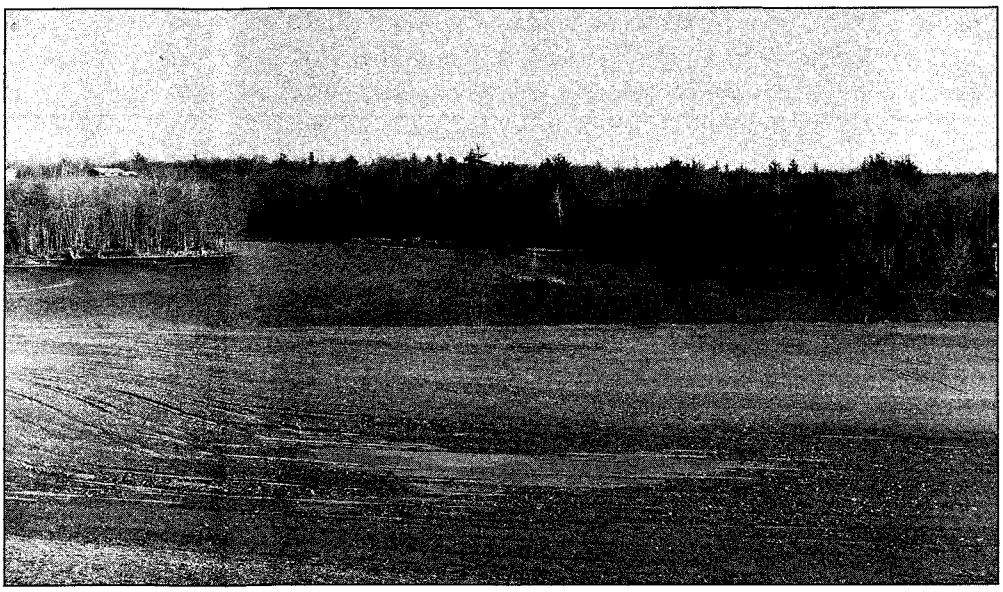

Figure V-1. *Erosion and sedimentation plans must be implemented during early construction stages.*

Site-specific erosion and sedimentation control plans should be prepared and implemented prior to any earthwork operations. For example, silt fences should be promptly erected on work limit areas adjoining wetlands, drainageways, streams and other bodies of water. Other temporary control devices include sediment basins, diversion berms, vegetative buffer areas, channel linings, energy dissipaters, seeding and mulching.

Figure V-2. *Timely soil erosion and sedimentation control during ditching operations.*

Permanent erosion controls can be built into structural earthwork design. These include terracing, slope flattening, stone and durable synthetic blankets, retaining walls, riprap armoring, indigenous planting, sodding and grassland establishment.

B. Clearing and Grubbing

The project site should be cleared only within the limits of construction or as required for safety clear zone management. This work includes clear cutting, selective clearing or thinning of woody vegetation, tree trimming, single-tree removal including dead, blown-down, or uprooted trees. All stumps and debris within the safety clear zone of the right-of-way and easement areas should be removed.

Trees, shrubs, landscape and cultural features, and environmentally sensitive areas to be preserved should be designated and protected during the progress of the work. Alignment stakes, grade stakes, witness stakes, boundary markers, benchmarks, and tie points should be preserved until permission is given for their disturbance.

Figure V-3. *Cleared and grubbed area ready for ledge blasting.*

In areas where the natural ground at the site of a proposed embankment is not designated to be grubbed, all stumps should be cut off as close to the ground as is practicable. When stumps are to remain in the backslope, they should be cut flush with the final slope line.

In areas where stumps and shrubs are to remain, the surface of the ground should not be disturbed or compacted. Existing groundcovers should be preserved and the area left in a condition which is reasonably consistent with the surroundings. All trees to be removed should be felled away from trees and shrubs to be preserved so they are not harmed.

All live deciduous stumps, one inch or more in diameter and located between the construction limits and the outermost clearing or selective clearing lines, should be treated with approved herbicides to prevent regrowth.

Every effort should be made for useful disposition of woody material into the marketplace. If the contractor can demonstrate that a reasonably suitable market for the material is not available, other disposal methods may be approved. These include shipping, burning, or burying.

Wood chippers can be used to reduce woody material to chips. The chips can be spread evenly and randomly over the ground or stockpiled for eventual mulching and erosion control. When there are sufficient quantities, chips may be made available to fuel biomass furnaces for producing energy.

Waste wood can be burned on-site and away from preserved vegetation only when applicable permits have been secured. Toxic and polluting materials should not be used to start or maintain fires. Burning should be maintained to produce minimal amounts of nuisance and air pollution.

Extreme care should be observed where there is any possibility of burning, scorching, overheating, or otherwise jeopardizing trees, shrubs, surrounding forest cover, adjacent lands or buildings, or where there is a possibility of damaging overhead wires and buried cables. All fires should be tended throughout the burn period by a competent individual.

Brush and logs may be disposed of by burying in approved waste dumps or used in flattening slopes on the project. Wood waste can be placed in the outer portion of the embankments. In waste dumps, the wood is covered with a minimum of two feet of soil. Excavation or borrow used to cover brush or logs placed in the slope extension should be spread in layers at least two feet thick and compacted only to the extent that the stability of the slope is assured.

C. Loam Conservation

In some regions, loam is used as a medium to establish and maintain seeded areas. Loam sources remove significant amounts of productive top soil from agricultural acreage and should be conserved. Subsoil to be used as seedbed, should be reviewed at the site to determine the need to add loam. Ditches, shorelands, and water runoff areas near pavements and other structures require dependable erosion control and established vegetation requiring consideration of loam usage.

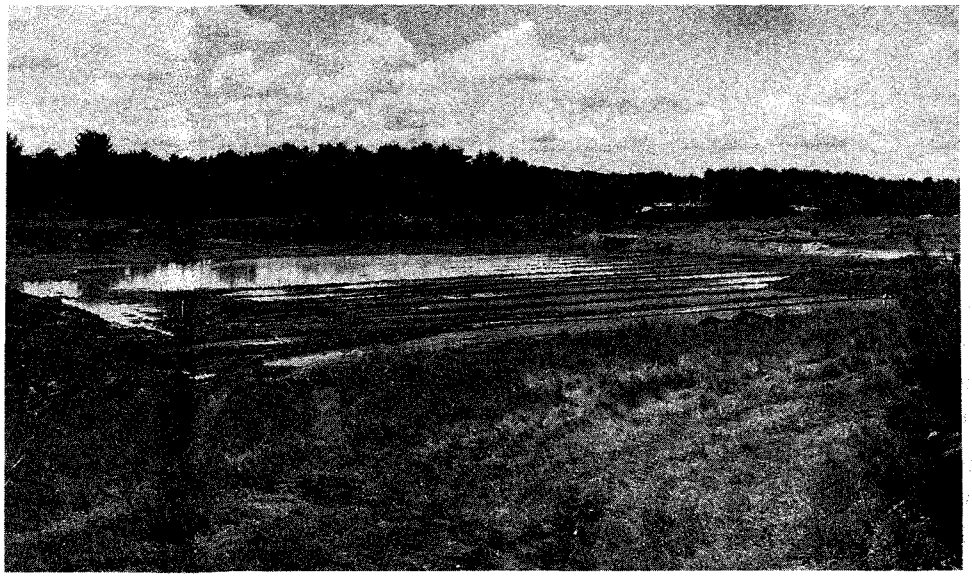

Figure V-4. *Loam-stripped sites can provide useful stormwater detention basins.*