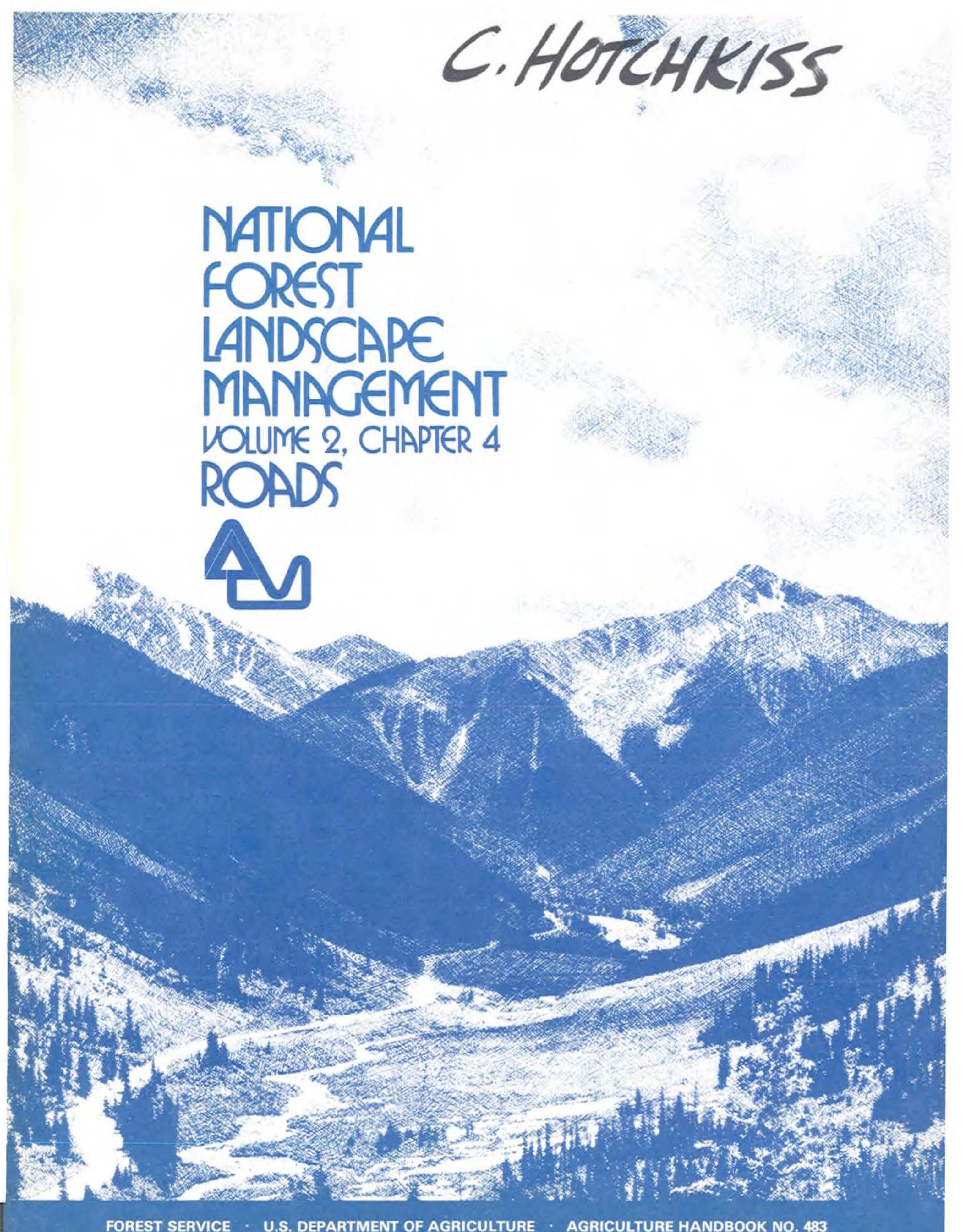
C. HOTCHKISS

NATIONAL FOREST LANDSCAPE MANAGEMENT

VOLUME 2, CHAPTER 4

ROADS



FOREST SERVICE · U.S. DEPARTMENT OF AGRICULTURE · AGRICULTURE HANDBOOK NO. 483

NATIONAL FOREST LANDSCAPE MANAGEMENT
VOLUME 2, CHAPTER 4
ROADS

FOREST SERVICE
U.S. DEPARTMENT OF AGRICULTURE
MARCH 1977

Foreword

Volume 1

National Forest Landscape Management, Volume 1 is a training document distributed throughout the National Forest System in April 1973. It is used as a basic text to illustrate the concepts, elements, and principles of our landscape management program. This program seeks to identify the visual characteristics of the landscape and analyze, in advance, the visual effects of resource management actions. Volume 1 was prepared by landscape architects, land management specialists, and research scientists from throughout the Forest Service over an extended period of time. It is available from the Superintendent of Documents, Washington, D.C. as Agriculture Handbook Number 483.

Volume 2

National Forest Landscape Management, Volume 2 will consist of several chapters (one of which you have before you), each dealing with the application of Volume 1 principles to a specific function or area of concern in the field of resource management. The effort to produce each chapter has been spearheaded by one Forest Service region, chosen for its experience and demonstrated expertise in the field, utilizing some contributions from other regions, research scientists, industry, and universities. These chapters will be published separately, as they are completed, for the purpose of prompt dissemination of what is, hopefully, very useful information.

When all chapters have been published and studied by all regions, and comments from other agencies and interested readers have been evaluated, we intend to revise and combine them into a single document—which will be Volume 2.

We hope you find this chapter thought provoking and useful. Comments and suggestions are always welcome.

John R. McGuire

JOHN R. McGUIRE
Chief

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Most of man's perception is based on sight. Most viewing of National Forests occurs from roads.

Introduction

Proper management of the resources of the National Forests has required the planning, design, construction, and maintenance of a 220,000 mile road system. The maintenance and expansion of this vast system will demand a continuing integration of landscape management considerations.

Roads on National Forest lands run the gamut from those passable only by 4-wheel drive vehicles to portions of the Interstate Highway System. The higher standard highways are designed, constructed, and maintained by the individual States under an agreement with the Forest Service. The lesser roads, however, are a function of the Forest Service. They form the largest low-volume, low-standard, low-speed road system in the world.

The more sophisticated ideas and concepts expressed in this chapter will sometimes be inappropriate (too costly, time consuming, or elaborate) for many National Forest System roads. They are presented, nevertheless, for use in those instances when Forest Service analysis or input is necessary for projects involving major highways (and even "Interstates") which will impact the National Forests. It is also expected that simplifications or modifications of these methods may have occasional application on even the smallest Forest Service or operator-constructed roads.

This chapter is concerned primarily with the visual impact of all these roads: the major impact being their linear configuration, which must be superimposed upon nonlinear landscapes. Further visual impacts are brought about by the limited gradients of road profiles, the relatively constant widths of road prisms, and the need for a hard smooth traveling surface which seldom matches the color or texture of the adjacent landscape.

Several good books have been written (see page **61**) on the process of land analysis and proper highway corridor location. It is a broad subject. With this in mind, and for the sake of reasonable brevity, this chapter has been designed for use in those situations where:

The *need* for and the *purpose* of the transportation system has been established.

The type of transportation system has been selected—in this case, a road.

The *general location* of the road has been selected, (i.e., going from "A" to "B" within a corridor "X" hundred feet or miles wide).

Objectives

The objectives of this chapter are:

To meet visual quality objectives by providing direction on integrating roads into the forest landscape with minimum adverse visual impact and maximum enhancement of scenic qualities.

To suggest and encourage imaginative analyzation and display techniques to aid the decision maker and the public in evaluating the visual impacts of proposed roads.

These objectives should be met while *simultaneously meeting the objectives of:*

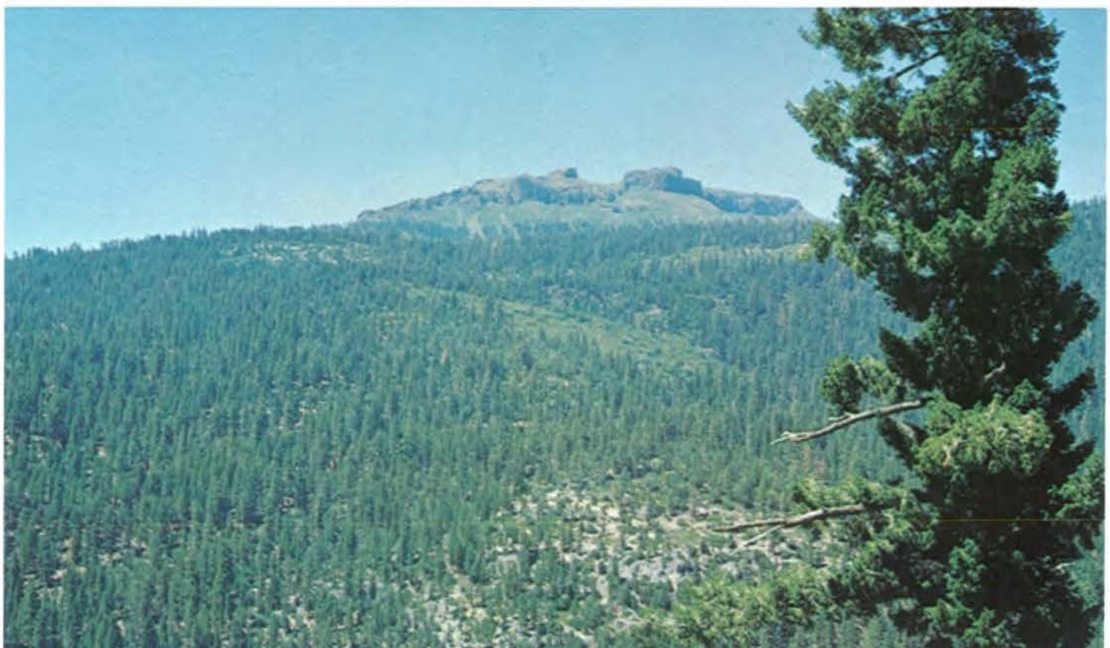
1. Functional adequacy of the transportation system.
2. Public Safety.
3. Compatibility with all other Forest multiple-use objectives.
4. Economy of construction, operation, and maintenance.
5. Public acceptance of the total project involved, i.e., acceptance of trade-offs that must be made to optimize the meeting of all objectives and requirements.

There are almost always trade-offs to be made to suboptimize all objectives. Road design can be as much an art as it is a science. Most road designers are trained in design, mathematics, and economics but not in esthetic design. This handbook was developed to help the engineer, as well as all other disciplines involved in road location and design, to understand more fully the reasons and benefits of visual resource trade-off values.

Reducing visual impact of roads







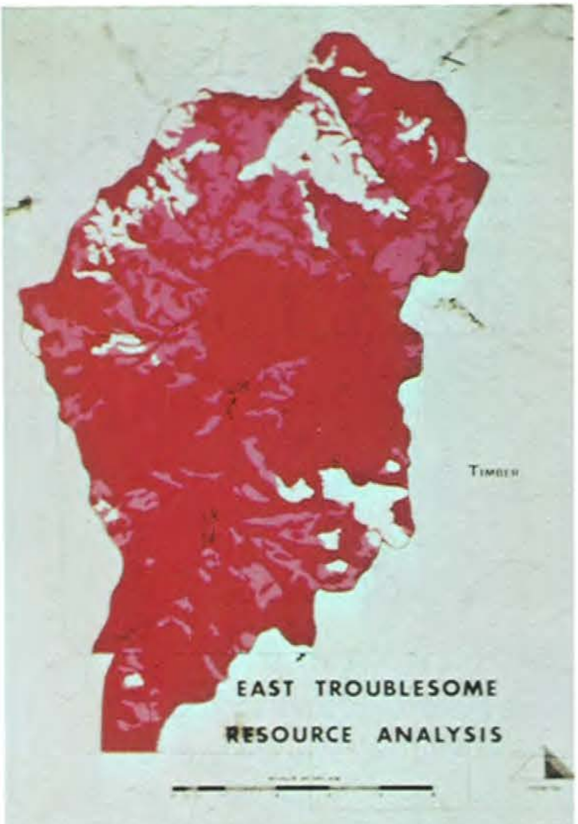
. . . to no visual impact.

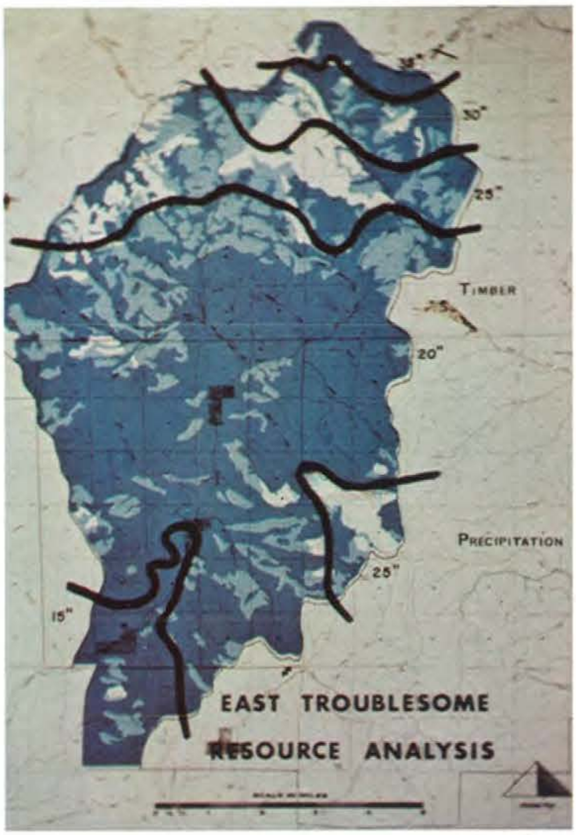
LOCATION

One of the relatively recent developments in transportation route location has been the transparent overlay rating system of resource, esthetic, and social values in addition to the normal criteria of physiographic, traffic, and engineering considerations. "Design with Nature" by Ian McHarg, portrays a manual transparent overlay system which helped set the stage for corridor selection studies a few years ago.

Computer mapping of such values is to a certain degree replacing the somewhat cumbersome overlay system. Techniques can be applied to such computer maps and values to explore alternatives rapidly. These methodologies, manual and computer-generated, also apply to activities other than roads. They are well represented in various publications and so are not covered in any detail in this chapter. For additional bibliographical references, see items preceded by an asterisk in the Selected References.

Before making any locative decisions on a road, a landscape analysis should be made to determine the makeup of the landscape it may pass through. The National Forest Landscape Management Handbooks, Volumes 1 and 2, should be used as references. This analysis will bring to the surface key visual data that will help determine the ultimate design of the road necessary to meet its intended visual quality objectives.





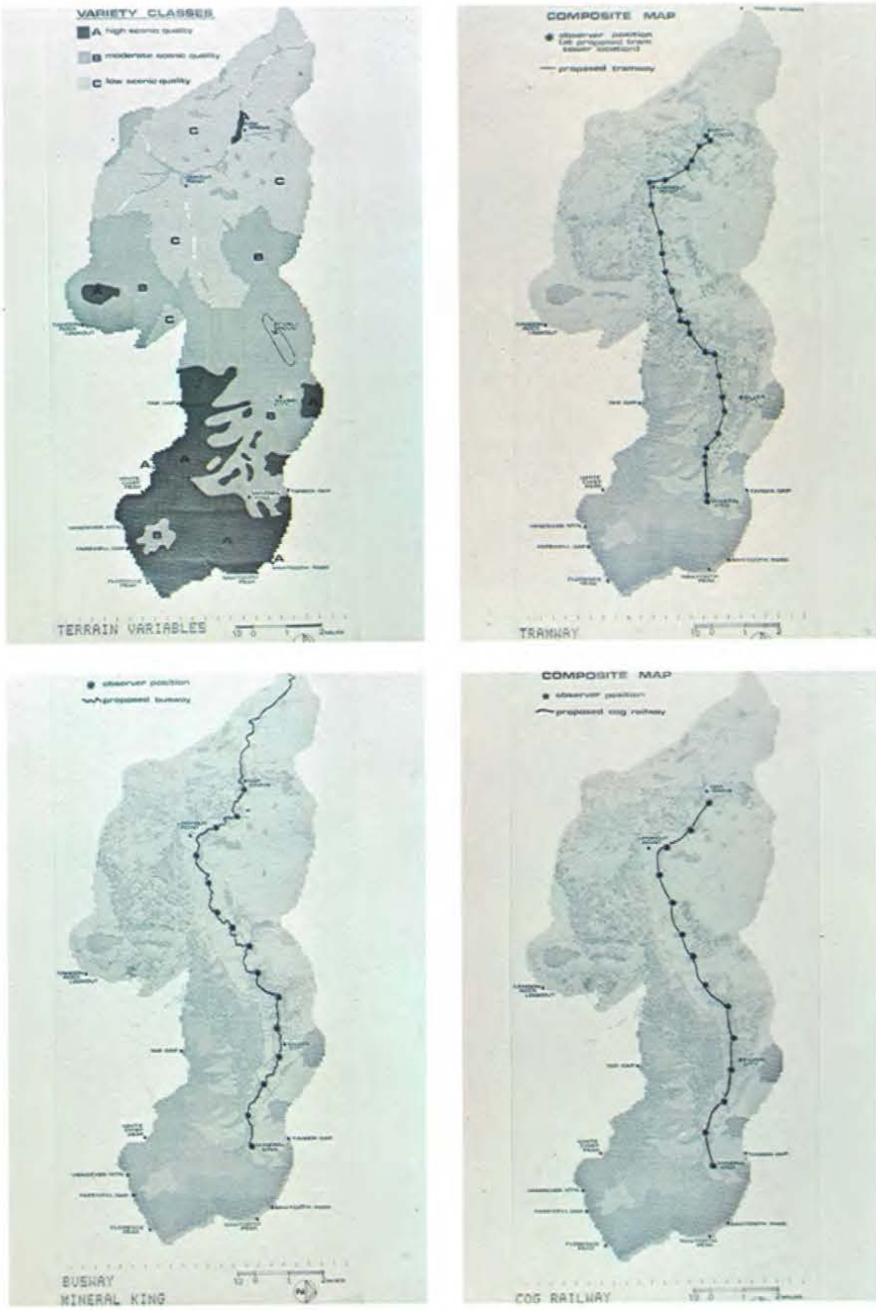
Overlays

Alinement—Following the agreement on the general location or routing of the road from point "A" to point "B," the next step is to work out the finer details of alignment. From a visual resources management standpoint the vertical and horizontal alignment should be designed to:

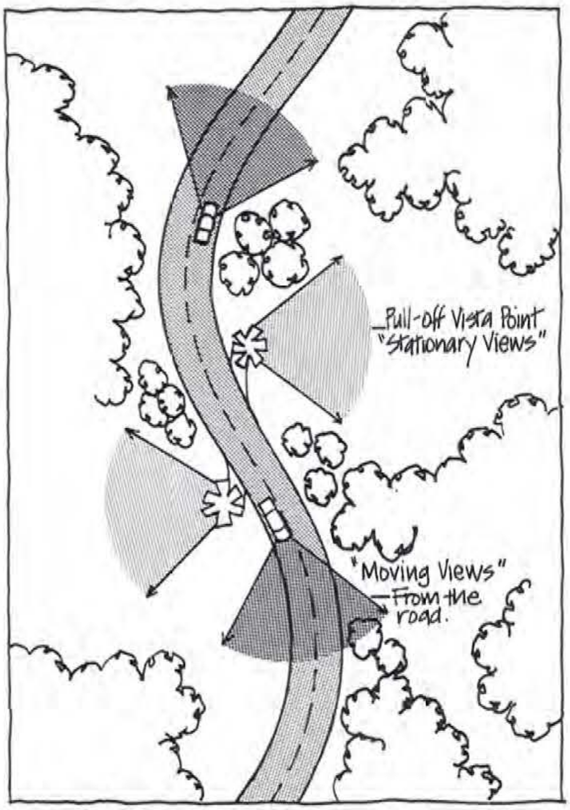
1. Fit the landscape with a minimum of landform modifications.
2. Present a true cross-section of the area's landscape character.
3. Direct attention to positive visual features in the landscape.
4. Capitalize on other opportunities that will create a pleasant visual experience.

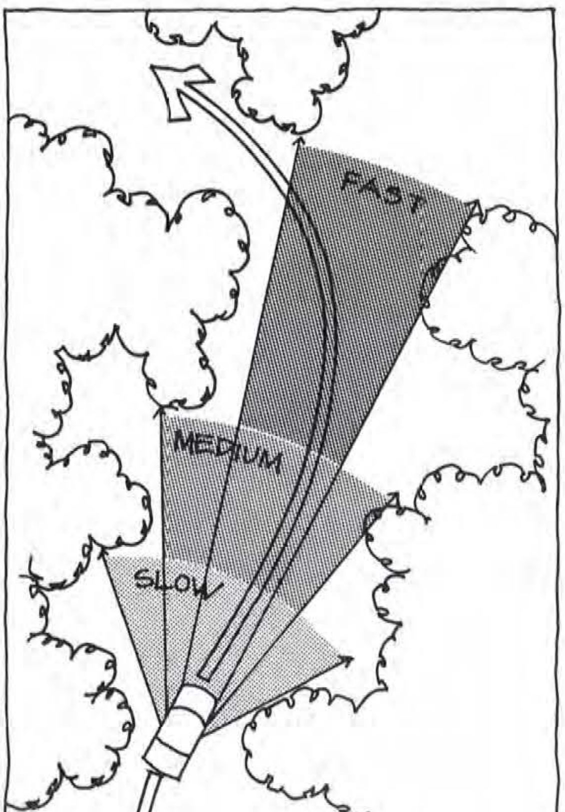
The primary objectives in shaping the road visual experience are threefold—

1. To design an alinement that harmoniously integrates the road into the landscape without unsightly visual impact, relieves the driver of monotony, and provides a positive visual experience.
2. To clarify and strengthen the driver's orientation to the landscape, to offer him a picture which is well-structured, distinct, and as far-ranging as possible. He should



Computer mapping





be able to locate himself, the transportation system, and the major features of the landscape; to recognize those features with surety; and to sense how he is approaching or moving past them.

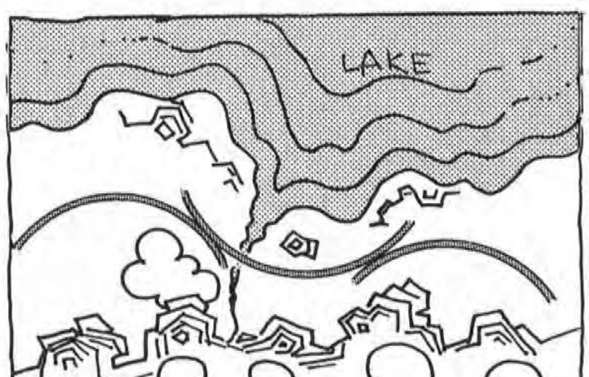
3. To deepen the observer's grasp of the meaning of his environment and to help him understand the use, history, or nature of the surrounding landscape.

Principal input-output relationships must be expanded—as speed increases on highways the user's attention is drawn further ahead of the vehicle, thus shutting out his perception of visual factors lateral to him; distant objects become more important. However, increasing lateral enclosure by vegetation or landform often causes the user to reduce speed.

If the transportation systems are to be truly topographically sympathetic, the traditional method of establishing tangents and then connecting them with relatively short circular curves must be discarded. Instead, a splineline projection or series of curves connected by short tangents is recommended.

In harmony with speed there is the need to build in factors which by their properties and arrangements are visually comprehensible.

Flowing, rather than abrupt changes of gradient and alinement are encouraged.








Good examples of curvilinear alinement

When choosing the location of a road, the following factors are indicative of the best and worst situations which would affect the degree of visual impact:

	Best	Worst
Landform and Soils	High degree of variety in landform. Gently rolling and varied landform in linear pattern. Dominant feature landforms visible. Stable soils. Fertile soils. Dark colored soils.	Low degree of variety in landform. No linear patterns present in landform. No dominant feature landform present. Poor soils. Reddish or yellow soils (due to contrast with green vegetation).
Vegetation	High degree of vegetative variety. Medium density of tall trees. Revegetation prospects high.	Homogenous cover of low dark green vegetation. High density of shrubs or short trees. Revegetation prospects low.
Viewers	Road infrequently viewed from other areas.	Road frequently viewed from other areas.

These factors, to a large degree, make up the visual absorptive capability of the landscape to accept a road with the least possible impact.

LANDFORMS

A basic consideration in reducing visual impacts of roads is the minimizing of landform disturbances and contrasts. Almost without exception, landforms must be disturbed to provide essentially flat cross sections of driving surface. The only alternatives to this are elevated structures above the landform or tunnels below it.

Reducing Sizes of Cut and Fill Slopes

The designer concerned with reducing contrasts between a road and its landscape should explore alternatives which would reduce the magnitude of exposed cut and fill slopes. There are three major ways that such reduction can be accomplished.

Location Alternatives

It is possible to seek out and test numerous alternatives for almost any proposed road. Later sections of this handbook point out more detailed considerations which will affect locative choices.

Design Criteria Alternatives

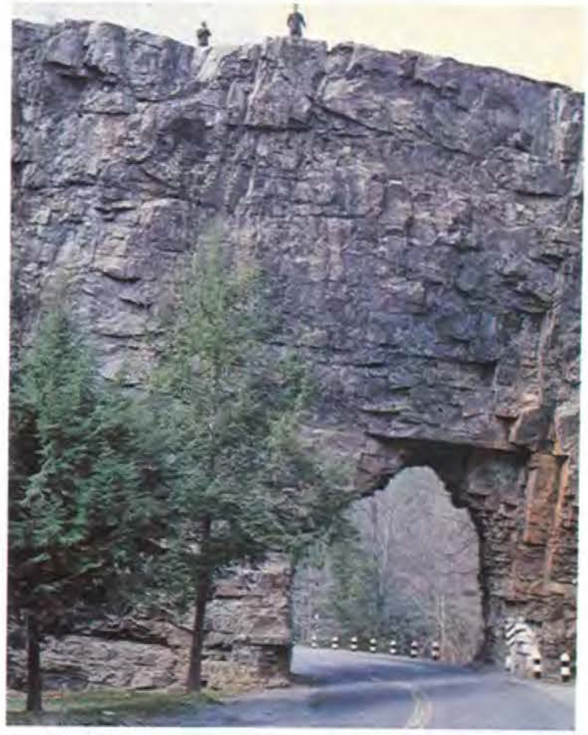
Although design criteria for roads have often been inflexible, it is always worthwhile to examine closely such criteria to determine if they are indeed applicable to the road in question or to all sections of that road. A change of even 1 percent increase in maximum grade, of minimum radius from 500 feet to 400 feet, in width of total roadway from 30 to 28 feet, in ditch width from 6 feet to 4 feet, in fill slope from 2 to 1, to 1.5 to 1, etc., can in some cases have tremendous effects on the cut and fill heights either as individual criteria changes or cumulative changes. There may be some opportunity for trade-offs in design criteria just as between other impact concerns. For instance, a ditch width specification for even a 1-mile section of road may not be valid for the entire project, depending upon the terrain, soils, and vegetation. A prudent reduction in its design criteria for a few hundred feet in a critical visual impact area may reduce the height of

a cut sufficiently to allow its screening from an important viewpoint by existing vegetation.

It is the responsibility of each member of a team establishing design criteria to explore the possibilities of adjusting such criteria to best fit the situations of an individual road or sections of road. If the resulting road is functional, safe, economical, and has a low visual impact, the adjusted criteria have met their test.

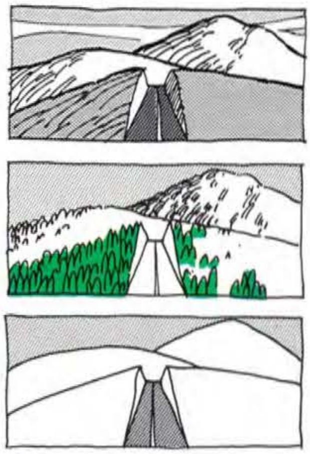
Design Alternatives

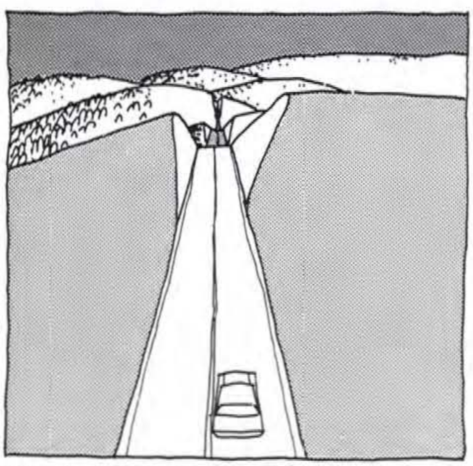
A further refinement in alternatives is reached in the actual design once the location and design criteria have been thoroughly analyzed. Grade adjustments and provision for structures such as binwalls, half bridges, full bridges, or tunnels can drastically reduce excavation and embankment quantities while reducing cut and fill heights. The trade-off consideration may involve higher construction costs to attain reduced visual, soil, and watershed impacts.



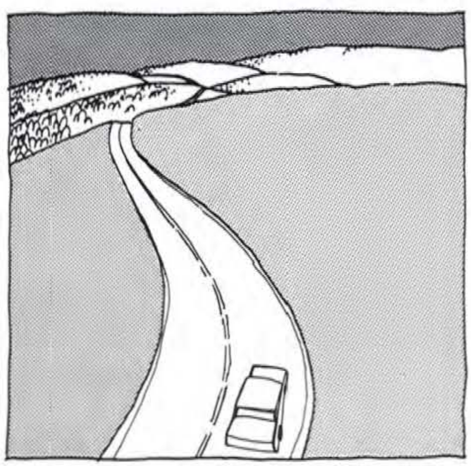
The visual impact is related to:

1. **Size**
2. Contrast in **Form**
3. Contrast in **Color**
4. Contrast in **Texture**
5. Contrast in **Lines**



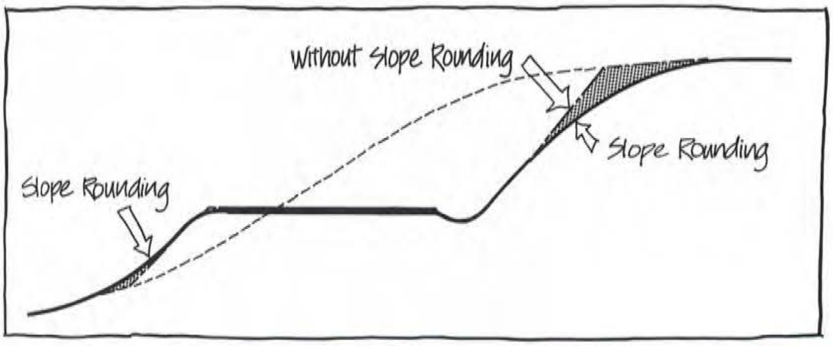


The visual impact of this alinement . . .



might have been minimized by this alinement.

There should be no question as to which of these two alternatives creates the least visual impaçt.

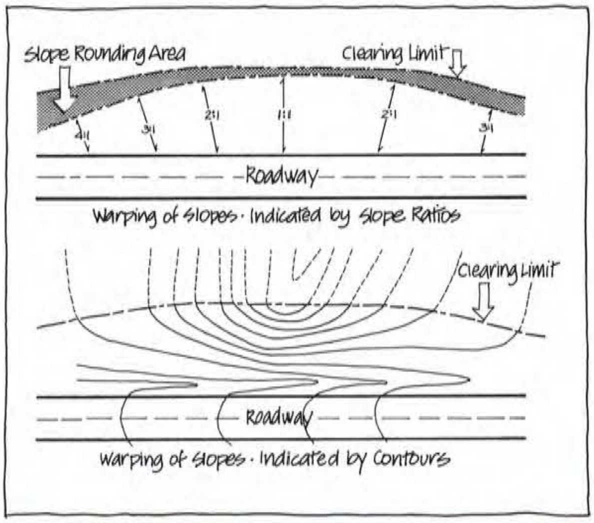


Reducing the Contrasts of Earthwork Modification

Once the above steps have been taken to reduce gross impacts, the efforts can then be fine-tuned to details of visual impact reduction during landform modification.

Form

There are several opportunities of reducing form contrast:

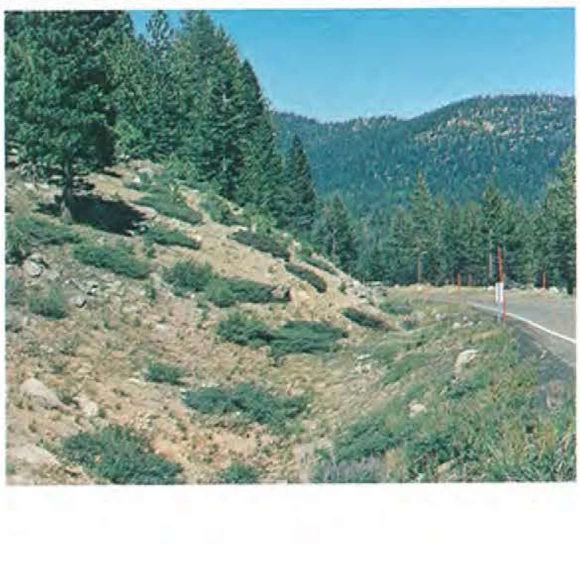


SLOPE ROUNDING

Slope rounding, although beneficial for revegetative purpose, is also a definite and positive means of blending landform modifications with existing landforms. It breaks the sharp unnatural edges formed by the junction of a constant pitch cut slope with the natural rounded landform.

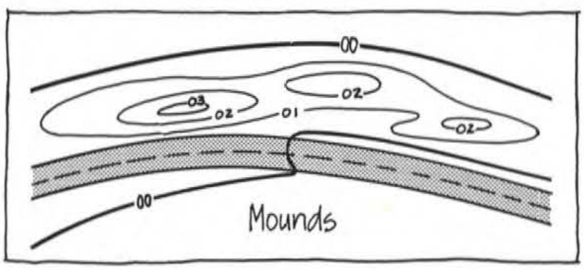
WARPING SLOPES

A further refinement of slope blending is to vary the pitch of cut and full slopes. It involves slope rounding in both vertical and horizontal form as a more natural extension of landform surface configurations. In some cases, it has been improperly used in conjunction with constant clearing widths in order to simplify staking.



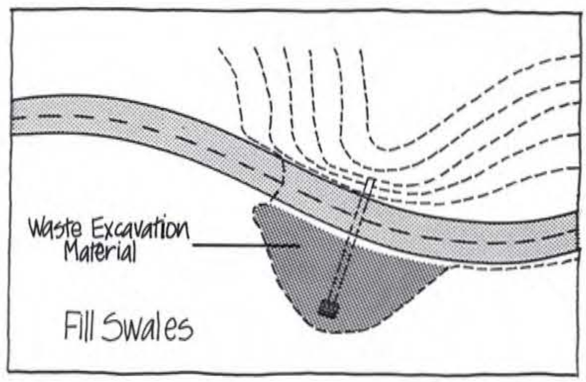
NATURAL FORMS OF DITCHES, SWALES, AND CHANNELS

Not only can cuts and fills be designed to blend with natural landforms, but so can the drainage system grading. Sharp contrasts of V-ditches or U-ditches and channels can be drastically reduced by rounding the edges. Diverging from perfectly alined tangents and curves that reflect the geometry of the road itself can also help reduce the contrast of roadway to roadside landscape.



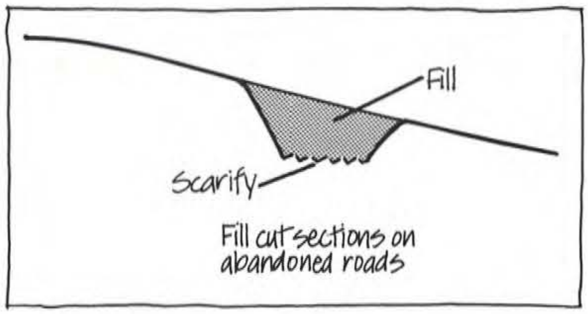
POSITIVE UTILIZATION OF WASTE EXCAVATION MATERIAL

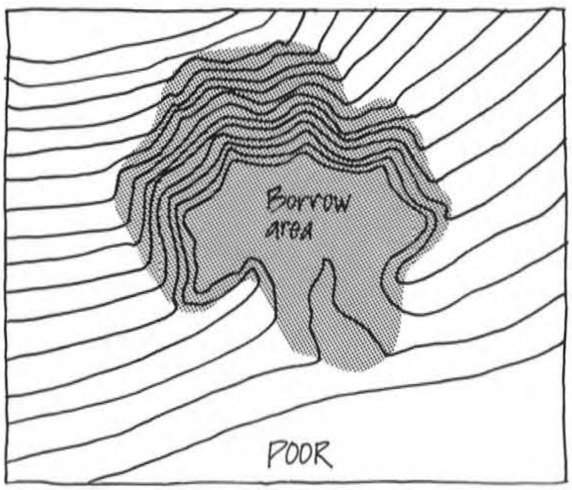
In some cases the landform contrasts can be reduced through the creation of low earth mounds.

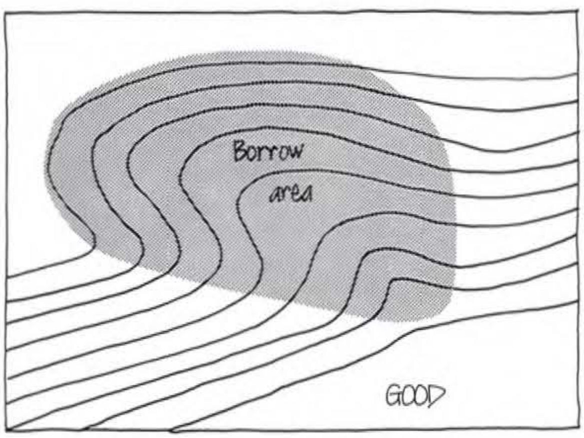


Excavation material can be used to fill depressions formed in roadway fills on the uphill sides of swales, where depressions appear foreign to the landform.

Cut sections on abandoned roads can be filled with excess excavation material.

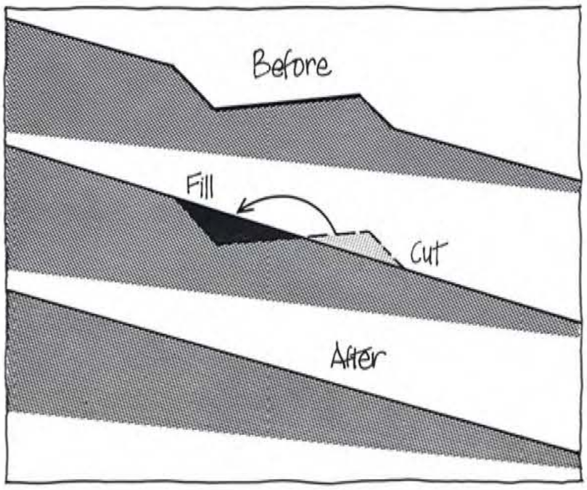


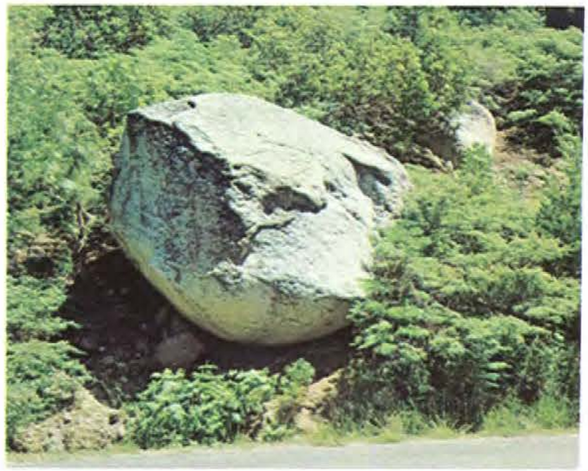




SHAPING OF BORROW AREAS

Similar methods of blending landforms of cut and fill slopes can be applied to borrow area excavations. Slopes can be improved by a combination of slope warping and rounding to simulate natural landform configurations.





RESHAPING FALSEWORK AND ABANDONED ROADS

In some cases there is need to cut out fills or partial fills and redistribute the material in cuts developed in old roadways or falsework of the construction project in order to reduce landform contrasts.

RETAINING LARGE ROCKS IN CUT SLOPES

Rock outcrops or large stable boulders found in the excavation of cut slopes should be retained in place where possible. This provides a more natural appearance by extending natural landforms into the disturbed landscape.

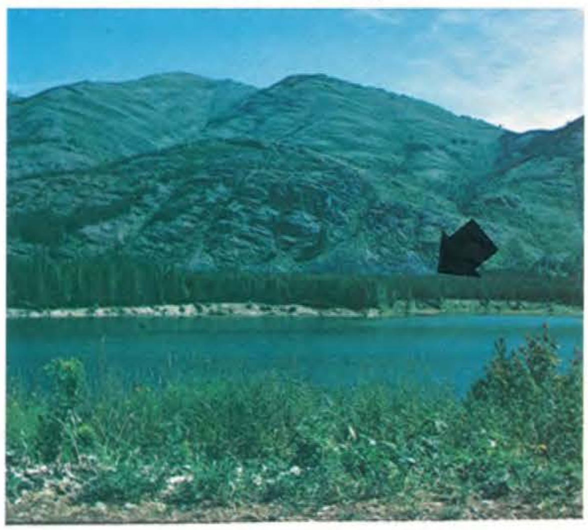
Color

Since color contrast is often the most noticeable result of disturbed soils in road cuts and fills, it presents possibilities for visual impact reduction. Some efforts have been carried out to do so but there appear to be many more opportunities where this would be practical.

TONING DOWN FRESHLY BROKEN ROCK FACES

There are several ways of "aging" freshly broken rock cuts or fill material. Asphalt emulsion spray has been utilized as well as various gray paints. In some cases, liquid fertilizers may assist in more rapid formation of lichens and mosses. A high degree of contrast reduction has been accomplished by such methods in sensitive locations where roads are in key viewing backdrops.

Removing rock from a talus slope for use in road construction creates this visual impact.



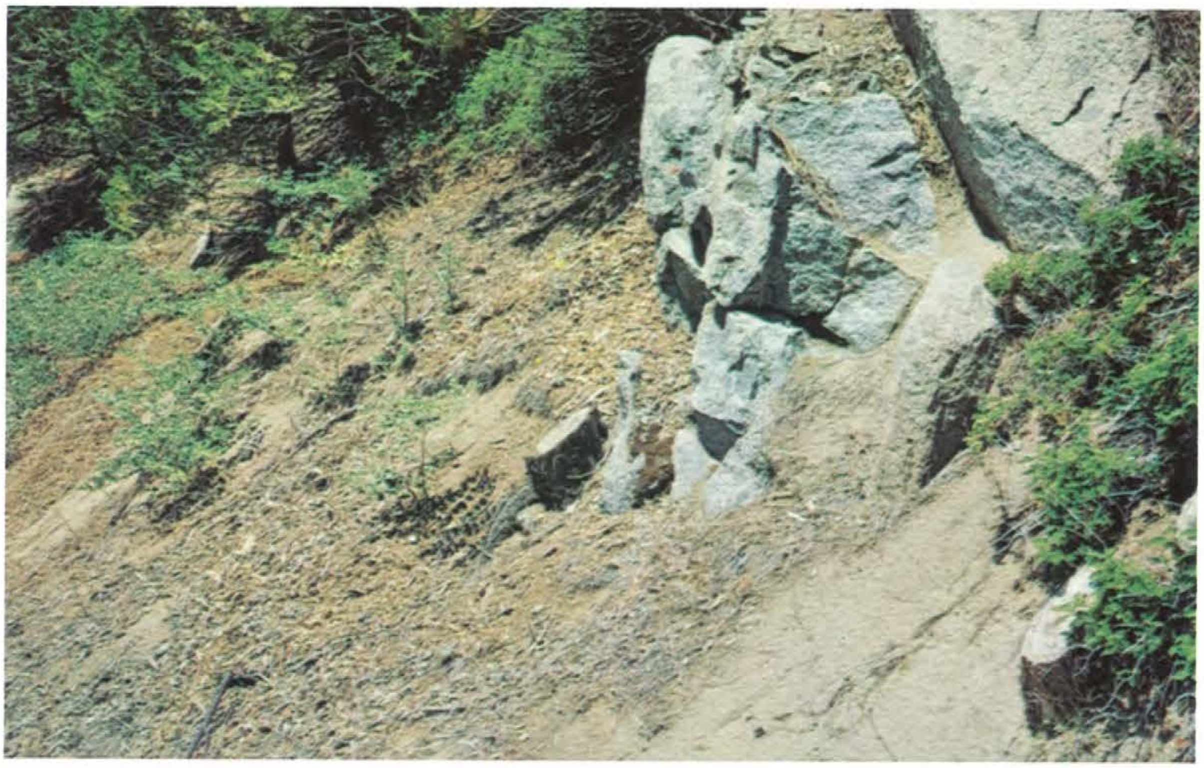
A simple application of asphalt emulsion makes it all but invisible.

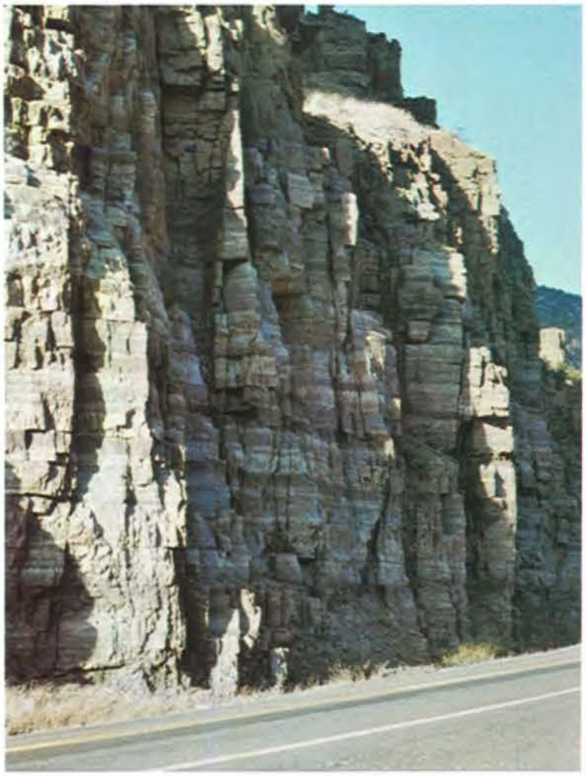
SPREADING TOPSOIL ON DISTURBED SOIL

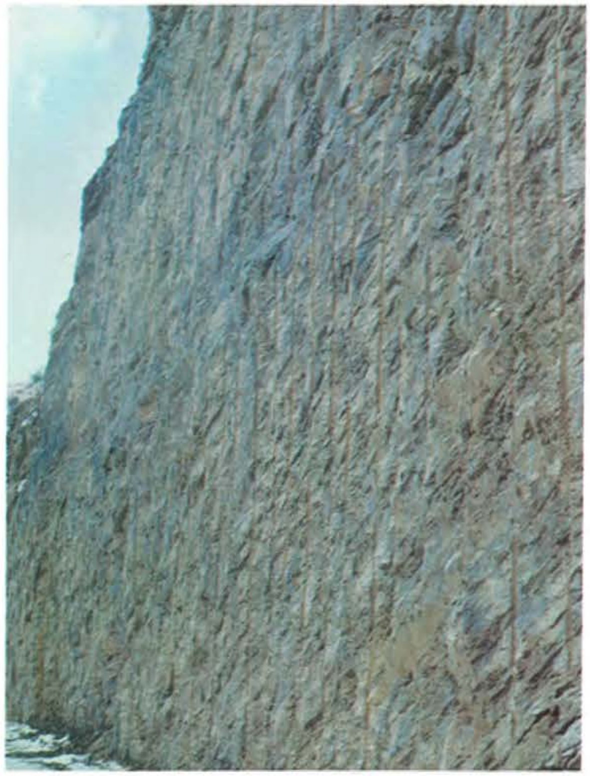
Since most disturbed soils in mountainous areas are much lighter colored than the undisturbed cover, there is a high potential for contrast reduction if dark topsoils are spread over such cut and fill slopes. The primary benefit of such action is improved revegetation potential.

MULCHING WITH LOW CONTRAST MATERIALS

Closely related to topsoil dressing of slopes is the use of mulching material of colors that blend with undisturbed soil areas. Increased revegetative potential is a by-product.





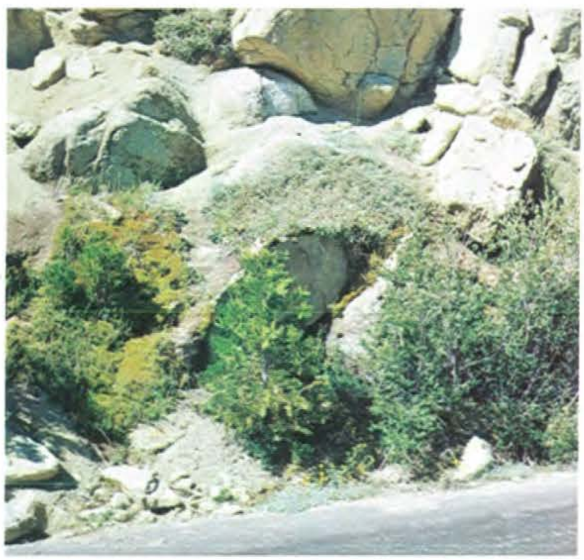


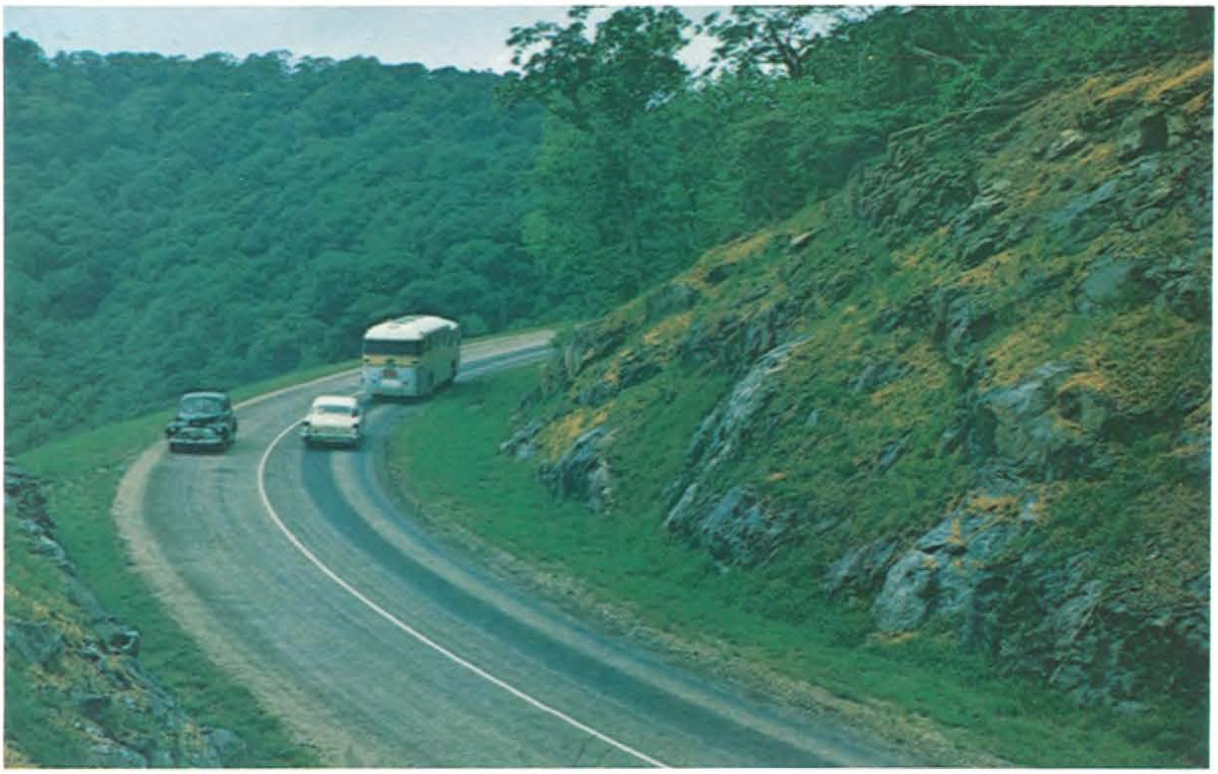
Texture

Textural contrasts of landforms may seem more subtle but they are important and can be reduced by modified construction techniques.

BROKEN-FACE ROCK BLASTING

Strive for a broken-faced rock cut effect in areas where it would blend in (exception—glacially polished areas). Encourage minimal manicuring of rock cuts to allow for rough texture with interplay of light and shadow. This will also provide planting pockets in the rocks which will allow more rapid revegetation for additional texture and color.





SCARIFIED CUT SLOPES

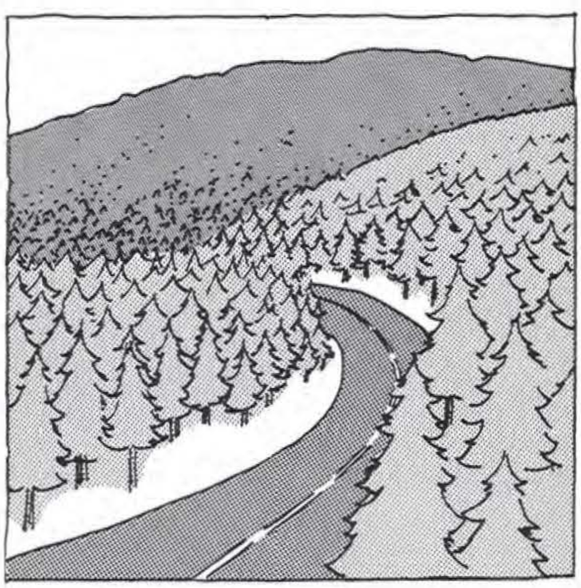
Cut slopes which are highly manicured are seldom in harmony with the natural land surface texture. Cut faces have in some cases been known to shine for lack of texture or surface variation. Random pattern scarification is most desirable. Again, a side benefit of scarification is improved moisture retention and revegetation potential.

MULCHING AND TOPSOILING

The mulching and topsoiling of cut and fill slopes will often have a beneficial texture contrast-reduction effect. It has the added advantage of reducing color contrast and improving revegetation.

VEGETATION

Once the landform modification alternatives have been selected which will minimize contrasts with the natural landscape, the living mantle on the landform should be analyzed to determine how it can best be blended.



Retention of Maximum Amount of Existing Vegetation

The first possibility of contrast reduction is to retain as much existing vegetation as possible. This, of course, must be weighed against other contrast-reducing actions (such as those listed under Landforms) which may be in conflict with such an objective, in order to determine the trade-off possibilities.

It must also be weighed against reasons *for* clearing such as:

To store removed snow

To remove trees and brush whose roots are badly damaged by the cut slope

To remove trees subject to windthrow

To remove brush that would soon grow out over the road

To allow maintenance access to tops of fills and toes of cuts

To allow room for equipment to build ditches or grub roots

To allow storage on top of cut slopes for topsoil for later spreading

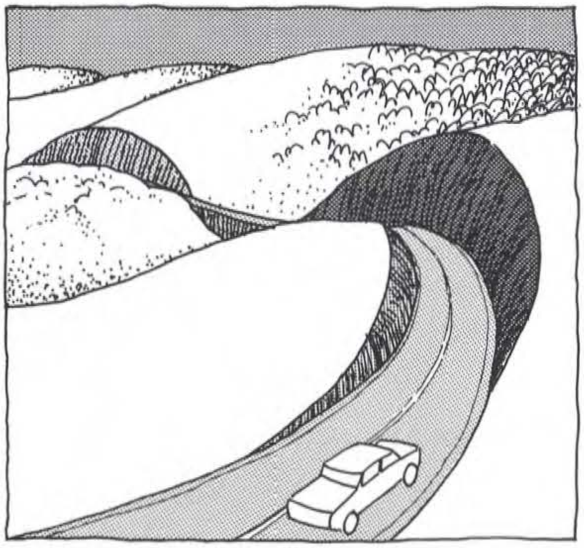
To meet sight/distance requirements on inside curves

To open views or vistas

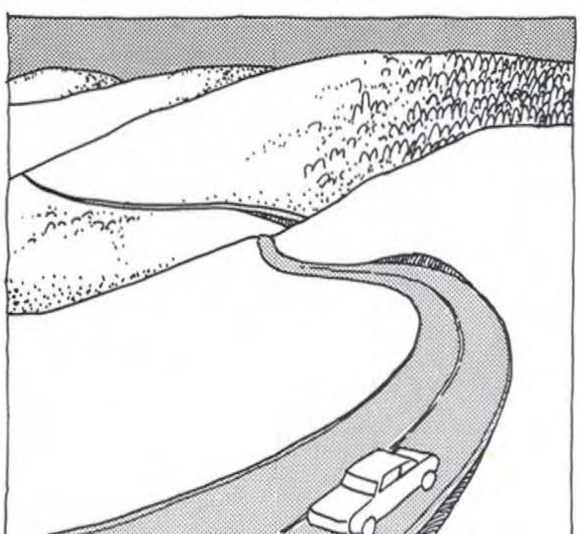
To eliminate winter shading causing ice hazards on the roadway

Reduction of Earthwork

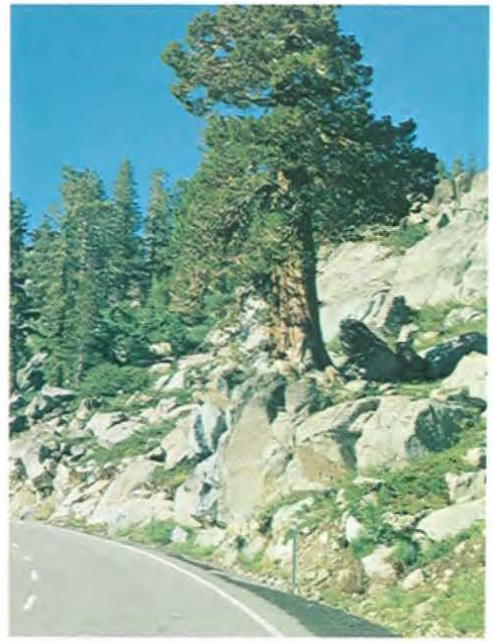
Closely allied to landform visual impact reduction is reducing earthwork (excavation and embankment) to the minimum, which will reduce the clearing limit requirements.



An obvious landform modification . . .

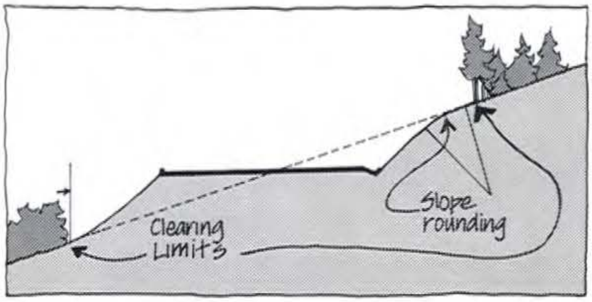


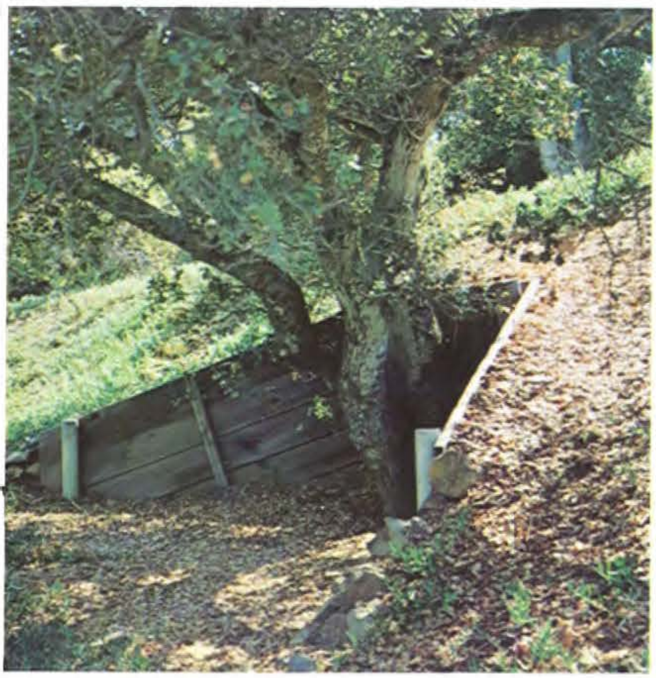
. . . which could have, by grade and alinement revisions, looked like this.



Minimal Clearing Beyond Tops of Cuts and Bottoms of Fills

Standardized clearing limit requirements, beyond the edge of grading activity, may be excessive in some cases to allow sufficient maneuvering room, with a margin of safety, for construction equipment. In most cases, clearing just to the edge of designed grading manipulation should suffice.

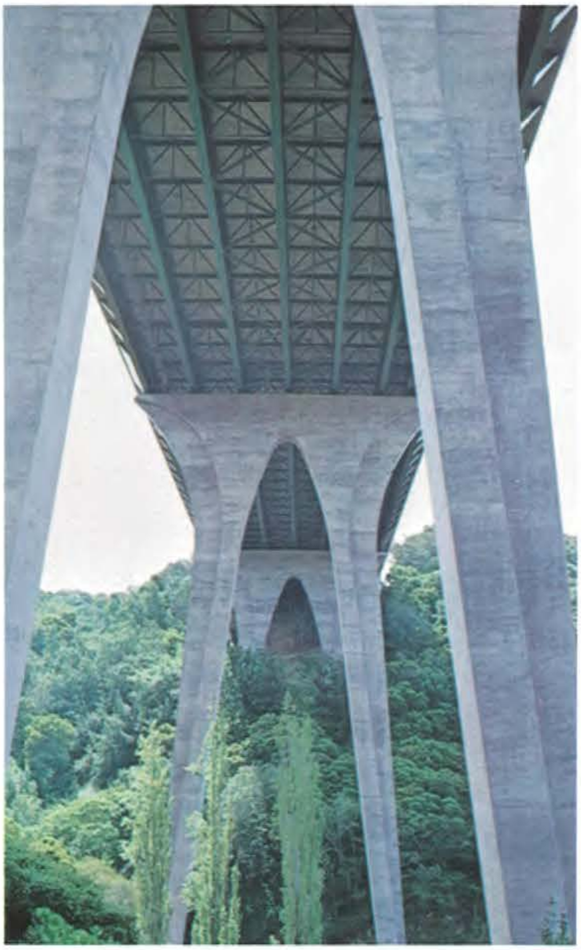




Treewells, Retaining Walls, and Binwalls

Structures can be utilized to retain vegetation—especially larger trees. Treewells can be utilized to save vegetation in fill sections or retaining walls can save it in cut sections. Retention of existing vegetation reduces the clearing width impact on the highway user and screens the road from other observer positions.

Binwalls, although serving other purposes at times, also serve as vegetative retention features. In most cases, they serve as a retaining wall for the roadway and thus steepen the angle of the fill slope to near vertical.

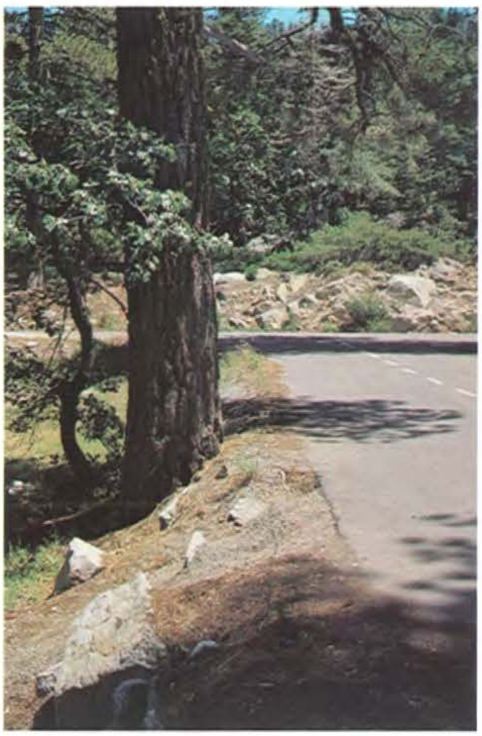


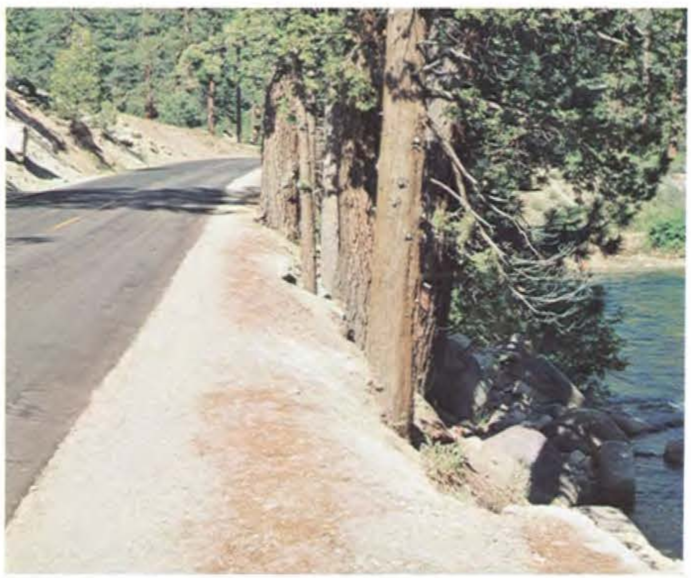
Bridges and Half Bridges

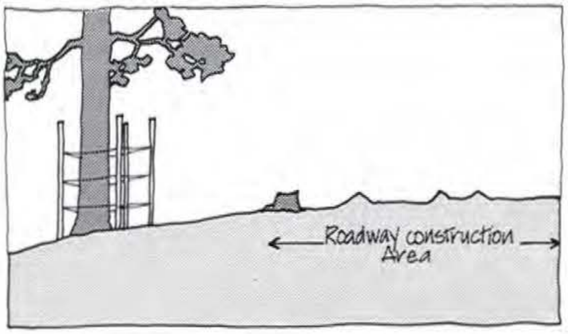
Bridges and half bridges may seldom be justified for solely vegetative retention purposes except for outstanding or rare specimens. They admirably accomplish the job of maximum vegetative retention by not only allowing adjacent vegetation to be practically untouched but also permitting much of the vegetation under the roadway to remain intact.

Allowance for Some Fill Over Tree Roots

It is not absolutely necessary to remove all vegetation within the construction limits of a road. Trees can often survive a 1- to 2-foot fill over their root systems. Different types of trees and soils will create varying effects. Special actions to assure air circulation and water drainage can be taken, such as the use of drain tile or coarse aggregate fill material.





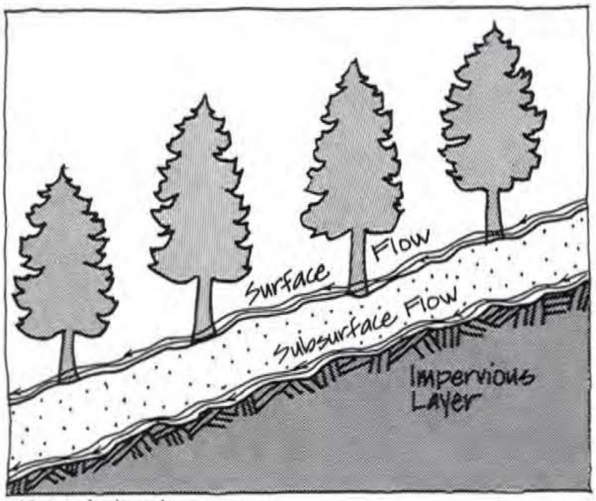


Protection from Equipment Damage

One method of vegetative retention that often is neglected is positive action to prevent skinning bark off larger trees or crushing small trees, shrubs, and ground cover by construction equipment which moves into areas just beyond clearing limits. This protection can be accomplished by including tree-damage penalty clauses in the contract, by using stakes, snow fencing wrapped on trunks, flagging, warnings on plans and/or verbal and written communication to construction crews, *and* close job supervision.

Protection from Blasting Damage

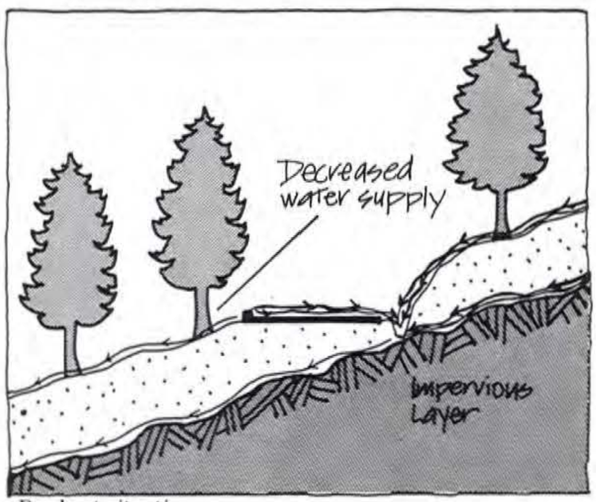
Closely allied to equipment damage is the protection of vegetation outside of clearing limits from blasting damage. Various methods of control are possible, including contract-penalty clauses, control of size of explosive charges, use of temporary earth berms, "blankets," etc.



Natural situation

Minimal Disturbance of the Hydrologic Regimen

Since road construction can intercept surface and subsurface water flows, the downhill side of the clearing limits can experience either a reduced or increased water supply to the root systems. One of the best methods to avoid such drastic changes in water supply is to carry water off the slope at minimal intervals to more nearly duplicate the natural flows present before soil disturbance. A side benefit to such action is the reduction of possibilities for increasing surface runoff flows in natural drainage channels which could cause accelerated erosion.



Road-cut situation

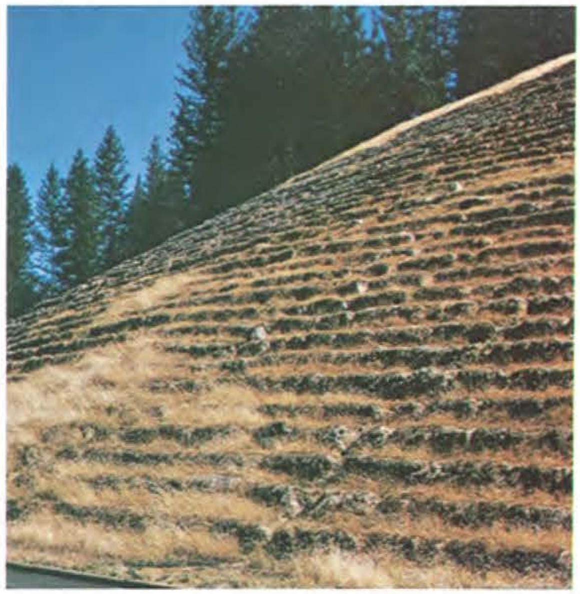
Providing Optimum Conditions for New Vegetation and/or Regeneration

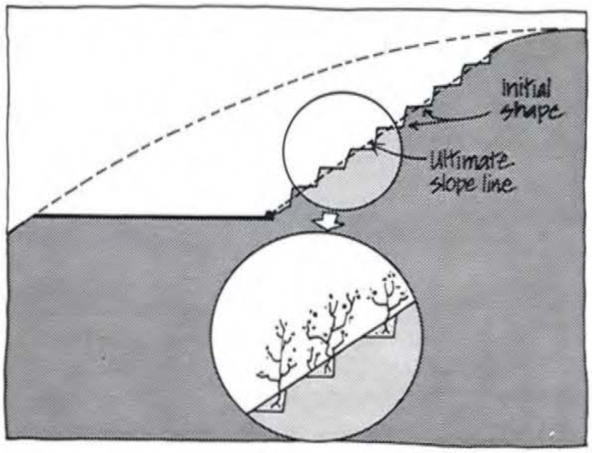
Once the goal of retaining the maximum amount of existing vegetation has been met, it is logical to determine what actions can be taken to encourage the most rapid revegetation of disturbed areas outside of the surfaced roadway.

Serrated Slopes

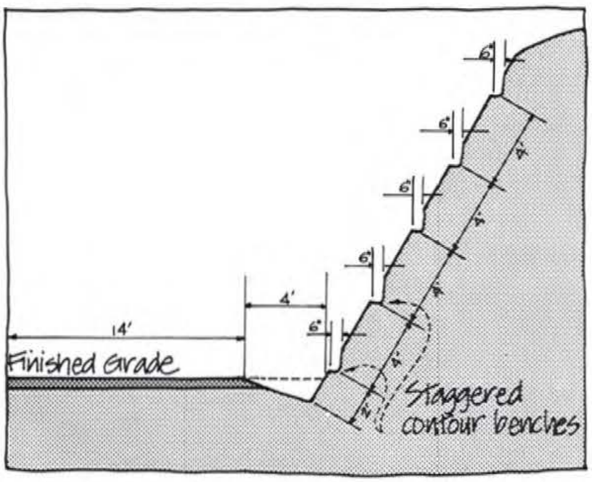
In recent years there has been much experimentation with serrated slopes; a common practice in several Federal Government agencies and State highway departments. Serrated slopes should be specified in areas where soil and climatic conditions are such that optimum revegetation can be anticipated if this method is utilized. Weigh the appearance of the initially unnatural landforms against the revegetation effect and the long-term effect on landforms. Some of the advantages of serrated slopes are:

1. Sloughed-in soil is not over compacted to hinder seeding success.
2. The serrations catch the seed and organic matter.
3. More moisture is retained on the slopes.
4. Seeding can be carried out immediately after earthwork by heavy equipment rather than after final shaping near project completion.
5. Rockfall pickup from shoulders and ditches is reduced.
6. Slope manicuring and handwork is largely reduced.

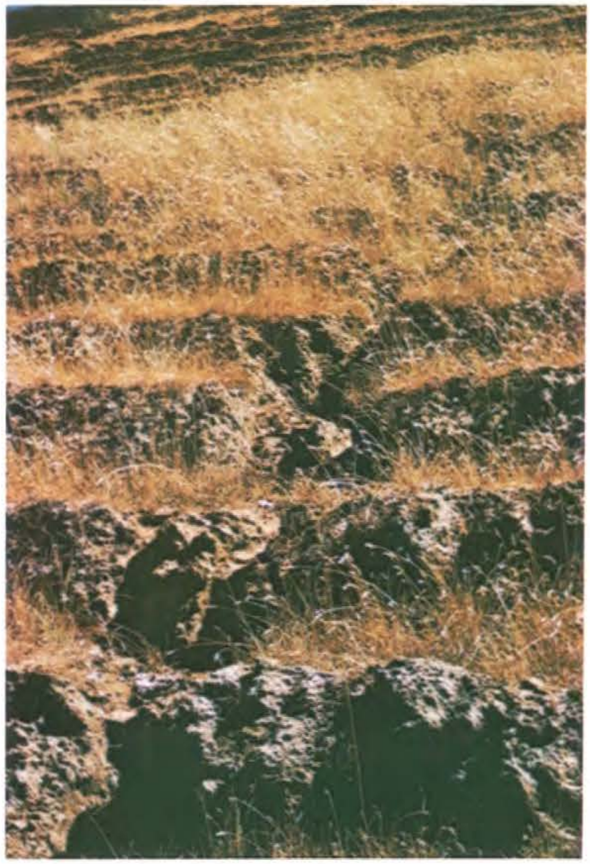




Serrated "steps" may be from 6 inches to 4 feet high. If the appearance of 3- to 4-foot high "steps" would not be acceptable, it may be satisfactory to drop to 6-inch or 1-foot "step" heights.



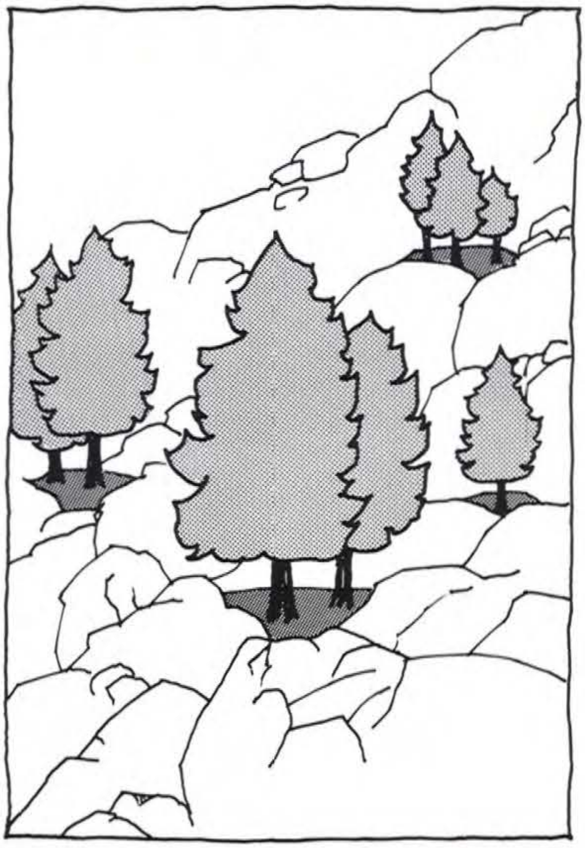
It may even be practical in some situations to develop modified serrated slopes in existing cut banks by handwork or by specialized equipment.



Developing Planting Holes or Pockets in Rock or Steep Slopes

A variation of serrations is individual planting pockets on steep slopes. Although the function is similar, this method would almost always require handwork. In soft but pure granite rock, plantings have been made by punching holes in weak spots with a bar and inserting 2-inch potted plants or by direct seeding.

On rock slopes which have been unevenly fractured, there are opportunities to create planting pockets by filling in natural pockets with soil or by purposely developing them by additional blasting. The length of time required to revegetate such sterile slopes can be significantly decreased.



Stockpiling and Spreading Topsoil

The lack of organic matter in subsoils exposed on cut and fill slopes is a definite deterrent to most revegetation attempts. The removal and stockpiling of forest duff and topsoil will preserve a valuable resource. Spreading it back on the disturbed areas to be revegetated will not only add significantly to the success of revegetation, but will help blend the colors of raw slopes to their background.

Fertilization

Another action to assure revegetation success is to add fertilizers to supplement the inherent nutrient level of the exposed soils. Best success will be assured by soil testing to determine the amount and type of mixture needed for the plant species to be used in revegetation.

Best responses to fertilizers are made by grasses and fast-growing woody plants. Slow-growing woody plants show little response or are sometimes damaged by fertilization.

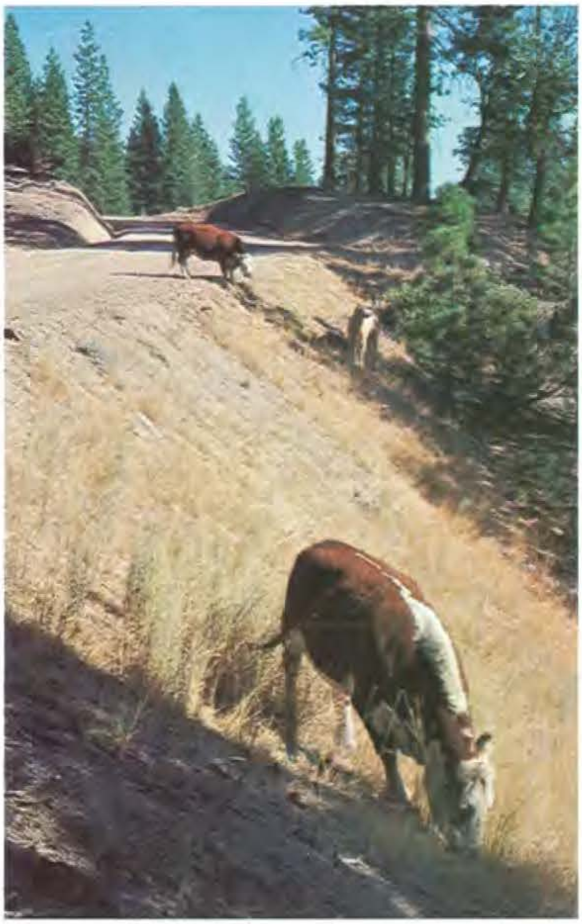
Mulching

Other soil additives which will improve revegetation through the addition of organic matter, temperature uniformity, and reduction of evaporation (especially on southwest-facing slopes) are mulches of various types. Critical in such selections are mulches which by their nature or method of application will be most likely to remain evenly distributed on the slopes until held in place by vegetation. Mulches have the added possibilities of reducing textural contrasts of the slopes.

A source of on-site mulch may often be the vegetative-clearing debris left on the roadway after log utilization. Chipping of such slash in stockpiles eliminates the disadvantages of burning, fire escape danger and air pollution. In some cases the addition of nitrogen fertilizer may be needed to counteract the loss of nitrogen caused by the breakdown of chips.

Watering and Irrigation

In critical rainfall areas it may be necessary to water the slopes being revegetated if there is to be any hope of establishing cover in the first several years. The use of permanent irrigation systems will seldom be justified on Forest roads except in critical areas. However, there are low cost temporary and portable irrigation systems which can either be considered in other less critical sections where a water supply is available or slopes can be periodically watered by tank truck for one or two dry seasons. Temporary water-storage facilities, such as plastic swimming pools may even be considered in some cases.



Selection of Correct Planting and Seeding Time

A critical consideration for the establishment of vegetative cover is the timing of planting or seeding. The selection of optimum time may be hindered because of contracting periods. If a good planting-seeding season can not possibly be attained during the construction contract, a separate contract may be worth considering.

Serrated slopes offer some advantages in that any slope that has been serrated is immediately available for seeding. Thus, seeding can be accomplished for all such slopes during the optimum period rather than awaiting the final manicuring of conventional slope work that often is delayed until the end of the project.

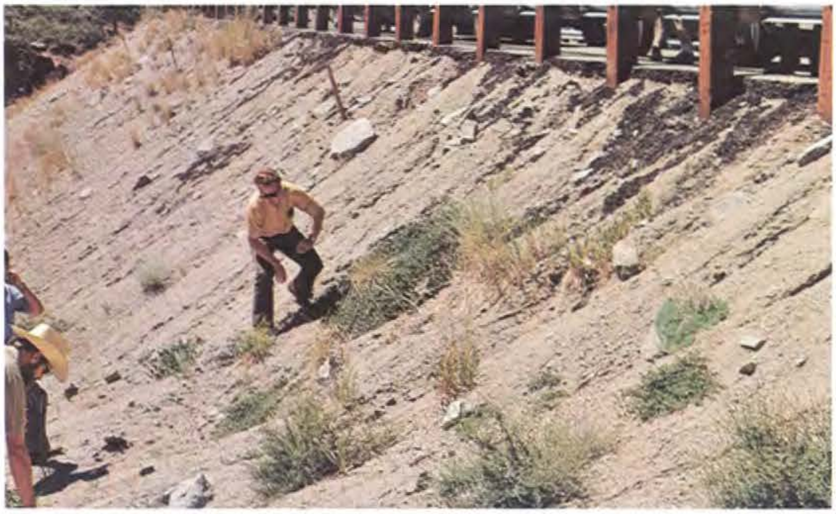
Correct planting times will need to be ascertained on a project-by-project basis in most cases, since there may be considerable variation in climatic conditions in a single Forest or District.

Selection of Plants Which Will Survive the Conditions

To assure prompt, as well as long-term vegetative cover, careful selection of plant materials or seed must be made. Normally, the greatest success will be achieved with plants and seeds native to the site and its microclimatic conditions. Such plants will also be most likely to blend in with the background vegetation form, colors, and textures.

Consideration must be given to the modified conditions that the road presents—exposure to sunscald, windburn, snow drifting, ice removal chemicals, water regimen, etc. In addition, selection should be made with consideration of possible damage from animals. If the plantings are attractive to either wild or domestic animals, they may be seriously held back due to heavy grazing or browsing.

A continuous strip of high quality range grasses, for example, can become a linear pasture subjected to heavy use by cattle to the point that its erosion-control advantages are defeated.


Direct seeding by hand (woody plants)


Cuttings (willows, cottonwood, etc.)

Selection of the Best Planting Method

There are numerous methods of planting that can be used on roadsides and cut and fill slopes, such as:

Broadcast seeding
Drilling
Brush layering (willows, cottonwood, aspen, etc.)
Liner stock in 2-inch peat pots
Container stock from nurseries
Bare root stock (trees, shrubs)
Hydroseeding
Direct seeding by hand (woody plants)
Wattling (willows, cottonwood, etc.)
Cuttings (willows, cottonwood, etc.)

Knowledge of these techniques and their advantages and disadvantages under varying conditions is essential for effecting revegetation. To ensure success it often will be desirable to use a combination of planting methods on the same road.

Reducing the Contrasts of Vegetative Modifications

In addition to maximizing existing vegetation and providing optimum conditions for revegetation, there is another series of suggested actions to improve the visual appropriateness of vegetative change.

Utilize Freeform Irregular Clearing Limits

Edges formed by clearing limits are potential focal points due to their high degree of contrast. An undulating edge will often help reduce such contrast where cuts and fills are minimal. It will break up an otherwise straight line which reinforces the unnatural line of the road itself.

A side benefit of the undulating edge is that of providing the traveler with a sequence of enclosures and openings which add variety to the driving experience.

Feathering Clearing Edges for Gradual Transition

In addition to undulating the clearing line, another key method of reducing the line, form, color, and texture contrast is to feather the edges. Successful feathering involves a reduction of vegetative density in transitional degrees *as well as* a gradation of tall vegetation down to low vegetation at the clearing edge. Thus, the contrast is faded out into a wide transitional band and focalization on an artificial line is decreased.

Feathering has an added benefit of reducing possibilities of large trees falling across or onto the highway. Windthrow is less likely to occur.

When selectively removing trees or shrubs on newly cleared projects to attain feathered edges, cull *out* those which will be less likely to survive the new conditions produced.

Those which:

Require shade to exist.

Are subject to windthrow.

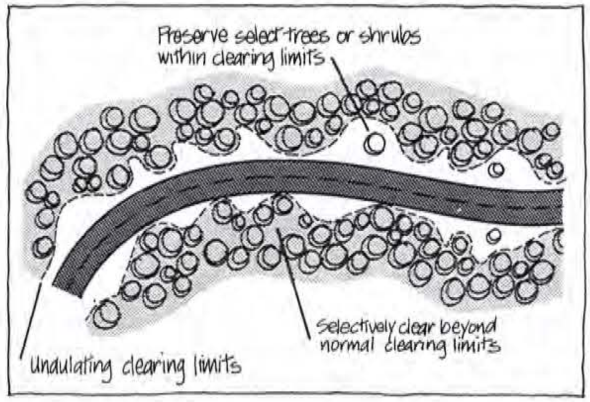
Are intolerant of ice-melting chemicals anticipated.

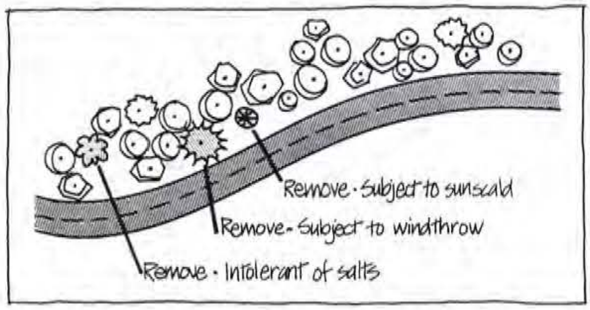
Are subject to sunscald.

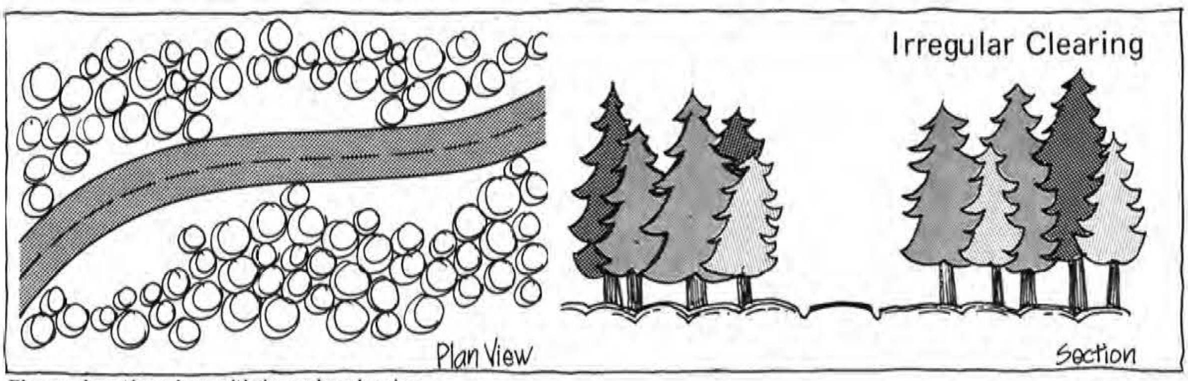
Have highly sensitive moisture requirements.

Are sensitive to air pollution levels anticipated.

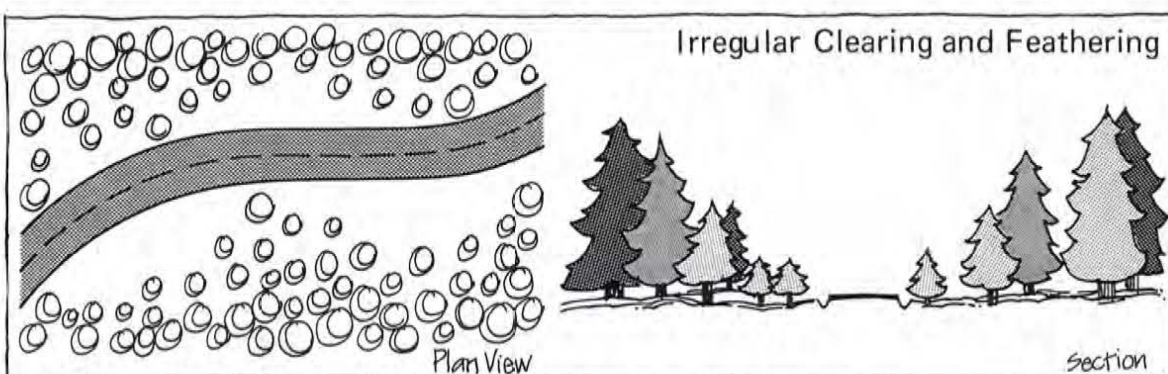
Are dying or diseased.







Plan and section view with irregular clearing



Plan and section view with irregular clearing and feathering

Debris Disposal

All road construction produces debris of some sort. Rock and earth which are excess in a cut area can often be deposited in the adjacent fill section. Tree trunks, branches, stumps, and other vegetative matter (commonly called "slash") are usually unsatisfactory fill materials and must be disposed of in other ways. If they are unmarketable for pulp they are usually burned on the spot (within the right-of-way) or in a nearby "boneyard" where they are carefully piled to achieve optimum burning conditions. If they cannot be burned, usually because of air pollution requirements or hazardous forest fire conditions, they can normally be buried. Road contractors have often objected to burying because of the costs and time involved in trucking debris to a site, digging the ditch or hole, covering the materials, and revegetating the area. Some who have tried the practice, however, have become its staunchest supporters since it can normally be scheduled as the contractor wishes without unexpected delays due to harmful air-pollution readings or dry season "bans" on fires in the Forest.

Debris burying offers the road designer the opportunity to:

—Create interesting visual "pockets" in an extensive forest canopy.

—Provide browse or forage for livestock and/or wildlife, depending upon the revegetation methods used.

—Create small roadside recreation sites at minimum cost.

Right, road construction slash

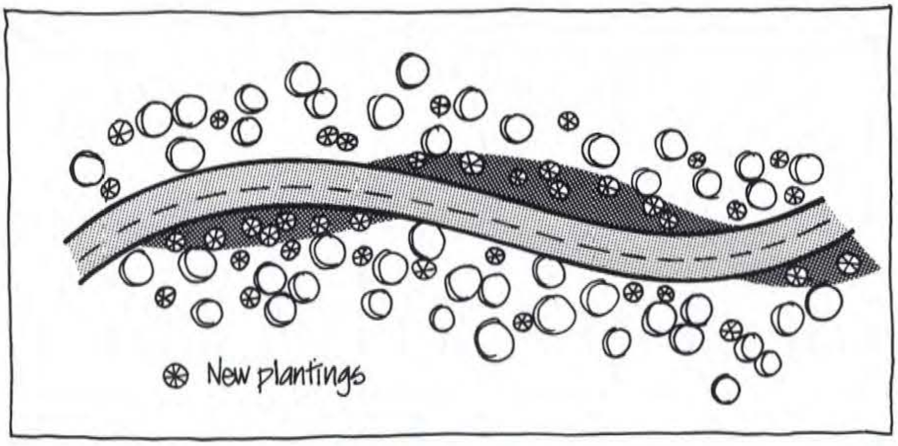
Below, these debris-burial sites were photographed a few months after completion of the road contract

Vegetative contrast is created if slash is left along road-clearing limits; the color, texture, and line are not in tune with its surroundings and thus, attract attention.

If suitably crushed or chipped, small trees and the branches, needles, leaves, etc., of larger specimens can often be beneficially used as mulch on newly exposed soil.

Proper clean-up of slash

Along with slash disposal, color contrast reduction can be greatly reduced if freshly cut stumps are treated. Notice how a shovelful of dirt reduces the contrast of the stump on the right.



Revegetation

There are several actions that can be taken to reduce contrast in revegetation activities.

Dispersion of new plantings into existing vegetative patterns.—Ordinarily, from a purely erosion-control standpoint, revegetation is limited to those areas within the clearing limits. Such limitations tend to further accentuate contrast.

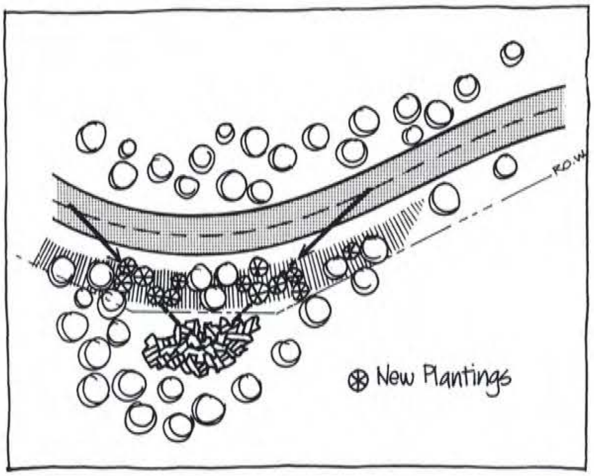
It would be more desirable to feather the revegetation edge as well as the clearing edge. Again, this would allow a transitional band rather than a sharp edge. Some modification of standard specifications would be necessary to accomplish this effect.

Encouraging mixtures of plants.—Rather than utilize a single type of plant in revegetation, it will often be desirable to utilize a mix of grasses, wildflowers, shrubs and trees.

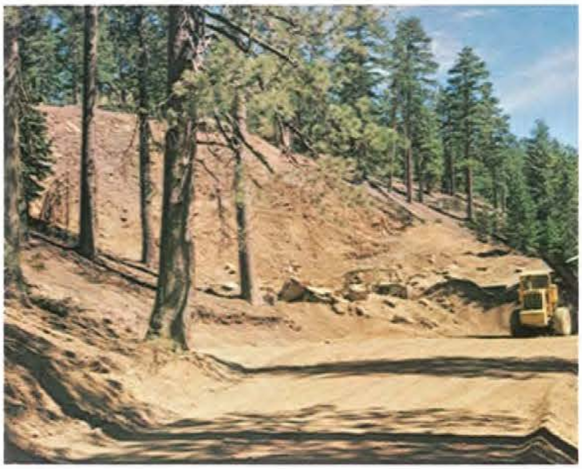
Greater variety of line, form, color, and texture thus achieved will better blend with adjacent undisturbed areas. Chances of plant establishment are also improved. Of course, this should be done with discretion; planting or seeding of trees across meadow or grassland cut or fill slopes would be entirely out of order.

Willow cuttings and grasses

Selection of plants with sizes, forms, colors, and textures which blend with existing vegetation.—Normally, plants of a type native to the area should be utilized to reduce contrasts. In cases where it is necessary to utilize nonnative species, they should be selected on the basis of their visual compatibility with the remaining native plants.



Utilizing vegetation to screen contrasts.—Another function of vegetative establishment is to screen areas of undesirable contrast in which such contrasts cannot be practically diminished by more direct means. A few trees may be utilized to screen off a vast area of modified landscape thus achieving more rapid results than could be attained by massive re-vegetation efforts within such areas.



A timber access road borrow pit was very carefully located to provide screening by existing trees. Although it stands out vividly from the spur road to the borrow area . . .

From the paved public highway it is totally impossible to see (in exact center of photograph).

STRUCTURES

Structures, as referred to in this chapter, are man-made objects of concrete, steel, wood, etc., which are as much a part of the road design as the driving surface.

Reducing the Number of Visible Structures

Since the major constraint of meeting landscape management objectives in road construction is the introduction of contrasting elements, the first efforts should be to reduce the possibilities of such contrasts.

In the case of structures, this can best be accomplished by a thorough analysis in every stage of planning to determine if all the structures are actually necessary. If necessary, must they be visible or can they be buried or screened? These structures would include but not be limited to:

- signs
- guardrails
- guideposts
- snowpoles
- overside drains
- cattleguards
- binwalls
- bridges
- fences
- culvert end sections

A lack of order and continuity of structural elements creates dominant focal points that are often disturbing to the viewer.

For road and landscape harmony, the designer should reduce the numbers of visible structures and/or their dominance upon the scene.

Remove or do not permit unnecessary signs

Remove or do not permit unnecessary guardrails

Remove or do not permit excessive guideposts

Remove snowpoles during the summer season

Provide for burial of overside drains

Paint or bituminous coat exposed culvert end sections and subdue with plantings

Bury power or telephone lines or locate them in an area screened from the highway

Subdue cattleguards by painting or by vegetative screening if they must remain

Screen fences or locate them in the adjoining forest

Reducing the Contrasts of Necessary Visible Structures

Once the number of structures has been reduced to the minimum consistent with good design, efforts can be shifted to reducing contrasts of the structures with the landscape. Alternatives in size, form, line, color, and texture should be explored for each type of structure in relation to its immediate surroundings.

Signs

The road designer should watch for hazardous situations in the early stages of design to preclude the need for warning signs. If the road is well designed from a traffic flow and safety point of view, traffic control signing can be minimized.

Several things can be done to reduce the unnecessary visual impacts of needed signs, even while recognizing that, to be useful, Signs must be seen, read, and understood. The mounting and the reverse side of a sign are not necessary to the communication of the message and are therefore subject to contrast reduction, especially of color, and to a lesser degree, texture. The reverse sides of signs and the entire post for the sign can be painted to match the backdrop. Grays, gray-browns and gray-greens usually are most successful. Harmonious signs will cause less distraction from the highway users view of the highway and landscape.

Signs that are of an informational nature may be located off the highway at pullouts where they can be read at leisure and where detailed maps can be studied.

Guardrails

Although there are standard sizes and shapes of guardrails, there may be some opportunity to reduce the apparent size and yet serve the purpose of keeping vehicles on the roadway. Metal rails may be of "self weathering steel" or galvanized steel guardrails may be given a dip treatment in galvanprime or similar solutions which turn the metal a dull or even very dark gray.


As seen from the road


A closer view reveals fence post

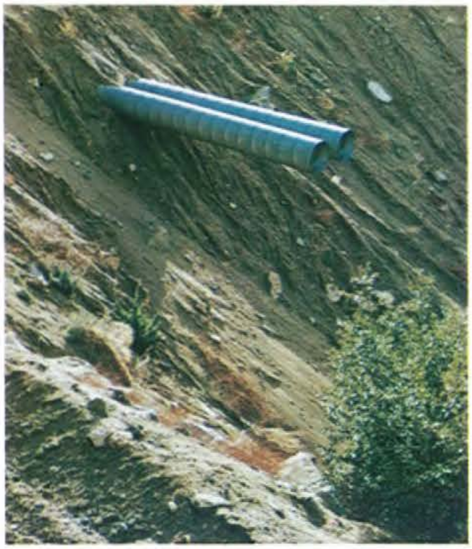
Fences

There is some flexibility in location of fences which will allow a higher degree of screening from the roadway. Fences do not have to be seen by the driver. Forms can be modified to reduce their visual magnitude, textures can be modified as practical for the materials utilized, and color can be modified by paints, stains, or self-weathering processes.

In some cases, such as in areas where rustic rail fences are common in the landscape, it may be appropriate to deviate from the goal of reducing contrasts. Such fences may be a desired addition to the landscape character which helps to strengthen that character as modified by man.

The concept utilized in the latter case is that the negative effects of visual contrast are overriden by the positive associative values of historic relics created by pioneering farmers and ranchers.


Yet closer, the fence post dominates




Culverts

A main visual concern on culverts is the treatment of the end sections.

Color can be modified to fit the landforms. This can be done by the use of paint, pretreated aluminum coatings, bituminous coatings, etc. Texture can be modified by sprinkling sand, disintegrated granite, or fine gravel on tack coats of asphalt or epoxy.

Forms can be modified to fit the landforms.

Another visual impact problem of culverts is their use as unburied overside drains. Burial of such overside drains is the most acceptable solution.



Cattleguards

Forms of cattleguards have a degree of latitude in that widths can be adjusted to set the "wings" back from the roadway to either screen them with vegetation or reduce the artificial enclosure experience. If the "wings" are sufficiently set back from the driving surface, the safety problem is diminished and colors can be modified to blend with their surroundings.

Road Surfacing

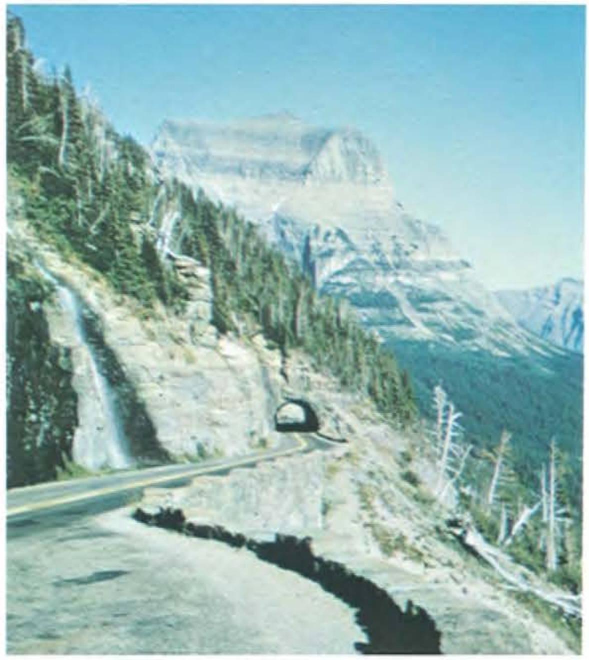
If the goal is truly to blend the road to the landscape it passes through, then even the road surfacing can provide alternatives.

To reduce the apparent width of the road (and thereby its impact on the natural landscape) use a color and texture of pea gravel or chips on the paved shoulders that more closely complements the surroundings.

The color contrast of the road surface can be improved in most cases. This reduces the visual impact on both highway users and viewers from other observation points. This can be done by selective surface treatment (chips, pea gravel) D.G., cinders, etc., on the seal coat). This may be more important in cases where road surfaces are viewed at middleground and background distances. In foreground views the visual resolution is so great that there is little possibility of its blending with the entire scene.

Retaining Walls

Numerous opportunities for visual impact reduction are possible here. The form and line of retaining walls can be modified slightly depending on the type of material utilized. There are some possibilities of curving the ends of retaining walls to blend with the landforms.



Rock masonry with rock guard wall

Dry wall of large rock

Metal binwall—too much color contrast

Rock masonry with guardrail

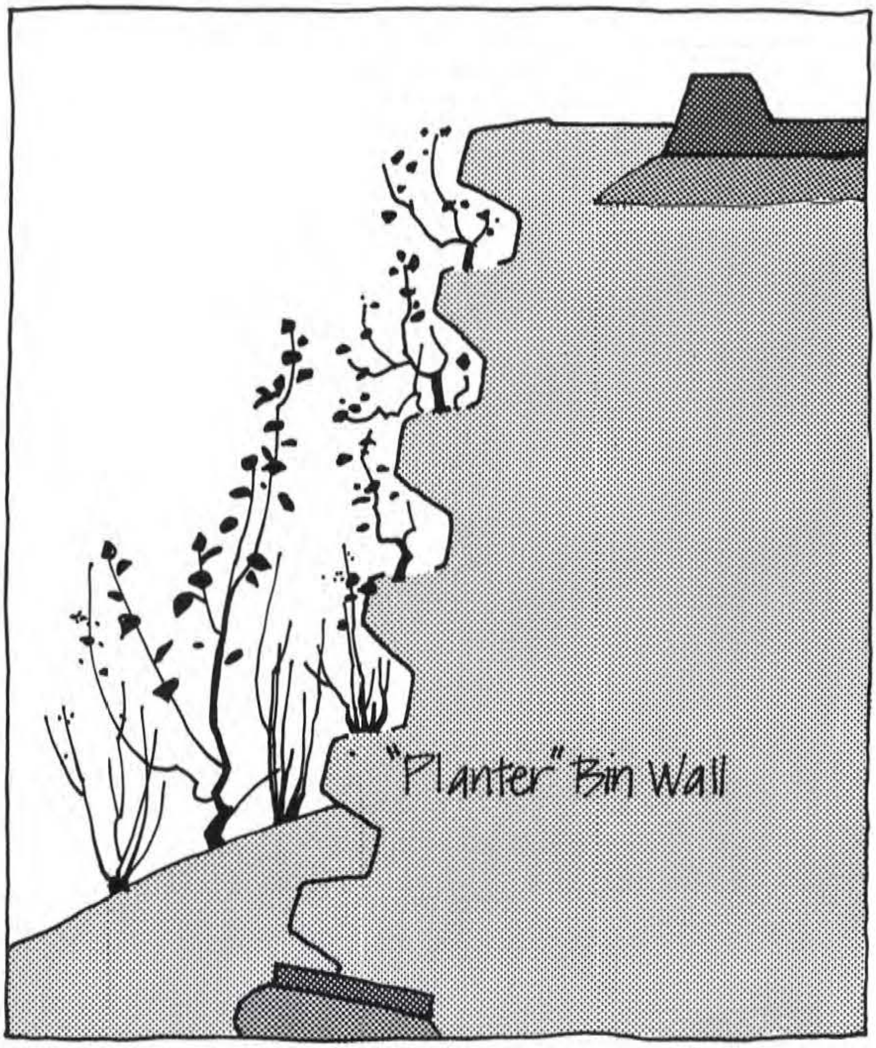
Rock masonry on poured concrete. If the entire retaining wall were composed of rock masonry, it would blend well.

The texture of crib-type binwalls is often quite coarse. Their contrast can be reduced by encouraging plants to grow on them.

"Planter" type metal bins are specifically designed for that purpose.

Textural effects of steel are less flexible than masonry but can be favorably affected by the size and design of the structural members.

Color options to meet low contrast objectives are best exercised by paints, colored pigments in the concrete, and stains for wood. Types of wood preservative treatment can modify color of wood. For instance, the greenish-blue tint of some chemical-pressure treatments may blend better in some situations than any paint or stain.



Texture of concrete or rock masonry retaining walls can be controlled by the size and shape of rocks used, the degree of joint raking, or by using exposed aggregate finishes. Vegetation can be encouraged to grow on or over the surface of these walls.

Bridges and Viaduct Sections

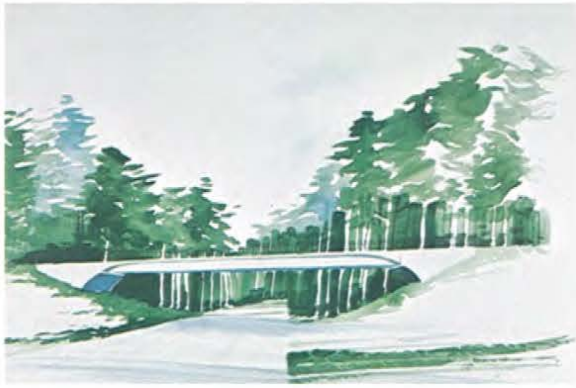
Well designed bridges and half bridges can be positive elements in the landscape. However, if the objective is to subordinate the structures to the strength of the landscape character so as to meet partial retention or retention visual quality objectives, there are several alternatives open.

The form of the bridge or half bridge has some possibilities for modification. For instance, a concrete structure can be sharply angular to resemble angular rock outcrops or it can be rounded to resemble water- and wind-worn rocks.

Slight adjustments of location can take advantage of vegetative screening potential where the objective is to screen the approaches.

Textures can be modified to provide a coarser surface that captures shade and shadow in patterns resembling natural backgrounds.

Colors can be selected that borrow from those of the immediate site.

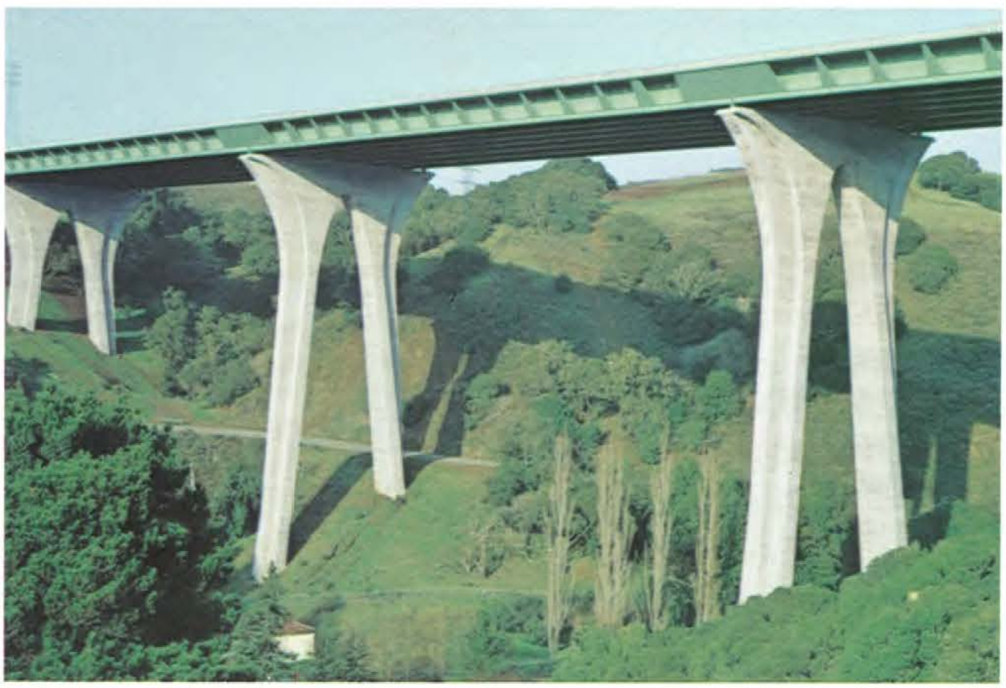


Enhancing the Designs of Structures That Are Impractical to Blend

The required size or location of a structure may be such that it would be impossible to subordinate its visual characteristics to the natural landscape character. It often is desirable in such instances to purposely design a beautiful structure which makes no attempt to blend in but forms a contrast of natural and manmade beauty working together in harmony.

Bridges and Half Bridges

Bridges can be compatible and contrasting at the same time if adequate care is taken in the design process. This is not to imply that an internationally famous designer is necessary for each bridge project, but that extra effort must be made to create a visually pleasing design if the structure is to have a positive effect on an already pleasant landscape scene.



Resolving conflicts of visual impact reduction (VIR)

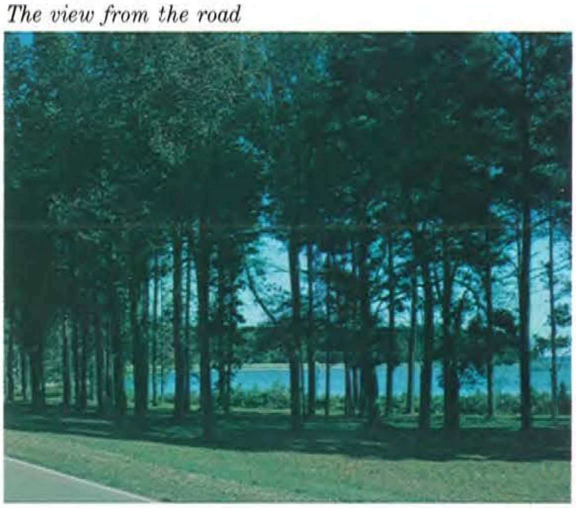
In the previous section on reducing visual impacts of roads the reader probably noted that some of these methods would be in conflict. For example, if landform visual impact reduction was to be carried out with slope rounding, it is obvious that this would be contrary to the vegetative visual impact reduction of retaining the maximum amount of existing vegetation.

Each section of the proposed roadway must be analyzed to determine the most important criteria for a decision when such conflicts exist.

DETERMINATION OF THE RELATIVE DEGREES OF IMPORTANCE OF VIEWING SITUATIONS

There are three major types of viewing situations to consider:

The view from the road



The view of the road from other roads, trails, or occupancy areas

The view of the road in the middleground and background from the road

Relative degrees of importance can be placed upon such views. Depending on the situation, such ratings may apply for the entire project or for individual sections of the project. For instance, the relative importance may be:

View from the road=5
View of the road from other areas=4
View of the road from road=4

or

View from the road=3
View of the road from other areas=5
View of the road from the road=2

The relative degree of importance is dependent upon:

Number of potential viewers.—How many people will view the area from each situation during a normal year?

Duration of view.—Will the potential viewers see the road for just a fleeting glance or will they view it for several hours a day? A combination of the number of viewers and the length of view will allow approximations of viewer days per year.

Type of potential viewers.—How concerned are these viewers with the maintenance of the quality of the scene viewed? Are they hunters, sightseers, local residents, or people who are just in a hurry to pass through?

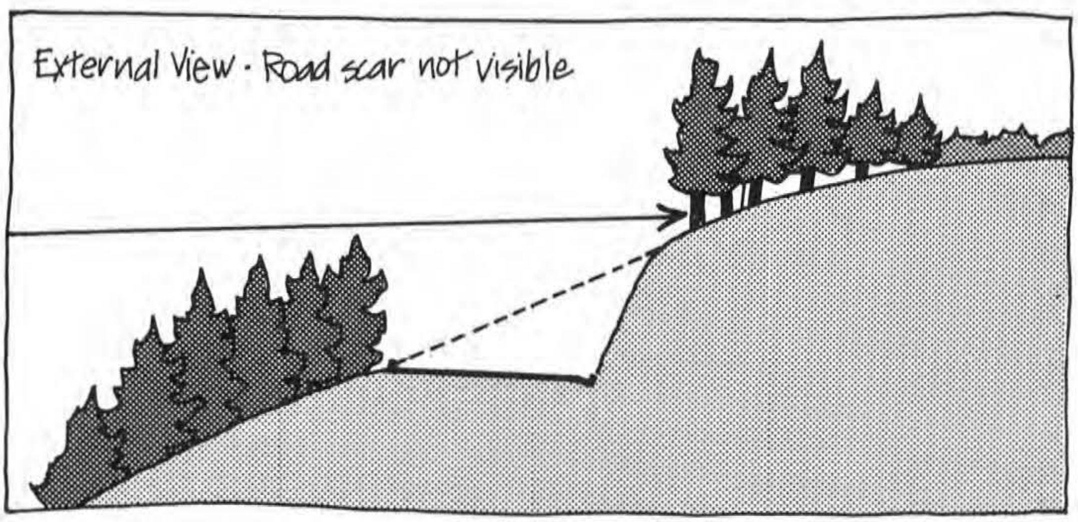
Type of area from which viewed.—This is closely allied with the types of potential viewers. Will they view the road from a developed recreation site, a wilderness, a back road, an interstate highway, etc.?

Number and intensity of focal points that compete with the road for attention.—Are there other features in the landscape which will draw attention away from the view of the road?

All of these factors should be given consideration, but the intensity of such analysis must be geared to the scope and importance of the project.

RESOLVING CONFLICTS BETWEEN LANDFORM VIR AND VEGETATION VIR

Slope flattening and rounding versus maximum vegetation.—Sometimes the view of the road from other areas, or of the roadway from other sections of the same road is more critical than the view from the road. It may be desirable to sacrifice immediate foreground landform blending in favor of saving all possible roadside vegetation.

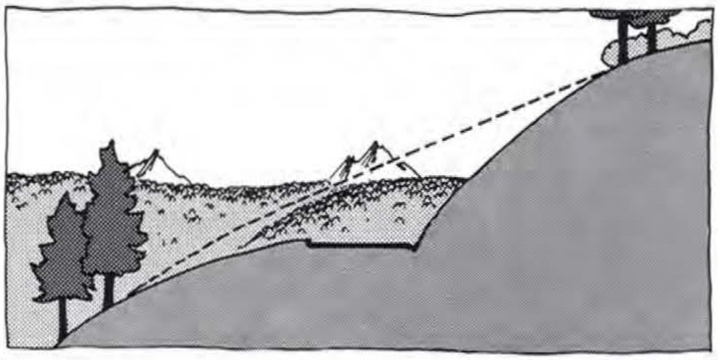


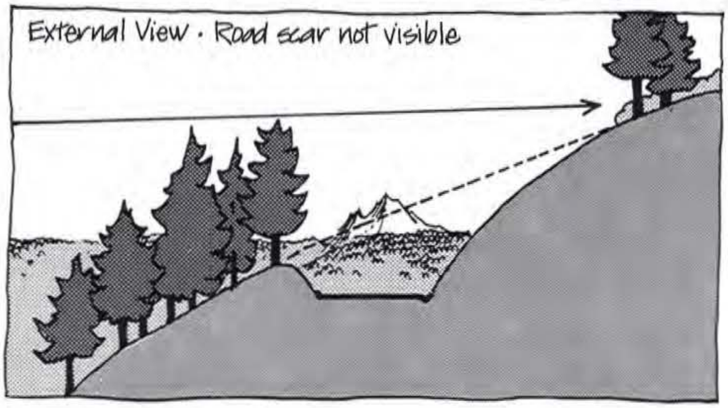
On the other hand, if the view from the roadway is much more important, a greater area to be revegetated is acceptable. Since then the initial scarring effect as seen from other areas is not as important as the long-term appearance, the slopes might be generously layed back and rounded.

Daylighting (removing a "knob" left on the outside of a through cut) versus maximum vegetative retention.—Daylighting of through cuts is often considered to be the desirable solution since it has great possibilities for eliminating incongruous landforms. However, there are cases where the landform contrast is more acceptable than the alternative. One situation is where the view of the road is sensitive from areas other than the immediate roadway and daylighting would remove the essential screening of the inside cut bank.

Another situation could be where the intent, at this particular location, is to direct attention to view ahead or to screen the road from an undesirable view.

In other cases the daylighting solution may be chosen due to greater importance of the view from the road. It could also be that the scar created on the inside cut bank is not expected to create much color or texture contrast or that the cut bank could be adequately revegetated in a relatively short time to meet the visual quality objective.

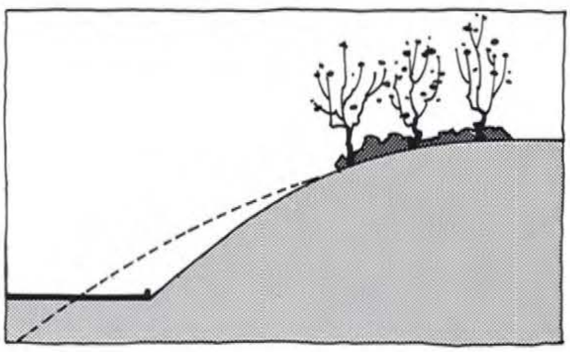


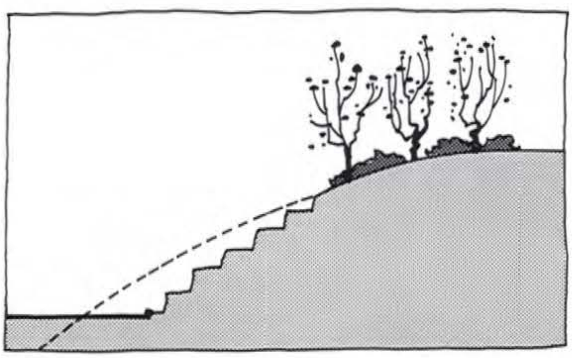


There also may be a situation where daylighting would open up a broad panorama which is an important consideration in the planned sequence of viewing experiences of that particular road.

Blending cut slope textures versus providing optimum conditions for new vegetation.—Although serrations may speed up the revegetation process on cut slopes, there may be cases where this horizontal-line visual impact is unacceptable. The rock types in a particular area may also be such that serrations would persist for many years rather than quickly losing contrast through sloughing.

In other cases, the initial impacts of the unnatural lines and forms of the practice are less important than the long-term effects of revegetation. It has also been found that serrated slopes revegetate very well in some rock-soil types where other methods have little assurance of success.





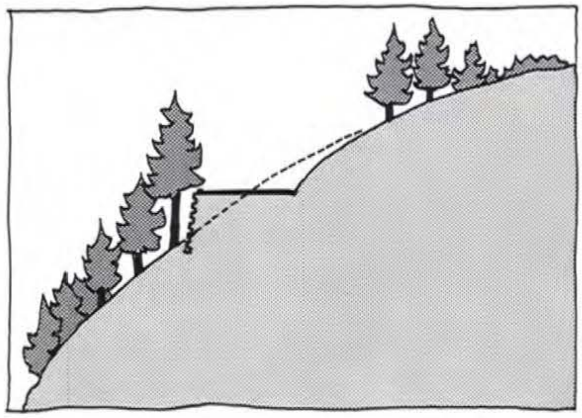
Slope warping, wasting fill material, or shaping borrow areas versus maximum vegetation retention. — Similar considerations should be given to conflicts arising when deciding to save-the-existing-vegetation or warp slopes, waste fill material in a depression, or shape the slopes of a borrow pit. In most cases, the choice should be obvious while in others, a compromise between the alternatives may best solve the problem.

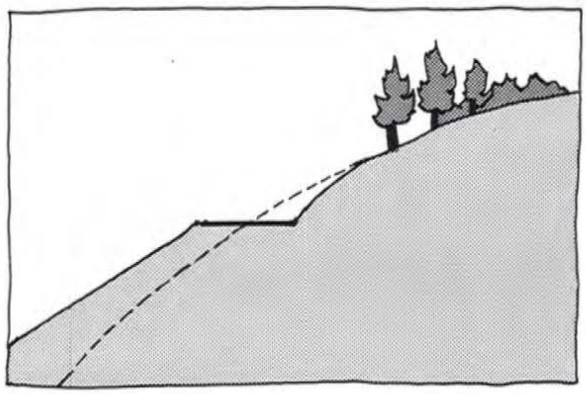
RESOLVING CONFLICTS BETWEEN LANDFORMS VIR AND STRUCTURAL VIR

Fills versus bridges or viaduct sections.— In most cases structures will not appear as natural features in the landscape. However, the negative visual impact created by the structure may be less than would otherwise be necessary by utilizing fills. If the initial blending is of greater importance than long-term landform blending, then bridges are the best solution. Of course, there may be even greater justification for bridges based on water quality maintenance and fishery considerations.

Cuts or fills versus retaining walls.—Structures used to retain earth are not likely to blend with landforms except in isolated cases of ledgerock. However, their advantages in reducing the amount of exposed cut or fill slopes often outweigh their landform contrast.

In many mountainous situations, a fill slope of $1\frac{1}{2}$:1 or 2:1 will not catch natural ground until it reaches the bottom of the canyon.





In most of these cases, economic considerations alone would point toward the use of retainers such as binwalls. In other situations, the economics of construction, fisheries, and water quality might not be sufficient to warrant binwalls but the visual quality might be great enough to swing the balance.

Fill-slope retaining walls which are in heavy stands of vegetation of equal or greater height than the wall actually do not create much visual impact since the landform is not clearly visible. This is especially true if the clearing limits adjacent to the toe of the wall are held to absolute minimums.

INTERNAL CONFLICTS— VEGETATION VISUAL IMPACT REDUCTION

All potential conflicts are not necessarily between landforms and vegetation, or landforms and structures. There can be conflicts between the various vegetation visual impact reduction options. The most common of these are:

Retention of existing vegetation versus feathering of edges.

Retention of existing vegetation versus irregular clearing limits.

Retention of existing vegetation versus vista clearings.

The retention of the maximum amount of existing vegetation concept must be weighed against these other alternatives which would cause the removal of additional vegetation outside of the normal clearing limits of a project. In most cases, feathering of edges, irregular clearing limits, and vista clearings will be of greater importance and should be carried out despite the apparent conflict.

INTERNAL CONFLICTS— LANDFORM VISUAL IMPACT REDUCTION

Minor conflicts may arise in the various alternatives for reducing landform visual impact. The bases for selection would be similar to those listed on pages .... Such conflicts may arise between:

Minimizing cut and fill versus slope rounding.

Minimizing cut and fill versus daylighting.

Minimizing cut and fill versus shaping borrow areas.

Methods of Display

Only when the decision-maker, and often the public, can envision the effects of different proposed alinements, design criteria, structures, etc., can intelligent trade-offs and choices be made. Rapid advancement is being made in the state of the graphic display and analyzation art. There are advances in the relatively simple manual techniques that are worthy of consideration. There are also computer-generated perspectives which have some application at present and considerable promise for the future.

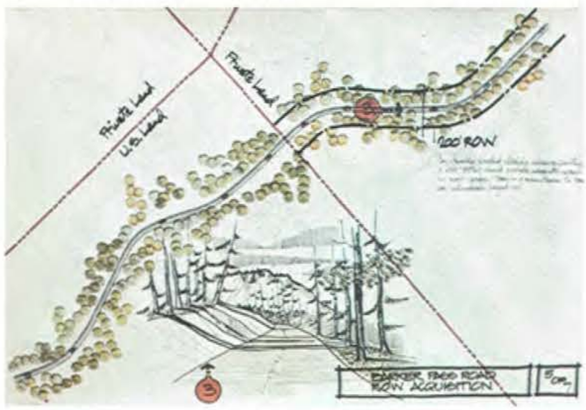
MANUAL GRAPHIC TECHNIQUES

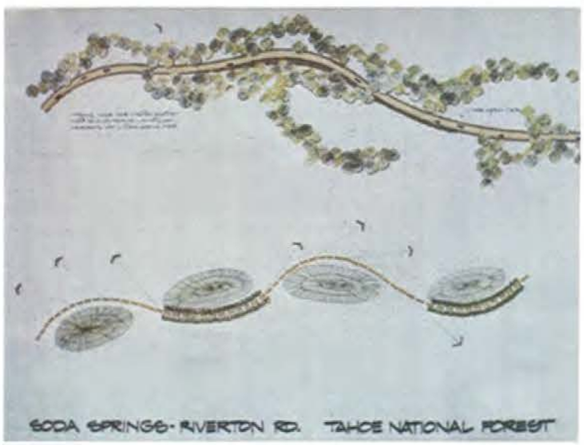
Perspective Sketches

The sketch of proposed modifications caused by roadway construction remains as a valid technique of simulating future landscape appearances. In some cases it can be improved and done more quickly by tracing from a projected photographic slide of the existing landscape. Color can be applied quickly with felt-tip pens to further simulate actual appearances.

Note: See the May 1970, Engineering Graphics Magazine, pages 12-14, for a method of preparing diazo blowups from color slides.

Plan views in combination with roadway perspective sketches.





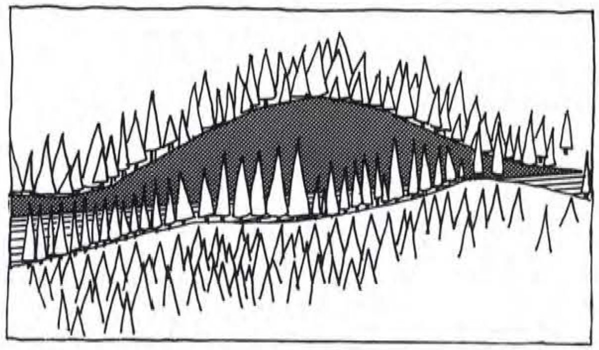
Sketch Superimposed on Photograph

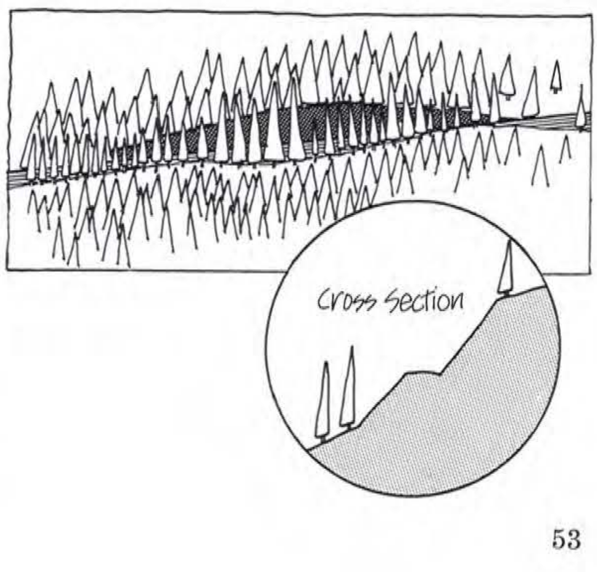
A variation of the perspective sketch is to superimpose a sketch of only the modified areas upon a photograph.

Abstract Diagram

Another method that has been utilized to illustrate visual impacts is shown in the following two figures. The grade of the road, the top of cut, and bottom of fill are plotted without any vertical exaggeration. Information on tree density and heights is obtained on the ground or from aerial photos. Trees are plotted to correct stand heights in abstract form resembling their effective screening shapes. The cut slope can be shown by vertical cross-hatching and the fill slopes by a horizontal cross-hatching. The cross-hatching then is indicative of the relative exposure of cuts and fills from a point of equal elevation to the highway.

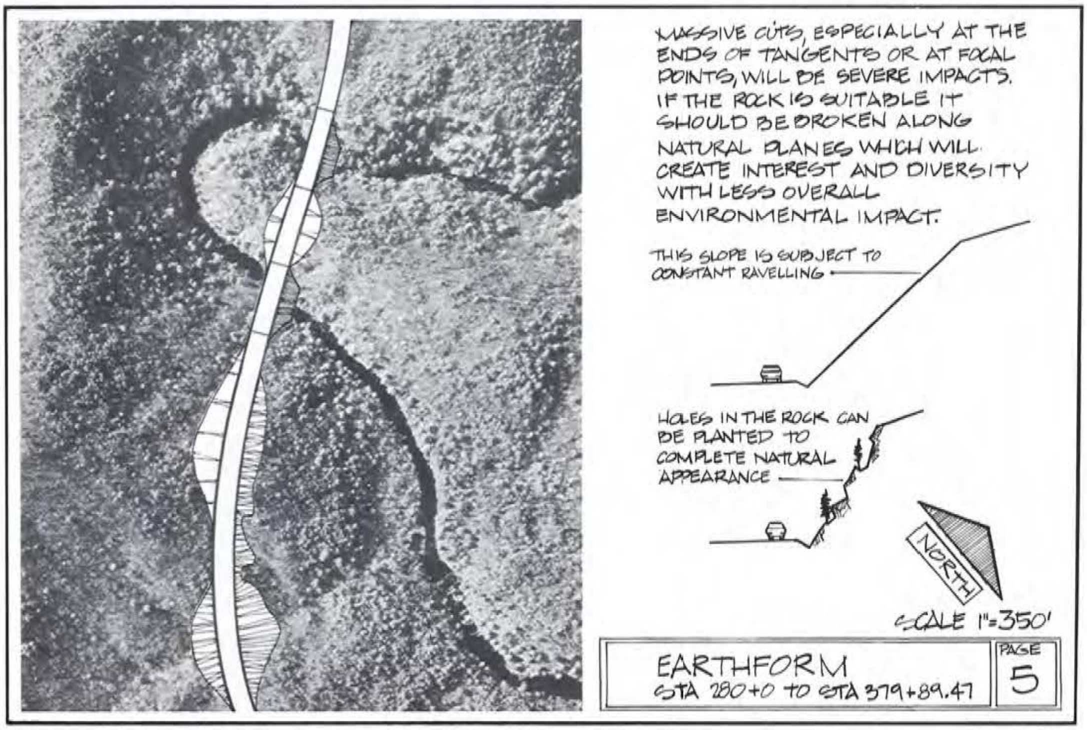
This illustration indicates how the impact of the same road could be reduced (without changing the road profile) by pulling the horizontal alinement out from the slope and using binwalls to retain the fill. This illustration combined with calculations of comparisons of clearing widths provides the decision-maker with the data he needs to make a choice. The added cost may be justified by the extent of visual-impact reduction achieved by using binwalls and slightly adjusting the alinement.

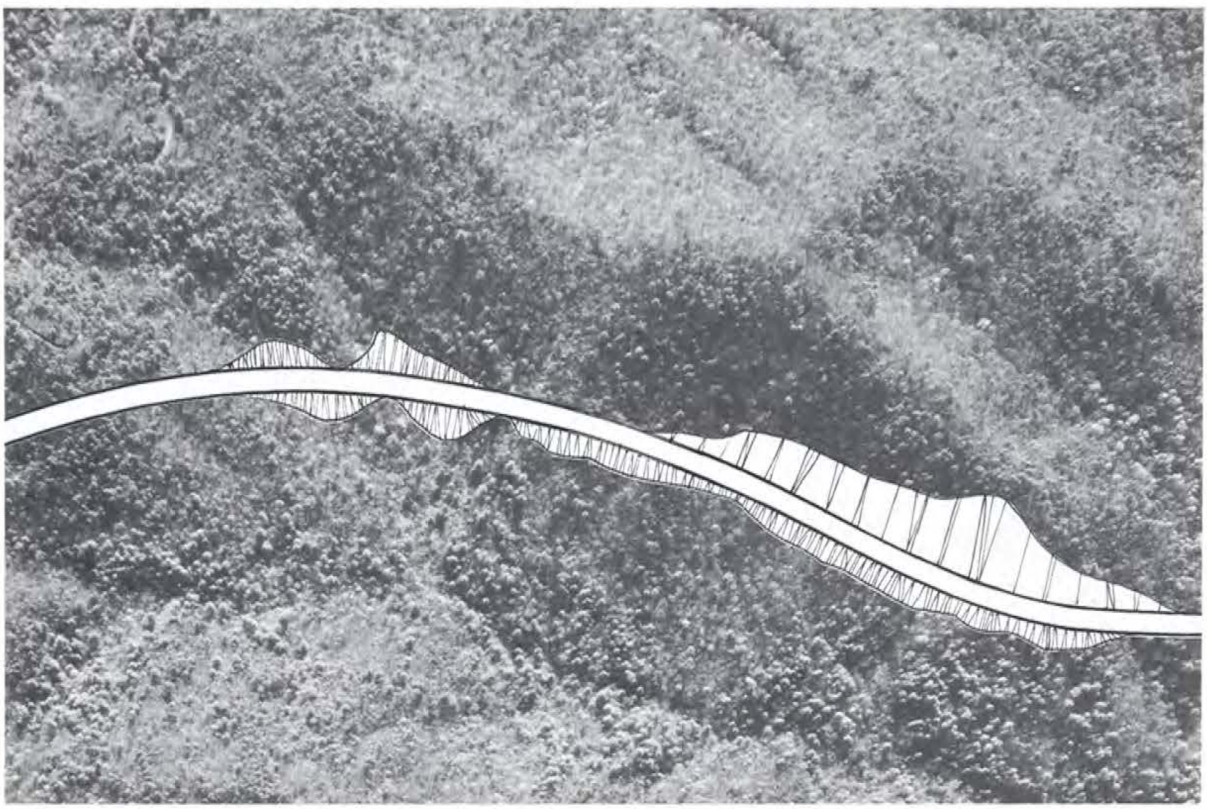


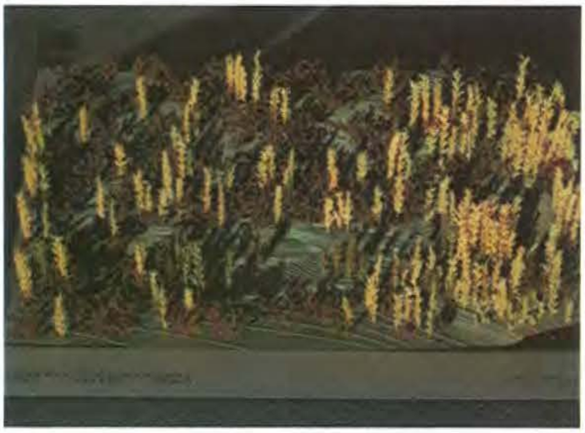


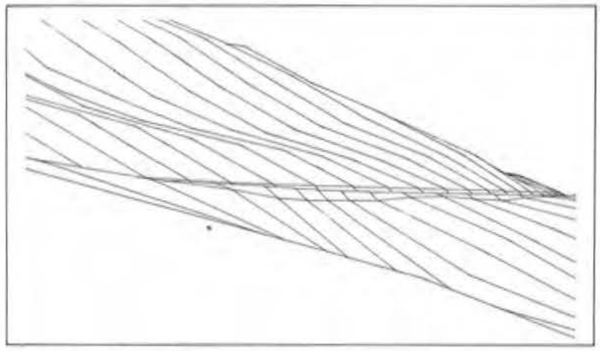
Plan View Diagrams

By interpolation from preliminary road plans and aerial photos; cuts, fills, and road alinement can be shown in this fashion.









Computer Perspectives

The basic output of the highway computer perspective program is a simple line drawing perspective.

TOPOGRAPHIC MODELS

If flexibility is desired in viewing situations it may be desirable to construct a topographic model of the road and its adjacent topography and vegetative cover. There are usually advantages in this method if the public is to visualize the effect.

COMPUTERGRAPHICS

There are some cases where computergraphics have been highly useful. A highway perspective computer program was developed by Larry J. Feeser of the University of Colorado. The "Smith River Visual Analysis Study" by Royston, Hanamoto, Beck, and Abey for the U.S. Forest Service, California Region and California Division of Highways used and modified this program.

Computer Perspective Montaged on a Photograph

A further sophistication of this program is super-imposing the computer perspective on a photograph. At least three points must be accurately matched from the photograph to the perspective plot. Although ground views (as observed from a vehicle) are desirable, experience has shown that unless viewing points are very selectively chosen, there is a good chance that problems will develop, in heavily forested sites, due to the need to show removal of foreground trees.

This can be partially compensated by collaging in expected background vegetation from other photographs. Low aerial oblique (or high vantage point) photographs appear to alleviate some of these difficulties.

Animated Computer Perspectives (Movies)

Another medium for displaying the visual effects of a road is a movie of computer perspectives in sequence. This technique was utilized on a 1-mile section of U.S. 199 (Smith River Highway in the California Region) with views spaced every 7.5 feet at the driver's eye level.* By increasing the speed of the projector one can simulate various driving speeds along the road. Since these computer-graphics are relatively expensive, they tend to be used only on the most critical road problems.

COMPUTATIONS

Comparative computations are valuable tools for the display of visual impacts. They can be used alone or preferably in combination with graphics of the highway.

The following actual examples involve the improvement of a 2.5-mile section of Forest Highway in steep terrain with high scenic quality and high viewer sensitivity. They illustrate two methods of comparing the magnitude of visual impacts of proposed highway design alternatives:

*The movie is available through the W.O. Division of Engineering and the R-5 Division of Engineering.

Method No. 1

Step 1.—The horizontal clearing width and vertical height of cut and fill for each affected cross section (50-foot intervals) were determined for the "First Revised Plans" and for proposed changes of the "Second Revised Plan" (Exhibit I).

Step 2.—The differences were determined for average clearing widths, average (unpaved) disturbed land width; vertical height of maximum cuts, fills, and combined cuts and fills; vertical height of average cuts, fills and combined cuts and fills; and square footage of binwalls (Exhibit II).

Step 3.—A comparison was made to determine the effect of a 1-foot and a 5-foot reduction in road section width (Exhibit III).

Step 4.—A comparison was made of the proposed 0.8:1 cut slope with 1:1 cut slope (Exhibit IV).

Step 5.—The amounts of exacavation and borrow for the alternative plans were determined (Exhibit V).

EXHIBIT I

Forest Highway "X"—Sample Section

	First revised plan		Second revised plan		First revised plan	Second revised plan
Station	Cut	Vertical total cut and fill	Cut	Vertical total cut and fill	Horizontal width of clearing	Horizontal width of clearing
38+50		14		6	78	61
39+00		33		16	103	56
39+59		36		18	100	47
40+00	0	39	2	19	100	45
40+50	0	44	3	23	110	46
41+00	0	53	0	21	125	46
41+50	0	55	0	22	132	45
42+04	0	50	0	18	125	46
42+50	0	48	7	19	120	49
43+00	0	51	20	30	120	47
43+50	8	49	23	30	124	61
44+00	11	54	30	32	144	64
44+50	0	22	20	31	45	59
45+00	8	29	17	31	52	57
45+50	14	31	18	31	55	59
46+00	14	32	18	33	56	59
Totals	55	640	158	380	1,589	847
Average	3	40	10	24	100	53

EXHIBIT II

Forest Highway "X"

Comparison of first revised plans and successive revision plans to reduce impacts

	First revised plan	Second revised plan	Third revised plan	Fourth revised plan
Average clearing width	97 ft.	65 ft.	65 ft.	58.6 ft.
Average unpaved—disturbed width	54 ft.	22 ft.	23 ft.	17.6 ft.
Maximum cut—vertical height	112 ft.	39 ft.	79 ft.	48 ft.
Maximum fill—vertical height	64 ft.	27 ft.	57 ft.	61 ft.
Maximum cut and fill—vertical height	154 ft.	49 ft.	79 ft.	61 ft.
Average cut—vertical height	20.7 ft.	11.8 ft.	15.5 ft.	11.2 ft.
Average fill—vertical height	14 ft.	14.2 ft.	11.5 ft.	11.6 ft.
Average cut and fill—vertical height	34.7 ft.	26 ft.	27 ft.	22.8 ft.
Square feet of binwalls	19,180 sq.ft.	101,800 sq.ft.	97,480 sq.ft.	122,860 sq.ft.

EXHIBIT III

A 1-foot reduction of road section width decreases average clearing width by 2 feet and average cut by 1 foot. (8%)

A 5-foot reduction of road section width decreases average clearing width by 9 feet and average cut by 4 feet. (31%)

EXHIBIT IV

A 1:1 cut slope would increase the average clearing by 8 feet and the average cut by 5 feet. (38%)

EXHIBIT V

Total Excavation Estimates—Plans

Original plan
= 304,000 cu. yd. x $3.50 = $1,064,000

First revised plan
= 177,278 cu. yd. x 3.50 = 620,000

Second revised plan
= 185,500 cu. yd. x 3.50 = 649,250

Third revised plan
= 116,100 cu. yd. x 3.50 = 406,350

*Fourth revised plan
= 73,000 cu. yd. x 3.50 = 255,500
+ 60,000 cu. yd. x 2.50 = 150,000**
405,500

Another comparative set of figures was used following the second revised plan to express the differences in alternatives in terms of total acres cleared and exposed and paved. That not only gave the land manager a better idea of visual impacts but also of soil and watershed impacts.

*Allowed for use of additional binwalls which increased need for borrow.
**Borrow material.

2.5-Mile Section of Forest Highway

	Alternatives	Existing exposed	Paved	New exposed	Total exposed	New clear-ing	Total clear-ing
I.	Existing—Do nothing*	10	0	0	10	0	10
II.	Pave existing road*	4	6	0	4	0	10
III.	Limited widen and pave**	4	7	1	5	2	12
IV.	Widen and pave—30-foot total	3	10	8½	11½	11½	21½
V.	First revised plan—43-foot total	5	13½	21½	26½	30	40
VI.	Second revised plan—43-foot total	5	13½	7	12	15	25

*Existing road varied in width from 12 feet to 25 feet of driving and shoulder surface with an average width of about 20 feet.
**Limited widening would have allowed a continuous 20-foot wide pavement.

Method No. 2

One simple method, now in use, places numerical ratings on a road's relative visual impact:

Evaluate the impact of the road from the viewpoint of the highway users:

Rate individual sections of the road plans (usually 100 to 1,000 foot segments containing similar visual characteristics) as to the predicted visual impact in both directions of travel. A numerical range of 1 to 4 is used:

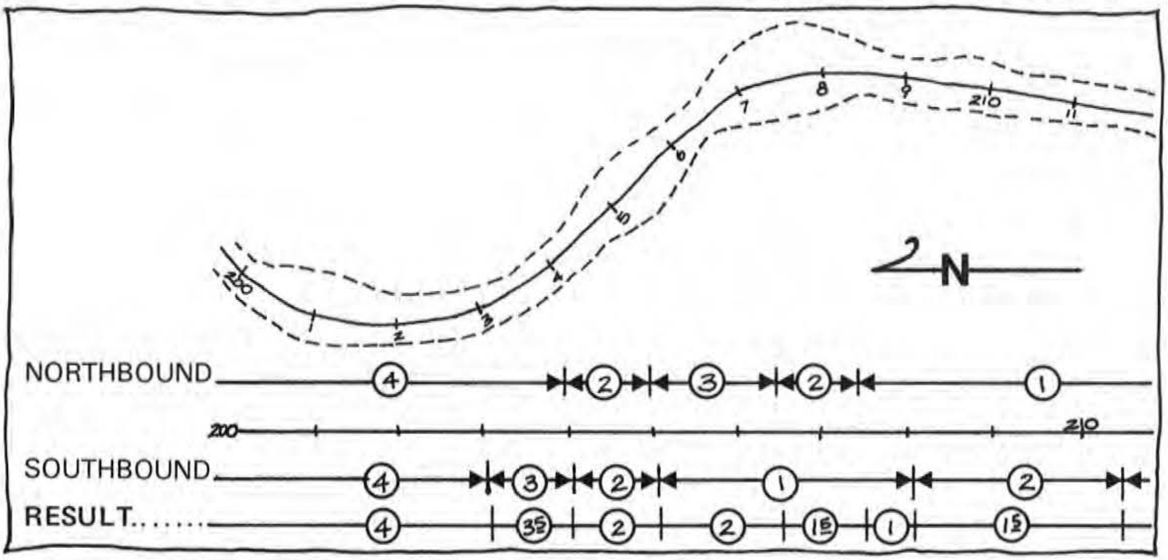
1=Head-on view into high fill and cut slopes.

2=On tangent with high cut banks.

3=On tangent with low cut banks and some external dominant features.

4=View is outward on curve toward dominant natural feature.

Different ratings will develop in each direction of travel. Therefore, the final product is an average of both travel direction ratings as indicated below in the "results" line:



Evaluate the impact of the road from external observer points:

As before, rate individual sections of the road plans as to predicted visual impact. Rate the exposure due to landform, vegetation, and observer points on one line . . .

1=Open exposed ridge viewed from many observer points.

2=Lightly screened by vegetation and viewed from many observer points.

3=Medium screening and viewed from a few observer points.

4=Enclosed landform and heavy vegetative screening.

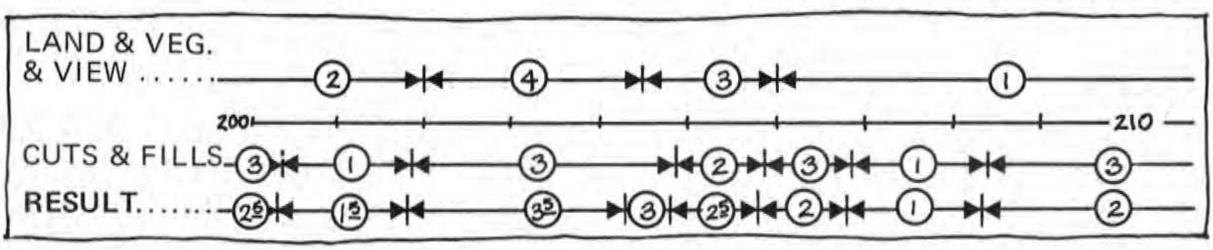
. . . and the relative heights of cuts and fills on the second line:

1=Cut and/or fill in excess of 30 feet.

2=Cut and/or fill in excess of 20 feet.

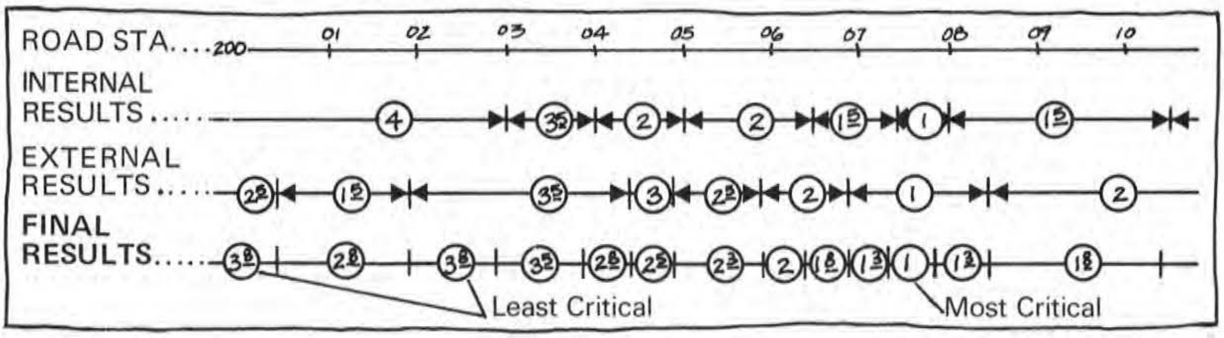
3=Cut and/or fill in excess of 10 feet.

4=Cut and/or fill less than 10 feet.



The final product is an average of both ratings as indicated below in the "results" line:

Next a determination is made based on the factors of numbers and types of people, types of observer points (other roads, developed sites, wilderness trails, etc.) and of the relative importance of internal versus external visual impacts. In the actual case it was determined that 60 percent should be assigned to external ratings and 40 percent to internal ratings, but for the sake of simplicity, we will assume a 50-50 basis for this example:



The final results indicate the relative degree of criticalness of the visual impact of the road. The design team can then concentrate its efforts on reducing impacts on a priority basis. This might involve changes in alinement, grade, typical section width, use of binwalls, treewells, etc., to reduce such impact in the most critical sections.

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