



TRC9202

Roadside Vegetation Management

James Marshall

Final Report

*Arkansas State Highway
and Transportation
Department*

*TRC 9202
Roadside Vegetation Management
Final Report*

June 1992



Arkansas

ROADSIDE MANAGEMENT RECOMMENDATIONS

Report of

ROADSIDE VEGETATION SUBCOMMITTEE

ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT

JUNE 1992

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle ROADSIDE VEGETATION MANAGEMENT		5. Report Date June 1992	
		6. Performing Organization Code	
		8. Performing Organization Report No.	
7. Author(s) Roadside Vegetation Subcommittee		10. Work Unit No. (TRAIS)	
9. Performing Organization Name and Address Research Section Materials & Research Division		11. Contract or Grant No.	
		13. Type of Report and Period Covered Final	
		14. Sponsoring Agency Code	
12. Sponsoring Agency Name and Address Arkansas State Highway and Transportation Dept. P. O. Box 2261 Little Rock, AR 72203			
15. Supplementary Notes			
16. Abstract <p>The purpose of this study is to determine the adequacy of the roadside vegetation management program of the Arkansas State Highway and Transportation Department. Records of the Department were examined, input was received from the various divisions of the Department which are involved in roadside maintenance activities, District Engineers, and from the Adopt-A-Highway groups. Prior studies of others were examined and input received from bordering states.</p> <p>Following analysis of the information available, including files of public complaints concerning our programs, costs, and industry trends, recommendations concerning the roadside vegetation management programs were made for improving those programs.</p>			
17. Key Words Roadside Vegetation Vegetation Management Roadside Maintenance		18. Distribution Statement None	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 115	22. Price

MEMBERS OF THE
ROADSIDE VEGETATION SUBCOMMITTEE

Mr. Veral Pinkerton, Chairman

Bill Stanton

Phil McConnell

Doug Nielsen

Perry Johnston

Henry Droughter

Treeca Dyer

James Marshall, Project Coordinator

TABLE OF CONTENTS

Background.....	1
History.....	4
Literature.....	12
Mowing Considerations.....	24
Herbicide Considerations.....	26
Complaint Considerations.....	29
District Considerations.....	31
Public Considerations.....	35
Conclusions and Recommendations.....	36
Recommended Policy Statements.....	43

Background

The current roadside management program of the Arkansas State Highway and Transportation Department has evolved over time. Several new programs added along the way have made alterations in our methods inevitable. Periodic reviews of our programs are made to evaluate their effectiveness and to insure efficiency. This project was initiated to evaluate our program and determine whether our program has proper balance and orientation.

During the 1960's and 1970's much work was accomplished in the area of selection of species for roadside vegetation. The educational institutions and agricultural extension service were heavily involved. At the experimental stations many test plots were planted and evaluations conducted. They were subjected to various chemicals at the birth of our chemical program to determine the effectiveness of chemicals on particular species. This resulted in the seed mixtures that were specified on construction projects since then. The initial chemical work begun at these institutions led to our first chemical control program--the "Bermuda release" program. Through the 70's and 80's a concerted effort was directed to the extermination of Johnson grass on the right-of-way.

During the 80's several events led to the current roadside vegetation control program as administered by the Arkansas State Highway and Transportation Department. The Transportation Research Committee examined the vegetation control program in 1980

and a report was issued recommending that the Construction and Maintenance division develop, coordinate and implement a vegetation control program including herbicide usage and mowing and provide a forum through the Maintenance Superintendents for discussion of costs and policy.

In 1981 the Transportation Research Committee sponsored a project with the University of Central Arkansas, Conway, to determine the viability of various wildflowers for use on the highway rights of way. A report was issued recommending:

- (1) a reevaluation of current AHTD seeding specifications and maintenance procedures, and
- (2) directions for establishing native roadsides including seed lists and planting techniques.(1)

In 1988 the Transportation Research Committee sponsored a project to examine the effect of herbicides on the native wildflowers on highway rights of way. This was an in-house study conducted by the Environmental Division. The report from this project has not yet been completed.

During this time the Construction and Maintenance division has developed and implemented a comprehensive roadside vegetation control program including the use of herbicides and mowing techniques. They have documented their program and published the Manual for Vegetation Control for use by the Department. The Environmental Division has developed the Wildflower Program(2) and is working with several citizens groups to establish numerous scenic wildflower highways. The

Environmental Division is also the contact agency for the Reforestation Program(3) begun in 1989.

Throughout this time numerous complaints have been received from the public citing various Department actions. In many cases investigations have been made and specific actions taken to limit recurrences. One of the most noteworthy was the study completed by the Construction and Maintenance division which found that the direction of rotation of brush-cutter blades and direction of mowing can be taken into account and the number of "thrown" objects striking motorists' vehicles can be reduced.

In recent times the complaints which are received from the public sector have been increasingly about environmental concerns. Also, the public sector is having another effect on maintenance budgets as the Adopt-A-Highway program spreads. As more and more of our technical and logistical problems are solved, this introduces a new dimension for which we must again evaluate our roadside maintenance programs and determine their best direction.

History

Nearly sixty years ago at the first meeting of the American Association of State Highway Officials Committee on Roadside Beautification a resolution was adopted, to wit:

Whereas roadside beautification and its varied activities reduce highway maintenance costs by checking erosion, preventing slides, and controlling drifting snow, reduce accidents, increase adjacent property values, promote civic pride, equalize temperatures, open and reveal natural beauty, advertise the state be it resolved that 1) adequate width of highway right-of-way be acquired at the earliest time to provide for future widening and a detailed plan of beautification; 2) conservation of natural growth be recognized as of first importance and that unnecessary destruction of roadside plants be prohibited; 3) the absolute control of the right-of-way be vested in the Department of Highways; 4) responsibility for roadside beautification be vested in a competent person to carry out the work of the department and to encourage individuals and organizations to assist in beautifying town entrances and the roadsides in their localities. The committee is in full accord that these activities are of primary importance and should be included in the general plan of roadside beautification.(4)

The progress that has been made since 1937 has come in a series of steps. As highway officials come and go, the basic roadside development philosophy has continued to evolve. This evolution has led to more definitive statements so that some aspects of roadside development and beautification were assigned a purpose. Iurka et al. found that landscaping should:

1) complement the primary function of the road by preserving natural features and enhancing appearance; 2) improve the adjacent land by providing a "green belt" to screen the road from nearby residences, and, possibly, to

include the development of amenities such as parks, playgrounds and similar facilities; and 3) facilitate maintenance not only by erosion control but by reducing maintenance work, particularly the expensive mowing, pickup of litter, and snow and ice control.(5)

In contrast, a more holistic view proclaims that "manipulation of roadside vegetation by landscape architects needs to be considered in light of costs that this manipulation may create. Can the money spent for artificially high maintenance landscapers be better spent?"(6) This view, of the more recent vintage, "has contributed to the consternation experienced by some states which have seen their highway maintenance budgets dwindle."(7)

Function

Well designed and maintained landscaping serves a number of functions not the least of which are aesthetics, safety, soil stabilization, erosion control, and, hopefully, reduced maintenance costs. In urban areas it may also help preserve or possibly increase the property values of adjacent landowners while assisting in noise abatement.(8)

Duell suggests that planting highway vegetation is an apology for defacing the land in the path of a roadway. He states:

[t]he complete highway incorporates four basic elements into its design: utility, safety, economy, and beauty... appropriate vegetation is a part of each of these requirements.(9)

As there is little consensus on what is beautiful, no precise definition of highway beautification exists.(10) Kates suggests that a distinction must be made between seeking to

beautify and seeking to minimize ugliness.(11)

Regardless of the definition, one thing is certain, a highway perceived by the traveling public as aesthetically pleasing is invariably a safer highway.

It would appear then, that since the term 'highway beautification' cannot be defined, the term 'aesthetically pleasing' would be more appropriate. The definition of aesthetically pleasing will then be determined by the traveling public. A U.S. Bureau of Public Roads report found that "surveys of motorists' desires show that scenic or beautiful highways are preferred by nearly all highway users."(10)

Some motorists have such a strong preference for scenic roads that they will travel farther or longer in order to traverse a scenic highway.

Michaels found that "a freeway with complete control of access and good geometric design generates significantly less driver tension than less rigorous designs."(12) In a subsequent study he concluded that "whenever the alternates available are equally stress inducing, drivers will always choose the route that takes the least time."(13)

Conversely, Davidson deduced that:

"...drivers will actually tolerate a time loss, as well as a distance loss, if the total stress to which they may be subjected is perceptibly reduced."(14)

Hence, as stress is reduced, highway safety is increased. With this in mind, it would follow that highway beauty (aesthetics) and highway safety are a function of each other and must be

considered together for as separately each would be out of context. Therefore, the traveling public will define aesthetically pleasing when given an option.

While aesthetics and safety must be considered together, the same may be said about soil erosion control and stabilization and economy in maintenance. These two functions of well designed landscaping go hand in hand such that a roadside with few or no erosion or soil stabilization problems is a roadside with low maintenance costs. Logic dictates that roadsides with 1:1 cut or fill slopes will have more slumping and soil erosion and will have vegetation more difficult to maintain than roadsides with 3:1 slopes. It is here that initial highway planning is most critical and input from landscaping and maintenance personnel essential.

Planning

The planning and construction of highways has traditionally been the responsibility of planning, location, design and construction engineers and right-of-way appraisal and negotiation and attorneys. The driving force of location and design is too often economy of construction. Iurka et al. observed that planning of this nature "....can produce problems which must be lived with for the life of the road." (5) Deakin noted that the acquisition of inadequate right-of-way for initial economic savings is poor planning when the subsequent maintenance costs are significantly higher than they need have been. (15)

Many times design and construction of the roadside creates built-in maintenance problems. Construction people follow plans and specifications, and the maintenance crews wait in the wings until the contractor has finished. As soon as the contractor leaves the project, the maintenance crews take over, often with the attitude that construction people did not mitigate the problems created by the design(16).

In England, an engineer is involved during the early stages of planning, however, a working party comprised of an engineer, an architect, an estates officer, a solicitor, a planner, a housing officer, a public health inspector and an officer from social services administer the program. While not specifically stated, it is implied that maintenance engineers are part of the entire construction program. Such broad involvement insures that the best possible design and construction techniques are utilized and that the concerns of all parties affected by the program are addressed.(17)

Such concerns and practices as pointed out above emphasize the necessity of proper planning during the initial phases of proposed construction. When one ignores the expertise of associated landscape architects and maintenance engineers, the "pay me later" costs, as opposed to "pay me now", can be burdensome. Such is too often the case when landscape and maintenance personnel are brought in after the fact. As Iurka et al. pointed out, it is in the early stages of location selection that consideration of cross-section design as related to drainage, planting, and maintenance requirements can be most valuable. Unfortunately, this appears more the exception than the rule.(5)

Landscaping

The professional landscape architect designs within the guidelines of form and function, with balance of each the parent of the final product. This is particularly true for highway landscaping where the primary function may be other than aesthetics. Considerations to be observed when choosing vegetation and planting designs are urban and rural differences, type and size of vegetation, ecology, criteria for species selection, implications for maintenance, criteria for selection of scenic versus functional design, traffic guidance, headlight glare, noise screening, drifting snow, and public relations.(5)

Deakin observed that:

[1]landscape design of the rural highway, in order to be effective and complete, must begin with the location of the highway. Highway landscaping must be an integral part of the original highway concept.(15)

Pennsylvania, in an effort to improve operational control of its roadsides, stresses consideration of all landscape details in the highway planning process.(18) Hence, the inclusion of a landscape architect in the initial planning stage of a highway project insures that the landscape plan, which can be drawn simultaneously, will be complementary to the highway roadside and adjacent areas and not the step-child of the construction engineers' final grade. Such input allows for more creative land form flow, increased vegetation variety, and planned ease of maintenance. The concept that things fit is part of the definition of aesthetically pleasing.(19)

A point for further consideration is the number of landscape architects assigned to highway roadside planning and design. If highway location and planning are to be reviewed by landscape personnel prior to construction, sufficient numbers of competent people must be employed to make the process meaningful. In addition to allowing for a more equitable work load, additional professional personnel allow for peer review and encourage creativity.

Maintenance

"In order that vegetation fulfills its expectations ... it must be watched over and cared for."(4) The truth of this statement is beyond question, however the reality of budgetary restraints tempers the ability to comply.

In North Carolina, Adams reported that maintenance costs were increasing at a rate far greater than anticipated revenue increases, and that those increases were projected on the basis of no additional maintenance personnel in spite of a 14 percent reduction in the equipment fleet.(7) While every highway authority in the United States must struggle with budgetary constraints, some maintenance relief may be found in avoiding the creation of problems in initial planning.

Armstrong suggests that maintenance work closely with landscape architecture in evaluating present practices and programming planting. Plans should be reviewed before finished drawings are made to evaluate future maintenance requirements and to avoid the creation of problems.(20)

In some states a maintenance management plan or system is developed as each new road is planned (or old road upgraded) so that future maintenance requirements are a known quantity. However, in order to accomplish this, maintenance personnel must know the landscape architects philosophy and goals in designing the project.(10) This requires the same open line of communication that should be present from the earliest planning stages.

Shanahan and Smardon present a format to involve the public in roadside vegetation management decision making. This format helps record information necessary for evaluating management alternatives, and improves communication between the public and the Department. It also includes the public and adjacent property owners in this participatory process for managing roadside vegetation.(21)

The Arkansas State Highway and Transportation Department has instituted the Project Review Committee to control some of these issues. The Project Review Committee consists of the Assistant Chief Engineers, the Bridge Engineer, the Roadway Design Engineer, the Construction and Maintenance Engineer, the Traffic Engineer, and the appropriate District Engineer and Federal Highway Administration Engineer.

The Committee is charged with evaluating projects completed and under construction to determine maintenance problems.

Literature

In San Antonio, Texas, at the Symposium on Roadside Vegetation Management and Manipulation, August 3-8, 1980, Foote reported:

Roadside management came into existence gradually over time as a scientific and administrative approach to roadside maintenance. In the 18th and 19th centuries, roadside vegetation was generally cut by hand (and later by machine) for forage. Roadsides were pastured by staked or free-roaming animals, burned, farmed, or neglected. Often, the roadsides were cut to avoid fire hazard or to provide good visibility against lurking highwaymen, to clear brush, and to provide a neat appearance. With the scientific agriculture movement of the late 1800s and early 20th century, agronomists advocated roadside mowing for weed control purposes. For almost the entire first 50 years of this century, mowing, tillage, and crop rotation were the main weapons available to fight weeds. The only one of these that could be readily used on roadsides was mowing, though some states also used fire on a regular basis. Considerable agronomic research efforts were directed at weed control through mowing during the first 30 years of this century.

Starting in the early 1930s, many states added roadside development units to their highway departments. These units often contained trained landscape designers, sometime agronomists, and generally engineering personnel. The idea that the roadsides were the front yards of the nation and the concept of the complete highway (right-of-way fence to right-of-way fence) were stressed. Roadsides were more frequently mowed and treated in an agronomic manner like a well-cared-for lawn. This approach continued through into the 1960s and chemical weed control was added to the program. Through manuals and training, the approach became institutionalized into many highway department operations.

In the late 1960s, a different approach developed. This was generated by rising costs, increased roadside acreages, environmental and ecological concerns, and the wider knowledge of and appreciation for the ecolog-

ical approach to vegetation management as put forth by the science of land management. The formal definition of rangelands included public rights of way. In today's era of shrinking funds for transportation agencies, the trend in roadside management has been toward the ecological approach.(22)

At that same symposium, Landers stated:

Roadside vegetation is both virtuous and villainous. On the one hand, it may provide welcome shade at rest stops, on the other, an immovable object for an out-of-control vehicle, avenues of wildflower beauty or routes of weed infestations, restful scenery or depressive monotony, and erosion stabilization or pavement destruction. Management makes the difference. Because roadside vegetation is most often a mixture of plant species, its management is more often based on principles from range rather than agronomic sciences. In other words, roadsides are more like rangeland than farmland. Plants growing in the right-of-way tend to be the same kind as those growing on adjacent land. There are some striking exceptions to this, but generally they are responding to a similar climate and soil. These broad vegetational types of naturally occurring communities of trees, shrubs, forbs, and grasses provide the basis for management. These change with different rainfall amounts and patterns.

Disturbance of the natural vegetation along the roadside during the process of road construction, repair, or maintenance usually initiates a sequence of changes in vegetation during the recovery process. An area begins to revegetate, with a tendency over many years to become similar to the adjacent vegetation. Dandelion, quackgrass, Johnson-grass--the list of species that are capable of moving into relatively new sites and staying there is almost endless. Some of these become permanent members of the community along with the native plants from across the right-of-way line.

The main objective of roadside vegetation management should be to keep the highway a safe and pleasurable place to drive. What is growing along the roadside should not

imperial nor distract the driver, yet it should provide a series of restful glances for the experienced driver and a certain flow of countryside scenes for the passengers. For ecological and economical reasons, the composition of roadside vegetation should depend on the locally adapted native species and a selected number of introduced species that are dependable. Due to the variability of most roadside conditions, a mixture of species has to be used since no single species has the adaptive scope to cover it all.

This program should promote beauty, prevent erosion, and reduce the spread of noxious plants. Mowing is an important maintenance procedure that has been designed for average vegetation of the region. Mowing height, interval, and placement, particularly on slopes, are very important to the roadside program."

The use of herbicides has traditionally been associated with the control of noxious species adjacent to crops and pastures into which they could readily spread. Often, it is the other way around. Chemical applications are approved for sterilization around signposts, guardrails, culverts, bridges, and warning posts to make the mowing effort less restrictive and more efficient. (23)

Morre of Purdue University said:

"Research is an important source of new developments in roadside management. However, for research to impact practice, it must be implemented. Sight distances must be maintained, signs not obscured, erosion prevented, and a healthy weed-free turf maintained. Research should include a planning phase that involves an analysis of the problem, outlines objectives and procedures, and assembles the required personnel and resources. This is followed by the actual conduct of the research, which may require several years.

Testing under field conditions is especially slow because weeds germinate and grass seedheads form only at a particular time each year. One must usually wait a year to repeat or confirm an observation although some additional information can come from the laboratory. After analysis, recommendations

are formulated and, if appropriate, implementation is performed. Implementation is aided if the major findings are evaluated under actual-use conditions as part of the research project. All should be aware of advantages, benefits, and projected or actual cost savings as well as any disadvantages of undesirable features. An individual should be prepared to modify recommendations to accommodate local needs.

Research has a continuing and important role in roadside vegetation management. A few examples from the program illustrate how research, once implemented, can lead to new maintenance practices with substantial cost savings. Many research and implementation activities would be facilitated by more information on what are the desirable or necessary ingredients of a well-maintained roadside and of special problems where solutions are currently unavailable. Research, and especially the implementation of research, ultimately involves not only the researcher but the user as well. An important ingredient of research implementation is good planning that begins even before the research is initiated.(24)

At the Symposium on Roadside Vegetation Management and Manipulation, Middleton reported:

Major challenges concerning inflation and energy use that we all talk about are opening the door to a number of significant changes. Many of these challenges are related to the optimum use of a changing budget and are concerned with such areas as holding mowing cost down and vegetation problems that occur with reduced mowing.

Today's planning of highway chemical prescription programs has changed radically in just 2 years. The flexibility and ingenuity of tank mixes are also becoming more essential for a successful program. Two years ago, the industry had three flexible materials that were either premixed or tank mixed and were used with other industrial products. Now they are no longer available.(25)

Ross of the Pennsylvania Department of Transportation reported:

The Pennsylvania roadside management program is fundamentally based on two ingredients common to most highway problems, i.e., needs and resources. The state roadside programs are formulated in the central office and implemented at the district levels with modification to suit local needs as dictated by population, traffic, terrain, and other environmental factors. The district roadside unit is involved in all facets of design, construction, and maintenance that relate to the roadside and its environment. In this capacity, roadside slopes and soil areas can be designed, graded, rounded, finished, and vegetatively treated to yield the best finished product with maintenance in mind. In many cases, the pre-design public hearings commit the department to specific practices that, if not performed in concert with the project construction, would possibly be delayed indefinitely due to subsequent lack of funds, traffic congestion, political changes, and many other factors. Through this complete project concept, all construction projects throughout the state, regardless of location, financing, or systems classification are given comprehensive consideration and treatment.(26)

Johnson, Head of Landscape, North Carolina Department of Transportation, reported:

The North Carolina Department of Transportation's Landscape Unit has developed a very progressive herbicide and growth regulator program in an effort to facilitate the control of vegetation along our roadsides and reduce the hand labor and machine operations that would otherwise be necessary to properly control the vegetation.

There is a great savings potential in the cost of routine mowing through the use of growth regulators. The control of broadleaf weeds must also be included when attempting to control the rate of growth of grasses. The use of herbicides and growth regulators,

as listed here, seems absolutely necessary to provide the North Carolina Department of Transportation with the tools to control vegetation along our roadsides and maintain the esthetics of our highway system. We are very proud of our strides in recent years in the use of chemical products to control roadside vegetation, and we are proud that some parties have indicated that our program is as progressive as any that can be found in the United States.(27)

Morris and Lewis of the Florida Department of Transportation reported:

Florida's Department of Transportation has long recognized the benefits to be derived from a sound vegetation management program. Management of our roadsides begins at the design phase. We maintain a close working relationship with the department's design staff and support ongoing vegetation research that is performed in-house and with the university system where repetitious vegetation problems are best solved.

Generally roadside maintenance is categorized as either maintained or non-maintained. Maintained areas receive routine and as-needed applications of fertilizer, mowing, and herbicides. Non-maintained limits are allowed to regenerate and/or supplemented with native tree species.

The Florida Department has developed a comprehensive manual on chemical weed and grass control that includes details of herbicide materials, plant identification, calibration programs, special considerations, equipment, and so forth. It provides detail and specifies desired treatment limits, nozzle configurations, and related application pressures and speeds.(28)

The vegetation management program of Texas has been designed to maintain the integrity of the asphalt surface, prevent or reduce soil erosion, provide safety for the traveling public, achieve maintenance efficiency, and provide beauty. The use of chemicals was demonstrated as the most efficient and economical

method of controlling undesirable vegetation. Herbicides are the major chemical tool used along roadways, however, insecticides and plant growth regulators may become important as our knowledge increases.

The chemical vegetation management program was divided as follows:

(1) Complete vegetation control (bare ground). The use of a residual herbicide at the proper rate will provide complete vegetation control unless resistant species are present. The number of these species must be considered. This type of vegetation management may be desirable in areas where it can be economically maintained or where plant growth decreases maintenance efficiency or creates a fire hazard. (2) Selective plant removal or weeding can be accomplished by using a chemical applied either as a pre- or post-emergent application. (3) Woody plant control or brush control. A number of woody plant species are serious problems as they produce stipulator spines that can cause flat tires or injury to individuals. (4) Bermuda grass release is a item for the chemical treatment of an area to damage or kill all of the vegetation with the exception of Bermuda grass. (5) Chemical mowing by using the rope-wick applicator over areas where Bermuda grass is absent is effective when the height of the rope-wick is above desirable vegetation. (6) Treatments around ornamental plantings. (7) Prepavement treatment (8) Plant growth regulators or retardants are used to slow down the growth of plants to reduce the frequency of mowing.

Buffington of the Texas Transportation Institute concluded:

In the Texas program, total vegetation control costs are significantly affected by such factors as the amount of vegetation inventory acreage, number of full-width mowing cycles, amount spent on contract mowing and in-house herbicide overspraying, and location such as urban/rural and or types of vegetation areas in the state. (2) As far as the increased use of contract mowing vegetation control strategy is concerned, contract mowing is considerably cheaper than in-house mowing even without considering overhead costs. (3) Evaluation of the increased use of chemical overspraying vegetation control strategy reveals that overspraying roadside Johnson grass is more cost-effective than mechanical mowing. (4) The previous finding suggests that the most cost-effective vegetation control strategy is a combination of contract mowing and Johnson grass overspraying with increasing emphasis on the latter.(29)

Costs reported in Buffington's study for mowing during FY-86 were \$19.08 per acre. (Arkansas' cost for the same year were \$19.07 per acre.)

Buffington further reported that:

[o]n a vegetation area basis, the cost differential is \$8.30 per acre in favor of herbicide spraying. Another comparison is on a mowed/sprayed area basis. In other words, the estimated area actually mowed by the mowers and the area in the spray path of the spraying unit are used as the area basis. The direct cost differential of \$1.47 per acre is smaller than that calculated on a vegetation area basis but it is still in favor of herbicide spraying.(29)

Corley and Smith reported:

During 1989 and 1990, research was conducted for the Georgia Department to determine optimum establishment methods, weed control techniques, fertility responses and

mowing effects for adapted wildflower species. The use of preplant, preemergent and postemergent herbicides improved wildflower establishment and performance by reducing competition from grassy weeds. Base fertility requirements for optimum wildflower bloom characteristics when mowed high during summer for bloom regeneration and for weed control. An improved basic wildflower mix was formulated for optimum initial performance and response to management practices.(30)

The Fall 1991 issue of Road Talk reported:

The Maine Department of Transportation roadside vegetation management program is structured around a wide ranging concern for safety--for protecting applicators, motorists, residents, wildlife and the environment. 'Highway safety is always the primary concern in everything we do' says Clyde Walton, landscape architect for the Maine DOT. We maintain our rights of way both mechanically and with herbicides. They each have a fit for different aspects of our program. Anyone who sees one of our trucks and has a question about the product being applied has only to call a toll-free number for further information. During application, two-foot-square signs with a roadside spraying symbol and the generic name of the compound being sprayed are mounted on the front and back of the spray truck. Our goal is to keep the public informed. Information about areas scheduled for spraying is also sent to local newspapers each month to alert residents. We provide citizens with complete information about or vegetation management program and the herbicides we use. Crews maintain no-spray buffer zones around environmentally sensitive areas such as non-forested wetlands, public water supplies and other water bodies. We may maintain 50 to 100 foot buffers around streams or near pastures where animals are grazing.(31)

In June 1991, the Charleston Exponent-Telegram reported:

Colorful, cheerful wildflowers are spreading like wildfire along the nation's often drab highways as states try to stem growing costs of maintaining rights of way

and civic groups pitch in to help.

"Something's going to grow out there whether it's grass or weeds or what, so why not have it be wildflowers?," said Anna Shahan, Adopt-a-Highway Coordinator for West Virginia's Division of Natural Resources.

"Highway departments are mostly interested in their budgets and color, and potentially what good it's doing for the environment," said David Northington, executive director of the National Wildflower Research Center of Austin, Texas. Interstates have become wildflower tapestries of unending color, like the burnt-orange hue of Indian paint brush in Texas, the fuzzy sagebrush of Oklahoma, and the hot pink phlox in Florida. Black-eyed Susans, purple cone flowers and yellow and blue coreopsis greet drivers in Ohio and West Virginia, while tall, yellowish strands of native Indiangrass wave along roadsides in Iowa and Kansas. Botanists and seed companies develop just the right mix for states according to climate and soil conditions. West Virginia's year-old roadside planting has yielded 130 acres of native wildflowers. About 81 acres were funded by the Division of Highways, while 49 acres were planted with donations from the states 220 garden clubs. "The nation's first wildflower plantings were purely for aesthetics, but the states are now planting native species to promote local pride, reduce highway mowing, prevent soil erosion and help nearby wildlife," Northington said. "The aesthetics and color can come and go, but people have more regional pride now," he said. "Whether the vegetation of a particular region is desert, hardwood forest or prairie, there is a regional identification and a concern for returning parts of the land that have been pretty much degraded by development. And if it saves the state money, so much the better."

"West Virginia's current crop of wildflowers saves the state up to \$125 an acre per season in mowing costs, or about \$50,000 over five years" said Jim Riggs, head of maintenance for the state Department of Highways. "The state saves more as it plants more wildflowers, which may have to be replanted every five years to fight weeds and patchiness." Riggs said, "the state will mow

wildflowers acreage once this year in the fall."

West Virginia's garden clubs donated more than \$18,000 for seed and promotional information, officials said. 'Each acre of wildflowers cost \$365,' said Isabel Swoope, immediate past president of the West Virginia Garden Clubs.

Roadside planting received a boost in 1987 when Congress required states to set aside one-fourth of one percent of money earmarked for federal highway landscaping projects for native wildflowers.

"It's really just a drop in the bucket for us," said Craig Steffens, head of landscaping for the Texas Department of Highways and Public Transportation. "In reality, we do very little landscaping with federal funds," said Paul Northcutt, a landscape architect with the Texas department.

"Texas spends about \$2,300 per acre on wildflowers, which includes labor and contracting costs, seeds, equipment and soil preparation," Northcutt said. He added that Texas spends about \$30 million annually on maintaining 750,000 acres of highway rights of way.

Landscape architects, botanists and highway maintenance departments say wildflowers also cut the need for insecticides and fertilizers, add nitrogen to the soil, save on expensive watering and discourage littering. The Exponent-Telegram article concluded, "And don't forget, they say, wildflowers are also just pretty and help encourage tourism."(33)

There are innumerable studies documenting impacts of herbicides to non-target organisms and ecological communities. There are a lesser number of studies which deal with worker safety and herbicide contamination levels. However, these studies are probably outside the scope of the present study and have not been considered in the literature review.

Native plants for use on Arkansas' highway right of way have been tested for viability and availability. Studies have been

completed which give recommendations concerning suitable, viable species for use on Arkansas highway rights of way.(1)

The Arkansas State Highway and Transportation Department's Wildflower Program is included at Appendix 1. The Arkansas State Highway and Transportation Department's Reforestation Program and Schedule is included at Appendix 2.

Mowing Considerations

The Mowing Program as operated by the Department has become of more significance as it is taking more and more of the funds available for maintenance purposes. An overview of the vegetation control program was given for the subcommittee by Mr. Bob Fulton, Staff Agronomist. (See Appendix 3.) Mowing expenditures in graphic form are included at Appendix 4.

Several conclusions can be drawn from the graphs, the most significant being that cost per acre over the last fifteen years has tended generally upward. This is particularly significant taking into account that we have been pursuing a policy to reduce mowing costs. We have downsized our mowing equipment and reduced the number of maintenance employees.

Some of these actions might have reduced costs, but the total program cost is up, and the cost per acre is up. This seems to indicate that efforts still need to be directed at cost containment for vegetation control. This can be enhanced by selecting known techniques for efficiency and stressing that efficient application of manpower, scheduling and techniques is what is required.

It may be that operating an older fleet of equipment is increasing total costs. The new procedure of purchase and buy-back of equipment should moderate this influence. Since FY 86, the Department has been purchasing mowing tractors under a guaranteed repurchase agreement. Under this agreement the bidder, at the Department's option, repurchases any or all units at the

end of one year at a price stated by the bidder in the original bid. The repurchase price has generally been 100% or more of the original purchase price. The Department has exercised the repurchase option for all units purchased to date under this arrangement. At present, 217 of 633 tractor mowers are on this program, with about 30 units being added each year. This agreement provides an increasing percentage of new mowing tractors in the field each year. Productivity and dependability should increase with new units while repair expenses should decrease, since repairs are performed by dealers under warranty.

A proposal has surfaced recently to decrease our use of chemicals and increase our use of mechanical mowing. The Construction and Maintenance Division has analyzed costs and concluded that without chemicals the mowing frequency would increase to five mowings per year instead of one partial and one full-width, which is currently required with chemicals. This increases the cost of vegetation control by 345%. This does not appear to be the wisest use of funds available. A second conclusion was that with the number of maintenance employees on board, the additional mowings are not physically possible.

A corollary to this study may be that given the change in our equipment fleet as our programs have evolved, such a change in policy would necessarily have to be made over several years to rebuild our chemical application and mowing equipment fleet.

Herbicide Considerations

An overview of the Herbicide Program was given the committee by the Mr. Bill Richardson, Mr. John Harris, and Ms. Wendy Welch. It is included at Appendix 5. An evaluation of costs of different chemical functions was made. Costs for the three years 1988, 1989, and 1990 are shown below:

FY	BROADCAST MSMA	Johnsongrass Control	Bermuda Release
1988	495,495	330,174	712,855
1989	560,409	332,042	779,444
1990	567,195	320,472	583,054

These costs include the cost of chemical, labor, and equipment. The average cost for broadcast functions is \$9.17 per acre over this three year period.

Herbicide program and results of some states near or adjacent to Arkansas are given below. Quantities shown are rates per acre.

Alabama

Pre-Emerge	None at this time.
Post-Emerge	MSMA and 2 4-D to control broad-leaf plants.
Comments:	Used Oust at varying rates, however, extremely delayed green up has led to a tentative decision not to use Oust.

Georgia

Pre-Emerge	Bermuda 1/4 oz Oust plus 8 oz Roundup February-March
Pre-Emerge	Fescue 1/4 oz Oust plus 1/4 oz Telar plus 8 oz Roundup
Post-Emerge	MSMA - 2 lbs.
Comments:	Used higher rates of Oust but delayed greenup of Bermuda was not acceptable. Trying the above reduced rates.

Louisiana

Pre-Emerge
Post-Emerge
Comments:

1 1/2 Oz Oust January-February
16 Oz Roundup plus 32 Oz Garlon 3
The Oust delays greenup of
Bermuda. This is acceptable as
it delays start of mowing

Mississippi

Pre-Emerge
Post-Emerge
Comments:

1 1/2 Oz Oust October-November
MSMA at varying rates in summer
Oust delays spring greenup.
This is acceptable as winter
annuals are controlled and
mowing is delayed.

Oklahoma

Pre-Emerge
Post-Emerge
Comments:

Campaign, i.e. 2 4-D and Roundup
applied February-March.
3/4 to 1 Oz Oust plus 12 to 16 Oz
Oust applied May-June
Discontinued use of Atrazine.
Now using Campaign to control
winter annuals.

Tennessee

Pre-Emerge
Spring Pre-Emerge
Post-Emerge
Comments:

1 1/2 to 2 Oz Oust broadcast Fall
Discontinued Oust as delayed
greenup is unacceptable and
possible damage to Bermuda
1/3 Oz Escort broadcast
The application of Oust delays
Bermuda greenup which is accep-
table as it delays mowing opera-
tions. At 2 Oz Marestail is con-
trolled. Escort controls most
broadleaves. Brownout is slower
with Escort.

Texas

Pre-Emerge
Post-Emerge

Also use :

Comments:

None
2 Oz Oust plus 32 Oz Roundup
applied June-July
Banuel for Thistle and
Escort for Broadleaf (some areas)
Non-use of herbicides as a Pre-
Emerge requires early start of
mowing operations which is a one-
pass cut except in areas requir-
ing finished appearance. The de-
layed application (June-July) of
Herbicides allows Johnsongrass,

Thistle, and other undesirables to reach a tall growth. Delayed application to this causes severe brown out which stands 4 to 6 weeks before fall cleanup mowing. Results are not particularly aesthetically pleasing.

Arkansas

Pre-Emerge
Post-Emerge

1/4 Oz Oust Fall and Spring
64 Oz MSMA June-August

Some comparisons of programs have been made. For example, with the Texas herbicides, rates, and schedules their annual cost is approximately \$90 per acre. With Arkansas herbicides, rates, and schedules the annual cost is approximately \$46 per acre. One of the more noteworthy observations which can be made is the much reduced rates of application and the use of somewhat milder chemicals in the Arkansas herbicide program. Knowing that our costs run significantly lower for vegetation control on a per acre basis than some of our neighboring states, it speaks well of our total vegetation control program. The preponderance of information seems to favor a larger chemical program with a smaller mowing program. This can reduce costs and improve the public image provided we continue to use herbicides with wisdom and restraint.

Complaint Considerations

The file of documented complaints from the Construction and Maintenance Division and the Environmental Division was reviewed and categorized. The file provided three years of history. There was no pattern discerned in the entire file. There were eight complaints on the mowing program. One complainant in 1988 was concerned that mowing disturbed wildlife areas. The other seven were concerned that we were not mowing enough. There were three complaints concerning the herbicide program. In 1988 one complainant was concerned that the use of herbicides was killing wildflowers. In 1989, one complainant wanted to stop the use of all herbicides to keep chemicals out of water supplies, and another wanted to stop the use of herbicides altogether.

There were twenty-four comments concerning the wildflower program. Three of the comments expressed appreciation for the work we were doing in the wildflower program. Three complainants were concerned that we were using herbicides on wildflowers. Eleven complainants were concerned that we were mowing wildflowers too soon or at all. Seven complainants were urging us to use more wildflowers on the rights of way.

If the complaints concerning the wildflower program and mowing or herbicide use are recategorized as mowing or herbicide complaints the program totals would be nineteen on mowing, six on herbicides, and ten concerning the wildflower program. The mowing complaints would be divided as follows: one concerned with wildlife; seven for not enough mowing; and eleven for too much

mowing. Herbicide complaints would be as follows: one concerned with water supply; one wanting not to use herbicides; and four concerned with herbicides and wildflowers. Wildflower complaints would be as follows: three for appreciation of the wildflower program and seven asking that more wildflowers be used.

Of the herbicide complaints it should be noted that three of them were from the same district. Upon investigation it was found that all three complainants wrote their letter on the same day. It is highly likely that these three complaints were from one incident or operation that was observed by motorists.

The preponderance of information available from the complaint files is in favor of our wildflower program. The totality of this information supports our use of herbicides and supports our mowing program although more coordination is needed between the mowing and wildflower programs.

District Considerations

It was determined by the subcommittee that one of the best program measurements available was the experience of our own district staff who are involved directly in the operation of our vegetation control program. The District Engineers (DE) constitute a wealth of information concerning virtually every aspect of the program. A questionnaire was developed which was forwarded to each District Engineer and solicited his input (See Appendix 6).

The questionnaire solicited information concerning Interstate, Primary, and Secondary highways in association with the mowing, herbicide, wildflower, natural reforestation, and reseeded reforestation programs. The districts differ from each other somewhat in terrain, natural species, and types of highway; this was reflected in the District Engineers' input. Nevertheless, several responses were striking in their similarity. Responses are summarized below.

Mowing Program

One DE thought more mowing on the Interstate System would be appropriate; one DE thought less mowing would be appropriate. The remaining seven thought our program was approximately correct.

On the Primary System three of the respondents thought more mowing would be appropriate, while one thought less mowing would be appropriate. The remaining six thought our program was approximately correct.

As to the Secondary System, four thought more mowing would be appropriate, and one thought less would be appropriate. The remaining five thought our program was approximately correct.

When asked what were the advantages of mechanical mowing, nine District Engineers cited appearance while one cited accident reduction. Nine cited cost as its disadvantage and one cited insufficient mowing.

Herbicide Program

On the Interstate System, four thought more herbicide would be appropriate and five thought our program is correct. On the Primary System, five thought more herbicide would be appropriate and five thought our program is correct. On the Secondary System, five thought more herbicide would be appropriate and five thought our program is correct.

When questioned about the advantages of the program, four DE's cited reduction in mowing as the prime advantage; three cited cost; two cited appearance; and one cited control of vegetation. The disadvantages of the herbicide cited were: three for improper application; two for public opinion; two for weather conditions; one eliminates some species; one for environmental risks; and one for control.

Wildflower Program

As to the Interstate System, two responded that less wildflowers would be appropriate while seven thought our program is correct. On the Primary System, one thought more wildflowers would be appropriate; two thought less wildflowers would be

appropriate. Seven thought our program is correct. For the Secondary System, one thought more wildflowers would be appropriate, two thought less would be appropriate, and seven thought our program is correct.

The advantages cited for the wildflower program were appearance(8), reduces mowing(1), and reduces accidents(1). Six DE's responded that disadvantages were unsightly stages; two found timing of mowing a disadvantage while one found herbicide application and one found restricting chemicals as disadvantages.

Natural Reforestation Program

On the Interstate System, two thought more natural reforestation would be appropriate while seven thought our program is correct. On the Primary System, one thought more natural reforestation would be appropriate and nine thought our program is correct. On the Secondary System, all ten DE's thought our program is correct.

When questioned about advantages seven stated that it reduces mowing; one cited cost, while one cited its prevention of erosion. One cited appearance as an advantage. Disadvantages cited were unsightly stages (six responses) and overhang (four responses).

Seeded and Planted Reforestation Program

On the Interstate System, three DE's thought we needed more planted reforestation efforts, one thought we needed less, and six thought our program is correct. On the Primary System three DE's thought we needed more, one thought we needed less and six

thought our program is correct. On the Secondary System two DE's thought we needed more, one thought we needed less and seven thought our program is correct.

When questioned about advantages of the seeded and planted reforestation program, six cited that it reduces mowing. One cited improved appearance, one cited faster growth, and one cited cost. Disadvantages cited were unsightly stages (five responses), overhang (two responses), low success rate (two responses), and cost (one response).

When asked to rank several maintenance problem areas in order of number of complaints received the categories scored as shown below in the order of most to least complaints received:

Mowing	: Highest
Potholes	: Second highest
Ice	: Third highest
Litter	: Fourth highest
Wild Flower	: Fifth highest
Low Shoulder	: Sixth highest
Reforestation	: Seventh highest
Other problems:	Eighth highest

Public Considerations

The groups involved in the Adopt-A-Highway campaign were surveyed to determine their opinion of our roadside management policies. Their response is shown in Appendix 7. In general terms they thought our mowing program is correct but would recommend more mowing on Primary and Secondary roads. They thought our herbicide program is correct, but would recommend less herbicide usage on the Secondary roads. Their responses indicated that our wildflower program needed more done in every category of highway. While our natural reforestation program is correct, they responded that our Planting/Seeding Reforestation Program needs to be expanded.

Citizens groups who are concerned enough to become involved in a Department program and to devote a part of their time to the causes in which they believe have responded favorably to our mowing and herbicide programs. They are resoundingly in favor of doing more in the wildflowers and reforestation programs.

CONCLUSIONS AND RECOMMENDATIONS

Some conclusions can be drawn from the information assembled during the course of this project. There are several schools of thought on roadside vegetation control procedures which range from a belief that roadsides should always look lawn fresh and newly mowed, to roadsides which only have woody vegetation removed from the vehicle recovery zone. Most highway departments now perceive that the more efficient roadside vegetation management systems include the use of chemicals and mechanical mowing. Our study indicates that the use of herbicides and chemical mowing permits fewer mechanical mowings and saves considerable maintenance funding.

We note first that the preponderance of information supplied by the District Engineers supports the continuation of our existing roadside maintenance management policies. This should not be surprising since the District Engineers have some direct input in setting up these programs. However, this still does not alter the fact that they provide the best measure of our roadside management program because they are in the forefront in awareness of the public's comments, desires, and complaints.

We can note in general terms that the public supports our vegetation control programs since there have been very few formal complaints. We can only presume that there must have been more complaints than those available to the subcommittee. In evaluating these complaints it becomes apparent that the department enjoys a great deal of support from the public. This is a fact

that should be capitalized upon and advocates for the department developed. The complaint ratio within the population is virtually non-existent. Each of these complaints, however, is very important. In those instances where a specific complaint was aired, appropriate corrective action was taken. On non-specific complaints, such as the department should use more wildflowers on the highways, we can only agree. With regard to the specific complaint that we abandon the use of all chemicals, it appears such an action would increase our vegetation control expenditures in excess of 300%.

We can note from the comments of the Adopt-A-Highway groups that they believe that we should do more in wildflowers and revegetation. Many of our groups represent urban organizations whose interest runs to calling attention to the urban-type area. One of the showiest ways to do this is through programs on the right of way near those areas. It may be somewhat surprising that not all of the desire for more wildflowers and revegetation is from urban-type areas. This should lead us to believe that the general public is concerned, which in turn, is reflected in our increased activity in wildflower and revegetation programs. This is an area where much can be achieved in "selling" the department's programs and in educating the public as to what our program consists of and why some of our actions are required.

We can learn from other states' experience, as well. Other states have found that the public needs to be better educated concerning policies and specific activity plans. Some states

have recognized that organizations involved in the Adopt-A-Highway program and similar groups may be permitted to take on greater responsibility which conserves the Department's maintenance budget.

Based on input from Highway Department personnel as well as the public, we can conclude that the Department's roadside management maintenance program is performing adequately given the program goals and current budget, manpower, and equipment limitations. The program may be improved by 1) more precisely defining roadside vegetation maintenance goals; 2) staffing additional technical supervisors for roadside development; and, 3) upgrading herbicide spray equipment through our equipment purchase programs.

It is recommended that the roadside vegetation maintenance program be provided a great deal of flexibility so that the Department can accommodate different needs in different areas of the state. The program is viewed by all travelers and every traveler has their own opinion of what should and should not be required in the program.

It is recommended that the department continue with the roadside vegetation management program and retain the components of that program: i.e., chemical application, chemical mowing, mechanical mowing, wildflower establishment and reforestation/return-to-nature. It is not the recommendation of this group that the scope of these three components be maintained at current levels, but that a mix of the currently employed

management modes be retained and the levels of each adjusted as necessary, periodically, to best meet the vegetation management policy and objectives of the Department.

The Department should consider the employment of additional technical supervisors, such as landscape architects, agronomists, or persons with comparable training. They would oversee the planning, training, and implementation of the vegetation management program. The Vegetation Management Specialist would be available to supervise activities in each of the three major physiographic regions of the state: the Delta, Gulf Coastal Plain, and Interior Highlands. Savings accrued through a streamlined chemical and mowing program could off-set the expenditures necessary to assure that adequate technical expertise and supervision are provided to the districts and the chemical applicators, the first line of safety and maintenance.

The Department is currently in a position where it needs to upgrade its chemical application equipment. The Department's equipment procurement program should emphasize the upgrading of chemical application equipment. This equipment could include computerized distribution systems, which would eliminate the tank-mix system currently in use. Costs incurred could be somewhat recouped through increased efficiency, which would reduce the amount of herbicide required to be applied as well as the time spent in applying that herbicide.

A procedure should be developed which will incorporate all aspects of vegetation control/roadside vegetation management into

a multi-disciplinary, multi-division planning process. This should include the Herbicide Program, the Wildflower Program, the Reforestation Program, as well as the Bermuda Release Program and others that operate to control vegetation along the rights of way. To this end another research project has been recommended for funding which give the highway designers the means to specify low maintenance vegetation in the design stages. This should contribute to allowing the vegetation management program to function in the planning mode.

Representatives from Construction and Maintenance, Roadside Development, Environmental, and each of the Districts should develop a vegetation control plan specific to the needs of the routes in each district. This would be a hands-on process evolving from field inspections, public input, and overall consideration of the vegetation management goals for a particular route. Revisions, additions, and deletions to the program would be made every other year. Additionally, the maintenance planning team should interface with Roadway and Bridge Design personnel prior to any new construction in order to include maintenance considerations in the design process.

Emphasis should be placed on public awareness and public participation in the vegetation management program of the Department. Periodic opinion surveys and news releases could be conducted in conjunction with program revisions on a regular basis.

As a pilot project in two or more districts, chemical application vehicles should be plainly marked as they operate along the rights of way of the state highway system. The information on those vehicles should provide the public with the name of the chemical being applied and the application purpose (Johnson grass control, Bermuda release, etc.). This will allow the Department sufficient information to pin-point the exact complaint received from the public rather than guess at what application was being complained of and where it took place.

Future considerations should include public participation in the right-of-way maintenance program. Landowners with property immediately adjacent to the right-of-way could be permitted to maintain the Department's right-of-way, but only within performance limits specified by the Department.

The use of the expertise of technical representatives of chemical companies which are current chemical vendors to the Department should be taken advantage of in the training of chemical applicators and their supervisors. Technical representatives of the chemical vendors have enormous expertise when it pertains to the chemical, and its safe and proper application. Their expertise, safety training programs, education videos, and other materials should be incorporated in our Department's training program rather than relying solely on Departmental personnel for training purposes.

It is recommended that a policy be developed in the Construction and Maintenance division requiring personnel in-

volved in vegetation control scheduling to view the work of others and provide a smooth transition at district and county boundaries. Closer supervision of the mesh of these programs with the wildflower and revegetation programs is needed. To reduce the number of complaints concerning the use of chemicals and the treatment of wildflowers and revegetation plots it is recommended that a greater public awareness campaign be undertaken. It is also recommended that information signing at selected locations advising the public about specific programs be instituted.

It is also recommended that the Construction and Maintenance division utilize new training courses that are developed by the U. S. Department of Agriculture and made available through the Extension Service. The "Roadside Vegetation Management" program is a 9 module series covering equipment, control, public relations, etc. It has been developed as a cooperative effort by USDA, EPA, Purdue University and others. It is the first comprehensive guide for roadside management practices. It is available on video tape and there is a series of publications which comes with the package. The package may be previewed by contacting Dr. John Boyd, USDA, Little Rock, AR. Ordering information can be obtained from Harvey Holt, Purdue University (317) 494-3585.

It is recommended that the following policy statement be adopted as the official Department policy for the vegetation control program.

RECOMMENDED POLICY STATEMENT

The Arkansas State Highway and Transportation Department is charged with, among other things, the maintenance of the right-of-way of the State's highway systems. The performance of this function will follow the policy prescribed below. All of the roadside management and maintenance functions of the Department will fall within the following goals and criteria.

1. All roadside management activities and functions in which the Department engages will be considered first from the aspect of safety. No activity will be undertaken which presents an undue hazard in any fashion to the motoring public or to Department personnel.
2. The roadside management activities in which the Department engages will be within the AASHTO Policy on Geometric Design, which the Department has adopted as its design policy.
3. All Roadside management programs and activities will include consideration of mechanical mowing, chemical mowing, spot chemical treatments, wildflower establishment, reforestation, litter pickup, and public involvement aspects.
4. The Department will engage in a mowing program which will maintain sight distances, drainage, and a neat appearance in the recovery zone on the right of way.

5. The Department will engage in an herbicide program which will reduce vegetative growth, sterilize soil at signs and bridge abutments, and other locations as required.
6. The Department will engage in a reforestation program which will reduce the requirement for mowing and mitigate some environmental changes.
7. The Department will engage in a wildflower program to add to the natural scenic beauty of the state's highway system.
8. The Department will foster public involvement in its roadside maintenance activities where it is deemed practical.
9. All programs will be conducted in such a manner as to provide for the maximum efficiency of each program in roadside maintenance activities and expenditures.
10. All programs which are developed for the control of vegetation will be evaluated for use on the state's highways. No program will be authorized which would operate to the detriment of the roadways or the public.

References

- (1) Culwell, D. and Wendy Welch, Selected Species of Native Plants for Use on Highway Right of Way, 1987.
- (2) Arkansas State Highway and Transportation Department Wildflower Program.
- (3) Arkansas State Highway and Transportation Department Reforestation Program.
- (4) Neale, H.J., Excerpts from Opening Address, St. Louis. Roadside Dev. Com. Rpt., June 1937.
- (5) Iurka, H. H., J. F. Toth, and W. S. Tuttle, Design of Urban Landscaping, Roadside Dev. Com. Rpt. 697, 3-14, 1959.
- (6) Grieves, C. J., "Issues in Roadside Conservation." Masters Thesis, Monash University, Vict. Aust., 1986.
- (7) Adams, M. C., Roadside Management in North Carolina (Abr.). Trans. Res. Rec. 647, 20-23, 1978.
- (8) Brinton, J. H. and J.N. Bloom, Effect of Highway Landscape Development on Nearby Property. Nat. Coop. Hwy. Res. Prog. Rpt. 75, 1969.
- (9) Duell, R. W., Highway Vegetation: For Utility, Safety, Economy, and Beauty. N.J. Ag. Expt. St. Bull. 822, 1969.
- (10) Economic Impact of the Highway Beautification Act. U.S. Bureau of Pub. Rds., Staff Rpt. Mar. 1967.
- (11) Kates, R., Pursuit of Beauty. Presentation at the Ohio St. U. Nat. Res. Inst. Symposium, Columbus, May 1966.

- (12) Michaels, R. M., The Effect of Expressway Design on Driver Tension Responses. Public Roads, 32:5, 1962.
- (13) Michaels, R. M., Attitudes of Drivers Determine Choice Between Alternate Highways. Public Roads, 33:11, 1965.
- (14) Davidson, P., J. Tomer and A. Waldman, The Economic Benefits Accruing From the Scenic Enhancement of Highways. Hwy. Res. Rec. 285, 117-131, 1969.
- (15) Deakin, O. A. Design of Rural Highway Landscaping. Roadside Dev. Com. Rept. 697, 15-18, 1959.
- (16) Berger, R. and I.C. Floyd, Approaches to Roadside Management. Trans. Res. Rec. 647, 26-27, 1978.
- (17) Jones, H., The Role of the Engineer in General Improvement Areas. Inst. of Mech. Eng. Proc. 102:2, 33-35, 1975.
- (18) Better Looking Roadsides. Better Roads 43:6, 16-17, 1973.
- (19) Colwill, D. M., J. R. Thompson, and A. J. Rutter, An Assessment of the Condition for Shrubs Alongside Motorways. Transp and Rd. Res. Lab., Berkshire, Eng., 26 p., 1982.
- (20) Armstrong, W. H., Maintenance of Street and Highway Landscaping. Calif. St. and Hwy. Conf. Proc., 58-60, 1969.
- (21) Shanahan, Deborah M. and Richard C. Smardon. "Participatory Process for Managing Roadside Vegetation." Transportation Research Record 1224:6-14.
- (22) Foote, L.E., Minnesota Department of Transportation, Symposium on Roadside Vegetation Management and Manipulation Program, TRR 805.

- (23) Landers, Roger Q., Jr., Texas Agricultural Extension Service, Symposium on Roadside Vegetation Management and Manipulation Program, TRR 805.
- (24) Morre, D. James, Purdue University, Symposium on Roadside Vegetation Management and Manipulation Program, TRR 805.
- (25) Middleton, C.W., Symposium on Roadside Vegetation Management and Manipulation Program, TRR 805.
- (26) Ross, Robert, Symposium on Roadside Vegetation Management and Manipulation Program, TRR 805.
- (27) Johnson, W. D., Symposium on Roadside Vegetation Management and Manipulation Program, TRR 805.
- (28) Morris, Bill G. and J. A. Lewis Symposium on Roadside Vegetation Management and Manipulation Program, TRR 805.
- (29) Buffington, J.L., TTI, Texas A&M University, Strategies to Reduce Vegetation Control Costs, TRR 1189, 1988.
- (30) Corley, W.L. and A. E. Smith, Jr. Establishment and Management Methodology for Roadside Wildflowers, , University of Georgia.
- (31) Herbicide Program Recoups Budget Cuts, Road Talk, Fall 1991.

APPENDIX A: Arkansas State Highway and Transportation
Department's Wildflower Program, Environmental
Division

HIGHWAY WILDFLOWER PROGRAM

The Arkansas Highway and Transportation Department maintains over 100,000 acres of highway roadsides and aspires to maintain this acreage in a manner that is most beneficial to the state. Public safety takes priority over any other factor in determining right of way management practices. Once this need is met, roadsides should be maintained to promote the natural diversity of the state and enhance the driving experience.

The objectives of the highway Wildflower Program are three-fold and include 1) Preservation of Existing Wildflowers, 2) Enhancement of Wildflower Populations, and 3) Wildflower Route Maintenance Policy. If accomplished, these objectives will reduce long-term maintenance costs, enhance roadside wildlife, provide an attractive roadside environment, and preserve rare plant populations. These objectives and methods of accomplishing them are presented in the following sections.

Preservation of Existing Wildflowers

Early spring wildflowers reduce unsightly weeds by competing for nutrients and sunlight, so it is beneficial to practice a maintenance policy that will enhance their growth. Arkansas highways harbor many populations of annual and perennial wildflowers which will prosper and return year after year when maintenance activities are delayed until maturation of seed. Policies that allow wildflower populations to grow and expand in-

clude: 1) restricted use of herbicides in wildflower areas and 2) mowing practices that allow wildflower seed to set, thus allowing wildflowers to return the next year.

Table 1 identifies highways that have been designated as wildflower routes because of their exceptional displays during peak bloom. Additional routes will be added as they are discovered.

Enhancement of Native Wildflowers

Native wildflowers can be used as a colorful, low-maintenance alternative for high visibility areas frequented by motorists. Wildflower plantings promote a progressive image of Arkansas as "The Natural State" to out of state visitors.

Several types of areas can benefit from the planting of wildflowers in existing turf. Areas have been selected for their potential for showy displays where the existing wildflower populations have been significantly reduced. These areas include:

A) Interstates and Primary highways with wide rights of way that offer the largest amount right of way. Much of the areas behind the 30 foot bermuda zone can be enhanced by wildflower planting, reducing the maintenance costs without interfering with the Bermuda Release program.

B) Tourist Information Centers, Rest Areas, and AHTD District Headquarters are known for their well kept lawns and shrubbery but maintenance expenses in these areas are high due to the number of mowings and repeat plantings necessary to maintain the landscape. Areas of transition on the lawn perimeter may be enhanced by wildflower planting.

Selection of planting sites will be limited by safety restrictions, site accessibility, chemical and physical character-

istics of the soil, and availability of seeds. Seed availability is an important aspect of enhancements. For early enhancement projects, seed may be purchased or donated but future plantings may use seed collected from preserved areas. One-half of the areas of dense populations may be harvested and used for enhancement projects thus cutting expenses and ensuring a native variety of wildflowers. Native populations have been shown to produce enough viable seed for project use.

Public Involvement

As stated, garden clubs, civic groups, and individuals have sought to beautify highway right of way by planting wildflowers. AHTD will continue cooperating in these efforts by planting and maintaining wildflowers provided by interested groups. AHTD will also provide assistance in selection of seeds.

The number and types of groups donating seed increases, not only in numbers, but in amounts of donations every year. More civic groups, garden clubs and The Native Plant Society are expressing an interest in conjunction with the "adopt a highway" cleanup program.

Wildflower Route Maintenance Policy

Mowing

Full width right of way mowing will be delayed until about June 15 in Districts 2, 3, 6, and 7 and until about June 30 in Districts 1, 4, 5, 8, 9, and 10 unless otherwise specified.

Where safety conditions require, a single pass (variable width depending on mowers available) may be mowed at any time. Wildflower routes will be mowed full right of way width only during the fall cleanup (once per year).

Herbicide Treatment

Broadcast herbicide treatments will be eliminated from wildflower routes. Spot spraying to treat problem vegetation will be allowed if coordinated with the Environmental Division.

Wildflower Plantings

AHTD will cooperate in planting wildflower seeds provided by garden clubs, civic groups, or individuals. No wildflowers will be planted in the bermuda zone of highways currently maintained by herbicide treatment. All sites to be planted will be coordinated between the Districts and Environmental Division. The Districts will provide a tractor and operator for planting the wildflower sites. Environmental Division will supervise the planting and provide a no-till wildflower seeder.

wildflower Enhancements

The Districts may have high maintenance areas requiring constant mowing or herbicide treatments that they would like to downgrade to low intensity maintenance. Wildflowers offer a low maintenance alternative that would be attractive along the boundaries of rest areas and or District Headquarters property. Problem areas such as slide prone embankments or rock slopes with

poor soil may also benefit from wildflower planting. Environmental Division will assist the Districts with any area they desire to convert to wildflowers.

ARKANSAS HIGHWAY AND TRANSPORTATION DEPARTMENT

WILDFLOWER PLANTINGS ON HIGHWAY RIGHTS OF WAY

The Department provides for participation of interested individuals or groups in its wildflower program. Should an individual or group desire to plant wildflowers on Department right of way they shall make application, in writing, through the District Engineer for coordination and approval of a planting site. A list of District Engineers is provided for your convenience.

It will be the responsibility of the applicant/s to purchase the wildflower seeds and the Department will perform the planting at no cost to the applicant. Assistance is available (and recommended) from the Department in selecting and purchasing a seed mix.

No signs will be allowed on Department right of way to designate a wildflower plot.

DISTRICT ENGINEERS

District 1
R. J. Woodruff
P.O. Box 278
Wynne, AR 72396
Phone: 238-8144

District 2
Jim Briley
P.O. Box 6838
Pine Bluff, AR 71611
Phone: 534-1612

District 3
W. E. Tyler
P.O. Box 490
Hope, AR 71801
Phone: 777-3457

District 4
Harold Beaver
P.O. Box 1424
Fort Smith, AR 72902
Phone: 646-5501

District 5
J. R. Chaney
P.O. Box 2376
Batesville, AR 72503
Phone: 251-2374

District 6
Ralph Hall
P.O. Box 9358
Little Rock, AR
72219
Phone: 569-2266

District 7
Coy Campbell
P.O. Box 897
Camden, AR 71701
Phone: 836-6401

District 8
Lawrence Fletcher
P.O. Box 70
Russellville, AR
72801
Phone: 968-2286

District 9
Ralph Fulton
P.O. Box 610
Harrison, AR
72601
Phone: 743-2100

District 10
Joe Barnett
P.O. Box 98
Paragould, AR 72450
Phone: 239-9511

APPENDIX B: Arkansas State Highway and Transportation Department's
Reforestation Program and Schedule, Environmental
Division

ARKANSAS HIGHWAY AND TRANSPORTATION DEPARTMENT
REFORESTATION PROGRAM AND SCHEDULE

Introduction.

"Plant the Future", Governor Clinton's reforestation project emphasizes the replanting of Arkansas' forests as a means of increasing Arkansans' awareness of the critical role of forests and trees to the state and world. While not a catchall cure, reforestation should be considered a tool to mitigate the greenhouse effect which is to blame for global warming. The build up of carbon dioxide and other greenhouse gases to the tune of 200 billion tons per year from deforestation and burning of fossil fuels is generally believed to cause the warming of the planet. Recent calculations indicate warming by 2-9 degrees Fahrenheit by the middle of the next century.

A single tree can convert carbon dioxide into wood and leaf fiber at a rate of 26 pounds annually through photosynthesis. An acre will consume at least six tons of atmospheric carbon each year. It will take at least 700 million acres of new forest to check the greenhouse effect but not reverse it. The Governor's goals include the planting of 10 million trees a year in Arkansas. This figure is the Arkansas portion of offsetting the 20 million acres of trees lost in the Amazon Basin each year and is in addition to the 75 million trees planted annually in the state. Other goals include establishing a "no net loss" policy of forest land in Arkansas, challenging other states to similar

programs and establishing bottomland hardwood demonstration forest in eastern Arkansas.

The AHTD's involvement in the "Plant the Future" program can be directly beneficial to the Department from a public relations standpoint and economically from a maintenance standpoint. National averages of \$25.00/acre to mow and \$42.00/acre to spray can be redirected when Interstate interchanges and wide rights-of-way are removed from standard maintenance practices. Another benefit that can be realized is from the replanting of bottomland and wetland forest species to aid in obtaining Corps of Engineers 404 permits and establish credit toward future small wetland takings.

This program also offers the opportunity to invite public participation in highway beautification. The donation of trees not being planted by the Department or the help in planting in appropriate places can establish some local interest and pride as well as add to the beauty and diversity of Arkansas' highways.

PLANTING SPECIFICATIONS
AHTD REFORESTATION PROGRAM

Tree Seedling Planting

Locations suitable for seedling planting include interchanges on interstate and interstate-type facilities. Wide Rights-of-way may also be considered with approval of the District Engineer.

Areas identifies for acorn planting will be approved by the District Engineer. Mowing to 2" will be complete prior to acorn planting. Any vegetation control of problem weeds should be initiated before planting. Severe infestation of grasses may need to be controlled on an as-needed basis.

Trees will be picked up at the specified Arkansas Forestry Commission (AFC) office. Locations and phone numbers are on the order forms and copies will be sent to each District. Trees will be one-year seedlings between 18"-24" tall with an 8" root. Only as many trees as can be planted in one day should be taken to the field. Trees should be transferred from nursery supplied bags to buckets or planting bags containing wet sphagnum or peat. Trees that are not to be planted that day should be housed in cold storage (still wrapped) at the Arkansas Forestry Commission office if possible. If trees must be stored elsewhere, they may be kept in a shop or shed, under trees or anywhere that cool, shaded conditions can be met so that roots will not dry out.

Seedlings should never be left out because exposed roots dry out very quickly in the sun. Seedlings should never be carried in one's hand for the same reason.

Planting will take place after the first of the year and proceed until May at the latest. Planting will be done manually with District personnel and supervised by Environmental. Approximately 8-10 acres/day can be planted with a five member crew. Tree planting KBC bars and tree bags will be furnished. The technique for planting is shown in Diagram 1 which is attached. It is important that seedlings be planted so that their roots may spread out naturally and they are not twisted or curled upwards or bent. Time will be taken prior to planting to train those assigned to plant trees.

Seedlings should be planted with root collars just below the ground surface (Diagram 2, attached). Planting too deep or too shallow, leaving air pockets around the roots or with bent roots resulting in j-rooting will cause the demise and ultimate fatality of the seedling.

Ordering of seedlings will be done by the Environmental Division but responsibility of payment will be from the District budget. Individual orders for each District will be made by Environmental to the Arkansas Forestry Commission and requisition for payment will be accomplished through the Environmental Division with notification and copies to each District.

PLANTING SPECIFICATIONS
AHTD REFORESTATION PROGRAM

Acorn Planting.

Locations suitable for acorn planting include interchanges on interstate and interstate-type facilities. Wide rights-of-way may also be considered with the approval of the District Engineer.

Areas identified for acorn planting will be approved by the District Engineer. Mowing to 2" will be complete prior to acorn planting. Any vegetation control of problem weeds should be initiated before planting. Severe infestations of grasses may need to be controlled on an as-needed basis.

Acorns will be picked up at the Arkansas Forestry Commission office listed on the order forms. Fifty acres of acorns can be planted in a day if planting locations are in close proximity to one another. Seed must be kept cool and away from rodents until planting. For this reason nuts should not be picked up until the week of planting, one to two days ahead if possible. Planting will take place in Winter (late Nov.- Feb.) or Spring (March - May) as conditions become conducive to planting. Acorn planting will be accomplished with the acorn planter and district tractor and two additional employees. Acorns will be planted at a depth of 2-2.5 inches in appropriate habitats. The Environmental Division will coordinate and supervise the plantings.

Acorn planter is statewide equipment and coordination for transfer will be done between the Environmental Division and the District.

Ordering of acorns will be done by the Environmental Division, but responsibility of payment will be from the District budget. Individual orders for each District will be made by Environmental to the Arkansas Forestry Commission, and requisition for payment will be accomplished through the Environmental Division with notification and copies to each District.

Program Description and Responsibilities.

The AHTD Reforestation Program will be coordinated through the Environmental Division with the Construction/Maintenance Division and the Districts. Each District was given the opportunity to identify locations for reforestation on district ROW and areas added by Environmental and Construction/Maintenance. These areas are those outside the clear zone, in interchanges or anywhere that trees will not cause structural or safety problems and maintenance costs can be minimized. The program will combine the plantings of seedling trees and acorns to reforest identified areas. The attached county maps identify the 1990 planting locations. Locations have been identified to continue planting into the future if funds are available.

The Environmental Division will coordinate and schedule the plantings. A tentative schedule is included. Weather and the

availability of plant materials (acorns/.trees) determine when planting can begin. The Arkansas Forestry Commission will supply trees and acorns while supplies last. Purchase of 1990 acorns began on October 2 and will not be available until late November for planting while seedling will not be available until after the first of the year. A limited supply of 1989 water and willow oak, Nuttall's and pin oak are available for fall 1990.

The following species associations will be planted (acorn or trees) in the appropriate habitats with the aid of the District personnel and equipment:

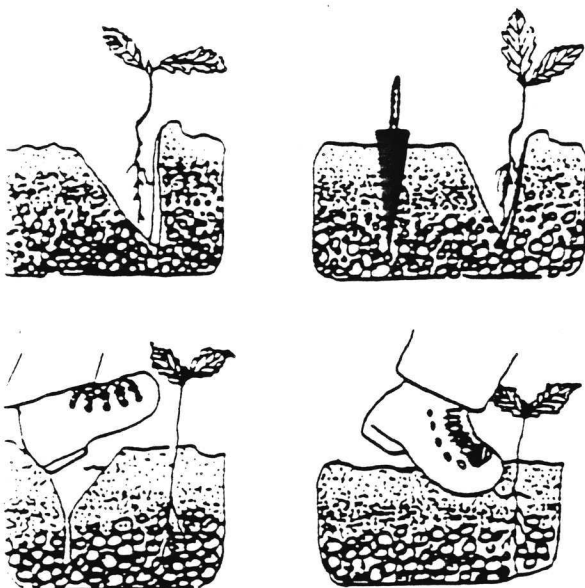
Wet, poorly drained: cypress, overcup, Nuttals's and
pin oak

Low, seasonally flooded, with some drainage: Willow,
water, Nuttal's, pin, Shumard's, cherrybark oak

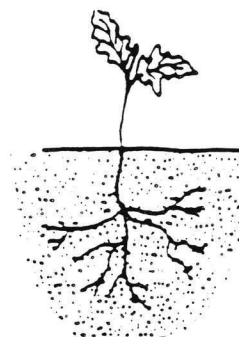
Well drained, mesic: Red, white, pin, willow and
water oak

It is very likely that all groups may be planted in the same area depending upon the grade and soil type.

All planting will be completed by May 1991 as weather permits. Specifications for planting are included and Wendy Welch, Environmental Division, will supervise all plantings.

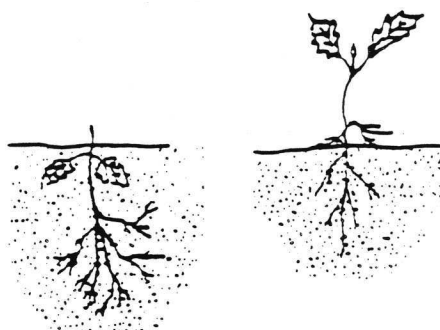


g technique for use with hand tools.



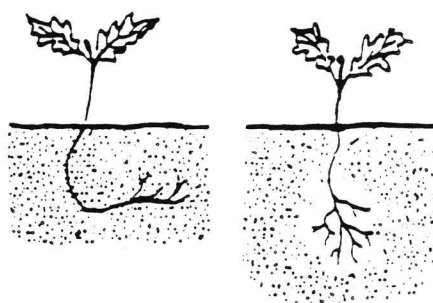
a. Properly planted seedling

Improperly planted seedlings



b. too deep

c. too shallow



d. roots bent

e. air pockets

DIAGRAM 2. It is critical that tree seedlings be planted properly (a), not too deep (b), shallow (c), with roots bent upwards (d), or with air pockets (e).

ILLUSTRATIONS FROM US OI AND USOA
"BOTTLING HARDWOOD REFORESTATION
IN THE LOWER MISSISSIPPI VALLEY."
SEPT. 1990

APPENDIX C: Vegetation Control Overview, Construction and Maintenance Division

Herbicide Program Review

On November 27, 1990, Mr. Bob Fulton presented to the Transportation Research Subcommittee on Roadside Vegetation Management a summary of the Arkansas State Highway and Transportation Department's Herbicide Program. Many aspects of the Herbicide Program were covered. Some of the highlights of his presentation follow.

Mr. Fulton defined several components of the Herbicide Program. The Bermuda Release Program is designed to remove from the area under treatment all taller growing vegetation and permit the Bermuda to flourish as it is a low maintenance, low growing grass, which releases labor and reduces safety hazards and mowing costs. The Bermuda Release Program is a pre-emerge treatment and we use a broadcast of Oust in the fall and spring, sometimes including MSMA at the spring treatment. Depending upon conditions, we may use MSMA alone in a second summer treatment. The Bermuda Release Program highways were shown on his map in green.

The Johnson Grass Control Program was shown on his map in yellow. Johnson Grass Program is now mostly a spotting sort of application. Where there are many other tall growing grasses and weeds they still must be treated to preserve sight distances.

The Bridge, Sign, Guardrails, and edge of shoulder treatment program uses Oust and Rodeo. These areas are difficult maintenance areas and can only be treated with hand methods or chemicals. Chemical treatment is by far the most cost effective. We

use Rodeo now rather than Roundup because of the addition of surfactant to pass Environmental rules for use with aquatics.

Benton county does not use chemicals. The topography is so porous the potential for contamination of ground water is somewhat high.

The Wildflower Program was shown in Red on his map. We do not treat those sections until the seeds have developed. Proposed Wildflower routes were shown in blue on his map.

In the Delta on the Interstate System we control Johnson Grass all over the right of way limits. In crop area if rows run parallel to the highway, we have to leave a buffer zone to avoid any crop damage. Where there is a turn row we treat to the right of way line. Beyond normal broadcast zone (30 feet) the additional right of way is hand sprayed.

We use Rodeo on Kudzu and it takes two to three years to clear it. Sometimes it is succeeded by another problem plant.

We've taken weeping love grass out of most of our seeding mixtures because we do not mow that often now and it becomes undesirable.

He also provided a Georgia DOT document which gives a very similar developmental history and end results as our own program. This report follows.

**COOPERATIVE RESEARCH
GDOT RESEARCH PROJECT NO. 8303
FINAL REPORT - PHASE III**



**HERBICIDES
FOR HIGHWAY
USE**



**COOPERATIVE EXTENSION SERVICE
UNIVERSITY OF GEORGIA**

AND



**DEPARTMENT OF TRANSPORTATION
OF GEORGIA**

1987

Cooperative Research
GDOT Research Report 8303

Final Report - Phase III

HERBICIDES FOR HIGHWAY USE

By

James F. Miller
Extension Agronomist-Weed Science
The University of Georgia

Percy B. Middlebrooks, Jr.
Chief, Operations Research Branch
Georgia Department of Transportation

Cooperative Research
between The
University of Georgia
and the
Department of Transportation of Georgia

in cooperation with
U. S. Department of Transportation
Federal Highway Administration

April, 1987

The contents of this report reflect the views of the authors who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Department of Transportation of Georgia or the Federal Highway Administration. This report does not constitute a standard, specification or regulation. The State of Georgia or the United States Government does not endorse products or manufacturers. Trade or manufacturer's names appear herein only because they are considered essential to the object of this document.

1. Report No. FHWA-GA-87-8303	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle HERBICIDES FOR HIGHWAY USE		5. Report Date April, 1987	
		6. Performing Organization Code	
7. Author(s) James F. Miller Percy B. Middlebrooks, Jr.		8. Performing Organization Report No.	
9. Performing Organization Name and Address Georgia Department of Transportation No 2. Capitol Square, Atlanta, GA 30344 and University of Georgia, Cooperative Extension Service, Athens, GA 30602		10. Work Unit No.	
12. Sponsoring Agency Name and Address Georgia Department of Transportation No. 2 Capitol Square Atlanta, GA 30334		11. Contract or Grant No. GA. HPR Project No. 8303	
		13. Type of Report and Period Covered Final Report - Phase III 1984-1986	
14. Sponsoring Agency Code			
15. Supplementary Notes Conducted in cooperation with the Federal Highway Administration, U.S. Department of Transportation			
16. Abstract <p>Numerous single and combination chemical applications were evaluated in four major areas of emphasis in an effort to provide a year-round chemical spraying program. The major areas were control of winter annual weeds, smutgrass control, control of lovegrass and suppression of fescue seedheads. A determination of arsenic residues from MSMA sprayed roadsides was compared with unsprayed roadsides.</p> <p>Sulfometuron (Oust) or Atrazine (Aatrex, et.al.) were determined the most effective treatments for control of winter annual broadleaf weeds.</p> <p>Hexazinone (Velpar) or dalapon (Dowpon M) were demonstrated as effective treatments for control of smutgrass.</p> <p>No satisfactory treatments were found for the selective control of lovegrass on roadside.</p> <p>Trials for suppression of fescue seedheads were conducted in three different years and on two dates of application in the first two years to determine and compare the efficacy of sethoxydim (Poast) and related compounds with sulfometuron (Oust) and glyphosate (Roundup).</p> <p>Analyses of soil samples collected from roadsides sprayed and not sprayed with MSMA indicated little or no evidence of arsenic accumulation after nine years of the roadside spraying program.</p>			
17. Key Words Weeds, herbicides, weed control, fescue, lovegrass, smutgrass, bermudagrass, sulfometuron, sethoxydim, wild garlic, glyphosate, seed-head suppression, roadside management		18. Distribution Statement	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 106	22. Price

ACKNOWLEDGEMENTS

Nine years of effort devoted to the improvement of the maintenance of highway rights-of-way through three projects has strengthened the level of cooperation between the Georgia Department of Transportation and the Georgia Cooperative Extension Service to the benefit of taxpayers in Georgia and other states.

Appreciation is expressed to Percy Middlebrooks, Co-Director of the project for his continual effort to coordinate planning and field activities with Jerry Wall and Dwayne Withrow, agronomists in charge of site selection and protection of trial sites. Their personal observations have been very helpful in ensuring the success of these efforts to develop the spraying program.

The team approach has provided the potential for continual development and refinement of spray schedules and techniques which should benefit the GaDOT roadside maintenance program for years to come.

James F. Miller
Project Director

IMPLEMENTATION

The State Agronomists and District Roadside Enhancement Coordinators with the Department's Office of Maintenance are fully involved in the conduct of this research. Prior to the start of each year of testing, one or two meetings are held between this group and project directors. The results of work during the previous year and proposed implementation are discussed. The Department generally moves gradually into the routine use of a herbicide or system which has proved itself in the research testing program.

At this same meeting plans are made for the testing program for the subsequent year. Each person identifies problem areas which should be studied and suitable problems are included in the research program. Plans are then formulated for site selection, materials to be tested and experimental design. A second meeting is held as needed to clarify such details as suitable sites, availability of materials and severity of the problem.

Maintenance personnel are on hand to assist with the establishment and rating of small plot trials. This allows first hand observation of results and a good working relationship to be established with project directors. Independent plot ratings are often made by maintenance personnel which are averaged with ratings made by project directors.

This procedure has proved to be very successful in guiding the research effort and obtaining the timely implementation of results.

The following is a list of the elements of the Department's ongoing herbicide program.

1. MSMA continues to be the basis for the program and rates remain at 2 lbs. ai/A. Bermudagrass which has spread and become the dominant species as the result of previous MSMA applications has suppressed competition from other species and reduced the frequency of MSMA application. On the average one to two applications per year is sufficient.
2. Sulfometuron (Oust) at 0.5 ounces ai/A or sethoxydim (Poast) at 0.25 lbs. ai/A is being used for tall fescue seedhead control. In 1986, 5,760 acres were treated with Oust and 960 acres with Poast. Results indicate that Oust should be used exclusively.
3. Oust at one ounce ai/A or atrazine at 3 lbs. ai/A is used to control winter annual weeds and has largely replaced the use of 2,4-D and dicamba. Treatments are applied in February and March which also allows more effective use of manpower. Presently Oust is the preferred treatment.
4. Oust at one ounce ai/A is also being used for guardrail treatment where Oust is not already being used for winter weed or seedhead control. When tolerant species such as honeysuckle are encountered, an application of 2,4-D at 2 lbs. ai/A is made.
5. The simplicity of the Department's herbicide program has been the key to its safety and success. For this reason spot treatment of johnsongrass with MSMA

continues to be the most practical method.

6. Sulfometuron (Oust) at one ounce ai/A is being used in a few locations as an alternate to MSMA for bermudagrass release.
7. Glyphosate (Roundup) at 4 lbs. ai/A and sethoxydim (Poast) at 0.25 lbs. ai/A is being used for vegetation control in landscape plantings.

COST SAVINGS

Figures have been prepared which show cost and acreage history of the herbicide program in GDOT. Figure 1 shows the number of acres sprayed, the number of acres mowed and the total acreage maintained. Acreage mowed with machines gradually declined as a result of the herbicide program. Drought conditions in 1986 resulted in some reduction of acreage sprayed. Figure 2 shows the cost per acre for chemical and machine mowing. This figure indicates the cost stability which has been achieved with chemical application and the general increase in the cost of machine mowing. Figure 3 shows the total cost of each program, the overall cost, and the cost of machine mowing had the spraying program not been available. Figure 4 shows the savings which have been achieved through the implementation of the chemical mowing program. Savings shown for each year are the savings for the year alone. Cumulative savings since the program began amount to over \$19 million. These saving figures are conservative because it is assumed that one chemical mowing equals one machine mowing when in fact one chemical application generally gives longer control and much more uniform and better looking roadsides over the control period. Most roadsides have neat and uniform appearance all year, except for some weed growth in early spring.

FIGURE 1

CHEMICAL VS. MACHINE MOWING

ACRES COVERED

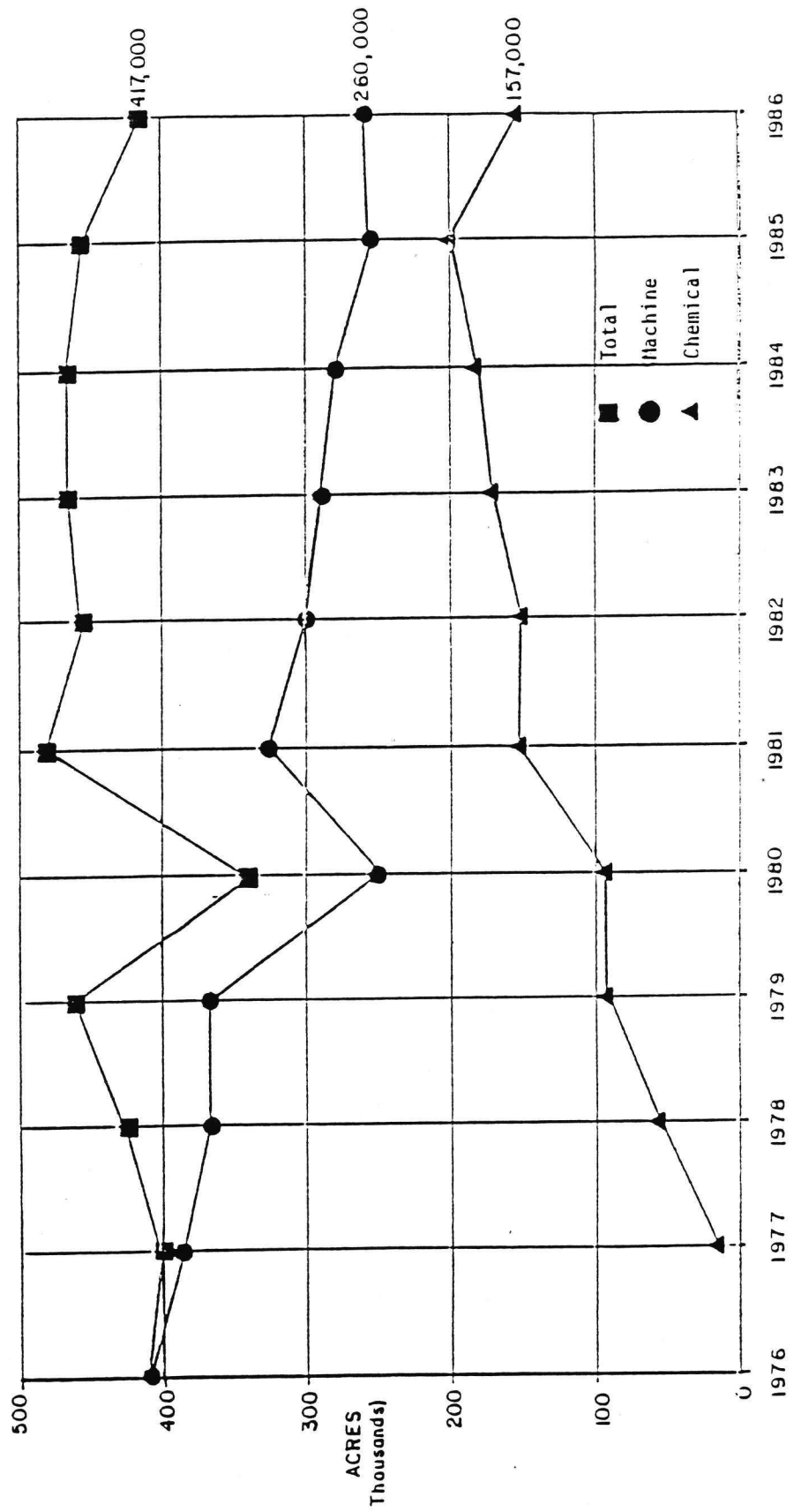


FIGURE 2

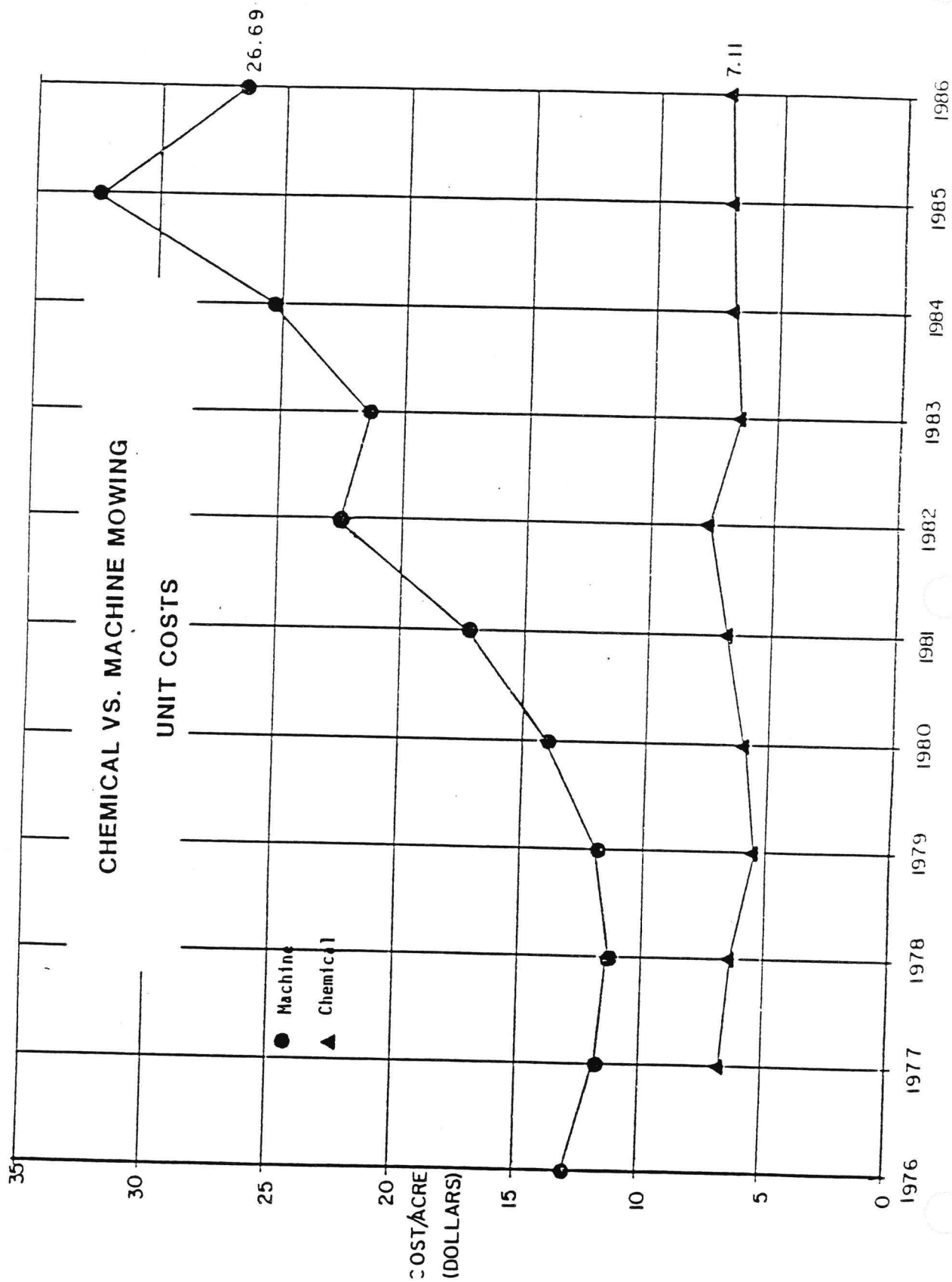


FIGURE 3

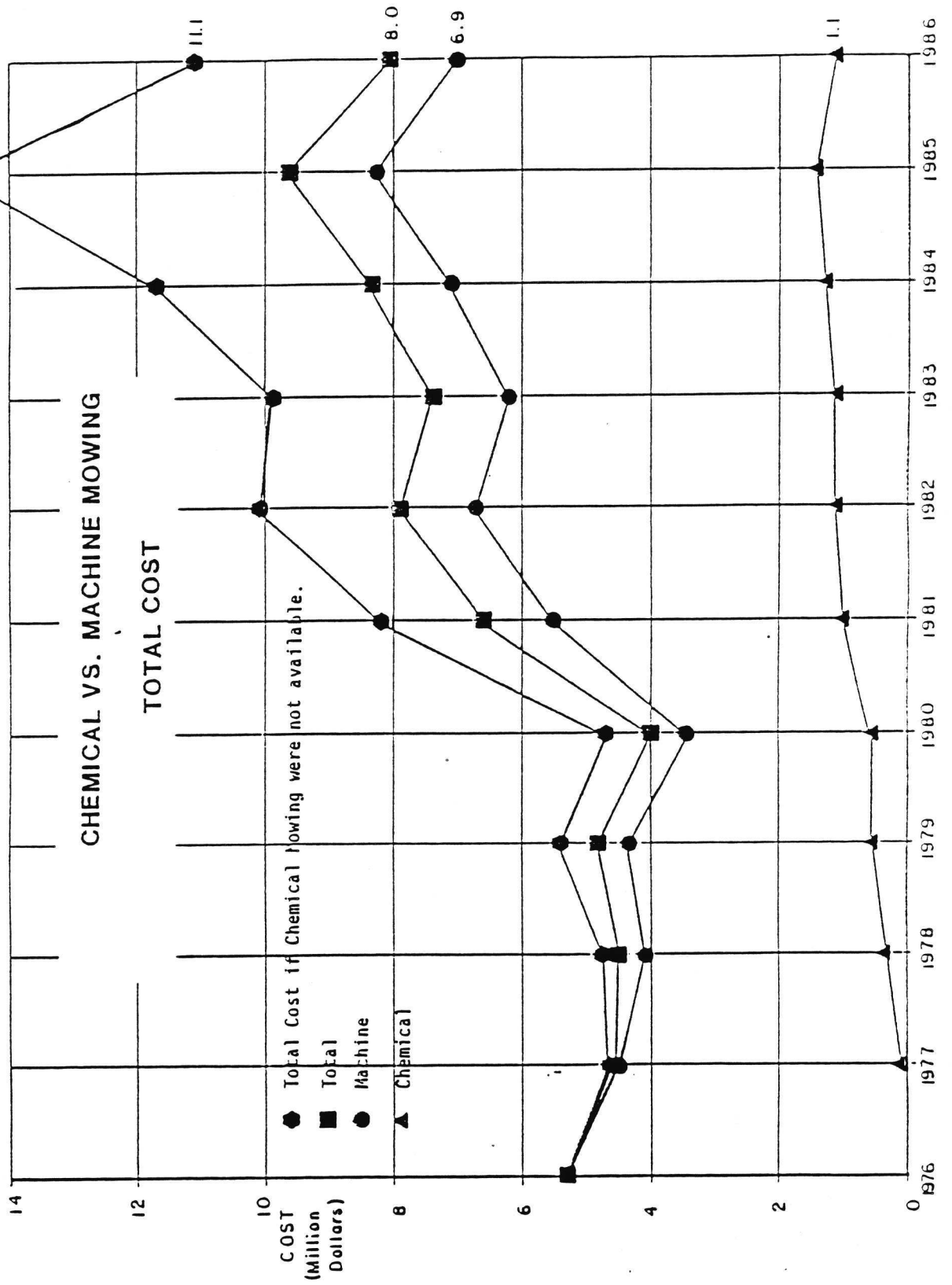
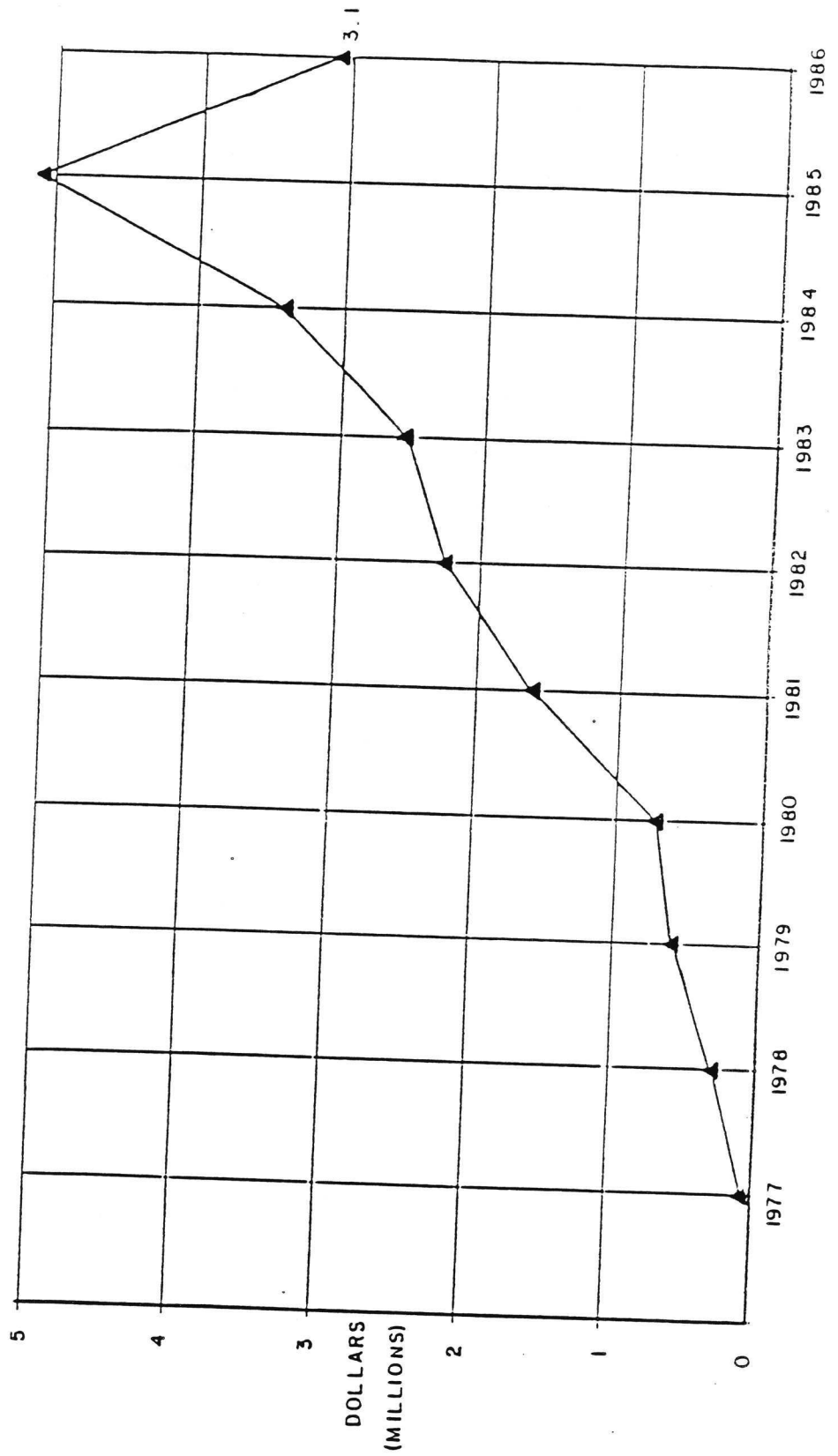


FIGURE 4

CHEMICAL MOWING SAVINGS



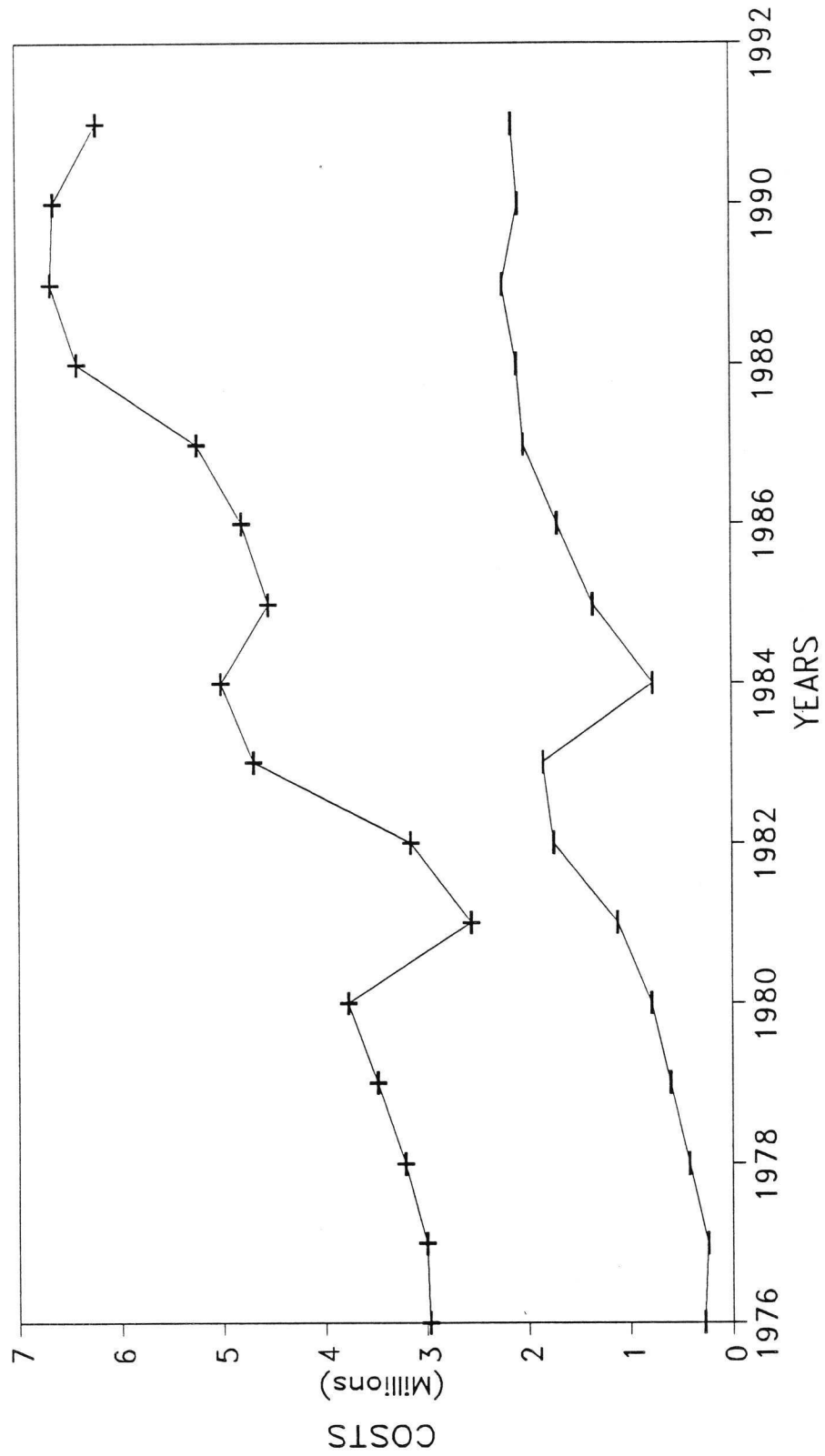
APPENDIX D: Mowing Expenditures, Construction and Maintenance
Division

ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT
MAINTENANCE DIVISION

CHEMICAL AND MOWING EXPENDITURES

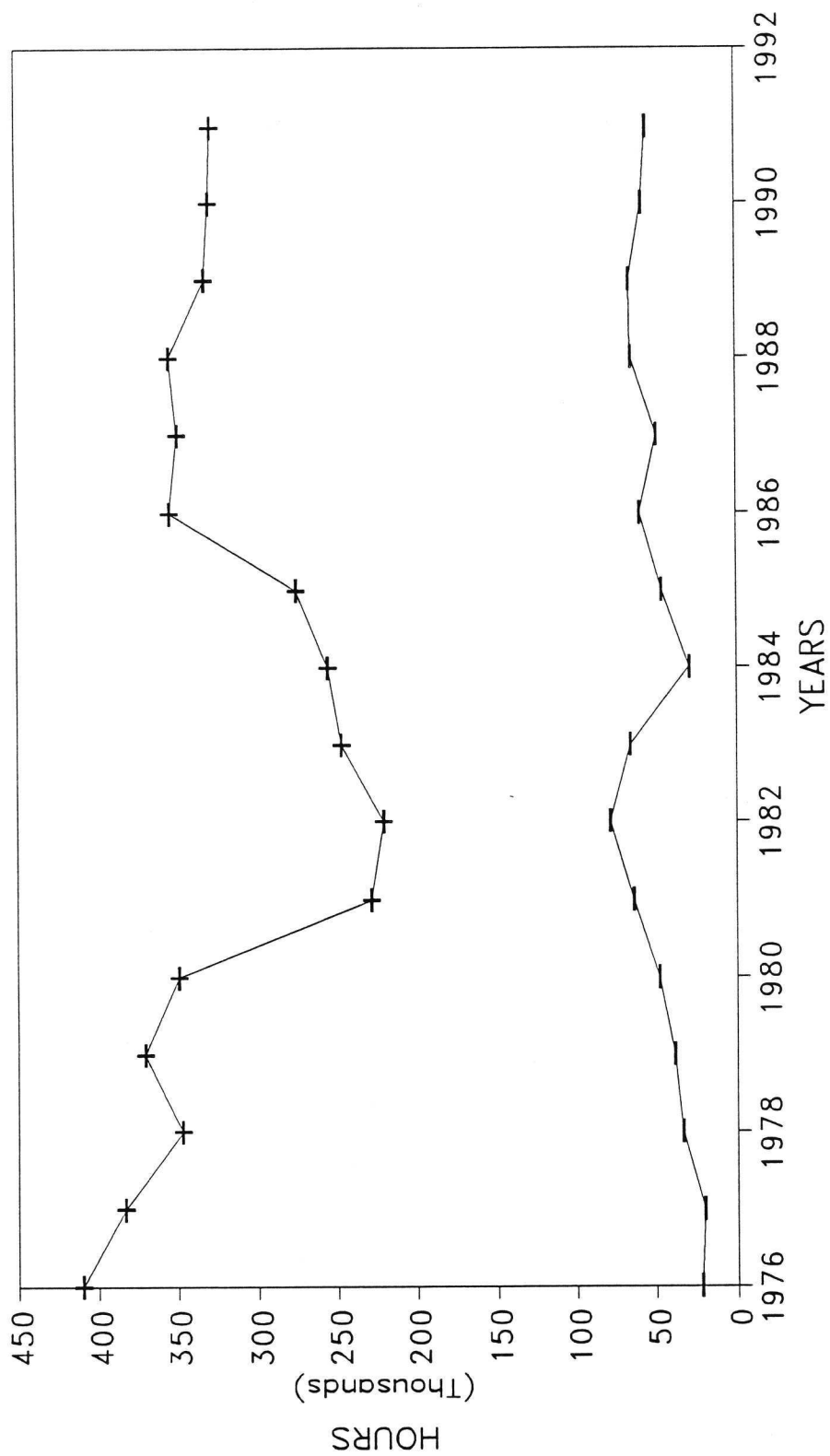
YEAR	HOURS	MOWING EXPENDIT	ACRES	ACRES	CORRECTED ACRES	COST PER/ACRE	HOURS	CHEMICAL EXPENDIT	COMBINED EXPENDIT
1976	409,847	\$2,959,320	269,775	297,832	9.94	21,984	\$260,784	\$3,220,104	
1977	383,591	\$2,990,966	287,339	255,444	11.71	19,641	\$233,616	\$3,224,582	
1978	347,172	\$3,209,749	306,258	233,369	13.75	33,347	\$423,355	\$3,633,104	
1979	370,308	\$3,484,796	310,884	260,521	13.38	38,735	\$591,390	\$4,076,186	
1980	349,250	\$3,760,773	309,773	164,236	14.03	48,657	\$781,454	\$4,488,227	
1981	228,542	\$2,546,248	300,130	238,303	10.68	63,817	\$1,112,818	\$3,659,066	
1982	220,883	\$3,148,087	290,577	325,156	9.68	78,311	\$1,729,039	\$4,877,126	
1983	246,927	\$4,684,887	173,314	283,540	25.53	65,413	\$1,844,008	\$6,528,895	
1984	256,025	\$5,009,216	173,525	190,183	26.34	28,276	\$768,140	\$5,777,356	
1985	275,580	\$4,543,837	174,009	195,760	23.21	45,959	\$1,347,081	\$5,890,918	
1986	353,923	\$4,793,485	174,648	251,318	19.07	60,135	\$1,694,017	\$6,487,502	
1987	348,885	\$5,236,029	297,592	429,449	17.59	49,004	\$2,020,590	\$7,256,619	
1988	353,720	\$6,401,891	267,572	250,719	25.53	64,864	\$2,082,470	\$8,484,361	
1989	331,488	\$6,652,517	276,532	238,094	27.94	65,883	\$2,224,138	\$8,876,655	
1990	328,462	\$6,633,061	267,118	225,982	28.35	58,126	\$2,075,090	\$8,708,151	
1991	327,777	\$6,197,260	267,588	225,042	27.54	55,119	\$2,134,267	\$8,331,527	

VEGETATION CONTROL EXPENDITURES



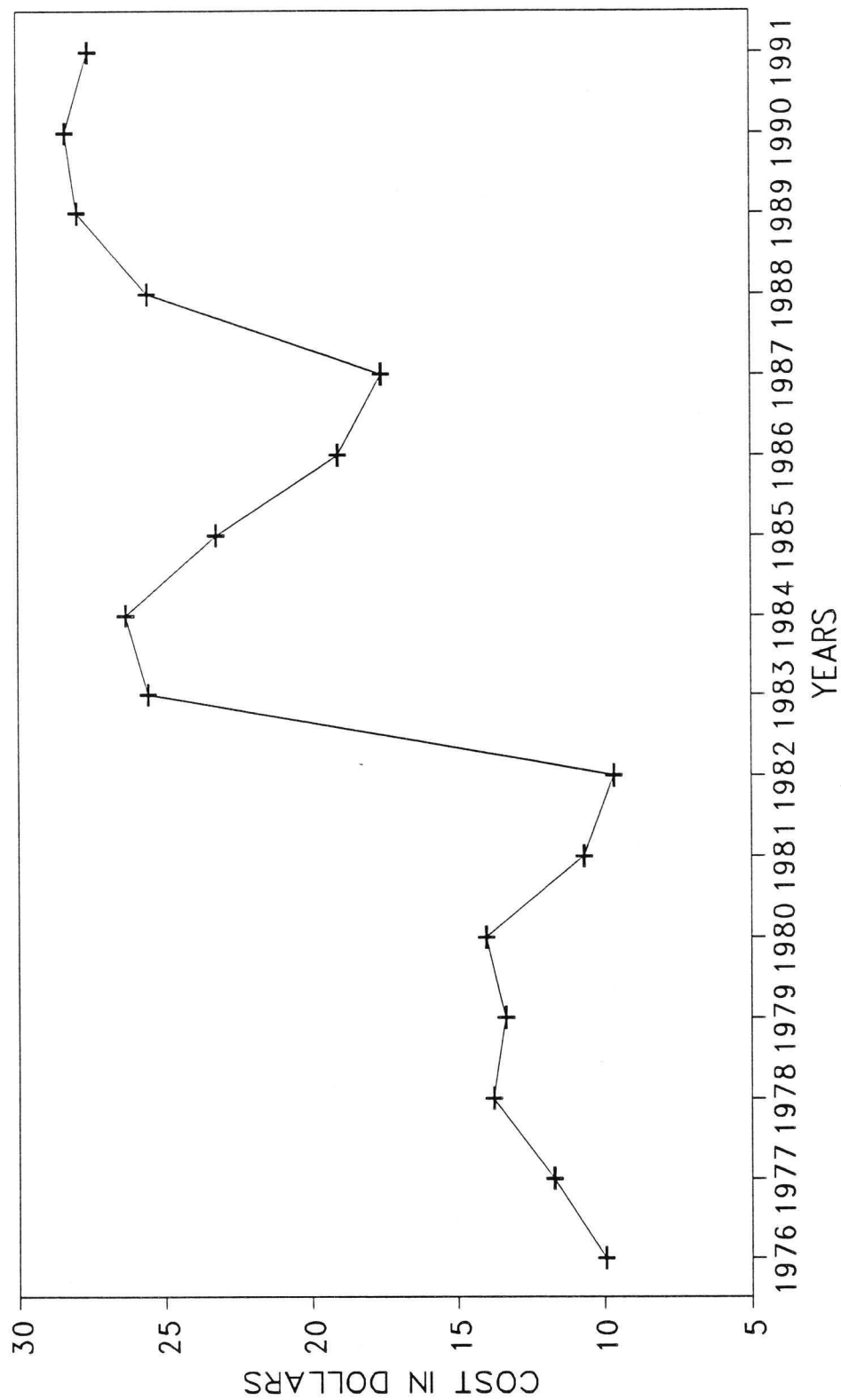
—+— MOWING COSTS —-— CHEMICAL COSTS

VEGETATION CONTROL HOURS



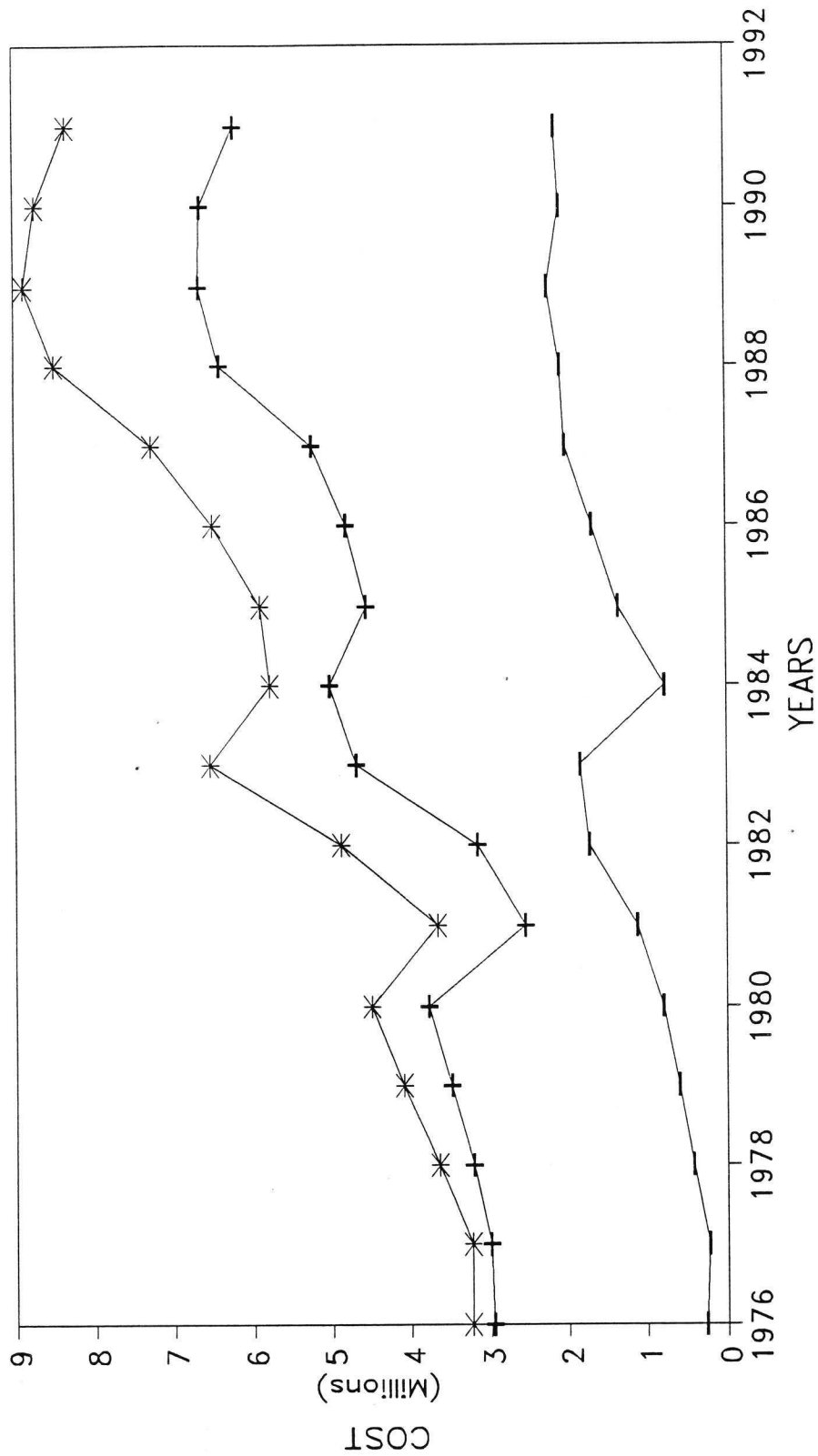
—+— MOWING HOURS —|— CHEMICAL HOURS

VEGETATION CONTROL
MOWING COSTS PER ACRE



—+— MOWING COSTS

VEGETATION CONTROL MOWING AND CHEMICAL COSTS



+ MOWING COSTS — CHEMICAL COSTS * COMBINED COSTS

APPENDIX E: Herbicide, Wildflower and Reforestation Overview,
Environmental Division

Overview of Herbicide, Wildflower, and Reforestation Programs

The Environmental Division has a lot of input in the Department Vegetation Control Program on Highway rights of way. Several management programs are involved. There are alternative ways to vegetation management. The Wildflower and the reforestation programs are alternatives to the herbicide and mowing programs. They do not neglect herbicides, but use them more discriminately. John Harris reviews chemicals for their effect and suitability for use by the department.

Everybody is looking for alternative methods for right of way management strategies. TRB is considering vegetation as a tool for right of way management and looking for plants to fulfill certain needs.

There is a conservation aspect of the program. We have about 400 miles of highway designated because of their natural displays as wildflower routes. We do not include interstates. They concentrate on areas where maintenance practices tend to remove all the naturally occurring wildflowers. A conscious effort is made to schedule with Districts their mowing so that flowers have an opportunity to flower and seed prior to mowing. We have Scenic Routes and Wildflower routes. Maintenance and Environmental Divisions have compromised to come up with optimum programs. Last year they planted 75 acres in wildflowers. Its something we can do with a positive public impact.

Prairie grasses have been reintroduced in some states most successfully. They were returned in response to public demand for wildlife considerations. The prairie grasses are suitable for highway rights of way. Their use would likely be much less expensive than trying to maintain a monoculture species. Monocultures tend to become thin and gappy unless farming procedures are used. This is a very expensive operation.

Mr. McConnell addressed what could be used in the 30' clear zone. Essentially anything can be used which will not interfere with a vehicle or with sight distance requirements. We are unaware of any height requirement other than for sight distance requirements in certain areas.

The Interstate is excluded due to the fact that Districts were managing it effectively without additional oversight. The interstate is one area where effects can be maximized as there is more public on the interstate.

Reforestation Program.

The Governor's Reforestation Program was designed to teach us how important trees are to clean air and the ozone layer. We got into the program because highway construction was a significant contributor to the loss of trees in our management of our rights of way. Therefore we have been planting acorns and seedlings to replace some of the trees that highways have removed. Some of these areas will look somewhat shaggy. We will put up

signs identifying these reforestation areas as we have found that the public is more prone to accept an unusual appearance when it is clear that the department knows what it is doing. The Reforestation Program reduces our mowing requirement except in some urban locations. Most of our reforestation efforts have been in rural areas.

The Reforestation Program puts a lot of emphasis on wet areas. We concentrate on the wet areas because these are problem areas for the District Engineers and they are anxious to find a means to get these areas out of the Maintenance program.

APPENDIX F: Questionnaire to District Engineers

ROADSIDE VEGETATION CONTROL QUESTIONNAIRE

Sheet 1 of 2

As part of a research project on Roadside Vegetation Control, the Roadside Vegetation Control Committee is seeking input from a wide array of interested and knowledgeable parties concerning vegetation control measures.

This questionnaire is submitted to obtain your District's information.

DISTRICT _____

Please check your opinion regarding the level of activity for the following practices in your district.

ITEM	SYSTEM	DESIRED LEVEL OF ACTIVITY		
		MORE	CORRECT	LESS
MOWING	INTERSTATE HIGHWAYS			
	PRIMARY HIGHWAYS			
	SECONDARY HIGHWAYS			
HERBICIDE	INTERSTATE HIGHWAYS			
	PRIMARY HIGHWAYS			
	SECONDARY HIGHWAYS			
WILDFLOWERS	INTERSTATE HIGHWAYS			
	PRIMARY HIGHWAYS			
	SECONDARY HIGHWAYS			
REFORESTATION (NATURAL)	INTERSTATE HIGHWAYS			
	PRIMARY HIGHWAYS			
	SECONDARY HIGHWAYS			
REFORESTATION (PLANTING/SEEDING)	INTERSTATE HIGHWAYS			
	PRIMARY HIGHWAYS			
	SECONDARY HIGHWAYS			

Prepare a brief description of the major advantages and problems associated with each of these control measures. Attach additional sheets as required.

MOWING	
HERBICIDE	
WILDFLOWERS	
REFORESTATION (NATURAL)	
REFORESTATION (PLANT/SEEDING)	

Provide information regarding locations by route, section and log mile that the committee could visit to view what you consider to be your best and worst vegetation control problem/solution.

SYSTEM	BEST			WORST		
	ROUTE	SECTION	LOG MILE	ROUTE	SECTION	LOG MILE
INTERSTATE						
PRIMARY						
SECONDARY						

Rank, in order of complaints received, the following:

MOWING: _____
 WILDFLOWERS: _____
 REFORESTATION: _____
 LITTER: _____
 ICE: _____
 POTHOLES: _____
 LOW SHOULDER: _____
 OTHER: _____

No. 1 = most complaints received

No. 8 = least complaints received

(Percentages also acceptable)

APPENDIX G: PUBLIC AGENCIES RESPONSE

Adopt A Highway Volunteer

Dear Volunteer,

The Highway and Transportation Department's Transportation Research Committee has undertaken a research project on "ROADSIDE VEGETATION CONTROL."

As an Adopt A Highway Volunteer, you have first-hand experience with Arkansas' roadsides, and may have some suggestions which would be helpful in conducting our research.

The primary objective of this project is to evaluate the costs and environmental concerns of each component of the roadside vegetation management program. This includes an assessment of the requirements of the program from an aspect of safety and operation, as well as the public's acceptance of the appearance of the highway right of way.

Please take a few minutes to fill out this questionnaire and return it to us. Your comments will be extremely useful in the overall development of a roadside management program.

Bill Stanton, Public Affairs Officer

Cut along dotted line, fold and return lower portion.

Roadside Vegetation Control Questionnaire

Please check your opinion regarding the level of activity for the following practices.

Item	System	Desired Level of Activity		
		More	Correct	Less
MOWING	Interstate Highways	6.5	89.5	6.5
	Primary Highways	35.2	64.7	0
	Secondary Highways	41.1	52.9	5.8
HERBICIDE	Interstate Highways	12.5	68.7	18.7
	Primary Highways	12.5	75.0	12.5
	Secondary Highways	25.0	62.5	12.5
WILDFLOWERS	Interstate Highways	70.5	23.5	5.8
	Primary Highways	64.7	23.5	11.7
	Secondary Highways	58.8	29.4	11.7
REFORESTATION (Natural)	Interstate Highways	43.7	43.7	12.5
	Primary Highways	23.5	70.5	5.8
	Secondary Highways	31.2	56.2	12.5
REFORESTATION (Planting/Seeding)	Interstate Highways	56.2	31.2	12.5
	Primary Highways	37.5	50.0	12.5
	Secondary Highways	33.0	53.3	13.0

Comments: _____

Dist. (1)

Group Name: _____ County: _____

Adopt A Highway Volunteer

Dear Volunteer,

The Highway and Transportation Department's Transportation Research Committee has undertaken a research project on "ROADSIDE VEGETATION CONTROL."

As an Adopt A Highway Volunteer, you have first-hand experience with Arkansas' roadsides, and may have some suggestions which would be helpful in conducting our research.

The primary objective of this project is to evaluate the costs and environmental concerns of each component of the roadside vegetation management program. This includes an assessment of the requirements of the program from an aspect of safety and operation, as well as the public's acceptance of the appearance of the highway right of way.

Please take a few minutes to fill out this questionnaire and return it to us. Your comments will be extremely useful in the overall development of a roadside management program.

Bill Stanton, Public Affairs Officer

Cut along dotted line, fold and return lower portion.

Roadside Vegetation Control Questionnaire

Please check your opinion regarding the level of activity for the following practices.

Item	System	Desired Level of Activity		
		More	Correct	Less
MOWING	Interstate Highways	47.4	52.6	0
	Primary Highways	66.7	33.3	0
	Secondary Highways	81.0	14.0	0
HERBICIDE	Interstate Highways	21.0	36.8	42.10
	Primary Highways	26.3	31.6	42.10
	Secondary Highways	36.8	21.0	42.1
WILDFLOWERS	Interstate Highways	71.4	9.5	19.0
	Primary Highways	55.0	25.0	20.0
	Secondary Highways	55.0	25.0	20.0
REFORESTATION (Natural)	Interstate Highways	39.0	34.0	27.7
	Primary Highways	27.8	27.8	44.3
	Secondary Highways	33.3	22.2	44.4
REFORESTATION (Planting/Seeding)	Interstate Highways	47.6	38.0	14.2
	Primary Highways	31.5	42.1	26.3
	Secondary Highways	36.8	36.8	26.3

Comments: _____

Dist. 2

Group Name: _____

County: _____

Adopt A Highway Volunteer

Dear Volunteer,

The Highway and Transportation Department's Transportation Research Committee has undertaken a research project on "ROAD-SIDE VEGETATION CONTROL."

As an Adopt A Highway Volunteer, you have first-hand experience with Arkansas' roadsides, and may have some suggestions which would be helpful in conducting our research.

The primary objective of this project is to evaluate the costs and environmental concerns of each component of the roadside vegetation management program. This includes an assessment of the requirements of the program from an aspect of safety and operation, as well as the public's acceptance of the appearance of the highway right of way.

Please take a few minutes to fill out this questionnaire and return it to us. Your comments will be extremely useful in the overall development of a roadside management program.

Bill Stanton, Public Affairs Officer

Cut along dotted line, fold and return lower portion.

Roadside Vegetation Control Questionnaire

Please check your opinion regarding the level of activity for the following practices.

Item	System	Desired Level of Activity		
		More	Correct	Less
MOWING	Interstate Highways	11.5	84.6	3.8
	Primary Highways	21.4	67.8	10.7
	Secondary Highways	60.7	28.5	10.7
HERBICIDE	Interstate Highways	4.0	56.0	40.1
	Primary Highways	7.7	42.3	50.0
	Secondary Highways	11.1	37.0	51.9
WILDFLOWERS	Interstate Highways	67.9	32.1	0
	Primary Highways	67.9	32.1	0
	Secondary Highways	70.0	30.0	0
REFORESTATION (Natural)	Interstate Highways	33.4	55.6	11.0
	Primary Highways	35.7	53.6	10.7
	Secondary Highways	26.9	61.5	11.5
REFORESTATION (Planting/Seeding)	Interstate Highways	48.1	44.9	7.40
	Primary Highways	46.7	46.7	6.6
	Secondary Highways	39.3	53.5	7.2

Comments: _____

Group Name: _____ County: _____

Adopt A Highway Volunteer

Dear Volunteer,

The Highway and Transportation Department's Transportation Research Committee has undertaken a research project on "ROAD SIDE VEGETATION CONTROL."

As an Adopt A Highway Volunteer, you have first-hand experience with Arkansas' roadsides, and may have some suggestions which would be helpful in conducting our research.

The primary objective of this project is to evaluate the costs and environmental concerns of each component of the roadside vegetation management program. This includes an assessment of the requirements of the program from an aspect of safety and operation, as well as the public's acceptance of the appearance of the highway right of way.

Please take a few minutes to fill out this questionnaire and return it to us. Your comments will be extremely useful in the overall development of a roadside management program.

Bill Stanton, Public Affairs Officer

Cut along dotted line, fold and return lower portion.

Roadside Vegetation Control Questionnaire

Please check your opinion regarding the level of activity for the following practices.

Item	System	Desired Level of Activity		
		More	Correct	Less
MOWING	Interstate Highways	31.6	58.3	10.
	Primary Highways	50.7	41.6	7.
	Secondary Highways	60.9	29.7	9.4
HERBICIDE	Interstate Highways	10.9	35.9	35.9
	Primary Highways	16.7	45.0	38.3
	Secondary Highways	17.9	41.0	41.0
WILDFLOWERS	Interstate Highways	85.7	12.5	1.7
	Primary Highways	80.0	16.7	3.3
	Secondary Highways	73.2	23.2	3.6
REFORESTATION (Natural)	Interstate Highways	50.9	45.4	3.6
	Primary Highways	43.9	49.1	7.0
	Secondary Highways	41.0	51.8	7.1
REFORESTATION (Planting/Seeding)	Interstate Highways	62.0	34.4	3.4
	Primary Highways	56.1	35.0	8.7
	Secondary Highways	53.7	38.9	7.4

Comments: _____

Dist. ④

Group Name: _____

County: _____

Adopt A Highway Volunteer

Dear Volunteer,

The Highway and Transportation Department's Transportation Research Committee has undertaken a research project on "ROAD-SIDE VEGETATION CONTROL."

As an Adopt A Highway Volunteer, you have first-hand experience with Arkansas' roadsides, and may have some suggestions which would be helpful in conducting our research.

The primary objective of this project is to evaluate the costs and environmental concerns of each component of the roadside vegetation management program. This includes an assessment of the requirements of the program from an aspect of safety and operation, as well as the public's acceptance of the appearance of the highway right of way.

Please take a few minutes to fill out this questionnaire and return it to us. Your comments will be extremely useful in the overall development of a roadside management program.

Bill Stanton, Public Affairs Officer

Cut along dotted line, fold and return lower portion.

Roadside Vegetation Control Questionnaire

Please check your opinion regarding the level of activity for the following practices.

Item	System	Desired Level of Activity		
		More	Correct	Less
MOWING	Interstate Highways	17.5	82.5	0
	Primary Highways	50.0	50.0	0
	Secondary Highways	13.0	27.0	0
HERBICIDE	Interstate Highways	14.3	54.2	3.1
	Primary Highways	19.4	38.9	4.6
	Secondary Highways	24.3	32.4	43.2
WILDFLOWERS	Interstate Highways	70.3	23.5	5.8
	Primary Highways	66.7	27.8	5.5
	Secondary Highways	51.4	42.8	5.7
REFORESTATION (Natural)	Interstate Highways	47.2	52.8	0
	Primary Highways	47.2	52.8	0
	Secondary Highways	37.8	59.4	2.7
REFORESTATION (Planting/Seeding)	Interstate Highways	61.1	36.1	2.8
	Primary Highways	54.2	42.9	2.9
	Secondary Highways	43.2	51.3	5.4

Comments: _____

Dist. 5

Group Name: _____ County: _____

Adopt A Highway Volunteer

Dear Volunteer,

The Highway and Transportation Department's Transportation Research Committee has undertaken a research project on "ROADSIDE VEGETATION CONTROL."

As an Adopt A Highway Volunteer, you have first-hand experience with Arkansas' roadsides, and may have some suggestions which would be helpful in conducting our research.

The primary objective of this project is to evaluate the costs and environmental concerns of each component of the roadside vegetation management program. This includes an assessment of the requirements of the program from an aspect of safety and operation, as well as the public's acceptance of the appearance of the highway right of way.

Please take a few minutes to fill out this questionnaire and return it to us. Your comments will be extremely useful in the overall development of a roadside management program.

Bill Stanton, Public Affairs Officer

Cut along dotted line, fold and return lower portion.

Roadside Vegetation Control Questionnaire

Please check your opinion regarding the level of activity for the following practices.

Item	System	Desired Level of Activity		
		More	Correct	Less
MOWING	Interstate Highways	47.9	49.3	2.8
	Primary Highways	40.3	51.6	8.1
	Secondary Highways	51.5	38.2	10.3
HERBICIDE	Interstate Highways	17.2	41.4	41.4
	Primary Highways	20.6	38.2	41.2
	Secondary Highways	21.7	36.2	42.0
WILDFLOWERS	Interstate Highways	67.9	30.9	1.2
	Primary Highways	69.0	29.6	1.4
	Secondary Highways	65.2	2.9	5.8
REFORESTATION (Natural)	Interstate Highways	45.4	47.0	7.6
	Primary Highways	47.0	48.4	4.6
	Secondary Highways	40.6	53.1	6.3
REFORESTATION (Planting/Seeding)	Interstate Highways	57.7	39.4	2.8
	Primary Highways	54.4	44.1	1.6
	Secondary Highways	50.0	45.5	4.5

Comments: _____

Dist. 6

Group Name: _____ County: _____

Adopt A Highway Volunteer

Dear Volunteer,

The Highway and Transportation Department's Transportation Research Committee has undertaken a research project on "ROAD-SIDE VEGETATION CONTROL."

As an Adopt A Highway Volunteer, you have first-hand experience with Arkansas' roadsides, and may have some suggestions which would be helpful in conducting our research.

The primary objective of this project is to evaluate the costs and environmental concerns of each component of the roadside vegetation management program. This includes an assessment of the requirements of the program from an aspect of safety and operation, as well as the public's acceptance of the appearance of the highway right of way.

Please take a few minutes to fill out this questionnaire and return it to us. Your comments will be extremely useful in the overall development of a roadside management program.

Bill Stanton, Public Affairs Officer

Cut along dotted line, fold and return lower portion.

Roadside Vegetation Control Questionnaire

Please check your opinion regarding the level of activity for the following practices.

Item	System	Desired Level of Activity		
		More	Correct	Less
MOWING	Interstate Highways	20	65.7	14.3
	Primary Highways	40.5	46.0	13.5
	Secondary Highways	56.8	24.3	1.9
HERBICIDE	Interstate Highways	5.8	58.8	35.3
	Primary Highways	14.3	45.7	4.0
	Secondary Highways	29.4	26.5	44.1
WILDFLOWERS	Interstate Highways	67.7	22.6	9.7
	Primary Highways	66.7	25.0	8.3
	Secondary Highways	50.0	41.7	8.3
REFORESTATION (Natural)	Interstate Highways	47.0	50.0	3.0
	Primary Highways	46.0	51.3	2.7
	Secondary Highways	40.0	57.1	2.9
REFORESTATION (Planting/Seeding)	Interstate Highways	62.5	25.0	12.5
	Primary Highways	48.5	39.3	12.2
	Secondary Highways	50.0	37.5	12.5

Comments: _____

Dist. ⑦

Group Name: _____

County: _____

Adopt A Highway Volunteer

Dear Volunteer,

The Highway and Transportation Department's Transportation Research Committee has undertaken a research project on "ROADSIDE VEGETATION CONTROL."

As an Adopt A Highway Volunteer, you have first-hand experience with Arkansas' roadsides, and may have some suggestions which would be helpful in conducting our research.

The primary objective of this project is to evaluate the costs and environmental concerns of each component of the roadside vegetation management program. This includes an assessment of the requirements of the program from an aspect of safety and operation, as well as the public's acceptance of the appearance of the highway right of way.

Please take a few minutes to fill out this questionnaire and return it to us. Your comments will be extremely useful in the overall development of a roadside management program.

Bill Stanton, Public Affairs Officer

Cut along dotted line, fold and return lower portion.

Roadside Vegetation Control Questionnaire

Please check your opinion regarding the level of activity for the following practices.

Item	System	Desired Level of Activity		
		More	Correct	Less
MOWING	Interstate Highways	29.3	56.9	13.7
	Primary Highways	44.8	41.4	13.7
	Secondary Highways	56.7	30.0	13.3
HERBICIDE	Interstate Highways	12.2	53.0	34.7
	Primary Highways	11.1	46.3	42.6
	Secondary Highways	15.4	40.4	44.2
WILDFLOWERS	Interstate Highways	70.7	24.1	5.2
	Primary Highways	64.4	30.5	5.1
	Secondary Highways	61.8	36.3	1.8
REFORESTATION (Natural)	Interstate Highways	42.3	51.9	5.8
	Primary Highways	39.6	54.7	5.7
	Secondary Highways	41.5	50.9	7.6
REFORESTATION (Planting/Seeding)	Interstate Highways	57.1	34.7	8.1
	Primary Highways	51.9	40.3	7.8
	Secondary Highways	54.0	34.0	12.0

Comments: _____

Dist. 8

Group Name: _____ County: _____

Adopt A Highway Volunteer

Dear Volunteer,

The Highway and Transportation Department's Transportation Research Committee has undertaken a research project on "ROADSIDE VEGETATION CONTROL."

As an Adopt A Highway Volunteer, you have first-hand experience with Arkansas' roadsides, and may have some suggestions which would be helpful in conducting our research.

The primary objective of this project is to evaluate the costs and environmental concerns of each component of the roadside vegetation management program. This includes an assessment of the requirements of the program from an aspect of safety and operation, as well as the public's acceptance of the appearance of the highway right of way.

Please take a few minutes to fill out this questionnaire and return it to us. Your comments will be extremely useful in the overall development of a roadside management program.

Bill Stanton, Public Affairs Officer

Cut along dotted line, fold and return lower portion.

Roadside Vegetation Control Questionnaire

Please check your opinion regarding the level of activity for the following practices.

Item	System	Desired Level of Activity		
		More	Correct	Less
MOWING	Interstate Highways	20.5	75.0	4.5
	Primary Highways	51.8	37.5	10.7
	Secondary Highways	49.0	41.5	9.4
HERBICIDE	Interstate Highways	11.1	42.2	46.7
	Primary Highways	23.0	36.5	50.0
	Secondary Highways	25.5	29.1	45.4
WILDFLOWERS	Interstate Highways	78.3	19.6	2.1
	Primary Highways	61.4	36.8	1.7
	Secondary Highways	61.5	32.7	5.8
REFORESTATION (Natural)	Interstate Highways	53.1	38.3	8.6
	Primary Highways	40.3	54.3	5.6
	Secondary Highways	43.1	45.0	11.8
REFORESTATION (Planting/Seeding)	Interstate Highways	67.3	26.5	6.2
	Primary Highways	49.0	45.4	5.4
	Secondary Highways	50.9	43.1	5.9

Comments: _____

Dist. 9

Group Name: _____

County: _____

Adopt A Highway Volunteer

Dear Volunteer,

The Highway and Transportation Department's Transportation Research Committee has undertaken a research project on "ROADSIDE VEGETATION CONTROL."

As an Adopt A Highway Volunteer, you have first-hand experience with Arkansas' roadsides, and may have some suggestions which would be helpful in conducting our research.

The primary objective of this project is to evaluate the costs and environmental concerns of each component of the roadside vegetation management program. This includes an assessment of the requirements of the program from an aspect of safety and operation, as well as the public's acceptance of the appearance of the highway right of way.

Please take a few minutes to fill out this questionnaire and return it to us. Your comments will be extremely useful in the overall development of a roadside management program.

Bill Stanton, Public Affairs Officer

Cut along dotted line, fold and return lower portion.

Roadside Vegetation Control Questionnaire

Please check your opinion regarding the level of activity for the following practices.

Item	System	Desired Level of Activity		
		More	Correct	Less
MOWING	Interstate Highways	8.3	58.3	33.3
	Primary Highways	25.0	41.6	33.3
	Secondary Highways	27.2	27.3	45.4
HERBICIDE	Interstate Highways	18.1	27.3	54.5
	Primary Highways	27.3	18.1	54.5
	Secondary Highways	36.3	9.0	54.5
WILDFLOWERS	Interstate Highways	83.3	8.3	8.3
	Primary Highways	75.0	16.7	8.3
	Secondary Highways	75.0	16.7	8.3
REFORESTATION (Natural)	Interstate Highways	75.0	16.7	8.3
	Primary Highways	58.3	33.3	8.3
	Secondary Highways	58.3	33.3	8.3
REFORESTATION (Planting/Seeding)	Interstate Highways	75.0	16.7	8.3
	Primary Highways	50.0	41.7	8.3
	Secondary Highways	50.0	41.7	8.3

Comments: _____

Dist. 10

Group Name: _____ County: _____

