# HIGHWAY RESEARCH RECORD

**Number 206**

# Roadside Development

5 Reports

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# Foreword

This RECORD is comprised of five technical reports sponsored by the Highway Research Board's Committee on Roadside Development. These reports discuss several subjects of interest to those involved in the art and science of roadside development.

One paper presents results of an investigation of warrants, criteria and standards for highway scenic interest acquisitions. It is suggested that user benefits constitutes warrants for acquisitions, and these may be categorized within the concept of the "complete highway" which incorporates utility, safety, beauty and economy with the addition of propriety.

A second paper discusses the multiple land use concept of highway design. It visualizes an optimum level of service and maximum return on the investment when the roadside is devoted to all accessory uses possible which are compatible with the primary use. A unique situation in Binghamton, New York, is used to demonstrate the application of this concept and the development of the theme "The New Trichotomy: The Highway, The Roadside, and Recreation."

Two papers are devoted to the protection and stabilization of construction slopes. One paper describes an investigation to evaluate mulching practices with respect to soil erosion and seed and fertilizer loss prior to grass establishment. Thirteen mulches were evaluated by using a field plot rainfall simulator and a device to introduce additional surface flow over a test plot. The second paper describes an investigation to evaluate the same mulches on the same regraded slope and soil type in terms of their effects on soil temperature, soil moisture and seedling grass cover during the critical period of germination and establishment. The most effective mulches in each investigation are identified and several conclusions are drawn.

The final paper describes a series of experiments on the fertilization of roadside turf in Mississippi. The objectives of the investigation were to determine the optimum source and rate of application of nitrogen to maintain a desirable roadside turf, to measure the rate of release and percent recovery of nitrogen from these sources and to measure the suitability of mixtures of slow- and fast-release nitrogen sources for producing sustained growth of bermudagrass for periods greater than one year. Both field and greenhouse experiments were performed. Tenable conclusion are presented.

The papers have been published in a sequence which relates their respective scopes to land acquisition, land use, construction and maintenance.

# Contents

# Warrants, Criteria and Standards for Acquiring Land and Interests in Land for Scenic and Other Highway Environmental Purposes

WAYNE O. EARLEY,
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Scenic interest acquisition is justified by highway purposes as related to user benefits. These user benefits constitute warrants for acquisition and may be categorized with the "complete highway" concept of safety, utility, beauty, and economy with the addition of propriety.

To achieve full utilization of benefit from highway construction and operation, highways must be located and designed as an integral element of their environment with recognition and consideration given to elements within the "corridor" that have a relationship with the highway.

Applications are the action phase of a scenic strip program. This action may be classified as preservation, restoration, enhancement, development, and development control. Insofar as the interests to be obtained in the corridor lands are concerned, restoration and enhancement applications may be grouped together as improvement.

The inherent characteristics and relationships of the scenic strip parcels rather than expedient administrative considerations must provide and be the dominant impetus for acquisition in order for a scenic strip acquisition program to enjoy any degree of success. Full and explicit understanding with the owners of lands affected by acquisitions must be achieved to obtain maximum benefits at minimum costs.

Parcel boundaries are established at the nearest logical physical or legal boundary where the warrant is diminished to the point it is overcome by economics or simply ceases to exist. Many states must have additional enabling legislation to achieve effectively and completely operational capability in environmental highway design.

•IN 1954, the late Fred Burggraf, Director of the Highway Research Board, said, "Roadside beautification and its varied activities reduces highway maintenance costs by checking erosion, preventing slides and controlling drifting snow, reduces accidents, increases adjacent property value, promotes civic pride, equalizes temperatures, opens and reveals natural beauty, advertises the State and provides a healthful recreation and enjoyment for all highway users" (1, p. 25).

Thus, Mr. Burggraf added his personal eminence and the prestige of the scientific world of highway building to the recognition of the thesis propounded by the roadside development professionals since the early 1930's. This thesis holds that incorporating the disciplines of landscape architecture and attendant sciences (land-use planning, horticulture, agronomy, and forestry) with the art and science of highway location, design, and management will result in the addition of values and amenities to the highway facility at minimal or no direct cost with great future direct and indirect user benefits.

In order to sell their "product" to the public and the highway administrator, acting in behalf of the public, the roadside development profession embraced a slogan that would both encompass the objectives and make these objectives understandable to all concerned.

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Paper sponsored by Committee on Roadside Development and presented at the 46th Annual Meeting.

Madison Avenue could not have selected better. The profession chose the "complete highway" as their banner for all to contemplate and hopefully to accept as their own. The complete highway is more than a slogan—it is a concept. This concept defines the complete highway as being a highway that has safety, utility, beauty and economy in all of its elements.

For the purpose of this study, the author has taken the liberty of adding propriety. Propriety in its meaning of appropriateness is found throughout all roadside development literature.

A treatise could be written to explain the semantics and relationships of these five words as they relate to the complete highway. Suffice it to say that as used in this context, each word defines the other. Everyone seems to understand safety, utility, economy and propriety. Beauty is the hard one. Therefore, on the premise of defining one of the five words with the others, a beautiful highway is a highway that is safe, utilitarian, economical and appropriate in its elements.

The proper application of the complete highway concept is serious business. The stakes at hand are the same as offered by the founders of our country... "our lives, our fortunes, and our sacred honor." It is the motorists' lives, the motorists' and communities' fortunes (highway taxes and property values) and the honor of those who provide the highway facility (quality of product).

A few references to the complete highway found in the literature are as follows:

> One measure of the state of maturity of a civilization is its concern for the environment in which it exists. The future of roadside development in America is very much linked to the rate of this maturation.
>
> The highway right-of-way was once considered an entity in itself, both functionally and visually, and roadside development meant concern only for the land within this strip not occupied by pavement.
>
> In our Nation's growing understanding of the need for total environmental planning and design, the highway is not now seen as a right-of-way with a relatively narrow band of pavement and some immediately associated appurtenances, but as one element in an environmental complex—a visual corridor within which roadside development has a major function to provide a transition between the pavement and the adjacent landscape or cityscape, a foreground to the controlled progressive display of natural scenes and man-made developments. In short, we are now more than ever concerned with the "Complete Highway" (2, p. 73).

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> Finally, there is implicit in the complete highway an ideal which we do well to bear in mind. It is written that "if we want to lead our children to the mountains we must love the mountains." If we are set about the task of building a finer America we must love our country and be willing to enlist in its service. But we need also to think of ourselves and our service in a much wider frame of reference. We are not only descendants but ancestors. We are the trustees of a great inheritance that we dare not squander. A part of that inheritance in the countryside itself, the value and beauty of which must not be dissipated with reckless indifference. Years ago Joseph Joubert stated this truth with poetic insight: "We have received the world as an inheritance; none of us has a right to damage it and everyone has the duty to leave it in an improved condition." To such a high ideal highway officials and engineers are called to achieve the complete highway (3, p. 38).

Ross D. Netherton, Counsel for Legal Research, Highway Research Board, said:

> Those who have called for a change in the law to meet the demands of an urban, industrial, automotive society have rightly recognized that before these changes could occur there must be a stabilization—or at least a clarification—of community objectives, and an articulation of a new rationale for public administration. In short, the policymakers must say what kind of a society they wish to create before the lawmakers can say what kind of a legal structure should be created to achieve these goals (4, p. 5).

Roadside development, anticipating this need, responded with an articulation of its measure in the contribution highways could make to the national beautification effort by preparing and publishing "The Art and Science of Roadside Development," Special Report 88, Highway Research Board, 1966, which states:

Regard for the amenities and the visual aspects of highway location and design offer many benefits to the motoring public and to the residents of the areas traveled. Visual variety and interest afforded the traveler reduces the monotony of high-speed driving. Well-landscaped freeways benefit the rural and urban economy by encouraging new industry and business to develop in a park-like manner along the borders. Location and development of urban highways provide the structural framework for urban redevelopment and afford opportunity for large-scale improvement of the immediately surrounding area (2, p. 10).

President Johnson convened the White House Conference on Natural Beauty in May 1965. The report of this conference, and the President's response "have become recognized statements of the national aspirations and the public interest in roadside development and beautification" (4, p. 10). Fred Burggraf said in 1954:

Engineering has been defined as "The Art of directing the great sources of power in nature for the use and convenience of man." Note the nice distinction between "use and convenience." Engineering does not try to tell man what he should want, or why he should want it. Rather, it recognizes a want—and then tries to meet it. Hence, engineers—especially highway engineers and landscape architects, perhaps more than any others—are interested in man—interested in what we want—how we live—and how we react to our environment (1, p. 27).

Even though to some it may seem that the roadside development beautification philosophy came into national prominence from "nowhere," it has a history of hard fought struggle and frustration. An understanding of this history helps to understand the warrants of obtaining interests in land beyond the presently normal rights-of-way.

At the turn of the century cities began to look with growing alarm at their transportation route problems, and by the quarter-century mark this concern was spreading throughout the country. The acceleration of both our economy and our population growth rate at the end of World War II predicted a highway network that might well occupy a significant percentage of our land mass. Stimulated by the projected Interstate Highway System, some hard looks were taken at the concept that highways were not merely pavements in selected right-of-way corridors, but important elements in the environments they passed through.

Two other facets of highway design that had their beginnings in the twenties and thirties were also by this time gaining supporters whose collective voices were being heard and who had developed a body of fact to support their beliefs. One dealt with the individual as the important element in the travel process—his behavior, reactions, comfort and safety. The other dealt with the belief that the landscape seen from the road and the road seen from the landscape had a responsibility to be visually pleasant.

As most of you know, the history of the latter is a checkerboard of frustrations and satisfactions. In the twenties, "roadside beautification" became household words which unfortunately rooted too firmly in the engineering and public mind as a concept of embellishment and gained for its proponents the still lingering nickname of "pansy-planters." The forties called forth "complete highway," a quadruped in which beauty was the left hind leg but which still implied that concern generally stopped at the right-of-way line.

Now words like aesthetics, environmental spaces and visual experiences are being used. It is also said that the responsibilities of highway location and design extend to whatever can be seen or be affected by the highway's presence. What is more, these things are being said forcefully and repeatedly by some of the most important people in the highway systems of this country.

What is emerging from the confluence of these evolutionary movements is a realization that highway planning is an integral part of the total land planning process. It must therefore be a conceptual process before it can be an engineering process, and it must be based on data relevant to man and his environment as well as vehicles in corridors. As a part of the environment, how it looks can be as important as how it is used (5, pp. 49-50). [Emphasis added.]

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The growing recognition that roads are more than merely service arteries and that highways may provide pleasure and satisfaction to those who see them and travel on them implies that if they are thus

identified as an important part of the landscape they will automatically be developed as an integral part of the environment (2, p. 5).

The search for warrants for taking additional rights-of-way or interests in land has obviated the fact that current practices of warrant identification, and the taking by standard setback are outmoded and insufficient. These practices are partly the result of convenience of standard and defensibility of warrant by precedent.

It is unfortunate that the majority of the current Interstate Highway program has already been located, designed, or constructed without thorough incorporation of landscape planning benefits in all phases. However, even as with this program of scenic interest acquisition, the exigencies of the times required that these highways be built as fast, efficiently and correctly as possible with the resources available. It is appropriate that preservation, restoration and enhancement, development and development control, through the complete highway concept be added to existing highways where possible and incorporated throughout all phases of future highways.

The warrants for taking of rights-of-way are based on "highway purpose" and "highway benefit."

It has been propounded and recognized in law that highway purpose is for the benefit of the user and that society is the user, whether on the highway in a vehicle or in homes, factories, cities or on farms. The rights and interests of the highway user do not terminate when he physically leaves the right-of-way. Therefore, what benefits the highway through highway purpose, benefits society. Conversely, what benefits society who is the highway user, benefits the highway. It is axiomatic that each is related and interdependent. This relationship will continue until another more suitable method of transportation is achieved.

## WARRANTS

Within the framework of the complete highway concept appears a suitable categorization of warrants for taking scenic easements of rights-of-way per se. These warrants would be the taking of lands or interests in lands for safety, utility, beauty, economy and propriety as highway purposes. For uniformity all taking shall be referred to as rights-of-way. The interests to be taken and the restrictions to be applied are detailed in the sections for Standards and Restrictions.

### Safety

The warrants of taking for highway safety purposes are to provide reasonable and adequate space or depth of right-of-way for the following reasons.

1. To provide distance from traffic lanes for protection from slides, rock and tree fall, and ice prolonging shade. The amount of space required for protection of the traffic lanes will vary with the conditions. The distances will be determined by the height of vegetation, topography grading conditions, and stability of cut material.
2. To provide space for the removal of roadside obstructions. Space for the removal of roadside obstructions will vary with design, speed and feasibility. Roadside obstructions to forward vision will also vary with horizontal curvature and intersecting traffic.
3. To remove or prevent roadside clutter and "dirty" scenes and thereby reduce motorists' tension and confusion. Those views from the road that reflect blight, disorder, poverty, garish desperation for attention, confusion, abandonment, desolation and such, will adversely affect the motorists' attitude and safe performance. In 1950, Wilbur Simonson, Chief, Roadside Branch, U.S. Bureau of Public Roads, said it as follows:

> One final word on highway safety: Orderly conservation of roadside values is the key to the creation of a pleasant environment for travel. The conservation and control of the highway environment will do much to lessen confusion along our roadsides and thus contribute to highway safety (3, p. 65).

4. To provide barrier between or provide separation from areas generating pedestrian trespass.

5. Control areas of traffic generation and access. Warrants Nos. 4 and 5 are a form of indirect access control. By acquiring control rights over adjacent land before its development, subdivision, and industrial park type developments can be required to provide internal collector streets and to locate their access at the most favorable location. This will also preclude ribbon-type commercial and other development with numerous uncontrolled entrances. The accompanying separation barrier or area then becomes a valuable transition zone. This warrant is most appropriate in locations near urban areas where development is imminent.

6. To preserve or provide vegetation to reduce glare and heat. The acquisition of space for the protection or provision of vegetation to reduce glare or heat is particularly warranted in areas where there are high temperatures and great intensity and percentage of possible sunlight. This factor causes most of the criticism of gunite slopes and concrete retainer walls. Even though high-land value in urban areas is the principal justifier of steep slopes that must be retained with a durable and supporting concrete facing, it is short-lived economy because there is no space to expand the traffic carrying capacity. Either a duplicate parallel facility must be built or a tremendously more expensive (without previous provision for space) rebuilding of the existing one must be accomplished. In rural desert areas full protection and utilization of native vegetation should be made as well as providing occasional oasis-type planting at rest areas and other locations where irrigation is available. The acquisition of space or interests for this purpose is warranted.

7. To preserve, restore or provide attractiveness within motorist's views to stimulate his interest, reduce mental fatigue and improve his attitude. The preservation, restoration or enhancement of the quality of what is within the normal view of the motorist will have the opposite effect of those conditions listed in warrant No. 3. George M. Foster, Chief Deputy Commissioner of the Michigan State Highway Department in 1956 remarked as follows:

> To point up specifically the importance of attractive roadsides in relation to highway safety I have in mind a heavily traveled section of road in our state between Bay City and Standish. It is a thirty mile section having an above-normal accident record. The lands adjacent to the road are so cluttered with roadside vendors, billboards, utility poles and assorted eye sores that the main desire in driving this section is to cover the distance as rapidly as possible. Excessive speed is of course one of the most frequent causes of accidents.
>
> It is my opinion that, other things being equal, there will be fewer accidents along an orderly and attractively landscaped roadside than the one I have just described (6, p. 43).

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> "Overstandardization" of long stretches of mileage should be avoided, otherwise, will not motorists become weary of the sameness of mile after mile of monotonous scenery? Will not the resultant monotony in driving contribute to accidents? ... Is this not a major challenge to the landscape architect to assist the engineer in providing highways pleasing and restful to drive by retaining the maximum variety and interest in planning and design to eliminate monotony and "driver fatigue" (7, p. 40).

In the preceding, Wilbur H. Simonson was addressing himself primarily to great continuous mileage of monotonous tangent. However, the continued static width of forest vegetation or unvarying plateau can cause the same effect.

8. To screen out of view or preclude development of distractions. To provide or control space for the screening, removal or prohibition of distractions would appear to be a paradox of warrant No. 7 wherein the objective is to create interest and attractiveness.

The differences between interest and distraction can be illustrated in the following manner.

Desirable. (a) Object or view is an attractive object or view; and (b) object or view requires only glimpse; effect is conveyed to motorist by impression.

Undesirable. (a) Object or view is an unpleasant attraction; (b) object or view requires the motorist to focus his attention off the roadway for an extended time for reading or other distracting conscious effort; and (c) when outstanding attractions occur, it

is beneficial to capitalize on them by encouraging the motorist to stop at an overlook or turnoff provided for that purpose. While he avails himself of a good look, he is taking an effective rest stop.

9. To control space containing the focal point of tangents and outside of curves that may provide advance warning of turns. By controlling the space in the motorist's forward vision desirable elements may be preserved or created that provide advance warning of roadway directional changes. These areas are also critical for the controlling of glare emanating objects or activities.

10. To provide space for structural protection of roadway and appurtenances. Space required to satisfy these requirements is determined chiefly by drainage conditions. The design and location of these structures should be carefully considered. When created improperly, these structures constitute the great roadside scars and can be traffic obstruction hazards in themselves.

## Utility

Utility is the category of warrants that incorporates and adapts the multiple-use concept for highways.

> For existing roads, rights-of-way are of varied, but fixed, dimensions. In view of the increasing trend toward the greater use of existing roads for purposes other than business [travel] there is a growing awareness of the need for additional right-of-way or other improvements to provide facilities for the pleasure, comfort and convenience of the pleasure drive. Considerable research has been done in this field and some highway and other agencies have established criteria and activated programs of roadside development (2, p. 13).

The warrants of taking for highway utility purposes are to obtain reasonable and adequate space or depth of right-of-way.

1. Roadway—to provide for the highway traffic facility and its appurtenances.

2. Education—to preserve and display natural and man-made objects, features, and areas for the information and education of the public as a highway user. Such objects, features, and areas as best depict the history, culture and physical environment of a region warrant acquisition of space for their preservation and display for the information, education and enlightened appreciation of society. Caution! The security and preservation of many such objects must be provided prior to visual identification or access.

3. Development of amenities—to provide for highway amenities by constructing facilities such as rest areas, scenic and interpretive overlooks and information centers for the pleasure, comfort, convenience and safety of the motorist.

> Within recent years, physical planning has tended to lay increased emphasis upon the environmental objectives of convenience, comfort and pleasantness. These objectives are embraced with the concept of "amenities"—a word which has recently found its way into the vocabulary of planners.... Physical planning to promote the amenities of environment should be aimed both at eliminating annoyances and at developing positive programs to increase living enjoyment (8, pp. 139-140).

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> Today's highway is more than just a facility designed to move cars, commerce, and people quickly from one place to another. It has other purposes. It endeavors to make that trip from "here to there" as safe, as restful, as diversified, and as interesting as possible. It encourages the motorist to use turnouts, rest areas, and wayside parks. It calls attention to historic events and to natural or other phenomena by means of wayside signs, exhibits, or museums, and by creating vistas to points of interest or areas of special attraction (9, p. 47). [Emphasis added.]

4. Recreation—to provide for a more complete recreation experience through motoring and highway use and to obtain and hold space particularly suited for recreational development by the proper public agency.

The current proposal for development of systems of scenic roads and parkways is a response to the findings of the President's Recreation Advisory Council that driving for pleasure is one of America's most widely and actively engaged in outdoor recreation pursuits, that urban and metropolitan growth is increasing the need for and decreasing the open space resources for outdoor recreation, and that substantial economic benefits generated from tourism and sightseeing are made possible by attractive roads and parkways. Application of the highway corridor concept, however, is not limited to roads catering primarily to recreational or pleasure driving. Its validity as an essential element of the planning and design of all highways is based on the universal need to alleviate the severity of the artificial geometric features which have become characteristic of—and, in some respects, a necessary part of—highway design and construction (10, p. 7).

5. Conservation and general welfare—to conserve values such as wildlife, water sheds, soil, timber, unique vegetation, archeological finds, and unrenewable resources for the general welfare of society.

This warrant will seldom occur by itself, but will occur in combination with education and recreation warrants and with beauty and economy categories of warrants (11, p. 17).

Oregon revised statutes define "general welfare" as follows:

366.345. Acquisition and development of scenic places. (1) The commission may acquire by purchase, agreement, donation or by exercise of the power of eminent domain real property, or any right or interest therein, deemed necessary for the culture of trees and the preservation of scenic places and other objects of attraction or scenic value adjacent to, along or in close proximity to state highways, or which may be conveniently reached from or by a public highway. The commission may in like manner acquire land and ground necessary for the development and maintenance of parks, parking places, auto camps, camp sites, roadside development, recreational grounds or resorts, forest or timbered areas or other places of attraction and scenic value which in the judgment of the commission are necessary for the convenience of the public or road user. (2) The commission may develop, construct, improve, operate and maintain the places named in subsection (1) of this section to such an extent and in such manner as will best afford to the motoring public and road users necessary conveniences and accommodations, and as will contribute to the general welfare of the people of the state or the members of the motoring public using the highways of the state. (3) The commission may acquire by purchase, agreement or donation real property, or any right or interest therein, deemed necessary for the culture of trees and the preservation of scenic places and other objects of attraction or scenic value (12, p. 22).

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The concept of the public welfare is broad and inclusive. The values it represents are spiritual as well as physical; aesthetic as well as healthy; spacious as well as clean, well-balanced as well as carefully patrolled (Justice Douglas in Berman v. Parker, 348 U.S. 26, 1954).

## Beauty

The warrants of taking for highway beauty or aesthetic purposes are to provide space to achieve the following:

1. To create beauty;
2. To preserve beauty;
3. To restore beauty; and
4. To enchance beauty.

The creation, preservation, restoration or enhancement of beauty becomes a highway purpose when such actions result in physical, mental, sociological or spiritual highway user benefits. The physical benefits are normally related to health, safety, and welfare.

Dr. Chauncey D. Leake, president-elect of the American Association for the Advancement of Science said in 1959:

Our cities are becoming more ugly, our landscapes more barren, our whole civilization is losing the natural beauty that belongs to all of us in the good regions of the earth. Let's get the trees back to

preserve our watersheds, to give us the oxygen we need to breathe, to remove the carbon dioxide dusts and other poisonous materials from the air, and let's get trees back into our cities to hide the ugliness of the buildings (13, p. 53).

This means simply that for our health we must preserve or provide open spaces with vegetation as a dilutant factor to relieve the toxicities created by a concentrated society. By improving the motorist's attitude, beauty increases his safety, and thus his physical well-being.

One of the early roadside development pioneers summed up the quality of roadside beauty in these words:

A very large proportion of the use of our highways is for the purpose of recreation, and a primary reason for pleasure-touring is enjoyment of scenery. Such scenery is not limited to shoulder slopes and fence lines. The eye takes in the hills, the mountains, the lakes and rivers, the plains and the valleys, sunlight and the shadow of passing clouds, the masses of trees and the stretches of wildflowers (1, p. 26).

***

Some of these effects are, however, intangible and so elusive as to apparently defy calculation. For example, recent writings about the discontent (or, at least, restlessness) over the condition of urban areas in the United States have stressed the probable links between the physical shape and appearance of those areas and the feelings of the public at large about what is happening in and to their environment. They have spoken of the results of both beautification and uglification in terms of intangible results—such as "a sense of identity and security," a "frantic search for novelty," the "seeds of vandalism" encouraged to grow because of the prevalent evidence of lack of respect or affection for non-utilitarian features and facilities, and "pride and love of city from which... good citizenship flows" (4, p. 29).

Because these effects resist calculation by our present means does not impugn their validity. The sociological benefits of beauty are found in the "neighborliness" of highways which can contribute to the reduction of community growth problems.

Another great thing we must be conscious of is improving the appearance of roadside, making it a nicer looking facility. It can be a tremendous asset from the standpoint of the community. We are going to be passing more and more frequently through communities and urban built up areas. There is a fear on the part of the public that these highways will be ugly monstrosities, which will have a deteriorating effect upon their community and their property. We know that need not be so. We know that these highways can be designed and constructed so they will be an asset to a community. The highway can be a green belt; it can be something that the community will be proud of rather than feel it is depressing and deteriorating the land surrounding it (7, p. 33).

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In my discussion last year, I brought out particularly that we must be very concerned and very much interested in creating green belts and in creating attractive roadsides as we develop this new highway system. We must not leave terrible, ugly scars across the landscape of America and particularly as we get into the cities, we must have attractive roadsides so that these highways will be a continuing asset to the community over the years ahead and not a liability. And that is a serious responsibility which we must face up to. We must get enough right-of-way to do the job and even though that will result in depriving the community of a certain amount of ratables or tax duplicate, as we say here in Ohio. Nonetheless, it's a continuing, lasting asset for the community. I don't think we have enough of these green belts. These areas provide light and air through our cities. Here is an opportunity that we must grasp while we have the opportunity to do it (14, p. 43).

Nelson Wells, Director, Landscape Bureau, New York State Department of Public Works in 1957 wrote:

On the other hand, if these roadsides are properly developed or even the triangles and left-over parcels of land which border the normal rights-of-way are developed with a belt of vegetation and

good landscape appearances, they will serve as a buffer between the traveler and the community, and we shall see untold social and economic benefits. Such benefits will continue for generations.

New York City is one of the few places where this kind of roadside development has progressed. Cul-de-sac areas have become miniature neighborhood playgrounds. Dead-ended streets have become attractively shaded sitting places. Rows of trees have somehow survived the reflected heat from pavements and skyscrapers to relieve the artificiality of the city highway (15, p. 44).

At this point the highway user and the highway taxpayer must be separated. There is warrant for the highway taxpayer to acquire "greenbelt" lands to improve the highway environs. However, the community (the highway user) will be the primary beneficiary of the existence and use of such areas. Therefore, it is proper that the highway accomplish the acquisition and improvement, and that the community maintain the improvements and administer the non-highway (throughway) uses of the lands.

This same principle of cooperation has been successfully applied to freeway frontage roads in urban areas.

In deference to the language of the National Act "creating" beauty is synonymous with "restoration" of beauty. In the restoration of beauty, the form that may be appropriate may not be the same as the original. Thus precluding "restoration" as it was before, but creating of a new form as may be desirable or feasible.

## Economy and Economic Purposes

The warrants of taking for highway economy and economic purposes are to provide space for the following reasons.

1. To protect the investment in the highway structural facility. Sufficient space must be taken to protect the investment in the highway facility from the forces of nature, such as flood, fire, slides, ice and snow. Space must be available for the proper location of ditches, dykes, cribs and bank piling, breakwaters, drift fences and stock fences. Stock fences are normally thought of in terms of traffic protection. However, much side hill erosion is caused by over grazing, which has removed the protective vegetative cover.

2. To reduce the cost of maintenance of the highway facility. James M. Usher, Regional Engineer, USFS, wrote in 1957:

> Proper management of adjacent watersheds can materially contribute to the economics of highway design and maintenance. Watersheds in a stable, healthy condition will minimize runoff peaks.... and the movement of enormous quantities of soil, rock, and debris. To downstream highway developments this can mean plugged culverts and washed-out bridges, slides, mud flows, and fill loss and settlement.
>
> In snow country, forest cover on areas adjacent to highways tends to minimize snow drifts and thus reduces the cost of keeping the highway open (16, p. 22).

In brief, the acquisition or control of space adjacent to the highway for economical maintenance is warranted (see standards regarding amount and location of space for this purpose).

3. To reduce future costs of acquisition and acquisition costs. It is economical to acquire lands for projected expansion of the highway facility and its amenities. In an expanding economy, land values are rising. Therefore, when acquiring right-of-way, the space taken will have lower unit value earlier in time than later. This factor, combined with the effect of the new highway service almost automatically raising abutting land values, dictates the taking of sufficient space for reasonable facility expansion as economically desirable and warranted. If this space for expansion is provided originally, the necessity and expense of most additional acquisition is avoided.

4. To prevent urban stangulation and decay. The taking of space for future highway expansion will also contribute to the prevention of urban strangulation and decay.

> With the rapid urbanization of most of Eurpoe and America during the 19th century, there developed an imperative need to build more urban routes. Unfortunately most of the city streets were built without imagination, foresight, or widths of right-of-way adequate for expansion. Many narrow streets now

held responsible for the decay of the central portions of American cities were built during this period (17, p. 77).

This decay causes considerable economic loss to society who is the highway user.

5. To preserve, stabilize and conserve external property and community values. The highway has the responsibility to protect the properties through which it passes from the adverse effects of its presence. These more serious effects in developed areas are the generation of traffic noise and fumes, severance, damage to privacy, disruption of community circulation and drainage patterns, and stimulation of uncontrolled development. In some instances there may be an adverse effect on visual integrity in the form of unattractive structures, land scars and traffic itself.

To fulfill this responsibility, the taking of space to buffer, screen or absorb traffic noise, fumes or visibility with plantings, structures or distance is warranted. Similarly warranted is the taking or control of space to prohibit uncontrolled development. This will improve the environs and efficiency of both the highway and the community. In fringe areas subject to imminent development, the same principles and objectives apply. However, their application is less expensive and their effectiveness is greater if properly planned and administered.

Current interest in development and beautification of the roadside is a sign of Americans' maturing outlook and understanding of their highway system. From the effort to preserve the natural and man-made beauty which is to be seen by the highway traveler, two main lines of benefit result. One group of benefits accrues to the highway itself through more complete achievement of the efficiency, safety, comfort and convenience which planners and designers originally visualized when the highway was laid out. The second group of benefits accrues to the community as a whole by assuring that the highway's influence on its surroundings is not a blighting or divisive one, but rather has an effect of harmonizing the highway with its surroundings and thus stabilizing or enhancing the aesthetic values of the community. Stated most briefly, it might be said the planners, designers, builders and administrators are recognizing that an important part of their work is to achieve a combination of functionalism and amenity in the highway system (10, preface).

In rural areas all adverse effects are minimized by the inherent space except severence and disruption or concentration of drainage. The precedents of relief from these effects are well established.

"Economy" in the roadside development objectives means not only economy of construction, maintenance and operation of highways, but the studied economic impact of highways, lands and peoples. In this regard, John J. Ryan of the New York Department of Public Works said:

The economic effect of a highway on the adjacent area is very important. Suffice to say that a highway with adequate right-of-way and landscaping invites an economic up-grading of the adjacent areas, just as a highway crowded in between buildings and without landscaping invites deterioration, both economic and physical, of the adjacent area (17, p. 78).

6. To conserve and protect internal roadside values. To conserve and protect internal roadside values, it is economically warranted to take or control space to prevent their loss through human or mechanical erosion, negation, or destruction. Existing amenities, whether the view, convenience or comfort facilities, vegetation, soil, water, special features or roadway, must be protected and conserved. In practice, after sufficient space has been acquired:

Those responsible for roadside development in any highway organization have as their role and responsibility the proper and efficient management of the right-of-way. The roadside is many things. It is acres and square miles; ground cover and forests; streams, rivers, lakes and ponds. It is roadside drainage, slopes, walls, barriers and fencing. It is turf plantings, orchards, and wildflowers. The roadside is picnic areas, rest stops, and scenic views. It is that essential area that both separates and unites the highway with its environs.

The view that the motorist sees from the road—both near and far—should be something of value to enjoy and preserve. To conserve the roadside is to demonstrate that every element of aesthetic worth is an enhancement to the safety of the roadway. The collaborative efforts of the engineer and the landscape architect in the planning, design, construction and maintenance of our highways results in safer, more utilitarian, and more aesthetic highways (2, p. 59).

7. To increase highway efficiency. The most serious deterrent to highway efficiency is the random access of uncontrolled roadside ribbon development. With loss of efficiency or "carrying capacity," the highway built for a 20 or 30-yr life suddenly is overburdened in 5 to 10 years, thus depreciating the highway investment. Netherton elaborated:

One has only to drive along a newly completed highway facility, designed to the highest construction standards, enjoying not only the ease of driving, but the peacefulness and tranquility induced by the natural beauty of the undeveloped roadside corridor—pleasant pasture land, groves of trees, a view of a distant mountain, river or lake—then take the same drive, even a year or two later, on the same highway, only to find the pleasant atmosphere completely destroyed by unplanned or ugly development of the corridor. A wide right-of-way and planned development along its borders can prevent this from happening. Cooperation of local governmental units in zoning, subdivision control, and other police power regulations can prevent such unfortunate development, but all too often, although the cooperative spirit is there, these mechanisms fail to achieve the goals anticipated. As Levin (18, p. 7) remarked in 1946, "Objectionable highway ribbon development has failed to arouse popular opposition largely because it has not been a sensational but rather an evolutionary growth. It is a creeping paralysis which spreads so slowly and stealthily that the ultimate consequences and their origin are not associated in the popular mind" (10, p. 60). [Emphasis added.]

"The Art and Science of Roadside Development" reaffirmed the control of roadside use for highway efficiency by stating:

Today, the dynamic qualities of aesthetics and roadside development in the engineering of highways are recognized and given consideration in highway programs. Experience is proving that the requirements of good landscape design, when embodied in highway development, enhance the efficiency of use, and do not usually involve more than normal expense—an expense which is fully justified by virtue of the additional public service thus provided. By harmonizing art and science in modern highway design the present and future value of the highway investment is conserved and protected (2, p. 9). [Emphasis added.]

8. To promote economic growth through tourism. Economic growth through tourism is directly related to highway growth and as Arizona's origin-destination surveys have shown, over 50 percent of highway growth is directly accountable to some form of touring. An oil company recognized this relationship and the role of beauty when it said, "The more beauty, the more travel; the more travel, the more gas." The company removed 1100 large posters and since then has spent thousands of dollars in educational campaigns for roadside beauty. In this vein the experience of the State of Michigan was recounted by Commissioner Foster in 1956 when he said:

In a sense the combination of highways and automobiles have become the means for the recreational pursuits of our people. Being one of the more important tourist states, we, in Michigan, feel the full impact of this type of travel. The tourist business in Michigan is second only to the automobile industry in economic importance to our citizens. This fact, as you might surmise, has influenced our entire concept of highway administration in our state. It has led to the formation of a philosophy of highway improvement programming which takes into account the economic well-being of those areas dependent on the tourist business for a large share of their annual income. To encourage concentration of traffic into new high-type traffic arteries would tend to isolate many of our recreational attractions and act to the detriment of our people in those areas. Roadside development is therefore essential, in proper proportion, to our entire highway system—a system well integrated to give the highest benefit to the most people.

The importance of this tourist business has influenced our highway programming schedule. There is at least one other influence that recreational travel has had on our highway philosophy. It deals with

the welfare of the motorist during the time he is traveling in our state. We take the position that good highways are of course the first requisition. However, we also feel that from a motorist welfare standpoint some opportunity should be made for periodic rest under safe and pleasant surroundings (6, p. 45).

9. To utilize values remaining in old roads. The utilization of values of obsolete roads where through traffic has been rerouted is certainly an economical endeavor. For example, it is a waste not to place suitable unused abandoned tangents in the hands of the state aviation authorities for designation and maintenance as emergency air strips. In 1963, Earl Disque recalled:

Many miles of these older roads do have many years of useful life. There are good reasons why they should be revitalized and continued in use. The old wagon roads, turned highways, generally have the advantage of having highly scenic locations. They were developed to standards which today do not lend themselves to travel at high speed. They followed streams and valleys, generally "on the ground," with relatively easy grades and alignment and shallow cuts and fills. There was little defacement of natural values along the way, and the way often led through towns and hamlets of distinctive character and charm.

...

In the mountains, too, the road was generally "laid-on-the-ground" with a minimum of cutting and filling and a maximum conservation of natural roadside values. Along the way, through the hills, were evidences of living and a way of life in the high country.

Here, then, are a few of the reasons why so many miles of older roads should be revitalized and continued in use: they possess scenic and other natural values, they give a chance for leisurely travel, and they offer an opportunity to observe, to study, and to enjoy the manner in which people lived in the recent past, the way in which they lived, and the nature of the land on which they lived (19, p. 23).

## Propriety

The warrants of taking for highway propriety purposes are to provide or control space for the following purposes.

1. To provide, protect or enhance desirable internal highway relationships.
2. To provide, protect or enhance desirable external, off-highway relationships.
3. To provide, protect or enhance desirable interrelationships between the highway and abutting space.
4. To prevent or minimize detrimental internal highway relationships.
5. To prevent or minimize detrimental external off-highway relationships.
6. To prevent or minimize detrimental interrelationships between the highway and abutting space.

It is warranted that space be taken or controlled for highway purposes that provide, protect or enhance environmental relationships that are appropriate, fit or becoming to the highway. It is similarly warranted to prevent those relationships which are not appropriate, fit or becoming to the highway.

These warrants are the tools of the environmental designer. Without premeditated, enlightened and creative environmental design the "complete highway" will never be complete.

The principles of environmental design are aimed at creating order among its interrelated parts. Natural order exists in the terrain as it was molded by geological processes. The irresistable forces which have shaped and which constantly modify our land forms are too often underrated in our eagerness to prove that technology can conquer all. Interference with or ignorance of the structural order and morphology of the landscape inevitably borrows trouble if the imposition of man-made elements on it is not handled with subtlety and understanding.

Geomorphology produces both regional and local characteristics which give each land area distinctive form and together with its vegetative mantle creates a functional and visual stability necessary to man's physical well being and mental health. The basic forms of natural order are rhythmic and asymmetrical, the alternation of open and closed visual spaces in limitless yet characteristic variety. Na-

ture has a total scalar quality and may be appreciated in the view from a mountain crest or the streambed of a narrow gorge; in the contemplation of a patch of woods or the venation of a leaf (5, p. 50).

Dr. Levin wrote the following in 1962:

The fact is no longer in doubt, that there is a very direct and intimate interrelationship between land use and highway development. There are differences in magnitude and kind inherent in this relationship. At any one point in time, one may be the cause and the other the effect, or vice versa. But the fact remains that today, we cannot consider land use without involving transportation accommodations, or talk about modern mobility without taking land use into account.

Accordingly, we seem to be impaled, as it were, on the horns of a dilemma. For we are in control, more or less, of one of the components of this relationship, but not the other. We have the means—financial, legal, and technical—to deal adequately with the highway improvement. But we are powerless today to control land use development, which, admittedly, profoundly affects the functioning of the highway plant we build (20, p. 48).

Mr. Preston said in 1962:

These routes are the front yards of America. We must have an enlightened viewpoint with regard to aesthetics and beauty and appropriateness on our highways (20, p. 40). [Emphasis added.]

George B. Tobey, Jr., Head, Department of Landscape Architecture, Ohio State University, 1963, described the results of environmental design from the motorist viewpoint as follows:

Thoughtful individuals have often been heard to remark that the average highway user is quite unaware of the highway, other than a means of comfortable, rapid communication between where he came from and where he is going. Further reflection, however, about highway users leads one to believe that, subconsciously or not, a sense of the fitness or the lack of fitness of many highways, is impressed on the traveler's senses.

He may also never have heard the terms: "Land use, environmental ecology," or the four AASHO basic requirements for the complete highway, "utility, safety, beauty, economy," but he's willing to tell his neighbor after a road trip, "Gee, that was a delightful trip," or (and we hope not often) "Don't take that route; it's terrible!"

As intimated, the average motorist may not know why, despite the fact the pavement was excellent in both cases, one highway a pleasant experience, while the other gave him discomfort. The fact remains, these reactions exist, in numbers too great to ignore (19, p. 1). [Emphasis added.]

## Relationships

In "The Art and Science of Roadside Development," the following comment is made concerning right-of-way, scenic areas and adjacent land use:

Once it has been established that a new road is needed, or an existing road must be improved, a development plan must first be prepared. A key element in any development program for a new road is the acquisition of right-of-way. And the most important natural resource in such acquisition is land. Design requirements for new roads call for many acres of land to be withdrawn from agricultural production or other function and maintained simply as part of the highway facility. Seldom does it have any other purpose. A portion of the land is needed for the direct use of traffic. This land is devoted to the pavement, shoulders, median, structures, and drainage ditches. The remainder is considered the roadside and embraces the areas needed to provide transition from the original, natural topography to the topography required for the highway. Under today's concepts, the roadside also may include adjacent areas as they relate to natural beauty. Although the roadside does not contribute directly to the movement of traffic, it is an integral part of the development of a highway as a complete traffic facility (2, p. 12).

The recognition that neither the functional potential of the highway nor its harmonious integration with the environment can be fully achieved if the application of good design and landscape principles is limited to the area of the right-of-way raises the question

of how far out into the adjacent land should the planner and designer look in their work? Pioneer work in developing a sound basis for answering this question was done in 1963 by the Wisconsin Department of Resource Development and Wisconsin State Highway Department in their inventories of the scenic, cultural and recreational resources of their state. In these inventories, it was discovered that the location and distribution of these resources formed patterns which correlated generally with the highway system, so that corridors could be identified, and these corridors, in turn, could be correlated with actual travel patterns. From these findings, highway planners were able to map with reasonable precision the environmental features which presently or potentially are objectives of travel or observation by travelers.

With the tools of environmental design, the designer may match the artificial to artificial, he may transition rustic to modern, he may mix confinement and openness, he may contrast garish and mundane; he may buffer active from passive, filth from beauty, and he may do all these in reverse—to create a conceptual environmental design for the benefit of the highway, the highway user and the adjacent space.

## CATEGORIES OF APPLICATION

The categories of application for the stabilization of the highway environs are preservation, restoration, enhancement, development and development control. These categories may be illustrated as follows:

1. If the environs are good, keep them good by preserving them—preservation.
2. If the environs are damaged or deteriorated, improve them by restoring them—restoration.
3. If the environs can be made better by physical treatment, treat them—enhancement.
4. If the environs are needed for usable construction, develop them for use—development.
5. If the environs are in danger of undesirable development or if development of a certain character is desired, control the development—development control.

With a liberal interpretation of enhancement, the development category could be eliminated. However, for the sake of clarity, development will be indicated as a separate category of application. Insofar as the interest to be acquired is concerned, restoration and enhancement may be combined and designated "landscape improvement." These applications may be warranted singularly or in combination with each other in varying degrees of prominence as conditions indicate.

It is most likely that preservation will occur singularly more frequently than any other category. By its nature of being a stabilization category, it will usually be applied to the improvement categories of restoration and enhancement.

An example of the application of preservation would be the acquisition of rights over space containing desirable elements in view or otherwise affecting the highway; e.g., buffer zones, beautiful views, interesting or educational features.

An example of restoration would be the acquisition of rights over space containing undesirable views, or other elements affecting the highway, for their removal or correction; e.g., dumpgrounds and drainage problem generators.

An example of enhancement would be the acquisition of rights over space having elements of actual or potential value to the highway by the application of physical treatment to existing features; e.g., selective clearing or thinning of vegetation, painting structures, turfing, and reforestation.

An example of development would be the acquisition of rights over space having actual or potential benefits to the highway that can be achieved by placing or constructing objects thereon; e.g., rest and recreation areas, drainage control structures, visual screens, and sound baffles.

An example of development control would be the acquisition of rights or interests in land, developed or subject to development by its owner for noncompatible uses. Through the application of development control restrictions, only that development that is compatible or desirable within the highway corridor would be allowed.

## CRITERIA FOR IDENTIFICATION

Concerning criteria for identification of parcels for taking of interests in land for highway purposes, J. J. Dukemenier, Jr., wrote regarding aesthetic criteria in 1955 that:

> The cry for precise criteria might well be abandoned because it does not make sense. Beauty cannot be any more precisely defined than wealth, property, malice, or a host of multiordinal words to which the courts are accustomed. Planners can give reasons for saying a particular arrangement of objects in the environment is beautiful based upon perspectives common in high degree among the people in the community, but they cannot prove it, and proof which is unattainable should not be demanded. What is needed is to decide that whether beautiful can be used in an intelligible manner by planners is not a foredoomed search for precise criteria for its correct employment, but rather a clarification of some of the operations indicating how the general public and planners use the word and an evaluation of these operations by reference to community goals.
>
> In the long run, it has been suggested, what the public acclaims as beautiful and harmonious provides planners and lawmakers an operational index of what is beautiful and harmonious as far as land use in the community is concerned (4, pp. 21-22). [Emphasis added.]

The possibility of precise, definable criteria for this specific purpose (highway aesthetics) is probably not as dim or illusive as described by Mr. Dukemenier. Its definition may not be as direct as would please some. However, this does not disqualify its existence.

The criteria for identifying space adjacent to highways that is warranted to take rights thereto for highway purposes are affected by purpose and accompanying warrants, abutting land use and application. Because of the great number of possible combinations it would be cumbersome to project and describe each. Therefore, a check list of the most prominent factors is provided.

When this check list is knowledgeably applied to the selection and measurement of parcel qualification, patterns and gradations of qualifications will emerge. When these grades are studied in combination with other factors such as administration and fund resources priorities of acquisition will result and thus the program is defined.

Criteria are standards of measurement and are thus synonymous. For this study, the section on standards shall contain guides for the selection of the parcel boundaries which are expressed by size and shape and location.

As a matter of reader interest, the features listed in the literature as desirable roadside elements are as follows:

Natural Features

Topographic
- Mountains
- Hills
- Ridges
- Mountain peaks
- Panoramic balconies
- Bluffs
- Vistas
- Rock out-cropping
- Geological exhibits
- Canyons
- Escarpments
- Dunes

Water
- Lakes
- Streams
- Rivers
- Ponds
- Sea shores
- Lake shores
- Stream shores
- Cascades
- Waterfalls
- Swamps

Vegetative
- Forests
- Forest floors
- Meadows
- Trees
- Shrubs
- Grasslands
- Vines
- Groves
- Wild woods
- Wooded areas
- Flowers
- Reeds
- Rushes

Fauna
- Wildlife and game refuges
- Wildlife habitats

Man-Made Features

Historic
- Historic sites
- Military encampments
- Archeological exhibits
- Plaques
- Mile stones
- Historic buildings
- Historic roads and trails

Cultural
- Agricultural exhibits
- Cotton, sugar cane and other field crops
- Farm houses, barns
- Orchards, hay stacks, pasture lands

Buildings of architectural value
- Church steeples and indigeneous architecture of a period or culture

Buildings of civic value

Engineering achievements
- Dams, locks, levees, bridges, old bridges, reclamation projects

Commercial exhibits
- Boats, barges

Industrial exhibits
- Mines and other spectacular industrial activity

Recreation areas

Villages

Scientific phenomena

This listing gives an indication of things to look for along our highways. However, these objects may or may not be desirable roadside elements. Their desirability depends on such things as condition and location. The village at the foot of the overlook may be very charming, but the same village placed on each side of a highway could strangle the highway and expose negative visual impacts.

The agricultural field choked with weeds and cluttered with abandoned equipment could be very depressing. A mountain side scarred with pipe line and power line installations evidences the rape of a landscape. A spectacular industry may be an informative attraction or a distractive nuisance.

Those features found listed in the literature as undesirable roadside elements are the following:

Utility lines
Billboards
Junk and salvage yards
Garbage dumps
Borrow pits (improperly located and unrestored)
Factories (certain types)
Service areas
Residential and commercial slums

It has been suggested that the placing of new highway corridors through residential and and commercial slums be used as an instrument of urban renewal.

The check list embodying criteria is as follows:

CRITERIA CHECK LIST

FA ROUTE NO._____ OTHER ROUTE NO._____ MILE POST_____ . _____ R LM
OR ROUTE MILE

1. DESIGN PURPOSE (WARRANT)
_____Safety _____Utility _____Beauty _____Economy _____Propriety

2. URGENCY OF ACQUISITION
1_____Immediate 2_____Soon 3_____Program

3. EFFECTIVENESS OF APPLICATION
1_____High 2_____Medium 3_____Low 4_____Doubtful

4. DURABILITY OF APPLICATION
   1_____High 2_____Reasonable 3_____Problematical
5. QUALITY OF PARCEL (POSITIVE-NEGATIVE)
   1_____High 2_____Medium 3_____Low
6. TRAFFIC VOLUME
   1_____High 2_____Medium 3_____Low
7. TRAFFIC TYPE
   1_____Tourist 2_____Mixed 3_____Non-Tourist
8. PROXIMITY TO POPULATION
   1_____Close 2_____Intermediate 3_____Far
9. POSITIVE VISUAL IMPACT
   1_____Exceedingly 2_____High 3_____Medium 4_____Low
10. NEGATIVE VISUAL IMPACT
    1_____Exceedingly 2_____High 3_____Medium 4_____Low
11. POTENTIAL FOR IMPROVEMENT
    1_____High 2_____Average 3_____Low 4_____Not Applicable
12. REST AND RECREATION AREA POTENTIAL
    1_____Very Good 2_____Good 3_____Fair 4_____None
13. LEGAL JUSTIFICATION
    1_____Yes 2_____Doubtful 3_____No
14. ECONOMIC FEASIBILITY
    1_____Feasible 2_____Difficult 3_____Not Feasible
15. POSITIVE ECONOMIC IMPACT
    1_____High 2_____Moderate 3_____Nominal
16. NEGATIVE ECONOMIC IMPACT
    1_____High 2_____Moderate 3_____Nominal
17. INTIMACY OF PURPOSE
    1_____Highway Purpose 2_____Multiple 3_____Non-Highway Purpose
18. EXTERNAL HARMONY
    1_____High 2_____Not Applicable 3_____Conflicting
19. SOCIAL GAIN
    1_____High 2_____Medium 3_____Low
20. GEOMETRIC SUITABILITY
    1_____Favorable 2_____Acceptable 3_____Unfavorable
21. CORRELATION WITHIN ROUTE
    1_____Excellent 2_____Good 3_____Fair
22. QUALITY OF CORRIDOR
    1_____Outstanding 2_____Superior 3_____Average 4_____Poor
23. COMPATABILITY FOR INTERPRETATION
    1_____Yes 2_____Can be made so 3_____No 4_____Not Applicable
24. EXPECTED MAINTENANCE COSTS
    1_____Low 2_____Medium 3_____High
25. EXPECTED HIGHWAY LIFE
    1_____30 years 2_____20 years 3_____10 years 4_____Abandoned
26. ACCESS CONTROL
    1_____Yes 2_____No

Discussion of Criteria Check List

1. Design Purpose or Warrant:

Example: The reforestation of an abutting hillside might be done primarily for economy of maintenance with accompanying side effects of enhancing beauty and providing wildlife habitat or utility. The form would be marked as follows:

_____Safety __3__Utility __2__Beauty __1__Economy _____Propriety

With all other factors equal, the greater the number of design purposes involved indicates the greater potential benefit from the acquisition.

2. Urgency:

The urgency factor denotes the incipient perishability of the considered roadside value.

3. Effectiveness of Application:

Probable (anticipated) effectiveness of application is illustrated as follows:

If the clean-up of a disposal area is being considered, and that particular area is the only blight on that section of highway, its removal will certainly be effective in enhancing the route.

If, on the other hand, the entire adjoining route is "trashy" the removal of one such blighted area will scarcely be missed; i.e., the effectiveness of application of enhancement is nil.

Similarly, a buffer area considered to forestall the clash of ribbon development with the highway and such development never occurs, the effectiveness of the application of preservation is reduced or nullified.

4. Durability of Application:

Durability of application is the expression of possible change in the need or form of controls or treatment considered for application over a particular space.

5. Quality of Parcel:

This is the expression of relative merit of the parcels' characteristics in its total degree of warrant.

6. Traffic Volume:

Traffic volume can be expressed in terms of hourly, daily, or annual traffic, as well as in the more general terms of high, medium or low traffic. In the design of scenic strips the general terms are sufficient.

7. Traffic Type:

Traffic type denotes the class of viewer of the roadside corridor. This varies from the commercial traffic through mixed commercial and tourist to that traffic that is mainly engaged in some form of recreation touring.

8. Proximity to Population Centers:

This measures the potential of "the greatest good for the greatest numbers" factor.

9. Positive Visual Impact.

10. Negative Visual Impact:

The visual impact upon the motorist is an important factor in a scenic enhancement program. In a normal highway program, however, it becomes just another

consideration in the complete highway concept. It is to be recognized that there are both positive (good, beneficial, upgrading) visual impact, and negative (bad, deleterious, downgrading) visual impact. The higher the rating in either the positive or negative visual impact, the greater is its conformance to the criteria for scenic preservation and enhancement. As W. F. Cron wrote in his "Seven Principles of Highway Landscaping":

> Where eyesores exist outside the right-of-way, increase the normal width to provide room for screen planting. Where good views exist, increase normal width to protect these views (21, p. 24).

Some of the factors considered by the highway landscape architect or environmental planner in measuring positive, and sometimes negative, visual impact are the following:

Uniqueness
Distance from viewer
Duration of experience
Contrast or variation of scene
Climax point
Scale of details
Size
Frequency and progression of focal points (dynamic flow to moving viewer)
Blending or transitioning
Continuity, relatedness, harmony
Coordination with geometrics
Shape, form
Vividness of color
Landscape character
Psychological reactions (viewer self-identification with surroundings, symbolism, parallelism)

Just what is highway aesthetics? The dictionary defines aesthetics as "the branch of philosophy dealing with beauty or the beautiful, especially in the fine arts." Three aspects of highway aesthetics are generally recognized. The first of these concerns the views outward from the highway. The second concerns the relationship of the highway to its surroundings—how it fits into the landscape of which it is a part—and the third concerns the appearance of the road itself as a work of man, irrespective of its surroundings (22).

Bradford Sears wrote in 1964:

> Alternations between confinement and spatial freedom offer great opportunity for dramatic visual contrasts. The excitement of bursting from a constricted view into a spacious one increases the impact on the new scene. Sometimes these occur automatically because of natural topography features, but usually the effect is created, sometimes purposefully, more often accidentally (23, p. 57).

The California "Scenic Route" guide reports regarding aesthetic judgment:

> No exacting specifications can be established for the delineation of corridor boundaries, nor can they replace the judgment of trained and experienced persons from State and local agencies, private firms, and citizens. These criteria only form bases on which to formulate a judgment.

### 3.1.2 Angle and Duration of Vision

Passengers have a generally wide sweep of vision offered by modern cars, oriented in the direction of travel by the seating arrangement. The driver, however, must operate within a relatively narrow cone of vision centered on the roadway ahead, with a limited impression made by his peripheral vision of lateral objects. The angle at which certain areas and features of the landscape may be seen from the highway, in both direction of travel, the foreground features framing them, and the period of time during which they can be observed will bear on the delineation of the corridor.

Consequently, design speed and geometrics of the highway, and the existence or possibility of roadside rest areas and vista stations, must be taken into consideration. The scenic highways should provide the motorist with a total and continuous, though varied, visual experience. This continuity should be accomplished by an uninterrupted corridor (24, p. 13).

In 1957, Earl A. Disque said, concerning the visual impact created by selective thinning of vegetation:

A discussion of the selective removal of vegetation from roadsides should revolve around two points of view, that of the driver of a car and that of his passenger. No attempt is made here to describe or explain the principles and interrelationships of philosophy, psychology, and human behavior as they relate to highway design and construction. These are subjects gaining in recognition and in application. It should be sufficient to state that the occupants of a vehicle generally are pleased with and grateful for the use of any principles or devises employed by the highway and landscape engineers in the design and construction of a road that have made the task of driving safer and more pleasant, even though the driver and passenger may not be able to indicate or describe exactly what it is that has caused driving to be less of a chore (9, p. 45).

11. Potential for Improvement:

This means "Are the features necessary for the considered improvement present and suitable?" Effectiveness of application measures the degree of expected improvement possible.

12. Rest and Recreation Area Potential:

This factor gages the quantity and quality of features available for public use and enjoyment. However, it should not be confused with "potential for improvement." This applies only to rest and recreation facilities and potential for improvement is applicable to restoration and enhancement work.

13. Probable Legal Justification:

This is included to remind the designer of the criteria for legal justification in the selection of space for acquisition.

In the simplest terms, the constitutional validity of state or federal laws which regulate the use of private property in favor of roadside development and beautification depends on the reasonableness of the legislature's action in this context. If a reasonable (i.e., real and substantial) relationship exists between objective, means and public need, the requirement of due process of law, as it applies to the substance of the regulatory legislation is satisfied (4, p. 18).

14. Economic Feasibility:

Economic feasibility must be determined for the projection of an acquisition program.

It would be necessary to protect the quality of the landscape as seen from the proposed parkway. Marginal strips of wildwood, bluff faces, swamps and islands, would be acquired outright and added to the right-of-way. Such lands are generally inexpensive and are best preserved for public purposes. Many of these areas should remain permanently undeveloped in order to provide refuge for wildlife, to further conservation of the soil and to give man a bit of unspoiled breathing space.

Outright purchase of the farm scene, wide-spread through the valley, would not be necessary. Instead, scenic easements or reservations would be sought, averaging 300 feet in width along both sides of the construction right-of-way. There would be purchased from the owner only his right to convert certain parts of his farm land to residential or commercial uses. While he could not add new houses or erect billboards, paralleling pole lines, or other structures, he would continue to exercise all other privileges of ownership and in no way would be restricted in his agricultural pursuits. Neither would the public have any right to enter upon these lands for any purpose. This method of scenic conservation should result in large savings over outright purchase, retire less farm

land from the tax rolls, and attach the pastoral views permanently to the parkway without cost to the public for maintenance (7, p. 10).

* * *

On the other hand, since they entail fund expenditure and possibly some improvements and maintenance, the total of any section of highway must be kept within practical limits. The total of the program for which the estimate is to be made should be a studied effort considering all of the outstanding scenic strip possibilities along each route. Through comparison analyses and ratings, those possibilities along the route that are marginal in value, those that are inordinately costly, and those that otherwise are not good "buys" for scenic enhancement purposes should be successively eliminated until a practical attainable program remains (25, p. 27).

15. Positive Economic Impact.

16. Negative Economic Impact:

Economic impact upon adjacent lands is self-explanatory. This applies only to the lands adjacent to the space being taken or controlled. It does not apply to the lands being taken or controlled.

17. Intimacy of Highway Purpose:

Intimacy of highway purpose is used to gage the degree of relationship existing between the considered acquisition and the highway. Examples and solutions are suggested by these statements:

As a practical matter, it will not be possible, or in the public interest to effectively screen all unsightly roadside areas. An example would be an unsightly area on a natural slope or in a valley in rolling and rough terrain. By any practical treatment within or closely adjacent to the highway, it is virtually impossible to blot out the view of such areas from the highway. Other cleanup programs are needed for such cases, outside of highway programs (26, p. 4).

* * *

Conservation of historic buildings, monuments, gardens and other man made features of interest and educational value should be preserved whenever possible in locating a new highway. If partially within the right-of-way, they may be transferred to the appropriate agency to operate and maintain (27, p. 4). [Emphasis added.]

18. External Harmony:

External harmony is the measure of relationships between normally off-highway elements, additions, or improvements.

An ecological unit is often destroyed when parts of it are encroached upon or damaged. The integrity of such unit, and the flora and fauna constituting its scenic value, should be preserved by including all of it in the corridor where feasible, regardless of the visibility factor (24, p. 22).

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This seems to suggest that what makes an object beautiful in the eyes of the law, should be no different than what makes it beautiful in the eyes of any other beholder, and that the chief reference point for making a judgment is the context in which the object is placed. In this respect, the focal point of judgment cannot be exclusively in the object judged or in its environment; the focus must be on the results of placing the two in combination with each other. Thus, the U.S. Supreme Court's remark about a "pig in the parlor rather than the barnyard," in Euclid v. Ambler Realty Co., was not meant as a judgment of either pigs or parlors as such, but of the two in combination. And so aesthetic judgments regarding roadside zoning have to be made in terms of the design character and function which is desired for the highway and the roadside corridor through which the highway runs. The judgments which are made in the case of an express-way or urban arterial thoroughfare will obviously be different than in the case of a carnival midway or of a shopping street (272 US 365, 388, 1926).

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By applying methods of formal aesthetic analysis, a distinction between the internal and external harmony of the highway can be made. The former concerns the roadway as an abstract ribbon in space. The latter concerns its relationship with the environment. Some relevant criteria to judge internal harmony are continuity of alignment, three-dimensional coordination and harmony of enclosed areas. Some relevant criteria to judge external harmony are integration with the macroenvironment and the microenvironment, definition of elements, and frequency and progression of focal points (28, p. 89).

19. Degree of Social Gain:

Degree of social gain measures the impact, value and benefits to the community, i.e., society in general. These values may or may not be directly related to highway benefits.

The aesthetic relationship of the highway to its surroundings must take into account social as well as physical factors. Social environment is as closely related to visual values as it is to highway economics and technology (2, p. 11).

20. Highway Geometrics:

Highway geometrics are a consideration of visual impact. However, because of their relationships, such as facility access, it is appropriate to list them separately. Rex Whitton, former Federal Highway Administrator, said:

And above all, we must do a good job. We have got to do a creative job and it must be geared to the dynamic flow of the landscape viewed from the automotive vehicle. We must coordinate with highway geometrics; we must be practical and down to earth. If we can do that, gentlemen, we will continue to have beautiful and creditable landscapes along the highways of America (7, p. 35). [Emphasis added.]

21. Correlation With Other Parcels:

The correlation with other parcels factor is the expression of the degree of conformance with the ideal scenic design for the route.

22. Quality of Corridor:

The quality of corridor is used as a plateau or beginning point from which to measure other factors; i.e., an area with high visual impact within a high-quality corridor will in itself be more significant and desirable than an area with high visual impact in a low-quality corridor.

23. Compatibility for Interpretation:

Turnouts shall be provided as suitable locations affording historical, agricultural, industrial, or scenic views. These turnouts shall be considered as highway facilities and maintained as such. Vistas shall be cleared to embellish scenic views. Where the provisions of these facilities require a work agreement with adjacent property owners, such agreements or required additional right-of-way shall be obtained by negotiation and normal right-of-way procedures.

24. Expected Maintenance Costs:

This measures the future expense of acquired usage or interests in the parcel being considered so that those parcels with obviously high upkeep can be correctly evaluated against the highway warrant.

25. Highway Life:

Highway life is a different expression than durability of application. With highway life, durability is dependent on the longevity of the route. Durability of application

is determined by the expected life of the warrant provided the route remains unchanged.

26. Access Control:

Access control affects certain administrative and design considerations. It also concentrates development pressure at interchange access points.

In addition, to those relating to the parcel, the highway and its traffic, there are a multitude of factors that may be grouped under administrative considerations. These may be state highway or U.S. Bureau of Public Roads policy and procedures, or they may be connected to the ownership of the parcel.

Administrative considerations are those that are necessary for the operation of a program but do not necessarily have any bearing on the idealistic achievement of the objectives of a scenic enhancement program. Examples might be as follows:

1. There is not to be Federal-aid fund participation in work to develop or construct facilities for active recreation practices, such as areas for overnight camping, boat launch ramp areas, hiking trails, swimming facilities, etc. Such facilities are not to be permitted on the interstate system (29, p. 11).

* * *

2. a. Those roads that were proposed to be scenic roads under the Scenic Roads and Parkways study conducted in 1965 and are part of the Federal-aid Secondary System should be re-examined to determine if the proposed work on such secondary roads fits the concept of landscaping and scenic enhancement and should be included in this estimate.

b. Those Federal-aid secondary routes having sections which approach or are in an urban area, should be further valuated for additional appropriate work.

c. Those other Federal-aid secondary routes having sections which have unusually high scenic beauty values, carry large volumes of traffic, and otherwise warrant landscaping and scenic enhancement, including the development of rest and recreation areas and scenic overlooks, should be further evaluated for additional appropriate work (25, p. 3).

* * *

There is a danger, however, that this program could fall far short of its great potential through a standardized or unimaginative approach to the problem. Unfortunately, imagination and freshness of approach are always in short supply, especially in any large operation. Worthy policies, pronounced at the highest administrative levels as useful guides, are not only inappropriate at times for local conditions, but also have a habit of becoming encrusted, inflexible articles of faith at the operational level, with few technical personnel willing to strive for new interpretations. Thus, the specifications for the construction of scenic roads may come right out of the standard engineering manuals, with little heed paid to the nuances that distinguish one landscape from another. Indeed, in some areas, the uncritical application of a "ready-made" scenic road could even destroy much of the scenic character it is supposed to preserve and make accessible to the motoring public (30, p. 582).

## PRIORITY

Priority is the relationship of one factor, object, or occurrence to another in ascending or descending order within a designated system of value or importance. It must be recognized that a system of priority of acquiring scenic strips, additional rights-of-way or interests in abutting lands is predicated upon the existing administrative structure for the highways.

The present structure is based on the class of major highway systems. These systems are the Interstate and the ABC systems. Those systems commonly known as the ABC system are the Federal-Aid Primary (FAP), Federal Aid Secondary (FAS), and their urban extensions. We are also concerned with the state non-Federal-aid roads.

There is normally a difference in usage between the primary and secondary system and there is a great difference between the ABC systems and the Interstate. A system of priority based solely on the highway system class would be in direct conflict with the opportunity and need for application of scenic strip acquisition.

As was indicated by the scenic highway study and the inventory of scenic strips, there are more scenic resources on the secondary system than on the primary and there are more on the primary system than the Interstate. However, the Interstate System carries more traffic on fewer miles and is a higher standard facility than the ABC systems. Except at interchanges the limited-access feature does reduce the urgency and effectiveness of application.

## Criteria and Priority Factors

Because of this conflict between usage and the opportunity and need which parallels the system class and because of the desirability of a balanced program for all systems, it is recommended that a system of allocating funds be established that assures equitable application on all systems.

Thus priorities can be established relating similar highways with one another. We must compare factors with a common denominator; i. e., apples to apples and oranges to oranges, not apples to oranges.

This division of funds between the systems could be based upon dollars, acres or miles. It is suggested that on the average, miles and acres along one system will generally have the same unit cost as along another. Therefore, the division of dollars seems most feasible and equitable.

Another factor to be considered is the "catch-up" program on existing routes and the program for future routes and construction. It is suggested that funds and projects for catch-up application be divided as follows: Interstate, 50 percent; and ABC, 50 percent.

The ABC proportion funds would then be further divided as provided for the allocation of regular funds with FAP receiving 45 percent; FAS, 30 percent; and urban, 25 percent. Those funds not used for the urban extensions would revert to the secondary system, or proportionally to the needs of both the primary and secondary. It is suggested that the funds for future construction and routes be divided on a direct ratio to the construction allocations.

It is impossible to predict the rate of fund allocation to the states for scenic strips. It is hoped that they will be available at a rate sufficient to complete the catch-up phase within no more than 10 years and to provide simultaneously for current construction needs. These considerations are predicated upon legislative and administrative determinations and are beyond the scope of priority.

Generally, the relative priority designation is a function of conformance to the criteria. The parcel with the greater degree of conformance receives a higher priority rating than one with less. However, because of the variance of application to the parcel, all parcels cannot be judged by simple mathematical formulas. Some criteria factors must be more heavily weighted than others. Also certain factors may be absent or not applicable to all highway purpose applications (preservation, restoration, enhancement, etc.). Therefore, as with the initial selection of parcels, the assignment of priority between similar parcels becomes a matter of judgment based on criteria guidelines.

The following are the criteria factors most frequently used in the selection of parcels. They are arranged in descending order of usual importance. This order may be varied for unusual conditions.

*1. Warrants
2. Urgency
3. Effectiveness of application
4. Durability of application
5. Quality of parcel
6. Traffic volume
7. Traffic type
8. Proximity to population
9. Positive visual impact
10. Negative visual impact
11. Potential for improvement
12. Rest and recreation area potential
*13. Legal justification
*14. Economic feasibility
15. Positive economic impact on adjacent lands
*16. Negative economic impact on adjacent lands
17. Intimacy of purpose
18. External harmony

19. Social gain
20. Geometrics
21. Correlation with other parcels
22. Quality of corridor
23. Compatability for interpretation
*24. Expected maintenance costs
25. Highway life
26. Access control

*Could be a disqualifying factor by itself.

Again, it is not presumed that these factors are all that might be concerned, but are those that most parcels will have in common. For example, in the actual acquisition program, the public or no-cost lands and interests will probably be acquired as rapidly as the application can be made and approved without regard for priority. Their priority should be considered, however, for the development and restoration-enhancement (improvement) phase.

These factors were rated as shown on the criteria check list sheet, numerically coded in descending order of importance or value. If all parcels for all purposes could be judged equally on all factors, the lowest resultant code number would designate the highest priority. However, the variables do not allow such a simple determination. The factor rating numbers do aid in making parcel comparisons and help to define its character.

For the purposes of this study, parcels were established as separate parcels for each roadway side or median and not to exceed ten miles in length. In establishing priority, all continuously joined parcels of similar purpose or character should be rated alike or in a group. Similar parcels on opposite sides of the roadway should also be grouped together for acquisition as one protects the value of the other.

## INTERESTS AND RESTRICTIONS

The interests taken and the restrictions applied comprise the core of this program. Those interests and restrictions can only be determined after thorough study of each parcel, its relationship to the roadway, and the warrants for taking. Depending on the category of application, the landownership class, present and protected land use and original warrant, the interest may be in fee, by positive easement, negative easement, a combination of positive and negative easement, use permit, grant, interagency agreement, or a combination of any or all means of acquiring the desired interest.

Experience shows what interest and means are best suited to specific application situations. The experience gained on our national and state parkways has indicated certain guidelines that are helpful in avoiding some of the more common pitfalls. It is appropriate to reiterate that the warrants for taking interests in abutting land are safety, beauty, utility, economy and propriety.

The categories of application are: preservation, restoration-enhancement, development and development control. Restoration-enhancement are combined because they are both facets of improvement and require acquisition of the same interest.

The landownership classifications used are private, quasipublic, and public.

Insofar as acquisitions of interests in private land are concerned, they will all be considered the same. However, the quasipublic (private utility lands and Indian Reservations) must be considered in the light of their function and legal status.

Interests and restrictions on public land must also be designed to accommodate the administrative position of the landholding agency. Different means must be used to acquire the desired highway interest on U.S. Forest lands, Bureau of Land Management lands, National Parks, Military Reservations, State lands, State School Trust lands, county and municipal lands, etc.

It is mandatory that the sovereignty of the highway administrative agency over the highway corridor be acknowledged by all other public agencies and that the warrants be fulfilled by universal application throughout the entire highway system without undue regard for artificial administrative boundary lines. (This is not to be confused with specific parcel boundary line selection.)

Restrictions must be designed to accomplish and maintain the highway purpose for as long as that purpose is warranted. Therefore, it is desirable to include provision for

TABLE 1

| Principal Land Ownership Class | Preservation | Restoration-Enhancement | Development | Development Control |
|---|---|---|---|---|
| Private | Negative easement or fee with entry to maintain | Combination easement with entry to maintain | Fee | Negative easement with penalty to enforce regulations |
| Utility | Combination easement with entry to maintain | Combination easement with entry to maintain | Relocation agreement | Negative easement |
| Indian | Negative easement grant agreement with entry to maintain | Positive easement grant with entry to maintain | Easement grant for use | Easement grant, also encourage reservation plan adoption |
| USFS | Agreement with entry to maintain | Positive easement use permit with entry to maintain | Use permit | Special use permit |
| USBLM | Negative easement with entry to maintain | Positive easement with entry to maintain | Grant decision | Easement grant for deed restrictions in case of sale |
| MIL. RES. | Agreement with entry to maintain | Positive easement with entry to maintain | Easement for use | Agreement |
| National Park | Agreement to protect corridor in case of abandonment | Not applicable | Not applicable (Right-of-way from National Park Service is obtained by special use permit) | Not applicable |
| Bureau of Recreation | Negative easement with entry to maintain | Easement with entry to maintain | Easement for use and public entry | Agreement or negative easement |
| *State lands | Negative easement with entry to maintain | Positive easement | Easement for use | Negative easement |
| *State school and institutions | Negative easement with entry to maintain | Positive easement | Easement for use | Negative easement |
| County | Negative easement with entry to maintain | Positive easement | Fee or easement for use | Negative easement |
| Municipal | Negative easement with entry to maintain | Positive easement | Fee or easement for use | Negative easement |
| State park | Agreement | Positive easement | Agreement | Agreement |

*The granting of interests in state land is being litigated in the U.S. Supreme Court. The State Land Department is presently only giving the state highway department right-of-entry and a gentlemen's agreement to administer lands as per the highway department's request.

review of these interests periodically as highway life and projected change in abutting land usage indicate. These periods should range from ten to thirty years for most interests.

At the time of their review, the interests may be abandoned, renewed, or strengthened as the then existing conditions dictate.

The category of application is the prime designator of the interest to be acquired. Table 1 gives the most feasible interests and means for the different categories.

## Negative Easement or Agreement Restrictions

### Prohibited Uses

1. The present use of the restricted areas by the grantor shall remain unchanged unless a written permit is issued by the grantee.
2. No material that is considered unsightly or offensive by the grantee shall be dumped on the restricted areas.
3. The restricted area shall not be subdivided without the written approval of the grantee.
4. No buildings or utility structures may be erected upon the restricted area except for farm or residential purposes.
5. New building construction or major alterations to existing buildings shall have prior approval of the grantee.
6. No commercial buildings shall be constructed upon the restricted areas except with prior approval of the grantee; existing structures may be altered or the property may be otherwise improved for the purpose of continuing the established use.
7. No mature or stable tree, shrub, cactus, or other plant shall be removed or destroyed on the restricted area, except such seedling plants as may be removed in accordance with good farm practice or grounds maintenance operations, and except that cultivated crops and orchards may be pruned, sprayed, harvested, and otherwise maintained in accordance with good cultural practices and except as may be required for reasons of drainage, sanitation and disease control.
8. No dump of ashes, trash, construction waste or salvage, sawdust, slashings, obsolete appliances or equipment, or any unsightly or offensive material shall be placed upon the restricted areas.
9. No sign, billboard, or advertisement shall be placed or displayed upon the restricted areas, except one sign not greater than 18 by 24 in. advertising the sale of the property or agricultural products raised upon it.

10. No part of the grantor's remaining and adjoining property, within 500 ft of the lands herein conveyed shall ever be used for the placing and/or maintenance of advertising signs, bills, or posters.

11. No quarrying, mining of gravel or other nonmineral material, cutting or uprooting of trees, shrubs or cacti, stripping of topsoil or over burden, and other practices detrimental to the scenic value shall be allowed on the restricted areas.

12. No new construction or enlargement of existing utility shall be allowed in the restricted area except for major transmission lines requiring a crossing over the highway. Such crossovers must have the prior approval of the grantee and cross the restricted areas and the highway in the shortest possible distance.

13. No utility lines shall be constructed or maintained in the restricted area.

14. No utility lines shall be constructed or maintained in the restricted area without prior approval of the grantee.

15. No more than one access point will be allowed to the highway from the restricted area. Said access location shall have prior approval of the grantee.

16. The grantor shall not cut or harvest any trees or timber except those designated by the grantee and any such activities allowed shall be done as directed by permit from the grantee.

17. No use or occupation other than the hereinafter permitted use shall hereafter be established or maintained within or upon the restricted area.

18. No commercial or industrial use shall be permitted in the restricted area except that upon written approval of the grantee, certain commercial traffic service uses may be allowed.

19. This easement includes the right of the State of Arizona and its agents to enter upon the restricted area only for the purpose of inspection and enforcement of the terms of this easement.

20. Any damage to the natural beauty or appearance within the restricted area shall constitute trespass of state property.

Sample Positive Provisions

Permitted Use

1. The grantor reserves the right to continue to use the restricted area in any manner not inconsistent with the described terms and conditions, and further reserves the right to continue any use not heretofore specified.

2. The grantor reserves the right to develop the restricted area for low density residential use in cooperation with the grantee, to preserve the scenic values for the benefit of the highway traffic.

3. The conditions of this easement shall not prevent any permanent excavation for the purposes of the permitted use.

4. The grantee or its agents may from time to time enter upon the restricted areas for the purpose of doing any and all things considered necessary by the grantee to improve, enhance, restore, preserve, and protect for scenic purposes, the natural beauty of the restricted areas.

5. The grantee or its agents may enter upon the restricted areas for the purpose of _____.

Sample Combination Provisions

1. This easement does not grant the public the right to enter upon the restricted areas for any purpose.

2. This easement does not change any prior agreements between the grantor and the grantee concerning access rights to the abutting highway.

3. Whereas the State of Arizona desires to preserve and protect, for scenic purposes, the natural beauty of said restricted area and to prevent any future developments which may tend to detract therefrom, the following restrictions on future use and development and the following permitted uses are established.

4. Upon written request by the grantee, the grantor shall remove or relocate designated dumpings, material or equipment that, in the opinion of the grantee, detracts from the appearance or beauty of the restricted area. Upon failure of the grantor to correct the stated condition within a reasonable time after notification, in any event no more than ____ days, the grantee may accomplish said correction and collect his expenses for such operation from the grantor by any legal means, including labor lien upon the property. The grantee may similarly correct any use not in conformance with this agreement.

5. This easement does constitute public right-of-way to the extent that all state laws for the protection of native plants shall be applicable within the restricted area.

Scenic interests in abutting lands may be acquired by negotiated purchase, lease, permit, donation, grant or purchase through eminent domain, as authorized by State and Federal law. The taking of any dwelling or related building by eminent domain is prohibited by Federal Statute. The interest may be transferred by fee simple easement or reservation and agreement.

Enabling legislation that provides for the acquisition of scenic interests for highway purposes, in the same manner as provided for other highway purposes is mandatory before the application of scenic values can be combined with the highway function.

Wisconsin is one of the more advanced states in the use of the scenic easement. After study of the National Parkway experiences they have developed some methods and procedures that give them some degree of success. The most important lesson they learned was that each easement and its restrictions must be more or less tailored to accommodate the requirements of each parcel on which the easement is to be placed. They also have learned that it is of great aid to have direct contact with the landowner so that his problems and intentions can be learned and so that the state's plans and reason can be explained to him in detail.

Professor Jacob H. Beuscher, College of Law, University of Wisconsin, said in 1961 that careful drafting of the easements can preclude most problems of interpretation. He also felt that poorly drafted easements cause most of the legal problems.

Wisconsin also found that scenic easements controlling development density actually enhanced the market value of lots by preserving the scenic attributes of the area and encouraging a higher type of development.

The U. S. Department of Interior had a similar experience when it acquired scenic easements along the Palisades of the Potomac River to prevent high-rise apartment building construction that would have blocked the view and destroyed the neighborhood character. The Mill Creek area in Lower Merion Township adjoining Philadelphia is another example of development control on a voluntary basis tending to preserve land values.

Wisconsin also recognized that it was necessary to acquire fee interest on private woodlands with marketable timber, since the prohibition of cutting the timber caused the easement price to equal that necessary to acquire fee. It is not certain that easements could not be written embodying management and timber harvest practices that would be compatible with scenic interests.

Because of their parallel objectives, there should be complete accord with the U. S. Forest Service regarding the protection of roadside scenic values. However, it is very important that use permits and agreements be negotiated on such lands as shown to be warranted, so that the interest for the highway purpose can be attached to the lands in the event of their being exchanged, out of the forest to private ownership.

It is important that the U. S. Forest administrators recognize the higher use of highway corridor or travel influence zone lands.

There are certain forest management techniques and applications, as well as those for scenic enhancement, that are in conflict and must be reconciled. This can and should be done through the use-permit agreement.

When easements or other interests are acquired along the Federal-aid systems, permissible uses must be approved by the Bureau of Public Roads and must be consistent with the purposes sought to be effected by Section 319 of the U. S. Code.

The state highway department has the basic responsibility for administration and maintenance of the scenic strip parcels but direct responsibility for maintenance and/or operation may be transferred to other local, state, or Federal agencies or jurisdictions through agreements acceptable to the Bureau of Public Roads. This is particularly significant where historical sites and some types of recreation areas are concerned that are beyond the scope of the state highway organization.

Where warranted, scenic easements could include the widened portions of railroad property not used for the main lines, but that might be used for industrial platforms and warehouses.

Development. All areas selected for facility development must have interests taken that provide for public use and occupancy as well as the right for the state to construct, operate, and maintain the facility. For this reason, most such areas will be acquired in fee or by specific use permit. This is the only category of application that the public access is permitted by virtue of the state highway's interest in the lands.

Development Control. Those portions of parcels warranting the application of development control must be carefully studied to determine the appropriate restrictions to accomplish the desired purpose. These restrictions will incorporate those similar to zoning provisions. These provisions will provide for planned unit development, building heights and setbacks, residential density, lot size, land uses, building coverage, signs, screening and landscaping, excavations, street standards, access points, collector roads, architectural and site plan review, buffer zones, and underground utilities, as well as the specific boundaries of the restricted area.

It is important that the permitted uses be incorporated with the restrictions or listed separately upon the instrument of acquisition. If this is done wisely it will result in considerable savings in the price paid for the rights desired to accomplish the highway purpose. Rights acquired and restrictions applied must be forward looking with the future administration and management of the lands in mind.

It is also important that those who administer and apply scenic restrictions do not try to provide a panacea for all of the world's problems. They must be able to recognize the limits of highway need and highway responsibility. They must be alert to other remedial possibilities outside of the highway program. Some conditions can best be corrected or improved by the activities of others in the fields of health, safety, sanitation and recreation.

It has been historically shown that zoning powers alone are not dependable or effective controls of highway corridor. However, their use should be coordinated with the highway applications.

There is great potential for the preservation and improvement of the highway corridor through the application of architectural controls within the total scope of development control. By this means, the charm, character and culture of an area can be maintained and displayed. Too strict controls may result in a monotonous conformance to outdated construction styles and create a pseudotraditional impact that would be repressive. When properly applied with good architectural judgment, interest, vitality, and expression will result in benefits for both the restricted areas and the motorist. Architectural controls may only consist of specifications for color shades, building material, scale, style, or orientation, the objective being to provide or preserve visual continuity with the architectural tradition of the area.

## STANDARDS FOR ESTABLISHING PARCEL LIMITS

There should be a plan for each parcel or scenic strip. This plan should also be varied and resourceful to gain full benefit from every scenic and/or educational feature. This plan will consider property boundaries, topographical and ecological features, historical values, scenic design considerations, growth and usage patterns, etc., in the establishment of parcel limits.

The Highway Beautification Act of 1965 "provides for the acquisition of interests in and improvements of 'strips' of land necessary for the restoration, preservation and enhancement of scenic beauty adjacent to the highways." The Act also provides for the development of such areas within or adjacent to the right-of-way "reasonably necessary"

to accommodate the traveling public. The Act is silent on the length, width, location, size and other physical features of the "strips" of land. The Act is also silent on what is "reasonably necessary" to accommodate the traveling public; nor does it define "other facilities" as used therein. However, the Act does provide that the Secretary of Commerce shall administer the Act and the authority to administer has been delegated to the Bureau of Public Roads (31, p. 3).

Regarding the limits of selected parcels, the "Instruction Manual for Preparation and Submission of the 1967 Estimate of the Costs of Carrying Out the Provisions of the Highway Beautification Act of 1965" says:

> Scenic strip size and shape normally should be governed by a natural boundary such as a lake or river shore, the extent of a grove of trees or desirable adjacent geological feature, or a nearby terrain crest that is the limit of view from the highway. The interests in land obtained largely will be applicable to relatively narrow strips with lateral dimension of only a few hundred feet or less. However, in open terrain as with adjacent cultivated farm land, pastures, semidesert or other such conditions where easement only would be obtained, the limit of outdoor advertising controls may be a logical strip boundary. However, in an instance where the highway crossed an attractive stream valley which is clearly visible from the highway, the strip might extend about ¼-mile outward along the stream bed where needed to control the attractive view.
>
> In areas with wide adjacent forests a fixed width likely would be the strip limit, with width of about 100 to 200 feet, or as forestry experts may suggest. This width should be adequate to provide an effective screen, as seen from the road, and to minimize blow-down in the event the timber is removed from the noncontrolled areas beyond the strip. Where forests are continuous for many miles, an appropriate strip every 5 to 10 miles, located at a point of favorable terrain insofar as view from the highway is concerned, should attain the desired objective.
>
> Where terrain is generally rolling and open with only scattered wooded tracts and other attractive natural features, attention should be directed to selections of the more interesting adjacent strips in the general area. In flatlands and prairie country, with few if any clusters of trees or natural features, the entire open panorama is a continuous scenic view, little likely to change. Here, there could be many miles of highway between attractive, desirable strip sites, each of which would warrant study for possible use. In dry-land farm country and semidesert areas, scenic strips likely would be even fewer and farther between. Here, also, each case should be studied for possible use. In general, the broader and more unchanging the view from the highway, the less is the need for scenic strips (25, p. 27).

Scenic interest acquisition practices, presently in use, give guides as to expected parcel depths.

The greenbelt established by the National Capitol Commission of Ottawa, Canada, is from 1½ to 3 miles deep and contains 41,000 acres. The Pinal Pioneer Parkway, a state parkway in Arizona, was established within a 1000-ft wide strip.

Some parkway proponents have sponsored legislation to expand this to 2000-ft total width. This parkway is slightly over 30 miles in length.

The Idaho legislature authorized the Idaho Board of Highway Directors to acquire, maintain, and improve scenic strips that were parallel and contiguous to the highway up to 1000 ft from the adjacent right-of-way line.

The National Parkways Handbook established a minimum average of 125 acres per mile for 1000 ft to be acquired in fee with no point being narrower than 300 ft. They also require 25 acres per mile or 200 ft average of extra width to be controlled by scenic easement.

Officials of the Great River Road of Wisconsin agreed that 350 ft width from the highway center line was the minimum effective width for scenic control unless a natural screen was closer. It must be remembered by western and prairie states that Wisconsin is densely wooded. These authorities also mention that the interest must extend at least far enough into the woods to provide a screen of trees and buffer beyond.

W. F. Cron of the BPR suggests that the boundaries will be quite variable but that they will seldom extend beyond the 660 ft from the edge of the right-of-way, as has been adopted for billboard control zone. He acknowledges that exceptions will be made for meritorious cases with certain extentions reaching out for as much as ½ mile.

The U. S. Forest Service uses what they call "travel influence zones" in planning their forest management programs. These zones vary from a few hundred feet to over a mile. The travel influence zones correspond to the highway corridor concept, except that the forest management objective is for the highest multiple use and the highway corridor's objective is for compatible use.

There are at least three major divisions to be considered when recommending standards or guidelines for the establishment of parcel boundaries. The first two divisions are based on whether the viewer is stationary or moving. The third is based on the use of the parcel or object being protected. Each division has characteristics peculiar to itself and degrees of difference between them.

It is at this point that terms such as road focus, distant visibility, range of visibility, and effective visibility came into use when establishing the outer limit of a scenic strip.

The section on vision in motion in "Man Made America—Chaos or Control?" by Christopher Tunnard and Boris Pushkarev is recommended for those who wish to study the effects of motion on vision.

Briefly, increased speed shrinks peripheral or side vision, extends the focus point or point of concentration and diminishes perception of foreground detail. Therefore, the width of effective vision is lessened with speed and increased by reducing speed. Maximum effective vision is obtained when there is no motion.

Excluding the range of visibility factors of terrain and vegetation density, the strips to be viewed from high-speed highways will not normally be as wide as those along a lower speed highway. Those strips to be observed from stationary vistas such as rest areas and scenic overlooks will be much deeper than those for moving vistas.

The parcel limits for uses such as historic, archeological, recreation and rest areas will also be selected for protection of the visual harmony and propriety. However, such factors as the geophysical unit, space requirements for anticipated usage, development potential, and the protection of functional integrity will usually exert greater influence on parcel limits than do visual considerations.

Scenic strips to be viewed in motion are frequently limited in depth by the range of visibility being shortened by a ridge, cliff, or other topographical feature, vegetation or structure. In selecting parcel limits, consideration must be given to the probable permanence of the obscuration. Hedgerows, structures, orchards, and stands of timber may be removed deliberately or by accident.

It may happen that a certain non-contiguous feature should be acquired because of its location within the "road focus" or other factor giving it greater visual impact than the adjacent area.

The point of judgment of parcel limits is reached where the warrant diminishes to the point it is overcome by economics, range of visibility or effective visibility or where by reasonable judgment, it purely ceases to exist.

The beginning, end and depth of parcels should generally coincide with property lines and other legal boundaries unless factors of terrain, visibility and usage decree otherwise. Uniform conditions over large parcels indicate more parallel boundaries based upon the limit of the warrant.

When selecting the boundaries of an outstanding localized feature, it is important to provide protection for both the foreground and background as seen from the available view points.

Buffer strips depths must be selected that effectively accomplish their specific purpose. Interstate and other major rest areas usually should have controls over the abutting land for 1000 ft in depth and ½ mile preceding and following the area. Cost of restoration is sometimes the limiting factor of parcel depth.

The National Parkways Handbook states the following:

> Some of the most commonly used practices in boundary designation include setting the taking line just over the near ridge, or sufficiently beyond a stream to preserve it together with a protective fringe of trees or shrubs. At highway intersections, sufficient land is taken to provide for all possible access connections plus insulating space to keep the usual commercial developments out of sight. Scenic easements are used infrequently to supplement and protect open fields where fee simple acquisition is too expensive (32, p. 2).

At the request of the Bureau of Public Roads, Arizona's estimate arbitrarily designated a standard 1500 ft each side of a rural Interstate interchange, for the average depth of the contiguous parcel, as a desirable area to be reserved for private development. The feeling was that development pressures would preclude the application of the preservation, restoration, enhancement, and facility development categories. The author does not concur in this viewpoint.

It is believed that each area should be studied and all applications made as the conditions of each access point warrant.

Development controls must be applied to these areas very quickly or chaotic development will surely result and the entire strip and route will be impaired.

## METHODOLOGY

### Existing Routes

The first step in a program of scenic interest acquisition is the establishment of criteria for the identification and rating of the relative parcel merits and conformance to the program objectives. These criteria may be expressed and followed in several ways. One of the most utilitarian ways is in the form of a systematic check list that uniformly presents the criteria factors and parcel characteristics in a usable form with a maximum number of comparable common denominators.

It is not possible to provide complete uniformity of measurement to all parcels because of the different types of applications. However, by organizing the information in a systematic manner, judgment of the relative merit and need can be more easily and correctly evaluated by the planner, designer and administrator. This will also facilitate the preparation and explanation of the justification for taking where required.

At this point a person or persons trained and skilled in the recognition and judgment of these factors and characteristics must accomplish the actual field selection of the sites most closely conforming to the criteria factors. Further, he must be able to indicate correctly the relative degree of conformance to the criteria. There are many information factors such as traffic volume and type, landownership and proximity to population that can be provided by others. However, the total evaluation of the relative impact of all factors must again be accomplished by these with proper training and experience. These abilities are most usually found among land planners and landscape architects.

Further information, such as maps and parcel descriptions, is helpful in the definition and priority establishment of the acquisition program. In many instances, this preliminary information will be sufficient to provide a basis for either the acquisition or rejection of a particular parcel. This is particularly true of those requiring only preservation applications. Sometimes it will be sufficient for those requiring restoration or enhancement applications. Those parcels that indicate development or development control will require further individual study and planning to define properly the scope and character of these applications.

To avoid wasted effort and to enable the designer to address himself to current conditions, this additional study should be done shortly before the time the previously established priorities and program funds coincide to enable immediate acquisition and application. This does not mean that development funds must also be available. Development activities should be programmed to be accomplished after the acquisition of all perishable land interests.

As soon as the needs and interests are defined and the state is ready to proceed with the acquisition, the landowners of the parcels should be contacted and these interests desired and their objectives fully explained to them. Permitted uses as well as the restrictions should also be described. Full notes should be taken of the owner's future plans for the lands. The plan and restrictions should then be adjusted where possible to accommodate the owner's intentions. Previous experience in other states, such as Wisconsin, has shown this to affect substantially the price required to obtain the highway interests. In many instances, the highway applications will result in economic benefits to the parcel lands or their remaining portions. These benefits should also be explained. This will require the close cooperation of the negotiator and the designer.

Experience will develop the best techniques for negotiating scenic interests and a public information program will improve the climate for such negotiations.

It should be remembered that easements and other interests for roadside beautification or improvement work are, in their total scope, an integral aspect of the acquisition of all lands for highway purposes and thus treated accordingly.

In a letter to Mark Astrup of the Oregon Highway Department, Warren A. Schmitz of Wisconsin listed the major problems of appraisal, negotiation and enforcement of their scenic strip experience. These are as follows:

Appraisal problems:

(1) Comparable sale information involving properties encumbered by scenic easements is not available.
(2) Loss in value due to easement restrictions is difficult to judge.
(3) Values are based upon present use and future potential use which is remote.

Negotiation problems:

(1) Easement acquisition projects separate from right-of-way acquisition and construction projects are difficult for land owners to understand and accept.
(2) Owners do not understand the need of scenic easements and the easement restrictions.
(3) Owners resent having to obtain permission of Highway Commission to harvest timber, etc.
(4) Amount of compensation is generally minor and has little influence on owner conveying.

Enforcement problems:

(1) Not all easements have included entry rights to enforce easement or to selective clearing, etc.
(2) Correction of nonconforming items is difficult to enforce.

In appraising the interest to be taken by the state, the appraiser must base his judgment upon the effect of the taking upon the land under its particular circumstance and not upon the basis of the restrictions applied.

## ADMINISTRATION

The administration of the lands and interest acquired through this program will bring new professional disciplines within the scope of highway administration. In addition to those presently contributing, the land planner and the land management specialist should be added to roadside development so that together with the landscape architect, they can form a balanced team to provide proper administration for the best continuing acquisition and use of scenic strip lands. It may also be desirable to call upon the architect to assist in the establishment of specific development controls.

After acquisition of strips along existing routes and depending upon the rate of funding, it is recommended that parcel improvements be accomplished in the following sequence:

1. Restoration work
   a. Clean up
   b. Stabilization
2. Enhancement work
   a. Landscaping
   b. Selective thinning
3. Development
   a. Rest areas
   b. Overlooks
   c. Camp grounds
   d. Interpretive aids should be done simultaneously with other development work.

Maintenance of the parcels and inspection and enforcement of the restrictions will begin with each acquisition and continue indefinitely. Each parcel should be reviewed at the time established by the instrument when it is acquired.

The team established for the administration of the parcels should develop programs for the prevention and control of litter, weeds, pests, erosion, fire, flood, pollution, etc., on parcel lands.

There should be extremely close liaison between this team and the permits engineer and right-of-way technicians. The importance of their cooperation with and assistance to the location and design engineers in the construction of new routes has been previously cited.

This team must also be alert to the planning and zoning activities by cities and counties. They should work closely with such agencies, making appropriate suggestions and requests to them regarding matters affecting the highway corridors.

This team should review all abandonments to ascertain if it is warranted to reserve certain interests in the lands being abandoned.

This team should keep the state informed on all sales and exchanges of corridor lands by public agencies, so that any warranted highway interests may be obtained prior to the transaction.

The prime responsibility of the administrative team will be to insure compliance with and conformance to the Federal-Aid Project Agreement clause that states: "The Arizona State Highway Department is responsible for maintaining (the highway right-of-way) (the condition achieved and the interest(s) in the strips of land) acquired in accordance with the objectives of the Highway Beautification Act of 1965." (Section 8e, USBPR PPM 21-4-6, Jan. 24, 1966).

We need finally to accept the fact that we are dealing with a social environment as well as a physical one and that a social environment is tied as closely to visual values as it is to economics and technology.

It must be acknowledged that legal problems inherent in both the Highway Beautification Act of 1965 and the enabling legislation of several states present unique problems to the administrator. However, similar circumstances were faced in 1956 with the Interstate Program. The Interstate control-of-access features found several states unable to comply with the Act and thus unable to avail themselves of its benefits. In some instances, the Federal Government acquired the interest (access control rights) in its own name. Later, when the states were legally enabled to acquire these rights, the Federal Government then deeded them to the states.

Rather than being dismayed at the imponderable hypothetical questions facing the program today, it behooves us to proceed toward accomplishment step-by-step. Each problem will be met in the best manner available as its true character and extent is confronted and becomes known.

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# The New Trichotomy: The Highway, the Roadside, and Recreation

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•THOSE who were already inhabitants of this planet at the beginning of the twentieth century can look back and consider the changes that have occurred during this generation with bewilderment, pride, awe, or fear. The changes, although dramatic in the physical world, cut sharply into the economic and social fabric of society. The next generation will witness changes no less startling.

It is estimated that the population of the United States may nearly double by the year 2000, increasing from the 1960 total of 180 million to 331 million. By 1970 the population will increase to 208 million, in 1980, 245 million people will inhabit the country, and the following decade will witness a growth of an additional 42 million people.

The present population movement from rural to urban areas is expected to continue. City living appears to be the preferred mode of existence. The 1950 census contained 168 standard metropolitan areas which included 56 percent of the total population. By 1956, the population in these urban complexes had increased to 59 percent of the total. It is estimated that the 1975 population will approach 228 million people, of which approximately 150 million will live in metropolitan areas.

With 70 percent of the national population within the metropolitan sphere, the problems of housing, employment, recreation, land use, planning, traffic circulation and congestion will be intensified. Is this new growth to occur along the fringes of the existing urban pattern in an unguided, unplanned and speculative manner as in the past? Our present cities are ample evidence that this must be avoided. Hopefully there will be realized a true great society in which magnificent new cities will flourish. The engineering profession engaged in planning and constructing our highways has a major role to play in the future location and development of our communities.

## THE URBAN PERSPECTIVE

The backbone of the highway transportation network is the 41,000 mile Interstate system, which provides a nationwide linkage of centers of population. Equally important will be the primary and secondary Federal-aid systems and the local connecting links. There is a demand for improvement now on all levels.

Highways, particularly those within the urban complex, have such far-reaching effects upon community and regional structure that an understanding of urban growth and development is a requisite for proper planning. The highway engineer must concern himself with more than moving goods and people from point to point. He must become involved in the planning process.

What are the existing community land-use patterns? Is there an organized and balanced allotment of space for residential, business, industrial and recreational use? Are the space relationships, spatial arrangement and space organization in scale and harmony? Is there a feasible comprehensive master plan to guide future growth and development? Expressway plans must be an integrated element of the larger concept of community. They must fit the local scene without disrupting community values. They must give service to the community. The highway engineer must have as his

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objective the same purpose as all sound planning—the improvement of the human environment. He must relate to other disciplines involved in the overall planning process, develop a societal awareness and maintain an ordered perspective.

New Community Patterns

Module cities are envisioned as the pattern of the future, according to The Committee for National Land Development Policy. Each module city will include a core city "surrounded by self-sustaining satellite cities, and with all the units separated from each other by green belts of open land." A complete development plan would serve as a master control over incremental growth. The new cities would be located away from present urban areas on huge open tracts to allow preplanning of the entire complex. The central city would be the economic headquarters of its metropolitan area, while each sub-city would be an entirely self-contained community and not just a "bedroom community for the center city."

The green-belt concept, first advanced by Ebenezer Howard in 1898, envisages an area of open space devoted to agriculture, reforestation, or similar purposes. It is not a reservation for future community expansion. Similar ideas for regional development have been advanced in the past by Unwin in 1922 and Whitten in 1923.

The English planner, Raymond Unwin, suggested that town extension should progress by "means of detached suburbs grouped around some center and separated from the existing town by at least sufficient ground to provide for fresh air, recreation, and contact with nature." Robert Whitten advanced a theoretical regional development plan in which a "central city would be surrounded by numerous separate and self-contained suburbs or satellites; the permanent separate existence of these secured by broad, open development areas separating them from each other and from the central city."

Present concepts of the desirable form and type of metropolitan development are essentially similar to Whitten's proposal; i. e., a central core city serving as a nucleus and providing services to a group of ring communities.

We cannot hold all activities in abeyance until idealized centers evolve. Planning problems need immediate solutions. Preserving the existing open areas along the fringe of the present metropolitan communities as insulating space would be a gigantic step forward. A bold and imaginative public land policy in which the necessary insulating space would be in public ownership would accomplish this objective.

Every facet of community activity demands greater space allocation than a decade ago. Thirty years ago each population increase of one thousand in a metropolitan area absorbed 30 acres of land. Today between one and two hundred additional acres are required.

The competition for land is placing a premium on open space as lower population densities prevail in all facets of land use activities. There is a tendency to consider unoccupied land as an economic waste. Productive use with a measurable monetary return is the scale of value in the market place. There are taxation consultants who advocate a tax on land only and not on the buildings located thereon. They hold that this policy would force land development. Social values and social accounting are viewed as idealistic concepts that can wait indefinitely.

## THE LEISURE AGE

Contemporary society is experiencing a transition as profound as the first industrial revolution produced in its era. The technological advance epitomized by the computer is changing work processes, habits and needs. The worker is being relieved of the drudgery of monotonous repetitive operations.

Man is being supplemented by machine. Fewer workers are needed to obtain the former productive output. Increased production is accompanied by a decrease in the work period. A shorter work day and work week and early retirement is a new experience not without its problems.

Man has a considerable amount of uncommitted time—a new leisure. The Veblenian concept of a privileged leisure class characterized by freedom from toil is no longer applicable. We have a mass leisure that is challenging and significantly opportunistic.

It can be devoted to purposeful use or purposeless waste. Sutherland advances a philosophy of leisure which may be summarized under the ideas of integrity of purpose, liberty to choose goals, objectivity, equality in fellowship, common command of skills, growth and inner joy. Basically it is the community which must provide the stimulus to the objective use of leisure by the individual.

### Social Mobility

In addition to mass leisure our present society exhibits mass mobility. Increased car ownership and modern highways now available or under construction are symbolic of American mobility. Car ownership was estimated at 90 million in 1965 with an anticipated growth of 180 million by the year 2000. Two-car families are numerous and three-car families are increasing.

The resurgence of motorcycles in the United States is an additional verification of our mobile tendencies. There are approximately two million motorcycles in use in the United States today. The industry has been expecting sales of 800,000 units annually. The large influx of new cyclists among the younger group has induced and intensified some effects of social mobility which constitute social problems. In some instances bands of leather-jacketed cyclists have descended upon communities and resorted to inexplicable violence and destruction.

Under certain conditions our social mobility is symptomatic of a disordered society. Other patterns of behavior closely related to the automobile and the highway that are considered inimical to social values involve criminal activities and auto accidents. The instability of the family arising from extreme mobility is also a social problem. Although the automobile is the instrument in these contemporary problems, it is similarly the means of releasing the individual from a restricted, monotonous environment.

## HIGHWAY TRAVEL AND RECREATION

The average car owner drives about 10 thousand miles annually. He travels for business and for recreation, enjoying his liberation from the fixed tracks of the railroads. Highways are available for cross-continental driving to national parks or regional centers of interest. Rural roads lead to farmlands or remote camping areas and secret fishing haunts. The increased leisure of the age of automation has increased the time for travel and recreation. Expenditures for travel and recreation provide a significant income for many people.

In New York the state parks alone handle 35 million visitors annually. The state owns about 3,700,000 acres of recreation and conservation land, including large forest areas, 110 state parks, 46 public campsites, over 100 boat landing sites, so-called reforestation and game management areas, lakes both large and small, free-flowing streams and a variety of other facilities. Proposed plans contemplate the expenditure of some $40 million per year for the next 10 years on the development of state-owned conservation and recreation properties and on state-aided municipal recreation facilities. It is expected that by 1980 state facilities will be available to handle 65 million visitors annually, approximately double the present capacity.

The other 49 states possess similar recreational resources which attract millions of campers, sightseers, hunters, fishermen, other travelers and those engaged in the furnishing of needed services. At the same time, the private sector of the recreation industry contributes resources in excess of the public segment.

## HIGHWAY AND ROADSIDE

A constraint upon realization of the full potential of highway design is the width of the right-of-way. Under the provisions of highway laws, the right-of-way purchased is for highway purposes exclusively. This has been interpreted to mean a width sufficient to provide for the highway section, plus about 15 feet along each side to accommodate a ditch and maintenance equipment in fill sections, and even a more limited dimension in cut sections. A factor in determining this restrictive policy is the manner in which public funds are appropriated for expenditure. The appropriation bills specif-

ically limit the disbursement of the amounts specified for the construction of highways including the purchase of the necessary right-of-way. This provision has been interpreted as permitting the acquisition of enough width of right-of-way to construct the roadway section for the class of highway designated.

Advances in highway design have necessitated wider rights-of-way in which to place the traveled section. What is needed is an increase in the width along the roadway margins to provide a true roadside. More attention can be given to preserving the integrity of the roadside by maintaining natural landscape features such as trees, shurbs, stone walls, rock outcrops and ground cover. With wider rights-of-way the development of abutting property can be better controlled and marginal interferences to traffic movement minimized, resulting in increased safety.

In many cases present policies leave residual areas landlocked and inaccessible to the owner. It has been theorized that disposition could be made to abutting property holders. Acquisition costs, however, have been practically the full value of the entire parcel.

What is needed is a liberalization and broadening of the highway use concept, by legislation if necessary. Provision should be made for the full utilization of our land resources in the roadside.

## Social Sanctions

A project which improves the environment will receive public acceptance much more readily than one that does not. Highway officials have been subjected to individual and group social sanctions as expressions of disapproval. The public use of organized negative sanctions through the petitionary process has been widespread and effective. Individual sanctions as personal acts of opposition to a project, such as the location of an elevated highway that blocks a view, may trigger organized group sanctions with disastrous consequences. The complete stoppage of an expressway system in San Francisco is a case in point. Transportation arteries must be not only functional but aesthetically pleasing, in scale with their environment, and possess an internal and external harmony of alignment and elevation. New concepts must be formulated and utilized to minimize hostility and achieve public approbation.

## Multiple Land-Use Concept

The parkway is an excellent example of what can be accomplished by devoting the roadside to other desirable ends. Authority is needed to purchase and utilize roadside areas along all highways for recreational development when the land is sufficient in area and satisfactorily situated for such purposes.

The multiple-use concept can be advantageously extended from water resource utilization to land use. The Corps of Engineers has opened flood control areas to recreational use by permanently impounding waters in flood control reservoirs initially intended to remain empty until needed for control purposes. The resulting lakes are used for boating, swimming and fishing. At the Whitney Point Dam in New York the adjacent lands have been developed as county recreational areas. As a consequence, there is better public acceptance of flood control proposals which were initially considered preemptive.

The multiple land use of the roadside is particularly valuable in urban development where open space for recreation is seriously deficient. The need for roadside parks and rest areas close to metropolitan districts is critical.

The National Recreation Association has issued suggested criteria for recreational needs in communities. Although standards of excellence are helpful, it should be recognized that each situation is a distinct problem. A complete analysis of present land-use patterns and future needs is essential to ascertain deficiencies and how they can be met.

The modern highway occupies considerable acreage. The roadbed is not readily reversible to other uses. Whenever possible the highway should make a contribution to the living environment beyond its normal function. Aesthetic designs and open space are partial compensations. A change in the physical environment making additional

uses possible which were not initially enjoyed may be considered a creative accomplishment. There must be no conflict between the highway use and the additional use, nor can it be inimicable to the primary purpose. The multiple use should be enhancing and augment the roadside capabilities.

Use of the roadside for park and recreational purposes satisfies these criteria. Such multiple land use also increases the return on the investment. It is inevitable that a more efficient use of our land resources will be demanded. We can no

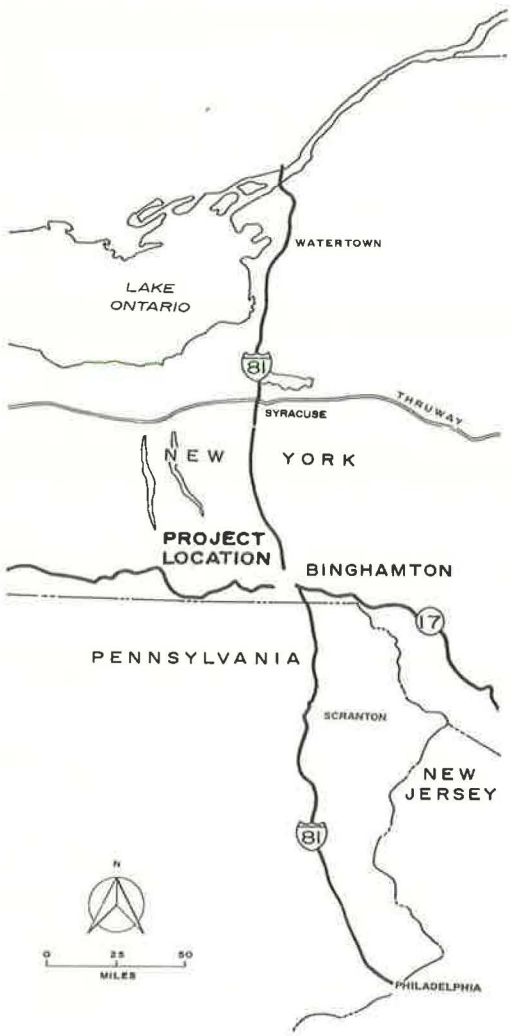



Figure 1. Project location.

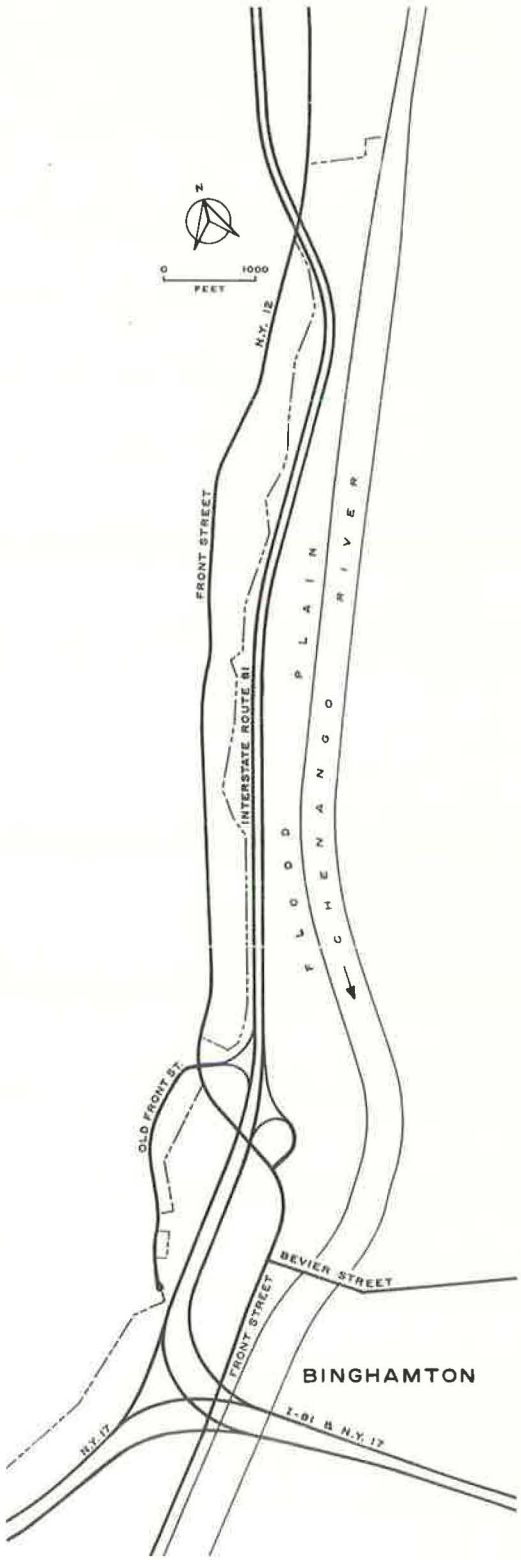



Figure 2. Interstate 81-Route 17 alignment.

longer afford the luxury of allowing public land to be partially utilized if it can be devoted to a beneficial public use.

The coordination of highway use with stream utilization is illustrated by a section of Highway 17 bordering the Willowemoc River at Roscoe, New York. Rights-of-way acquired for highway purposes extend to the water's edge. A portion of the right-of-way serves as valley storage during overbank flood flow. Jurisdiction over the excess area is being transferred to the State Conservation Department. That agency will control and administer the fishing rights of the stream and adjacent bank, which are to be opened to public use.

### Levels of Service Concept

The devotion of the roadside to compatible multiple use is consonant with the concept of level of service. Level of service may signify any one of a number of combinations of roadside uses. It may be considered a qualitative measure of the benefits arising from the specific services provided, such as parking, roadside rest area, scenic overlook, over-bank flood protection, erosion control, recreation, and park use. Level of service may be quantified by assigning values to the intensity of use of the respective elements comprising the multiple services involved.

A roadside fulfilling the single purpose of highway need is at a minimum level of service, if the roadside is suitable for additional public use. A roadside furnishing multiple use, for all such additional uses possible and practical, would be at an optimum level of service. Full utilization of our roadside resources should be the objective of the highway planner. The roadside has become syncretistic—it has a use function and a social value. The highway, the roadside, and recreation constitute the new trichotomy.

## THE UNIQUE SITUATION

The establishment of a land-use pattern by the construction of I-81 in the Binghamton, New York, metropolitan area is illustrative of a unique situation favorable to the application of the multiple land-use concept and optimization of level of service. The location, arrangement, and land acquisition demands for the arteries involved created a roadside capacity suitable for a 200-acre landscape park and a 30-acre community recreation center (Figs. 1, 2).

The most important feature of the situation is that an open land area of this magnitude is situated in the heart of the urban region. Acquiring land for the specific purpose of park development in such a location would be practically impossible.

I-81 enters Broome County at the New York-Pennsylvania line and follows a northerly direction to Syracuse and beyond. It utilizes a common roadbed with Route 17, an E-W artery along the northern periphery of Binghamton until the Chenango River is crossed. I-81 bends north along the west bank of the Chenango River for several miles. To economically site I-81, Route 17, the necessary interchanges and maintain the local road service, a 4-mi section of the Chenango River was moved east 400 to 800 ft. It was possible to reduce the river crossings from two to one with a consequent saving of millions of dollars.

In addition to the land needed for the roadway arteries, the land between I-81 and the river was acquired to protect the facility from flooding by providing overbank flow area. A wider and deeper channel was also constructed.

The portion of the right-of-way between the highway and the river consists of a ribbon of land of approximately 200 acres (Fig. 3). The width varies from 225 ft to 1100 ft. It is generally level. Portions support growth of willow, elm, maple and brush. Because it is subject to periodic flooding, most of it was undeveloped prior to its acquisition by the New York State Department of Public Works.

Near the south end of the site, some 30 acres of right-of-way are enclosed between I-81 and Front Street, a controlled-access local thoroughfare. This low-lying area is protected from direct flooding by the Front Street embankment. Although flood gates on the culvert outlets through the embankment protect the area from river flooding, interior drainage inundates the area under adverse conditions.

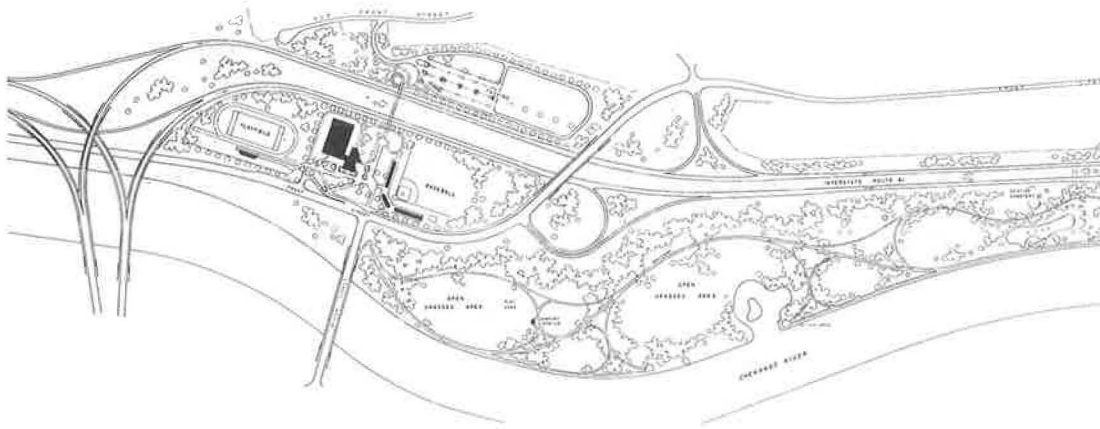


Figure 3. Re

Unlike the large riverfront section which is attractively related to the river, this portion of the right-of-way is blocked from outside view by the very embankments which protect it. Development of this area should be focused inward, and rely on its own internal design for interest.

Immediately west of the interchange there are approximately 20 acres of right-of-way acquired for interior drainage purposes. This otherwise unused area is generally flat and open. It can be reached from old Front Street, which terminates in a cul-de-sac.

## The Landscape Park Design

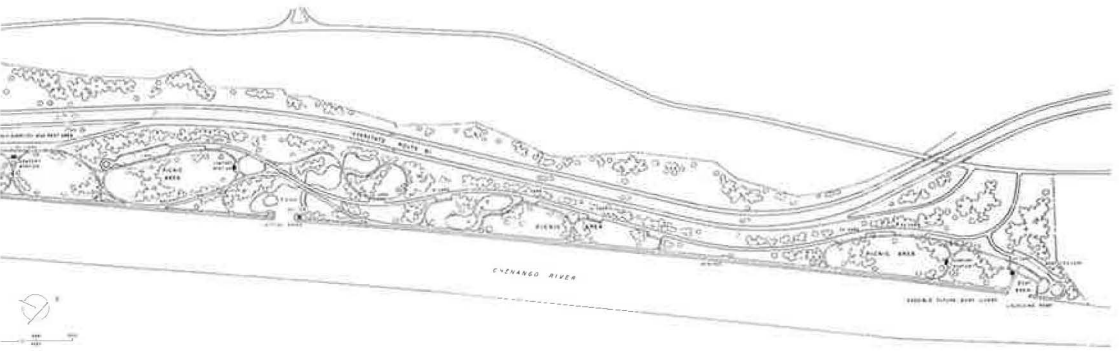
The ribbon of land between I-81 and the Chenango River is particularly suitable for a riverfront landscape park. It can be readily developed at a reasonable cost. The characteristics desirable in a landscape park are available in the naturalistic setting and proposed development. There are grassed areas for active recreation, natural and created groves, sheltered and spacious picnic areas, ponds and wildlife and a sweeping view of the river from various vantage points (Fig. 4).

Access to the park will be available at each extremity and at the center. Pedestrians may enter the park at the southern end by means of paved walkways from Bevier Street. Northbound Interstate travelers have access from a rest area and scenic overlook which is connected to the park area path system.

All motor traffic will be confined to the northern entrance road at Front Street, which is just east of an I-81 exit ramp. Although park roads are generally of greater utility if they form a circuit or series of circuits, the strip characteristics of the park site indicated a linear parkway would be preferable. The motorway runs about half the length of the park with small parking areas at intermittent points along the borders convenient to picnic areas. Traffic must reverse itself to leave the park. This layout restricts the use of the road to park visitors as it does not provide a shortcut or a means of avoiding the highway system.

Picnic and play areas and paths and sitting areas are strategically placed throughout the park. The path system makes a series of circuits interconnecting picnic areas, rest shelters, recreation spaces and other centers of interest. The pathways are small enough and conveniently dispersed in order to discourage shortcuts and wanderings that might trample shrub plantings and wear unwanted paths. Pedestrians may follow an interior curvilinear path system the length of the park or a pathway bordering the river edge. These longitudinal pathways are elements of the series of circuits. The pedestrian may take an uninterrupted stroll through the park enjoying the scenery or command a view of the river and the bridges in the distance.

The only structures introduced into the park scene are those that have a legitimate and necessary function to perform as a service, such as comfort stations and shelters. The comfort stations will have to be elevated above ordinary high water.



development.

Present demand does not indicate an immediate need for a boating facility on the Chenango River. If such a need should develop, a boat landing ramp and basin and possible boat livery could be created near the northern end of the site.

The landscape park occupies an unusual niche. It exploits an otherwise idle land mass. It furnishes a recreational need not otherwise available without usurping land required for community growth. The park, bounded by a river and an Interstate highway, is protected from an urban invasion of its serenity.

Figure 4. Landscape park.

Figure 5. Community recreation center.

## Community Recreation Center

The area within the Interstate 81-Front Street interchange is so centrally located with respect to areas of need that intensive development for active recreation would be most appropriate. Its development as a community recreation center includes a permanent covered ice skating rink, a baseball field, and a multipurpose athletic field with a running track (Fig. 5). All three areas envisage spectator seating. Such a facility would be used primarily by local residents and the area schools.

The skating rink design consists of a roofed outdoor artificial ice rink with an attached building housing administrative offices, maintenance and other service facilities.

The baseball field includes open bleachers along the baselines to seat 2000. The field could be used in the fall for football with portable bleachers to augment permanent seating.

The grassed multipurpose field would serve for football, soccer, or lacrosse. The field is situated inside a standard quarter-mile running track. Facilities for field events are also to be provided. Open spectator bleachers seating 500 are considered adequate. Additional spectators may sit on the adjacent grassed slopes.

## Parking and Access

There is adequate space between I-81 and Front Street to accommodate the recreational facilities, but it is insufficient for parking for visitors to the community recreation center. Parking spaces could be provided directly west of I-81 in the right-of-way area acquired for interior drainage purposes. A paved area there should provide spaces for 275 cars and stabilized turf overflow areas would accommodate an additional 800 cars. Bus parking can be accommodated on the perimeter of the same area.

A multispan pedestrian overpass from old Front Street bridges I-81 and provides access to the recreation area from the local street system and parking area. The pedestrian bridge is under construction. There is no necessity for direct vehicular access into the recreation center except for emergency and service vehicles. A mainte-

nance center incorporated into the skating rink annex will serve the entire recreation complex.

A pedestrian drop-off and pickup area for private cars and public transit buses could be developed along the west side of Front Street and ending in a loop that will permit treadle-operated signal-controlled turn-arounds.

The community recreational center and landscape park described as an integral development of the highway right-of-way of I-81 is an example of the broadened concept of optimum highway use. It illustrates the multiple-use concept to achieve the full potential of a land resource consistent with community needs and values.

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# Protecting Steep Construction Slopes Against Water Erosion

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Mulching practices on a roadside cut (3:1 slope) were evaluated with respect to controlling soil erosion and minimizing grass seed and fertilizer loss prior to grass establishment. A field plot rainfall simulator and a device to introduce additional surface flow over a test plot were used to evaluate the mulching practices. Measurements of soil erosion and grass seed and fertilizer losses were made from runoff samples taken through a series of simulated rainstorms. The effectiveness in protecting soil surfaces against water erosion was determined for 13 mulches. The best protection was provided by mulches of jute netting, wood excelsior mat, prairie hay (1 ton/acre) and fiberglass (1,000 lb/acre) anchored with asphalt emulsion (150 gal/acre). The least effective mulches were the latex (150 gal/acre) and a kraft paper netting. Anchoring a material with asphalt emulsion provided increased adherence to the soil surface and was generally beneficial.

•TEMPORARY stabilization of a disturbed soil surface until vegetation can become established is a continuing problem for state highway departments, the Department of Defense and other public agencies. Stabilizing the backslopes of dams and the side slopes of waterways and spillways are similar problems for soil conservationists. The advantages of holding the grass seed and soil in place until adequate cover has been established are apparent. In many instances, erosion may cause greater maintenance costs on a construction slope than the initial cost of smoothing, mulching, and seeding.

Conventional equipment can be used on slopes flatter than 4:1 for seeding, mulching and mulch anchorage. Steeper slopes pose special problems in the application of mulches and the establishment of vegetation. Research on mulching materials used to prevent water erosion on a 6-percent slope has been conducted, using simulated rainfall, since 1962 at Lincoln, Nebraska (3). During the summer of 1965, a rotating-boom rainfall simulator (2) was used to evaluate the effectiveness of 13 selected mulches for controlling the losses of soil, seed, and fertilizer on a 3:1 roadside backslope.

## MATERIALS AND METHODS

This study was conducted on a Wymore silty clay loam at a site located about 3 miles south of Firth, Nebraska, along State Spur 341. A roadside cut was shaped to approximately a 3:1 slope. The surface was quite moist at the time of shaping and hardened upon drying. A mechanical analysis of a composite sample from the cut soil surface analyzed 9 percent sand, 59 percent silt and 32 percent clay.

Twenty-six plots, each 10 × 20 ft, provided test plots for two replicates of 13 mulch treatments. These treatments, along with rates and methods of application, are given in Table 1. After application of the mulch, each plot was covered with plastic for protection against natural rainfall until simulated rainstorms could be applied.

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TABLE 1

MULCH TREATMENTS STUDIED

| Mulch Treatment | Description and Method of Application | Application Rate[a] |
|---|---|---|
| Wood cellulose | Wood cellulose fiber applied hydraulically as a water slurry | 1000 lb |
| Fiberglass | Continuous filaments of fiberglass applied with compressed air | 1000 lb |
| Asphalt emulsion | Emulsifiable asphalt diluted 1:1 with water and sprinkled on plot | 1200 gal |
| Latex | Emulsifiable material diluted 1:6 with water and sprayed on plot | 150 gal |
| Wood cellulose and asphalt emulsion | Wood cellulose fiber anchored with 1:5 asphalt emulsion | 1000 lb with 150 gal |
| Fiberglass and asphalt emulsion | Fiberglass anchored with 1:5 asphalt emulsion | 1000 lb with 150 gal |
| Prairie hay and asphalt emulsion | Prairie hay[b] anchored with 1:5 asphalt emulsion | 1 ton with 150 gal |
| Woodchips and asphalt emulsion | Pine woodchips from a portable chipper anchored with 1:5 asphalt emulsion | 6 tons with 150 gal |
| Corncobs and asphalt emulsion | Ground corncobs slightly larger than ¼ in. in diameter anchored with 1:5 asphalt emulsion | 5 tons with 150 gal |
| Prairie hay and wide-weave paper netting | Prairie hay anchored with tightly twisted kraft netting with a 2 × 0.5 yarn count | 1 ton |
| Wood excelsior mat | High-grade wood excelsior covered on both sides with a strong, large-mesh, kraft netting | |
| Jute netting | Heavy woven jute matting with a 1.6 × 1.1 yarn count | |

[a]Per acre; undiluted volume applied in the case of liquids.

[b]Average composition of the prairie hay was 74 percent bluestem, 23 percent switchgrass and miscellaneous grasses and weeds.

Four "storms" were applied to pairs of test plots as follows:

| Storm | Duration (hr) | Intensity (in./hr) |
|---|---|---|
| 1 | 1.4 | 2.5 |
| 2 | 1.0 | 2.5 |
| 3 | 0.3 | 5.0 |
| 4 | 0.8 | 2.5 plus introduced surface flow |

The second storm was applied 18 to 20 hr after Storm 1, and Storm 3 immediately followed Storm 2. The fourth storm included three successive increases of introduced surface flow over the plots. Each increase in surface flow was held constant for 0.2 hr after the first 0.2 hr of simulated rainfall.

The surface flows were introduced across the upper edge of a plot through a pipe with holes on the upslope side. The energy of the water jets is dissipated against a curved metal shield from which the water ran onto the plot. The rate of water addition was controlled by a valve and measured through a meter.

Runoff samplers designed by Meyer and further reported by Hermsmeier (1) were used in this study. A nearly continuous sample of the runoff with its sediment load was

obtained by taking successive samples over 6-min intervals throughout a test. A water-stage recorder provided a hydrograph of the runoff.

Grass seed and fertilizer were applied prior to mulching. Smooth bromegrass (Bromus inermis Leyss.) seed was applied at a rate of 120 seeds per sq ft. The seed was autoclaved to prevent germination on the plots or after collection in the runoff samples. The grass seeds in the fractional runoff samples were counted to determine the total number of seeds removed by the water runoff for a given storm.

Phosphorus was applied to each plot at the rate of 83 lb/acre in the form of treble superphosphate. The amount of phosphorus, both in the soil and in the water of each runoff sample, was determined.

## RESULTS AND DISCUSSION

### Soil Erosion

The mulches varied widely in the degree of erosion protection provided. A maximum soil loss of 16.5 tons/acre was measured from a 5-in./hr storm of 18 min duration on plots treated with the latex. The results from each mulch treatment, given in Table 2, are expressed in terms of a relative erosion value that indicates the effectiveness of a particular mulch in preventing erosion in comparison to the jute netting. The relative erosion values are weighted averages (weighted with respect to the amount of erosion for a particular storm) for three simulated rainstorms.

The mulch materials can be grouped into four distinct classes. Materials such as the jute netting, wood excelsior mat, and fiberglass anchored with asphalt emulsion provided excellent protection against water erosion. The amount of erosion was reduced by about 95 percent as compared to the soil loss from plots mulched with the latex. Good protection against water erosion was provided by woodchips, prairie hay or corncobs anchored with asphalt emulsion, and from asphalt emulsion alone. Soil erosion in this group was reduced by 85 to 90 percent when compared to the latex treatment. Wood cellulose, kraft paper netting, and the latex provided unsatisfactory protection.

TABLE 2

MULCH TREATMENTS RANKED ACCORDING TO RELATIVE EFFECTIVENESS AGAINST SOIL EROSION

| Mulch Treatment | Relative Erosion[a] (No. of times the erosion from jute-net mulch) |
|---|---|
| Jute netting | 1.0[b] |
| Wood excelsior mat | 1.1 |
| Fiberglass and asphalt emulsion | 1.4 |
| Woodchips and asphalt emulsion | 2.3 |
| Prairie hay and asphalt emulsion | 2.5 |
| Asphalt emulsion | 2.5 |
| Corncobs and asphalt emulsion | 4.5 |
| Prairie hay and wide-weave paper netting | 7.9 |
| Fiberglass | 7.9 |
| Wood cellulose and asphalt emulsion | 8.5 |
| Wood cellulose | 12.9 |
| Kraft paper netting | 20.7 |
| Latex | 25.4 |

[a]Average of three simulated rainstorms replicated twice for each mulch treatment.

[b]Mulch treatment used for comparison purposes.

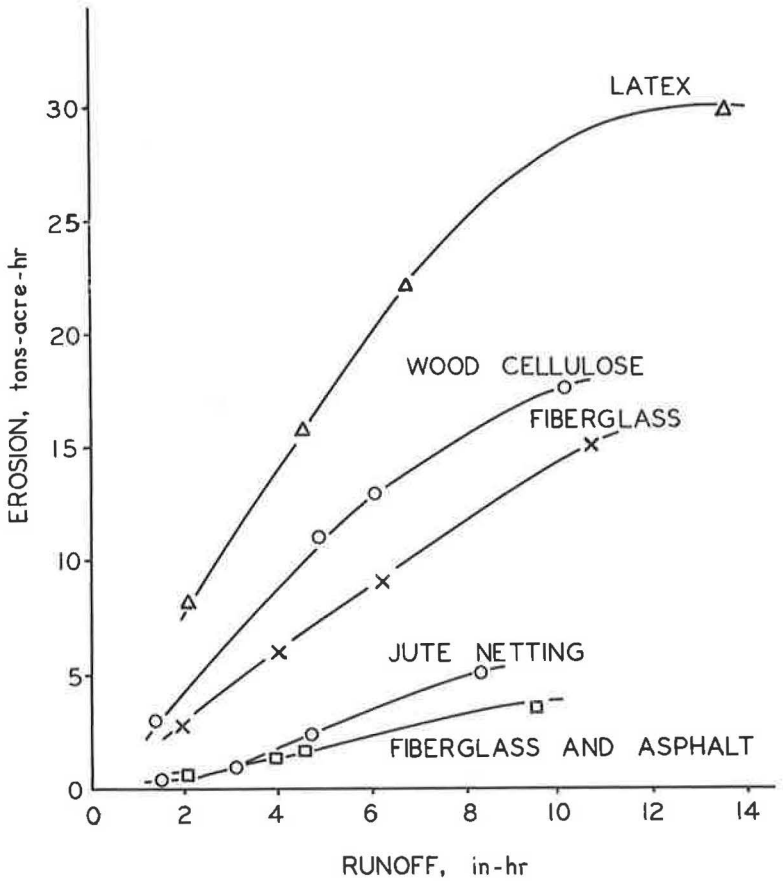


Figure 1. Rates of erosion as related to runoff for various mulch treatments.

TABLE 3

MULCH TREATMENTS RANKED ACCORDING TO SEED LOSS FROM RUNOFF PLOTS

| Mulch Treatment | Number of Grass Seeds Lost[a] | | | |
|---|---|---|---|---|
| | Storm 1 | Storm 2 | Storm 3 | Total |
| Jute netting | 0 a | 0 a | 0 a | 0 a |
| Wood excelsior mat | 0 a | 17 a | 0 a | 17 a |
| Prairie hay and asphalt emulsion | 0 a | 0 a | 32 abc | 32 a |
| Fiberglass and asphalt emulsion | 17 a | 0 a | 38 abc | 55 a |
| Fiberglass | 72 a | 0 a | 0 a | 72 a |
| Asphalt emulsion | 80 a | 16 a | 24 ab | 120 a |
| Woodchips and asphalt emulsion | 142 a | 6 a | 143 abc | 291 ab |
| Corncobs and asphalt emulsion | 250 ab | 127 ab | 127 abc | 504 abc |
| Wood cellulose and asphalt emulsion | 394 abc | 115 ab | 88 abc | 597 abc |
| Wood cellulose | 355 abc | 237 bc | 219 c | 811 bcd |
| Prairie hay and wide-weave paper netting | 665 bc | 124 ab | 194 bc | 983 cd |
| Kraft paper netting | 676 bc | 238 bc | 202 bc | 1116 cd |
| Latex | 762 c | 355 c | 169 abc | 1286 d |

[a]Seed losses followed by same letter are not significantly different (5% level).

The use of increased surface flows in addition to the simulated rainfall provided more distinguishable differences between the mulch treatments (Fig. 1). Accelerated erosion resulted when some of the mulch treatments failed under increased surface flow (latex, kraft paper netting, wood cellulose, and fiberglass), but nearly stable conditions persisted with others (fiberglass anchored with asphalt emulsion, wood excelsior mat, and jute netting). Some mulch materials provided relatively better protection than others as the flow rates increased. The fiberglass anchored with asphalt emulsion became relatively more effective than the jute netting with increased runoff.

## Grass Seed Loss

Of the 24,000 bromegrass seeds on each plot, a maximum of 2,186 were lost from the plots treated with the latex. No observed losses occurred from a plot mulched with jute netting during a series of three simulated rainstorms (Table 3). The maximum number of grass seeds removed from the test plots accounted for only about 5 percent of the number applied, which would still permit establishment of adequate grass stands. However, grass seed need not be removed from the test plot to cause inadequate grass stands. Seeds may be washed from some areas into concentrations, causing spotted grass

TABLE 4

MULCH TREATMENTS RANKED ACCORDING TO PHOSPHORUS LOSS FROM RUNOFF PLOTS

| Mulch Treatment | Storm 1 | Storm 2 | Storm 3 | Total |
|---|---|---|---|---|
| (a) Phosphorus Loss in Soil Removed From Plot Surface (lb/acre)[a] | | | | |
| Jute netting | 0.2 a | 0.1 a | 0.1 a | 0.4 a |
| Wood excelsior mat | 0.2 a | 0.1 a | 0.2 a | 0.5 a |
| Fiberglass and asphalt emulsion | 0.1 a | 0.1 a | 0.3 ab | 0.5 a |
| Woodchips and asphalt emulsion | 0.3 a | 0.1 a | 0.2 a | 0.6 a |
| Prairie hay and asphalt emulsion | 0.3 a | 0.2 a | 0.2 ab | 0.7 a |
| Asphalt emulsion | 0.2 a | 0.2 a | 0.3 ab | 0.7 a |
| Corncobs and asphalt emulsion | 0.5 a | 0.4 a | 0.3 ab | 1.2 a |
| Wood cellulose and asphalt emulsion | 0.9 a | 0.5 a | 0.2 ab | 1.6 a |
| Wood cellulose | 1.0 a | 0.6 a | 0.6 ab | 2.2 a |
| Fiberglass | 0.8 a | 1.0 ab | 0.9 b | 2.7 a |
| Prairie hay and wide-weave paper netting | 1.7 a | 1.1 ab | 0.7 ab | 3.5 a |
| Latex | 4.2 b | 1.9 bc | 1.7 c | 7.8 b |
| Kraft paper netting | 6.9 c | 2.2 c | 2.2 c | 11.3 c |
| (b) Phosphorus Loss in Runoff Water (lb/acre)[a] | | | | |
| Fiberglass | 0.7 a | 0.6 a | 0.4 ab | 1.7 a |
| Latex | 1.0 ab | 0.5 a | 0.2 a | 1.7 a |
| Asphalt emulsion | 1.0 ab | 0.5 a | 0.4 ab | 1.9 ab |
| Wood cellulose | 0.8 a | 0.8 a | 0.4 ab | 2.0 ab |
| Jute netting | 0.9 a | 0.8 a | 0.4 ab | 2.1 ab |
| Prairie hay and asphalt emulsion | 1.1 abc | 0.7 a | 0.3 ab | 2.1 ab |
| Wood excelsior mat | 1.0 ab | 0.9 a | 0.4 ab | 2.3 ab |
| Kraft paper netting | 1.2 abc | 0.7 a | 0.4 ab | 2.3 ab |
| Fiberglass and asphalt emulsion | 1.4 abc | 0.8 a | 0.3 ab | 2.5 ab |
| Wood cellulose and asphalt emulsion | 1.6 bc | 0.6 a | 0.3 ab | 2.5 ab |
| Corncobs and asphalt emulsion | 1.3 abc | 1.0 a | 0.4 ab | 2.7 ab |
| Prairie hay and wide-weave paper netting | 1.8 c | 0.7 a | 0.3 ab | 2.8 ab |
| Woodchips and asphalt emulsion | 1.7 c | 0.8 a | 0.4 ab | 2.9 b |

[a]Phosphorus loss followed by same letter not significantly different (5% level).

stands. Also, if the seed and soil are moved by runoff (inadequate mulch), much of the grass seed will be covered too deeply to germinate.

Few bromegrass seeds were lost in the runoff from plots mulched with jute netting, wood excelsior, prairie hay and fiberglass anchored with asphalt emulsion, fiberglass, and asphalt emulsion alone. Conversely, the latex, kraft paper netting, prairie hay anchored with wide-weave mesh netting, and wood cellulose did not control the movement and loss of grass seeds from the plot surface. Mulch materials that provided adequate protection against soil loss likewise prevented movement of the grass seed.

### Phosphorus Loss

A relatively wide range of phosphorus losses was measured in the eroded soil removed from the mulch test plots (Table 4). Since these losses are dependent on the amount of soil loss under the various mulch materials, the results obtained are similar to those for soil loss. Mulches of jute netting, wood excelsior, and fiberglass anchored with asphalt emulsion permitted the least phosphorus loss in the eroded soil; however, the values are not significantly less than those for most of the other mulches. The plots covered with kraft paper netting indicated significantly greater losses than those plots mulched with latex and, in turn, these two materials permitted significantly higher phosphorus losses than all other mulch materials.

After the first storm, phosphorus losses in the runoff water were relatively constant for the various mulch materials (Table 4) with no significant differences measured. Only the losses occurring in the runoff from the first 3.5 in. of water applied appeared to be dependent on the mulch material.

The average phosphorus lost in the eroded soil for all three storms was 2.6 lb/acre, and that lost in the runoff water was 2.2 lb/acre. The total phosphorus loss ranged from 13.6 lb/acre (16.5 percent lost) for plots mulched with kraft paper netting to 2.5 lb/acre (3 percent lost) for jute netting-mulched plots. Such losses are relatively small in comparison to the total amount (83 lb/acre) applied. Adequate amounts of available phosphorus should still remain on the plots under most of these mulches. It is possible, however, that the phosphorus fertilizer was moved and concentrated in areas on the plots with more erosion.

## SUMMARY

Simulated rainstorms of 2.5 and 5.0 in./hr were applied to plots located on a 3:1 roadside backslope and mulched with various materials. The plots were uniformly seeded with bromegrass and fertilized with phosphorus. The protection afforded against water erosion by each mulch was evaluated by measuring soil, grass seed and phosphorus losses. The best protection was given by materials such as jute netting, wood excelsior, and prairie hay (1 ton/acre) or fiberglass (1000 lb/acre) anchored with asphalt emulsion (150 gal/acre). The least effective mulches were latex (150 gal/acre) and kraft paper netting.

The most effective mulches were those providing both protection from raindrop impact and adherence to the soil surface. Anchoring a material with asphalt emulsion provided increased adherence to the soil surface and was generally beneficial. Adherence of the mulches to the soil surface increased surface detention of the runoff water and eliminated the undercutting of the mulch material which was a serious problem with some of the nettings.

## ACKNOWLEDGMENTS

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# Mulches for Grass Establishment on Steep Construction Slopes

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•THE Nebraska Department of Roads is constantly faced with the problem of establishing and maintaining vegetative cover along roadsides throughout the state. Prairie grass hay is most commonly used for mulching purposes. Anchorage is effectively and economically accomplished by means of a tractor-drawn mulch packer (4). Conventional tractor-drawn equipment, however, cannot be operated safely on slopes steeper than 4:1. For the purposes of this paper a steep slope is defined as one with a gradient of less than 4:1.

Slopes steeper than 4:1 pose special problems in the establishment of vegetation. Mulches, other than prairie hay and grain straw, and methods of application should be evaluated on steep slopes for ease of application, feasibility, erosion control, soil moisture retention, and for their effect on soil temperature during the critical periods of germination and establishment.

In 1965, a cooperative study was initiated between the Department of Agricultural Engineering and the Department of Horticulture and Forestry at the University of Nebraska. The purpose was to evaluate a number of mulching materials relative to their effects on erosion control and grass establishment on a variety of different soil types, slope gradients and cut and fill sections. Swanson et al (5) presents the results of the first study on a 3:1 roadside cut section relative to erosion control under simulated rainstorms. The objective of this paper is to evaluate the same selected mulches on the same regraded slope and soil type in terms of their effects on soil temperature, soil moisture and seedling grass cover during the critical period of germination and establishment.

## MATERIALS AND METHODS

On September 3, 1965, thirteen mulch treatments were applied to plots along State Spur 341 approximately 2 miles south of Firth, Nebraska. Plots 10 ft wide by 20 ft long were replicated twice in a randomized block design on a west-facing 3:1 backslope. A check plot receiving no mulch was included in each replication.

The soil on the experimental site is classified as a Wymore silty clay loam and tested pH 6.7, very low (5 ppm) in phosphorus and high (215 ppm) in potassium. Therefore, a 16-48-0 fertilizer at the rate of 415 lb/acre was applied to the surface but was not worked in. All plots were seeded with Lincoln bromegrass (Bromus inermis Leyss.) at the rate of 120 pure live seeds per square foot with a cyclone-type seeder. The mulch treatments at the rates given in Table 1 were then applied.

Data were gathered on soil temperatures, soil moisture, seedling stand, seedling height and percent cover as affected by each mulch treatment.

Since, with favorable moisture, Lincoln bromegrass will germinate and emerge in 7 to 10 days after seeding, soil temperatures and soil moisture were measured 6 days after seeding so as to be unaffected by grass growth.

Soil temperatures were measured at a ½-in. depth at random within thirds of each plot by means of a 3-probe thermistor thermometer. Soil temperatures were measured

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TABLE 1

MULCH TREATMENTS, DESCRIPTION AND RATES OF APPLICATION

| Mulch Treatment[a] | Description and Method of Application | Rate (per acre) |
|---|---|---|
| Latex | Emulsifiable material diluted 1:6 with water and sprayed on | 1050 gal |
| Fiberglass | Continuous filaments of fiberglass applied with compressed air | 1000 lb |
| Wood cellulose | Wood cellulose fiber applied hydraulically as a water slurry | 1000 lb in 3000 gal |
| Asphalt | Emulsifiable asphalt diluted 1:1 with water and sprinkled on | 2400 gal |
| Fiberglass and asphalt | Fiberglass anchored with 1:5 asphalt emulsion | 1000 lb and 900 gal |
| Wood cellulose and asphalt | Wood cellulose fiber anchored with 1:5 asphalt emulsion | 1000 lb and 900 gal |
| Woodchips and asphalt | Pine woodchips from portable chipper anchored with 1:5 asphalt emulsion | 6 tons and 900 gal |
| Corncobs and asphalt | Ground corncobs slightly larger than ¼ in. anchored with 1:5 asphalt emulsion | 5 tons and 900 gal |
| Prairie hay and asphalt | Prairie hay anchored with 1:5 asphalt emulsion | 1 ton and 900 gal |
| Prairie hay and light paper netting | Prairie hay anchored with tightly twisted kraft paper netting with a 2 × 0.5 yarn count | 1 ton |
| Medium paper netting | Tightly twisted, random colored kraft netting with a 7 × 4 yarn count | |
| Excelsior mat | High grade wood excelsior covered with large mesh, kraft paper netting | |
| Jute netting | Heavy woven jute net with a 1.6 × 1.1 yarn count | |
| No mulch | | |

[a]The latex is manufactured by the Velsicol Chemical Corp.; the fiberglass by the Pittsburgh Plate Glass Co.; the wood cellulose by the International Paper Co.; the asphalt (LS-1) by the American Bitumuls and Asphalt Co.; the paper nettings and jute net by the Bemis Bros. Bag Co.; the excelsior mat by American Excelsior Corp. The average composition of the prairie hay was 74 percent bluestem, 23 percent switchgrass, and miscellaneous grasses and weeds.

on a number of days, but only the date for September 11 and 13 are given in Table 2. The data on September 11 represent maximum and minimum relations on a clear day, while the temperatures on September 13 represent the maximum on a cloudy day. Minimum temperatures were taken from 6:00 to 7:00 a.m.; maximum temperatures were taken from 3:00 to 5:00 p.m.

Soil moisture was determined gravimetrically to a depth of ½ in. on September 9 by soil cores ¾ in. in diameter taken at two random locations within thirds of each plot. Soil cores were weighed, dried at 109 C for 24 hr and reweighed for moisture percentage.

Seedling stand, percent cover and seedling heights were observed on September 29 (26 days after seeding). Stand counts were made at random within quarters of each plot in a square foot quadrat. Percent cover was estimated by two independent observers within thirds of each plot, while seedling heights were measured at random within fifths of each plot. Grass cover percentages were also estimated 8 months and 14 months after seeding as a follow-up on the seedling phase.

TABLE 2

EFFECT OF MULCH TREATMENTS ON SOIL TEMPERATURE[a]

| Mulch Treatment | Sept. 11; Clear | | | Sept. 13; Cloudy |
|---|---|---|---|---|
| | Minimum | Maximum | Range | Maximum |
| Excelsior mat | 58.3 a | 82.0 a | 23.7 a | 71.8 ab |
| Prairie hay and light paper netting | 57.5 a | 85.0 b | 27.5 b | 71.8 ab |
| Fiberglass and asphalt | 57.5 a | 93.2 f | 35.7 def | 74.8 d |
| Prairie hay and asphalt | 57.0 ab | 86.8 bc | 30.6 bc | 72.3 ab |
| Corncobs and asphalt | 57.0 ab | 88.5 cd | 32.0 cd | 71.8 ab |
| Jute netting | 56.8 ab | 89.3 cd | 32.6 cde | 71.2 a |
| Asphalt | 56.2 bc | 101.5 g | 45.3 g | 76.5 e |
| Woodchips and asphalt | 56.2 bc | 89.5 de | 33.4 cdef | 73.2 bc |
| Latex | 56.2 bc | 90.2 de | 34.0 cdef | 71.7 ab |
| Wood cellulose and asphalt | 56.2 bc | 93.3 f | 37.2 f | 74.2 cd |
| Medium paper netting | 55.8 bc | 89.3 cd | 33.4 cdef | 72.5 bc |
| Fiberglass | 55.7 bc | 91.7 ef | 36.0 ef | 72.7 bc |
| No mulch | 55.2 c | 91.0 def | 35.7 def | 72.0 ab |
| Wood cellulose | 55.0 c | 90.3 de | 35.4 def | 72.2 ab |

[a]Any two means with different letters are significantly different at the five percent level.

All data were evaluated by analysis of variance. Duncan's Multiple Range test (3) was applied to identify differences significant at the 5 percent level of probability.

## RESULTS

Daily precipitation records from the U.S. Weather Bureau for September are given in Table 3. Precipitation following seeding was favorable. Rain fell on 16 days during September. The total amount of 5.82 in. was 2.55 in. above normal for the month.

The influence of the various mulch treatments on soil temperature ½ in. below the soil surface taken 9 days after seeding is given in Table 3. The plots treated with the excelsior mat had the highest minimum soil temperature, which averaged 58.3 F, but this treatment was not significantly different from prairie hay and light paper netting, fiberglass and asphalt, prairie hay and asphalt, corncobs and asphalt, and jute net treatments which averaged from 56.8 to 57.5 F. Likewise, all these treatments caused significantly higher minimum soil temperatures compared to the no-mulch treatment, which averaged 55.2 F.

TABLE 3

PRECIPITATION AT FIRTH, NEBRASKA FOR SEPTEMBER 1965

| Date | Amount | Date | Amount |
|---|---|---|---|
| 4 | 0.83 | 18 | 0.16 |
| 5 | T | 19 | 0.25 |
| 6 | 0.42 | 20 | 1.55 |
| 8 | 0.03 | 21 | 0.50 |
| 13 | 0.29 | 27 | 0.70 |
| 14 | 0.02 | 28 | 0.07 |
| 16 | 0.01 | 29 | T |
| 17 | 0.08 | 30 | 0.91 |
| | Month total | 5.82 | |
| | Normal | 3.27 | |

[a]Data from U.S. Weather Bureau.

The average maximum soil temperature under the excelsior mat was 82.0 F, which was significantly lower than all the other treatments; asphalt was 101.5 F, which was significantly higher than all other treatments. The maximum soil temperatures under the excelsior mat, the prairie hay and light paper netting, and the prairie hay and asphalt mulches were significantly lower, while the asphalt plots were significantly higher than the no-mulch plots, which average 91.0 F. The same relations held true for the day's range in soil temperatures.

Maximum soil temperatures taken on a cloudy day 10 days after seeding indicate

TABLE 4

EFFECT OF MULCH TREATMENTS ON SOIL MOISTURE, SEEDLING STAND, SEEDLING HEIGHT, AND PERCENT COVER[a]

| Mulch Treatment | Soil Moisture, Percent (6 days) | Seedlings per sq ft (26 days) | Seedling Heights, cm (26 days) | Percent Cover (26 days) |
|---|---|---|---|---|
| Excelsior mat | 28.0 a | 104.1 a | 11.1 a | 66.7 a |
| Prairie hay and asphalt | 25.0 ab | 71.1 ab | 9.6 ab | 59.2 a |
| Prairie hay and light netting | 24.9 abc | 81.2 ab | 9.4 bc | 64.2 a |
| Asphalt | 24.9 abc | 18.8 c | 5.1 f | 5.2 e |
| Woodchips and asphalt | 22.6 bcd | 83.4 ab | 8.5 bc | 66.7 a |
| Jute netting | 22.6 bcd | 82.2 ab | 7.2 de | 36.7 bc |
| Corncobs and asphalt | 22.0 bcd | 91.9 ab | 8.0 cd | 66.7 a |
| Medium paper netting | 21.6 bcd | 67.8 ab | 6.2 ef | 27.5 bcd |
| Latex | 21.4 bcd | 59.6 b | 5.5 ef | 14.3 de |
| Fiberglass | 20.8 bcd | 76.6 ab | 5.4 f | 22.5 cde |
| Wood cellulose and asphalt | 20.8 bcd | 72.5 ab | 7.2 de | 45.8 ab |
| Fiberglass and asphalt | 20.5 bcd | 68.0 ab | 7.2 de | 25.8 bcde |
| No mulch | 20.4 cd | 57.5 b | 5.7 ef | 18.3 cde |
| Wood cellulose | 19.6 d | 75.6 ab | 6.3 ef | 18.3 cde |

[a]Any two means with different letters are significantly different at the five percent level.

the asphalt plots were significantly warmer than the other plots. Plots containing asphalt, fiberglass and asphalt, and wood cellulose and asphalt mulches had significantly higher soil temperatures on a cloudy day compared to the no-mulch plots.

The data for soil moisture percentage, seedling stands, seedling heights and percent cover are given in Table 4. The plots with excelsior mat had the highest soil moisture averaging 28.0 percent in the top ½ in. of soil, but these plots were not significantly different in moisture content from plots having prairie hay and asphalt, prairie hay and light paper netting, or asphalt treatments, which averaged 24.9 percent. The excelsior mat and the prairie hay and asphalt plots contained a significantly higher soil moisture percentage than did the no-mulch plots, which averaged 20.4 percent.

Although the excelsior treatment averaged 104.1 seedlings per square foot, this stand was not significantly different from those treatments which had a minimum average of 67.8 seedlings per square foot. The asphalt-treated plots averaged only 18.8 seedlings per square foot, which was significantly lower than all other treatments. Only the excelsior-treated plots had significantly more seedlings per square foot compared to the no-mulch plots, which averaged 57.5.

The excelsior-treated plots had the highest seedling heights, averaging 11.1 cm, but not significantly different from the prairie hay and asphalt treatment, which averaged 9.6 cm. Both of these treatments plus prairie hay and light paper netting, woodchips and asphalt, and corncobs and asphalt treatments had significantly higher seedling heights compared to the no-mulch plots, which average 5.7 cm.

The highest grass cover of 66.7 percent was found on plots treated with excelsior mat, woodchips and asphalt, and corncobs and asphalt, although these treatments were not significantly different from prairie hay and asphalt, prairie hay and light paper netting, and wood cellulose and asphalt treatments, which averaged from 45.8 to 64.2 percent. These 6 treatments had significantly more grass cover than the no-mulch plots, which averaged 18.3 percent.

The analysis of variance of the data gathered at different locations within the plots showed that soil temperatures and soil moisture percentages were consistent and not

TABLE 5

PERCENT GRASS COVER 8 AND 14 MONTHS AFTER SEEDING[a]

| Mulch Treatment | Percent Cover May 24, 1966 | Percent Cover Nov. 30, 1966 |
|---|---|---|
| Excelsior mat | 93.5 a | 89.2 a |
| Prairie hay and light paper netting | 78.2 ab | 75.8 ab |
| Woodchips and asphalt | 73.5 b | 69.2 b |
| Corncobs and asphalt | 72.5 b | 71.7 b |
| Jute netting | 71.7 b | 70.0 b |
| Prairie hay and asphalt | 71.5 b | 74.2 ab |
| Wood cellulose and asphalt | 52.5 c | 53.3 c |
| Medium paper netting | 51.7 c | 47.5 c |
| Fiberglass and asphalt | 50.8 c | 45.8 c |
| Fiberglass | 48.3 c | 46.7 c |
| No mulch | 38.3 cd | 38.3 cd |
| Latex | 35.8 cd | 47.5 c |
| Asphalt | 35.8 cd | 30.0 d |
| Wood cellulose | 29.2 d | 43.3 cd |

[a]Any two means with different letters are significantly different at the five percent level.

significantly different throughout the length of the plots. There were, however, significantly shorter seedlings in the top one-fifth of the plots. Seedlings in the second fifth were significantly taller than the first fifth but still significantly shorter than the remaining three-fifths of the plots. There were significantly fewer seedlings per square foot in the top one-fourth and significantly less cover in the top one-third of the plots. All interactions of mulch times location were not found to be significant.

The data for grass cover percentage 8 and 14 months after seeding are given in Table 5. After 8 months, the plots treated with excelsior mat averaged 93.5 percent cover but were not significantly different from the plots treated with prairie hay and light paper netting which averaged 78.2 percent. In addition, plots treated with jute netting, and asphalt-anchored mulches of woodchips, corncobs, and prairie hay all had significantly more grass cover than did the no-mulch plots which averaged 38.3 percent.

Essentially the same relation was true after 14 months, except the excelsior mat and prairie hay and light paper netting mulches were not significantly different in grass cover as compared to the prairie hay and asphalt-anchored plots.

Significantly less cover was found in the top third of the plots as compared to the middle and bottom thirds at both the 8 and 14 month periods. All interactions of mulch times location were not significant.

## DISCUSSION

As a result of the rains during the period of September 4 to 8, seedling emergence began only 5 days after seeding. It was surprising to find differences significant at the 1 percent level in soil moisture percentages 6 days after seeding. As the plots did not have an opportunity to dry during this period, these data may indicate the mulches' influence on moisture infiltration into the soil rather than an effect on retarding evaporation. Wymore silty clay loam soil is characterized by a low infiltration rate but high water-holding capacity. The plots with excelsior mat had the highest soil moisture percentage, apparently because the excelsior mat intercepted more rainfall and allowed less runoff from the plots. Since no dry period intervened before seedling emergence, the mulches' effect on soil moisture retention could not be evaluated.

Because of the favorable amount and distribution of rainfall following seeding, many of the mulch treatments were not significantly different in seedling stand from the no-mulch plots. However, the asphalt-treated plots were found to have significantly fewer seedlings per square foot compared to the no-mulch plots. Since the asphalt plots had good soil moisture, the poor grass stand may have been due to the higher soil temperatures and the wider range between the extremes in daily soil temperature. The rate of 1200 gal/acre of emulsifiable asphalt may also have had a deleterious effect on germination. McKee et al (1) also found the liberal use of asphalt by itself actually retarded germination and lowered seedling stands.

September 13 was completely overcast until noon and partly sunny during the afternoon. Under these conditions the plots containing asphalt, fiberglass and asphalt, and wood cellulose and asphalt mulches had significantly higher soil temperatures than did the no-mulch plots.

Because of differences in seedling maturity and degree of tillering, percent of grass cover is considered to be more valid for evaluating mulches than the seedling stand. Only two treatments were significantly different in seedling stands from the no-mulch plot. However, on the basis of percent cover 6 treatments were statistically better than the no-mulch plots.

Significant differences in the upper areas of the plots were found in seedling heights, seedling stands and percent cover. This is in contrast to soil moistures and soil temperatures. Usually a poorer stand at the slope apex is attributed to a lack of moisture and high soil temperature as compared to the bottom of the slope (2). Although rainfall amounts during September were considered above normal and distribution good, there were two periods, one for 6 days and one for 7 days, during which no precipitation was received. There is a possibility that the soil surface may have dried during these short periods, in spite of the mulches, to account for differences within the plots.

In general, the better-performing mulches evaluated at 26 days after seeding remained consistently better for the first year as compared to the no-mulch plot with the exceptions of jute netting and wood cellulose anchored with asphalt. After 8 months the grass cover on the plots treated with jute netting increased to 72 percent which was significantly more than the no-mulch treated plots, which averaged 38 percent cover. The wood cellulose and asphalt-anchored plots averaged 52 percent cover which was not significantly better than the no-mulch plots.

## SUMMARY

Thirteen mulch treatments were evaluated on plots seeded to Lincoln bromegrass on a 3:1 roadside backslope in September 1965. Plots protected with excelsior mat, prairie hay anchored with a loose paper netting, or a combination of emulsifiable asphalt as an anchorage for woodchips, chopped corncobs, prairie hay, or wood cellulose had significantly more grass cover than did the no-mulch treatment one month after seeding. Although differences in soil moisture percentages and soil temperatures between mulch treatments were statistically significant, these factors apparently had no great practical effects on seedling grass stands—with one exception. The poor stand of grass on the plots mulched with emulsifiable asphalt may have been due to high soil temperatures and the wide range between soil temperature extremes. The rate of 1200 gal/acre also may have been excessive for good germination. Differences between mulches probably would have been greater under conditions of normal, or preferably below normal, precipitation.

The most effective mulches one year after seeding were excelsior mat, prairie hay anchored with a light paper netting and prairie hay anchored with emulsifiable asphalt.

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# Fertilization of Established Roadside Turf With Various Rates and Sources of Nitrogen Fertilizers

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A field evaluation of ammonium nitrate, urea, coated urea, ureaform and a natural organic at 25, 50, 100 and 150 lb of nitrogen per acre for fertilization of bermudagrass (Cynodon dactylon) sod on highway roadsides showed that the first two sources produced the most desirable sod density during the first growing season after application. During the second season, sod fertilized with ureaform was equal in density to that produced by ammonium nitrate, urea, and coated urea.

In the spring and early summer months after application, mixtures containing proportionally more ammonium nitrate than ureaform produced a denser sod than the reciprocal mixtures. However, by the end of the growing season, mixtures containing equal and greater amounts of ureaform to ammonium nitrate were producing sod of density equal to mixtures containing higher amounts of ammonium nitrate. All studies indicated that at least 100 lb of nitrogen are needed during the first season to develop a dense erosion-resistant turf, and that slow-release sources in combination with readily soluble sources can reduce fertilizer application frequencies and mowing costs.

•MAINTAINING established sods with sufficient density to resist erosion on roadside backslopes is a critical problem. Thousands of acres of roadside backslopes in Mississippi have been established to excellent stands of bermudagras and other grasses only to be lost to the ravages of erosion during the early years of maintenance. Inadequate soil nitrogen is believed to be the most limiting factor in maintaining grass sods in Mississippi. Most soils in Mississippi and throughout the Southeastern United States developed under an ecology of high mean temperatures and excessive rainfall, which produced very thin, sandy surface soils and very dense, highly erosive clay subsoils—both low in nitrogen. Fertilizer nutrients, particularly soluble nitrogen, applied to these soils are often leached away because of the high annual rainfall and erosive natur of the soils.

Experiments show that fertilizing with nitrogen has been very effective in maintainir established grasses on roadsides, and in providing adequate growth to resist erosion. However, several problems exist in the use of nitrogen fertilizer. Where the water-soluble sources of nitrogen are used, it is difficult to obtain grass growth adequate to provide erosion resistance without excessive overgrowth. Commonly used nitrogen sources such as ammonium nitrate or urea are readily available and cause a rapid, lus growth which usually results in at least one extra mowing. These mowings are costly and often remove excessive amounts of vegetative top growth, leaving the sod vulnerab to erosion, especially if mowing occurs in late summer and no significant growth occurs before dormancy of the bermudagrass.

Another problem is that the period of stimulated growth obtained from an applicatio of water-soluble nitrogen sources is only about 60 to 90 days, which means that where

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only water-soluble sources are used, annual applications of nitrogen fertilizer are needed. This frequency of application is expensive since labor costs are a large portion of the cost of fertilizing roadsides.

The use of a fertilizer which slowly releases nitrogen over a long period of time would seem ideal for use on roadsides. A slow release of nitrogen would prevent excessive growth yet give sustained growth longer than one season. The ureaformaldehydes and resin-coated soluble nitrogens release nitrogen more slowly than the currently available water-soluble sources.

The objectives of these experiments were: (a) to determine the optimum source and rate of nitrogen to apply to maintain a desirable turf, (b) to measure the rate of release and the percent recovery of nitrogen from these sources, and (c) to measure the suitability of mixtures of slow- and fast-release nitrogen sources for producing sustained growth of bermudagrass for periods greater than one season.

The studies were conducted on roadside slopes along Interstate and primary highways in central Mississippi during the growing seasons, and in greenhouses at Mississippi State University during winter seasons.

## RESULTS

### Comparison of Nitrogen Rates and Sources

This study consisted of four rates, 25, 50, 100 and 150 lb of actual nitrogen per acre arranged in a split-plot design with rates of nitrogen as the whole plots and sources as the subplots. Sources tested were ammonium nitrate, urea, coated urea, ureaformaldehyde and a natural organic. Some physical and chemical characteristics of these materials are given in Table 1. The study consisted of three replications and was established at two locations. Plot size was 10 ft by 50 ft, the latter running vertically up the backslope.

Data taken 6 months after nitrogen application are given in Table 2. According to the visual rating system employed at the time of these measurements, it was thought that a sod which received a density rating of 5 would provide a ground cover sufficient for erosion protection. All density ratings reported were average ratings for three independent visual estimates, rated on the basis of 1 to 10, with 10 being the densest sod. The density rating takes into consideration the ground cover, thickness of sod, ratio of leaves to stems and height of grass.

Table 2 shows that as the nitrogen rate was increased, there was an increase in sod density for each nitrogen source; i.e., as the actual nitrogen was increased from 25 to 150 lb/acre, the average density increased from 3.8 to 7.4. Six months after nitrogen application, the more soluble sources, ammonium nitrate, urea and coated urea, produced a denser sod than did the slower release sources, ureaformaldehyde and natural organic. After a period of 6 months, the only plots not producing the minimum acceptable density rating, 5, were the 25-lb rates of urea, coated urea, ureaformaldehyde and the natural organic and the 50-lb rate of ureaformaldehyde. Grass in all other plots gave acceptable erosion protection.

Table 3 gives the density ratings of the same bermudagrass 12 months after nitrogen application. Again, the more soluble forms of nitrogen were producing the densest sod.

TABLE 1

NITROGEN SOURCES

| Source | Description or Formula | Percent Nitrogen | Estimated Release |
|---|---|---|---|
| Ammonium nitrate | $NH_4NO_3$ | 33 | Fast |
| Urea | $CO(NH_2)_2$ | 45 | Fast |
| Ureaformaldehyde | Urea derivative | 38 | Slow |
| Coated urea[a] | Urea derivative | 20 | Slow-Fast |
| Sewerage sludge | Natural organic | 6 | Slow |

[a]This is a combination of a fast-release and a slow-release nitrogen contained in a pharmaceutical covering.

TABLE 2

SOD DENSITY AT SIX MONTHS[a]

| Nitrogen Source | Pounds of N per Acre | | | | Mean |
|---|---|---|---|---|---|
| | 25 | 50 | 100 | 150 | |
| Ammonium nitrate | 5.0 | 6.3 | 7.2 | 8.5 | 6.8 |
| Urea | 4.2 | 6.2 | 7.0 | 7.8 | 6.3 |
| Coated urea | 4.2 | 5.2 | 7.0 | 8.0 | 6.1 |
| Ureaformaldehyde | 2.8 | 4.0 | 5.0 | 5.8 | 4.4 |
| Natural organic | 3.0 | 5.0 | 5.2 | 6.8 | 5.0 |
| Mean | 3.8 | 5.3 | 6.3 | 7.4 | |

[a]In this and all subsequent tables, a rating of 10 was the most dense sod and a rating of 5 would have been adequate for erosion protection.

TABLE 3

SOD DENSITY AT TWELVE MONTHS

| Nitrogen Source | Pounds of N per Acre | | | | Mean |
|---|---|---|---|---|---|
| | 25 | 50 | 100 | 150 | |
| Ammonium nitrate | 6.0 | 5.8 | 8.5 | 9.8 | 7.5 |
| Urea | 5.5 | 6.2 | 7.2 | 8.5 | 6.9 |
| Coated urea | 5.0 | 5.0 | 7.5 | 8.2 | 6.4 |
| Ureaformaldehyde | 4.0 | 4.8 | 6.2 | 6.2 | 5.3 |
| Natural organic | 3.8 | 5.5 | 5.8 | 6.5 | 5.4 |
| Mean | 4.8 | 5.5 | 7.0 | 7.8 | |

TABLE 4

SOD DENSITY AT EIGHTEEN MONTHS

| Nitrogen Source | Pounds of N per Acre | | | | Mean |
|---|---|---|---|---|---|
| | 25 | 50 | 100 | 150 | |
| Ammonium nitrate | 6.0 | 5.8 | 8.5 | 9.8 | 7.5 |
| Urea | 5.5 | 6.2 | 7.2 | 8.5 | 6.9 |
| Coated urea | 5.0 | 5.0 | 7.5 | 8.2 | 6.4 |
| Ureaformaldehyde | 4.0 | 4.8 | 6.2 | 6.2 | 5.3 |
| Natural organic | 3.8 | 5.5 | 5.8 | 6.5 | 5.4 |
| Mean | 4.8 | 5.5 | 7.0 | 7.8 | |

However, the density produced by the slow-release sources was increasing and the difference in densities produced by the slow-release and rapid-release sources of nitrogen were of a smaller magnitude. At this 12-month rating, the only plots which were producing unacceptable sod densities (less than 5) were those receiving the 25-lb rates of ureaformaldehyde and the 25-lb rate of natural organic.

A great change in trend of sod density produced by the various sources was evident 18 months after nitrogen application (Table 4). At this time, the densest sod was produced by the urea, followed by ammonium nitrate. There was no significant difference produced by the slow-release and the fast-release sources. Plots which received only 25 lb of nitrogen from slow release sources were not producing ground cover sufficient for erosion protection; the 100 and 150 lb of nitrogen from all the sources were producing adequate densities.

For comparison purposes, a summary of ammonium nitrate and the ureaformadehyde at 6, 12 and 18 months is given in Table 5. There was a significant difference in ground cover at 6 months and 12 months; but at 18 months after nitrogen application, there was no significant difference in ground cover produced by these two sources. A dense, lush growth was obtained from the ammonium nitrate as evidenced by the mean density rating of 8.4; whereas a rating of 5 would have been sufficent for erosion protection. The growth rate produced by the ureaformaldehyde was uniform throughout the 18-month period, with a mean rating of 6.0. Therefore, the most ideal growth rate was obtained from the ureaformaldehyde. It did not produce a lush growth which would have required mowing.

## Determination of Release Rate and Recovery of Nitrogen Fertilizer

This study utilized the same five sources: ammonium nitrate, urea, coated urea, ureaformaldehyde and the natural organic. Each source was applied at rates of 50, 100, 150 and 300 lb of actual nitrogen per acre to bermudagrass sod. The experiment was conducted in the greenhouse in 2-gal pots for 4 months. Dry matter yield of clippings was obtained at 3 months and at the conclusion of the study at 4 months. After each of the harvests the plant materials were analyzed for percent nitrogen. From the percent nitrogen, the percent nitrogen recovery was calculated by the following formula:

TABLE 5

SOD DENSITY AS AFFECTED BY 150 lb NITROGEN FROM 2 SOURCES

| Nitrogen Source | Months After N Application | | | Mean |
|---|---|---|---|---|
| | 6 | 12 | 18 | |
| Ureaformaldehyde | 5.8 | 6.2 | 5.9 | 6.0 |
| Ammonium nitrate | 8.5 | 9.8 | 7.0 | 8.4 |

TABLE 6

PERCENT NITROGEN RECOVERY IN CLIPPINGS AT THREE MONTHS

| Nitrogen Source | Pounds of N per Acre | | | |
|---|---|---|---|---|
| | 50 | 100 | 150 | 300 |
| Ammonium nitrate | 63 | 53 | 42 | 22 |
| Urea | 55 | 51 | 42 | 23 |
| Coated urea | 67 | 55 | 41 | 21 |
| Ureaformaldehyde | 24 | 18 | 21 | 17 |
| Natural organic | 14 | 14 | 12 | 9 |

TABLE 7

PERCENT NITROGEN RECOVERY IN CLIPPINGS AT FOUR MONTHS

| Nitrogen Source | Pounds of N per Acre | | | |
|---|---|---|---|---|
| | 50 | 100 | 150 | 300 |
| Ammonium nitrate | 14 | 21 | 24 | 17 |
| Urea | 7 | 11 | 15 | 18 |
| Coated urea | 14 | 23 | 24 | 16 |
| Ureaformaldehyde | 7 | 5 | 5 | 4 |
| Natural organic | 7 | 7 | 6 | 4 |

TABLE 8

PERCENT NITROGEN RECOVERY IN ROOTS AT FOUR MONTHS

| Nitrogen Source | Pounds of N per Acre | | | |
|---|---|---|---|---|
| | 50 | 100 | 150 | 300 |
| Ammonium nitrate | 3.5 | 3.5 | 4.7 | 2.9 |
| Urea | 3.5 | 3.5 | 3.5 | 3.4 |
| Coated urea | 3.5 | 3.5 | 4.7 | 4.1 |
| Ureaformaldehyde | 3.0 | 1.8 | 1.2 | 1.2 |
| Natural organic | 3.5 | 1.8 | 1.2 | 1.2 |

$$\text{Percent N Recovery} = \frac{\text{Treatment (Yield} \times \% \text{ N)} - \text{Check (Yield} \times \% \text{ N)}}{\text{N Applied to Treatment}} \times 100$$

Table 6 gives the percent nitrogen recovery in bermudagrass tops at 3 months. As expected, the percentage of nitrogen recovered was greatest from the more soluble sources of nitrogen. At rates within a given nitrogen source the lower the pounds of nitrogen applied, the higher the percent recovery. The soluble sources of nitrogen were the only sources in which more than half of the nitrogen applied was recovered at the first clipping.

Table 7 gives the percent nitrogen recovery in the tops at 4 months. The uptake of nitrogen was similar to that obtained at 3 months. However, the amount of nitrogen recovered from any treatment was reduced considerably from the 3-month clipping. The amount recovered from ureaformaldehyde and the natural organic was a very small portion of the total nitrogen applied.

Table 8 gives the percent nitrogen recovered in the roots of bermudagrass at the 4-month harvest. There were no significant differences in the nitrogen recovery in the roots; however, the trend was toward a smaller recovery from the slow-release sources.

Total nitrogen recovery is given in Table 9. Plants fertilized with the low rate of ureaformaldehyde recovered only 34 percent as compared to an average of 76 percent nitrogen recovery for the more soluble sources of ammonium nitrate, urea and the coated urea. As the pounds of nitrogen per acre were increased, the percent recovery decreased considerably.

## Performance of Ureaformaldehyde-Ammonium Nitrate Mixtures

In another series of studies, combinations of ureaformaldehyde and ammonium nitrate applied in mixtures to established bermudagrass sod were evaluated. Sixty-six lb of actual nitrogen were used as the total nitrogen in half of the experiment and 100 lb of total nitrogen were used in the other half. This experiment was conducted in south Mississippi and was observed through 1965 and 1966. Ratings were made in May, June and November 1965, and during June 1966. The fractions of nitrogen applied at the 66-lb/acre rate from ureaformaldehyde and ammonium nitrate are given in Table 10.

TABLE 9

PERCENT NITROGEN RECOVERY IN TOTAL PLANT MATERIALS

| Nitrogen Source | Pounds of N per Acre | | | |
|---|---|---|---|---|
| | 50 | 100 | 150 | 300 |
| Ammonium nitrate | 80 | 78 | 70 | 42 |
| Urea | 65 | 65 | 60 | 43 |
| Coated urea | 84 | 81 | 69 | 41 |
| Ureaformaldehyde | 34 | 25 | 27 | 28 |
| Natural organic | 18 | 23 | 19 | 14 |

Where only 66 lb of total nitrogen were applied, none of the plots were giving sufficient erosion protection (rating of 5.0) when rated 1 year and 6 months after nitrogen application. At no time during the study did the check plot give sufficient erosion protection.

Table 11 gives the fractions of nitrogen for the two sources totaling 100 lb/acre. After 1 year and 6 months the density of

TABLE 10

SOD DENSITY AS AFFECTED BY MIXTURES OF NITROGEN SOURCES

| Pounds N/Acre | | 1965 | | | 1966 | Mean |
|---|---|---|---|---|---|---|
| Ureaform | $NH_4NO_3$ | June | Sept. | Nov. | June | |
| 66 | 0 | 3.7 | 3.4 | 3.8 | 4.3 | 3.8 |
| 50 | 16 | 5.3 | 3.8 | 5.0 | 3.7 | 4.5 |
| 33 | 33 | 6.6 | 5.2 | 7.3 | 3.0 | 5.5 |
| 16 | 50 | 5.4 | 5.2 | 5.8 | 3.7 | 5.0 |
| 0 | 66 | 7.2 | 6.2 | 7.0 | 4.0 | 6.1 |
| 0 | 0 | 2.5 | 1.6 | 1.7 | 1.0 | 1.7 |

TABLE 11

SOD DENSITY AS AFFECTED BY MIXTURES OF NITROGEN SOURCES

| Pounds N/Acre | | 1965 | | | 1966 | Mean |
|---|---|---|---|---|---|---|
| Ureaform | $NH_4NO_3$ | June | Sept. | Nov. | June | |
| 100 | 0 | 3.9 | 4.1 | 4.7 | 3.7 | 4.1 |
| 75 | 25 | 6.1 | 5.4 | 6.7 | 5.3 | 5.9 |
| 50 | 50 | 7.0 | 6.2 | 6.3 | 5.0 | 6.1 |
| 25 | 75 | 7.8 | 6.3 | 7.3 | 5.0 | 6.4 |
| 0 | 100 | 7.3 | 6.8 | 6.7 | 4.7 | 6.4 |
| 0 | 0 | 2.5 | 1.6 | 1.7 | 1.0 | 1.7 |

the sod receiving 100 lb of nitrogen from ureaformaldehyde was 3.7 and the density rating of the sod receiving 100 lb ammonium nitrate was 4.7. These sources alone did not provide sufficient erosion protection. However, mixtures of these two sources resulted in ratings of 5.3, 5.0 and 5.0 for the 75-25, 50-50 and 25-75 mixtures respectively. These combinations were producing an ideal growth rate for all four rating dates. No lush growth was obtained from these mixtures throughout the growing period, and during the second season ratings still indicated adequate erosion protection. Ammonium nitrate alone resulted in early periods of lush overgrowth, thus causing extra mowing problems (Table 11).

From the preceding data, two management systems for refertilization of roadsides could be employed: (a) 100 lb of nitrogen applied biennially with one-half in a slow-release form and one-half in the form of a soluble source of nitrogen, or (b) at least 66 lb of nitrogen from ammonium nitrate could be applied annually. In an attempt to compare costs of these two systems, the following assumptions were made:

| | |
|---|---|
| Ammonium nitrate cost | $ 66.00 per ton |
| Ureaformaldehyde cost | 250.00 per ton |
| Cost of fertilizer application | 2.00 per 100 lb |
| Assume 1 (one) extra mowing per year where ammonium nitrate is used alone | 5.00 per acre |

From the above assumptions, the cost of the two maintenance systems for a 2-year period is as follows:

A. Combination slow release-fast release nitrogen

| | |
|---|---|
| 50 lb N from ammonium nitrate | $ 5.00 |
| 50 lb N from ureaformaldehyde | 18.50 |
| Cost of application | 6.00 |
| Total cost for 2 years | $29.50 per acre |

B. Fertilize annually with ammonium nitrate alone

| | | |
|---|---|---|
| 66 lb N from ammonium nitrate | 6.60 × 2 years = | $13.20 |
| Cost of application | 4.00 × 2 years = | 8.00 |
| Mowing per acre (extra) | 5.00 × 2 years = | 10.00 |
| Total cost for 2 years | | $31.20 per acre |

Excess of system B over system A = $31.20 − 29.50 = $ 1.70 per acre

## SUMMARY

1. At least 50 lb of nitrogen from the soluble sources and at least 100 lb of nitrogen per acre from the slow release sources were required to develop a bermudagrass turf dense enough to resist erosion on roadside backslopes.

2. Ammonium nitrate alone did not provide an ideal nitrogen release pattern for roadsides in Mississippi, because it gave periods of dense overgrowth.

3. Ureaformaldehydes alone provided neither adequate immediate nor residual release of nitrogen.

4. Combinations of ammonium nitrate and ureaformaldehyde applied in mixtures produced sods with adequate erosion protection and showed promise of providing sustained nitrogen release well into the second season after application. These combinations of nitrogen sources could reduce frequency of application and mowing costs.