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The Signing of the Federal Employees Liability Reform and Tort Compensation Act of 1988

On November 18, 1988, President Reagan signed H.R. 4612, the Federal Employees Liability Reform and Tort Compensation Act of 1988. The intent of the act is to afford greater protection to Federal employees from suits based on negligent acts or omissions that they perform within the scope of their employment. The act seems to make the Federal Government—as opposed to the Federal employee—the party defendant in many such cases.

The impetus for the act was the recent erosion of the common law tort immunity that previously had been afforded Federal employees through the 40-year-old Federal Tort Claims Act. This erosion of immunity arose from recent judicial decisions, and particularly from the decision of the U.S. Supreme Court in *Westfall* v. *Erwin*. The diminished immunity had reduced the usefulness of the Federal Tort Claims Act as the proper remedy for Federal employee torts. It had created a serious situation whereby Federal employees were facing greater risk of personal liability and Federal employee morale was affected to a degree that impeded the ability of Federal agencies to carry out their missions.

As soon as the Office of the General Counsel develops an interpretation of the act, we will publish it in *Engineering Field Notes*. Until then, we are including for your own interpretation the text of the Federal Employees Liability Reform and Tort Compensation Act of 1988.

—Dennis Carroll
Editor, EFN

FEDERAL EMPLOYEES LIABILITY REFORM AND TORT COMPENSATION ACT OF 1988

(Final language as signed by President Reagan 11/17/88)

HR 4612 Frank (D-MA) 10/20/1988
Enrolled (finally passed both houses)

HR 4612

Agreed to October 20, 1988

One Hundredth Congress of the United States of America

AT THE SECOND SESSION

Begun and held at the City of Washington on Monday, the twenty-fifth day of January, one thousand nine hundred and eighty-eight

An Act

To amend title 28, United States Code, to provide for an exclusive remedy against the United States for suits based upon certain negligent or wrongful acts or omissions of United States employees committed within the scope of their employment, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. SHORT TITLE.

This Act may be cited as the "Federal Employees Liability Reform and Tort Compensation Act of 1988".

SEC. 2. FINDINGS AND PURPOSES.

(a) Findings.--The Congress finds and declares the following:

(1) For more than 40 years the Federal Tort Claims Act has been the legal mechanism for compensating persons injured by negligent or wrongful acts of Federal employees committed within the scope of their employment.

(2) The United States, through the Federal Tort Claims Act, is responsible to injured persons for the common law torts of its employees in the same manner in which the common law historically has recognized the responsibility of an employer for torts committed by its employees within the scope of their employment.

(3) Because Federal employees for many years have been protected from personal common law tort liability by a broad based immunity, the Federal Tort

Claims Act has served as the sole means for compensating persons injured by the tortious conduct of Federal employees.

(4) Recent judicial decisions, and particularly the decision of the United States Supreme Court in Westfall v. Erwin, have seriously eroded the common law tort immunity previously available to Federal employees.

(5) This erosion of immunity of Federal employees from common law tort liability has created an immediate crisis involving the prospect of personal liability and the threat of protracted personal tort litigation for the entire Federal workforce.

(6) The prospect of such liability will seriously undermine the morale and well being of Federal employees, impede the ability of agencies to carry out their missions, and diminish the vitality of the Federal Tort Claims Act as the proper remedy for Federal employee torts.

(7) In its opinion in Westfall v. Erwin, the Supreme Court indicated that the Congress is in the best position to determine the extent to which Federal employees should be personally liable for common law torts, and that legislative consideration of this matter would be useful.

(b) Purpose.--It is the purpose of this Act to protect Federal employees from personal liability for common law torts committed within the scope of their employment, while providing persons injured by the common law torts of Federal employees with an appropriate remedy against the United States.

SEC. 3. JUDICIAL AND LEGISLATIVE BRANCH EMPLOYEES.

Section 2671 of title 28, United States Code, is amended in the first full paragraph by inserting after "executive departments," the following: "the judicial and legislative branches,".

SEC. 4. RETENTION OF DEFENSES.

Section 2674 of title 28, United States Code, is amended by adding at the end of the section the following new paragraph:

"With respect to any claim under this chapter, the United States shall be entitled to assert any defense based upon judicial or legislative immunity which otherwise would have been available to the employee of the United States whose act or omission gave rise to the claim, as well as any other defenses to which the United States is entitled.".

SEC. 5. EXCLUSIVENESS OF REMEDY.

Section 2679(b) of title 28, United States Code, is amended to read as follows:

"(b)(1) The remedy against the United States provided by sections 1346(b) and 2672 of this title for injury or loss of property, or personal injury or death arising or resulting from the negligent or wrongful act or omission of any employee of the Government while acting within the scope of his office or employment is exclusive of any other civil action or proceeding for money damages by reason of the same subject matter against the employee whose act or omission gave rise to the claim or against the estate of such employee. Any other civil action or proceeding for money damages arising out of or relating to the same subject matter against the employee or the employee's estate is precluded without regard to when the act or omission occurred.

"(2) Paragraph (1) does not extend or apply to a civil action against an employee of the Government--

"(A) which is brought for a violation of the Constitution of the United States, or

"(B) which is brought for a violation of a statute of the United States under which such action against an individual is otherwise authorized."

SEC. 6. REPRESENTATION AND REMOVAL.

Section 2679(d) of title 28, United States Code, is amended to read as follows:

"(d)(1) Upon certification by the Attorney General that the defendant employee was acting within the scope of his office or employment at the time of the incident out of which the claim arose, any civil action or proceeding commenced upon such claim in a United States district court shall be deemed an action against the United States under the provisions of this title and all references thereto, and the United States shall be substituted as the party defendant.

"(2) Upon certification by the Attorney General that the defendant employee was acting within the scope of his office or employment at the time of the incident out of which the claim arose, any civil action or proceeding commenced upon such claim in a State court shall be removed without bond at any time before trial by the Attorney General to the district court of the United States for the district and division embracing the place in which the action or proceeding is pending. Such action or proceeding shall be deemed to be an action or proceeding brought against the United States under the provisions of this title and all references thereto, and the United States shall be substituted as the party defendant. This certification of the Attorney General shall conclusively establish scope of office or employment for purposes of removal.

"(3) In the event that the Attorney General has refused to certify scope of office or employment under this section, the employee may at any time before trial petition the court to find and certify that the employee was acting within the scope of his office or employment. Upon such certification by the court, such action or proceeding shall be deemed to be an action or proceeding brought against the United States under the provisions of this title and all references thereto, and the United States shall be substituted as the party defendant. A copy of the petition shall be served upon the United States in accordance with the provisions of Rule 4(d)(4) of the Federal Rules of Civil Procedure. In the event the petition is filed in a civil action or proceeding pending in a State court, the action or proceeding may be removed without bond by the Attorney General to the district court of the United States for the district and division embracing the place in which it is pending. If, in considering the petition, the district court determines that the employee was not acting within the scope of his office or employment, the action or proceeding shall be remanded to the State court.

"(4) Upon certification, any action or proceeding subject to paragraph (1), (2), or (3) shall proceed in the same manner as any action against the United States filed pursuant to section 1346(b) of this title and shall be subject to the limitations and exceptions applicable to those actions.

"(5) Whenever an action or proceeding in which the United States is substituted as the party defendant under this subsection is dismissed for failure first to present a claim pursuant to section 2675(a) of this title, such a claim shall be deemed to be timely presented under section 2401(b) of this title if--

"(A) the claim would have been timely had it been filed on the date the underlying civil action was commenced, and

"(B) the claim is presented to the appropriate Federal Agency within 60 days after dismissal of the civil action.".

SEC. 7. SEVERABILITY.

If any provision of this Act or the amendments made by this Act or the application of the provision to any person or circumstance is held invalid, the remainder of this Act and such amendments and the application of the provision to any other person or circumstance shall not be affected by that invalidation.

SEC. 8. EFFECTIVE DATE.

(a) General Rule.--This Act and the amendments made by this Act shall take effect on the date of the enactment of this Act.

(b) Applicability to Proceedings.--The amendments made by this Act shall apply to all claims, civil actions, and proceedings pending on, or filed on or after, the date of the enactment of this Act.

(c) Pending State Proceedings.--With respect to any civil action or proceeding pending in a State court to which the amendments made by this Act apply, and as to which the period for removal under section 2679(d) of title 28, United States Code (as amended by section 6 of this Act), has expired, the Attorney General shall have 60 days after the date of the enactment of this Act during which to seek removal under such section 2679(d).

(d) Claims Accruing Before Enactment.--With respect to any civil action or proceeding to which the amendments made by this Act apply in which the claim accrued before the date of the enactment of this Act, the period during which the claim shall be deemed to be timely presented under section 2679(d)(5) of title 28, United States Code (as amended by section 6 of this Act) shall be that period within which the claim could have been timely filed under applicable State law, but in no event shall such period exceed two years from the date of the enactment of this Act.

SEC. 9. TENNESSEE VALLEY AUTHORITY.

(a) Exclusiveness of Remedy.--(1) An action against the Tennessee Valley Authority for injury or loss of property, or personal injury or death arising or resulting from the negligent or wrongful act or omission of any employee of the Tennessee Valley Authority while acting within the scope of this office or employment is exclusive of any other civil action or proceeding by reason of the same subject matter against the employee or his estate whose act or omission gave rise to the claim. Any other civil action or proceeding arising out of or relating to the same subject matter against the employee or his estate is precluded without regard to when the act or omission occurred.

(2) Paragraph (1) does not extend or apply to a cognizable action against an employee of the Tennessee Valley Authority for money damage for a violation of the Constitution of the Untied States.

(b) Representation and Removal.--(1) Upon certification by the Tennessee Valley Authority that the defendant employee was acting within the scope of his office or employment at the time of the incident out of which the claim arose, any civil action or proceeding heretofore or hereafter commenced upon such claim in a United States district court shall be deemed an action against the Tennessee Valley Authority pursuant to 16 U.S.C. 831C(b) and the Tennessee Valley Authority shall be substituted as the party defendant.

(2) Upon certification by the Tennessee Valley Authority that the defendant employee was acting within the scope of his office or employment at the time of the incident out of which the claim arose, any civil action or proceeding commenced upon such claim in a State court shall be removed without bond at any time before trial by the Tennessee Valley Authority to the district court of the United States for the district and division embracing the place wherein it is pending. Such action shall be deemed an action brought against the Tennessee Valley Authority under the provisions of this title and all references thereto, and the Tennessee Valley Authority shall be substituted as the party defendant. This certification of the Tennessee Valley Authority shall conclusively establish scope of office or employment for purposes of removal.

(3) In the event that the Tennessee Valley Authority has refused to certify scope of office or employment under this section, the employee may at any time before trial petition the court to find and certify that the employee was acting within the scope of his office or employment. Upon such certification by the court, such action shall be deemed an action brought against the Tennessee Valley Authority, and the Tennessee Valley Authority shall be substituted as the party defendant. A copy of the petition shall be served upon the Tennessee Valley Authority in accordance with the Federal Rules of Civil Procedure. In the event the petition is filed in a civil action or proceeding pending in a State court, the action or proceeding may be removed without bond by the Tennessee Valley Authority to the district court of the United States for the district and division embracing the place in which it is pending. If, in considering the petition, the district court

determines that the employee was not acting within the scope of his office or employment, the action or proceeding shall be remanded to the State court.

(4) Upon certification, any actions subject to paragraph (1), (2), or (3) shall proceed in the same manner as any action against the Tennessee Valley Authority and shall be subject to the limitations and exceptions applicable to those actions.

(c) Retention of Defenses.--With respect to any claim to which this section applies, the Tennessee Valley Authority shall be entitled to assert any defense which otherwise would have been available to the employee based upon judicial or legislative immunity, which otherwise would have been available to the employee of the Tennessee Valley Authority whose act or omission gave rise to the claim as well as any other defenses to which the Tennessee Valley Authority is entitled.

Road Program Costs: Continuing Efforts Addressing the Issue

Forest Service Strategic Plan—NFS Road Program

John Holt
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Introduction

In the summer of 1987, the Forest Service Strategic Plan was implemented. The overall goal was to "assure that Forest Service programs encourage the realization of the maximum public benefits from the management and productive use of our Nation's forest and rangeland resources."

Implementing Tasks were developed for 18 key issue areas, including the Road Program. This plan is dynamic and is updated as the issues change. Periodic review addresses the changes and notes accomplishment of the action items and resolution of the issues.

The following is an update of the NFS Road Program (Implementing Task C of the Strategic Plan). See table 1. Staff at all levels of the organization have been responsible for increasing public understanding and the support of the current administration through the accomplishment of the actions noted.

NFS Road Program

Objective

The Strategic Plan's objective is to ensure that the NFS Road Program is funded at a level adequate to meet NFS management objectives.

Situation Statement

The Forest Road Program has received considerable national attention over the past few years. Controversy and misunderstanding have been apparent in the media and congressional hearings. The essential nature of the Road Program required to support National Forest management activities is not well understood.

Another issue has been the cost of the program during a period of austere Federal budgets. Since 1981, there have been numerous actions taken by the Forest Service to ensure cost-effective management of the Road Program. Road costs were drastically reduced and the total expenditures for roads cut by 43 percent. We have reached the point where the present investment level may not be economical for long-term management, and, in some cases, we are accepting higher risks of adverse resource effects. It will not be possible

Table 1.—Implementing Task C of the NFS Road Program.

Action items	Target date	Progress/strategy change
1. Complete implementation of the public relations initiative "Roads to Understanding."	September 1988	
a. A slide tape program is currently being prepared by Public Affairs Office Staff for internal and external use. Explains why roads are critical for resource management.		Done. Distributed to each RO, Station, and National Forest.
b. Prepare a roads brochure as a companion to the slide tape.		Done. Distributed 32,500 in July 1988. Ordered new printing for Regions—60,000 copies requested.
c. Regions and Forests are preparing informational packages, with Region 9 being the most active; a Regional brochure prepared, a Forest brochure prepared, a Forest slide tape prepared, and a Forest video being prepared. Region 9 brochures and slide tape sent to other Regions.		Local efforts are continuing at Regional, Statewide, and Forest levels. Several Regions have developed and distributed Regional brochures/pamphlets, etc.
d. Article written by NFS's L. Henson to be published in *American Forests Magazine.*		Done. Article published in the January issue of *American Forests Magazine.*
e. WO Staff participate with FHWA and other Federal agencies in development of long-range national transportation policies as part of the Highway Users Federation Transportation 2020 program.		Done.
f. Regional Foresters participate in Statewide Transportation 2020 meetings sponsored by Highway Users Federation. Explain the role of the Forest development road system in meeting national transportation needs and how the system affects transportation policies.	June 1988	Done. All Regions participated and presented testimony in State forums. Written statements provided to all States with National Forest System lands.
g. Public Affairs Office Staff develop a video program that brings to the surface all viewpoints, pro and con, related to the Road Program.		Video program completed. Industry, user, and conservation groups participated along with the Forest Service in open discussion. Cosponsored by American Forestry Association. Done. Distributed to each Region/Station. Regions have ordered 76 additional copies.
h. Prepare article for *Congressional Quarterly* magazine.		*Congressional Quarterly* reported on Senate action on Interior and Related Agencies Appropriations Bill Report included in September 26, 1987, issue, pages 2314 and 2315.
i. Conduct seminar at Michigan State University.	November 1987	Done by Associate Chief George Leonard, November 12, 1987.

Table 1. (cont.)—Implementing Task C of the NFS Road Program.

Action items	Target date	Progress/strategy change
2. Host "brown bag" session with interest groups to discuss Road Program.	March 7, 1988	Done. Fifteen people representing 12 groups participated.
3. Implement the recommendations of the "ROad Analysis and Display System" report as a means of gathering current and accurate data to use in briefing congressional staff, OMB, and others, and for use as a management tool to evaluate program effectiveness.	October 1987 & March 1988	Done. ROADS is implemented. Fiscal year 1987 accomplishments were reported with ROADS. Fiscal year 1988 final allocation, fiscal year 1989 President's budget, and the fiscal year 1990 preliminary program are formulated and tracked using ROADS.
4. Develop factsheets for briefing congressional staff, OMB, and others, dispelling distorted or inaccurate statements by lobby groups.	August 1987 & May 1988	Task completed; distribution made to all members.
5. Continue to conduct briefings for congressional, department, and OMB staffs on various elements of the Road Program:	Continuing	
—OMB Budget Examiner		Done, including field trip with Dave Allen. Along with Timber Staff, met with Bruce Beard on October 5, 1988.
—Assistant Secretary for Natural Resources and Environment		Done.
—House and Senate Appropriations Staff		Fifteen briefings done as of October 25, 1988.
—Congressional Research Service (Ross Gordy)	December 9, 1987	Done December 9, 1987.
—Congressional Budget Office	December 9, 1987	Done December 9, 1987.
—Congressman Valentine		Done June 2, 1988.
6. Continue cost reduction initiatives.	1988	
a. Complete national assessment of road planning and design processes initiated in 1983.		Done.
b. Implement the finding of the Road Technology Improvement Program (RTIP) initiated in 1984.	Continuing	Action items 90 percent completed, and continue to verify on monitoring trips.
c. Implement the recommendations of the Road Productivity Improvement Team (PIT).	Continuing	Action items 90 percent complete and continue to verify on monitoring trips.
d. Continue participation in FHWA's Council on Technology Improvement Program.	Continuing	Ten projects completed or under way, covering roadway surfacing, bridges, culverts, stabilization, and CTI.

Table 1. (cont.)—Implementing Task C of the NFS Road Program.

Action items	Target date	Progress/strategy change
e. Disseminate information on cost-reduction efforts through internal and external publications (*Engineering Field Notes*, etc.).	Continuing	Continuing with bimonthly articles in *Engineering Field Notes.* Regions 5 and 6 have set up periodic newsletters for information sharing.
7. Explore the possibility of defining only two categories of work for the total Road Program, that is, construction (new road where no system road exists) and maintenance. These categories would relate directly to the Investments and O&M approach to the Forest Service budgeting process currently being proposed.	April 1988	Done. Decision made to retain existing appropriation structure, but to track and report reconstruction separately from construction.
8. Implement a Scenic Byways Program, emphasizing the recreation potential of forest development roads.	May 1988	Program announced on May 1 by Chief at a national Scenic Byways conference that was sponsored by 22 organizations. Ten scenic byways designated to date. Partnership being formed with Plymouth Division of Chrysler Corporation to support program.

to further reduce road investments while maintaining existing timber sale program levels without further compromising sound economic and resource-protection decisions.

The Forest Service needs to ensure that the public and Congress understand the integral role of roads in managing the National Forests.

Strategy

The following two items form the strategy:

(1) Develop and implement a program to inform the general public of the purpose of a Forest Service road system.

(2) Provide timely and accurate information concerning the Forest Service Road Program to Congress, other organizations, and the public.

The lead responsibility is with National Forest Systems, the Engineering Staff, the Public Affairs Office, and the Programs and Legislation Staff.

Summary of Key Results to Date

The ROad Analysis and Display System (ROADS) data have played a large part in furthering understanding and gaining support for the Road Program. The November-December 1988 issue of *Engineering Field Notes* included a letter to Chief Robertson from John Fedkiw, USDA Associate Director for Renewable Resources and Special Services, commending the team response and performance in this effort. The Chief also received a letter of appreciation personally signed by Senators McClure, Hatfield, Johnston, and Byrd for the staff assistance provided the Senate Appropriations Committee during the fiscal year 1988 hearings.

There was intense lobbying for a $100 million reduction in Road Program funding for fiscal year 1988. The House and Senate Conference Committee reduced appropriations for construction/reconstruction by $26.8 million, but it increased road maintenance funding $17.9 million and added $9.4 million for engineering support for the fire salvage program. In total, this exceeded the President's original budget request by $0.5 million.

During the fiscal year 1989 appropriations process, both House and Senate committees again were aggressively lobbied, this time for a $106 million reduction in the Forest Road Program (FRP). House action included a $31.3 million reduction in FRP and a $4.5 million increase in maintenance. Senate action included a $16.6 million reduction in FRP and a $13.1 million increase in maintenance. The final appropriation resulted in a $21.2 million reduction in FRP and a $12.6 million increase in maintenance. Overall, this provided about 97 percent of the amount requested in the President's budget for the Road Program.

Independent of congressional action, the Office of the Inspector General has given the Forest Service a "clean bill of health" following their National Road Audit.

The Future

The U.S. Department of Agriculture has approved the Forest Service's recommendation to discontinue the formal documented action plan and considers this effort a success to date. The issues involved are expected to continue, and the ongoing activities in the action plan are essential to further understanding and support of the Road Program. These activities will be monitored during future activity and program reviews.

The completion of the action plan to date is attributed to the diligence of the staff at all levels of the Forest Service.

Workstations—Are They for Everybody?

Dale R. Petersen
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Information in this article is not official direction. The primary basis of the article is from information gained while the author served on a four-person Workstation Environment Task Group. The task group's report is included in a 6600 WO letter dated October 5, 1988. This article is a popularized version intended to help Engineering employees understand workstations and how they could influence the way work is done.

What Is a Workstation Anyway?

Like the computer industry itself, the Forest Service is going through "growing pains." In and prior to the 1970's, mainframes were our computing source, finally accessible by remote terminals. In the 1980's, we have seen the entry and growth of minicomputers with the installation of the Data General (DG) system. With the advent of the microcomputer, we are seeing an exploding increase in desktop computing capability, which is highly cost-effective. "Marry" that capability with the DG, and "presto," you have workstations! Well, not quite. The missing ingredient is to integrate the DG and the micro in a "seamless fashion" to provide the full Forest Service architecture to desktop applications. By 1991, when the GIS workstations start arriving, we should see a workstation better defined and demonstrated. The Forest Service is evaluating responses to the GIS RFI (Request for Information). This dialog will continue among ourselves and industry to more effectively allow us to obtain a true workstation for GIS.

Will the GIS Workstation Satisfy All Our Needs?

No. Indications are that the number of GIS workstations will be limited unless the unit cost is much lower than expected, although they should be available at all sites when the contract is completed. This indicates that there may not be enough workstations. The GIS workstation, like the DG itself, will provide part of the "backbone or foundation" for the needed information network. Many other off-line applications will be needed by that time. One area in question is Engineering Computer-Aided Drafting and Design (CADD). This is a logical GIS application. In practice, it may not happen because of the limited number of GIS workstations and because there likely will be priorities to view and manipulate the myriad forest resource spatial data. In the meantime, Engineering has been using very capable micro and workstation Computer-Aided Design (CAD) applications. Our goal should be to have the data compatible with GIS.

What Are Some Other Workstation Uses?

The Workstation Environment Task Group produced a table to show its view of how workload migration has moved from a few applications on mainframes in the 1970's, to many applications on minis in the 1980's, to perhaps most if not all applications on workstations in the 1990's. Essentially, the workstation becomes the interface between the user and the information. Unlike simple menus, as on the DG at present, the future will offer windows and access to more than one application at a time (figure 1). For example, in one window you may be checking your mail in CEO, while you are waiting for a data-base query in another window and plotting a section of road plans in another. In some cases, you may actually be accessing several computers at once although you may be unaware of it. If one is down or very slow that day, you just keep right on working on your highest priority task as the computer resources are available. Think of the windows environment, such as the top of your desk where you use your phone, in-basket, and a number of different paper tasks. You merely have traded the desktop and pen for a computer screen with a mouse and keyboard, for those ready to do so.

The best example of a Forest Service workstation environment in operation today is the DG DS/7540 TEO workstations in Region 1. They are located in Engineering on each National Forest, with several in the Regional Office. The workstation gives you a personal and fast response. You most likely will retrieve and file your information on a server (probably a DG) but input, edit, or manipulate it on your workstation. Another advantage of a workstation is that it is possible to have some of your personal productivity tools in the form of popular or specialized software that can integrate with the corporate information environment.

All of this requires MIPS (millions of instructions per second). Because the trend in cost-effective MIPS is in the workstation, microcomputers are beginning to fill the need. They only will be effective as workstations, however, if they are properly networked and meet emerging Federal standards. This should happen by 1991.

How Do I Get a Workstation?

First, what is it you are going to do? If you are like most employees doing primarily word processing and electronic mail, then the current DG should be adequate for some time. If you will need GIS, then you will have to wait until 1991–95 unless you are at a location where there are some pilot or other special consideration GIS workstations. Then even those may not be as flexible as the newly planned ones. If you are doing some Engineering work now on a micro, such as road design or CAD, you may have all you need without all the features of a workstation. However, power users may need more features and speed than present systems provide. Those people may need a workstation. The period between now and 1991 is a period of transition from one of a mixture of micros and the DG. If you need a computer for any task that cannot be adequately served today, you might consider a workstation. In brief terms, this means a "focused" microcomputer that will likely meet evolving workstation standards. In plain English, this is, as a minimum, a 286-based chip micro. The Workstation Environment Task Group estimated that approximately one-half of the existing micros will not meet workstation standards. The 286 may or may not meet the final requirements.

The most logical choices for a workstation today are a 32-bit 386-based chip or a 68020 machine. These should only be purchased if your need demands it, and your application needs to be integrated with other Forest Service information. In some cases, a lesser "throwaway" or stand-alone machine may be the best choice to do your present job most economically. At the other end of the scale, we will expect to see 486 and Reduced Instruction Set Computers (RISC) used for workstations. Whether these will be used for Forest Service GIS or not remains to be seen. In addition, high-end engineering workstations, such as those used by State departments of transportation, may have a place in Forest Service work; however, the need to date has not been demonstrated. The best advice today is to follow the trends, particularly with GIS, and buy only what you need. Keep in mind the probable environment by 1991. Ask yourself how well what you are buying today will fit.

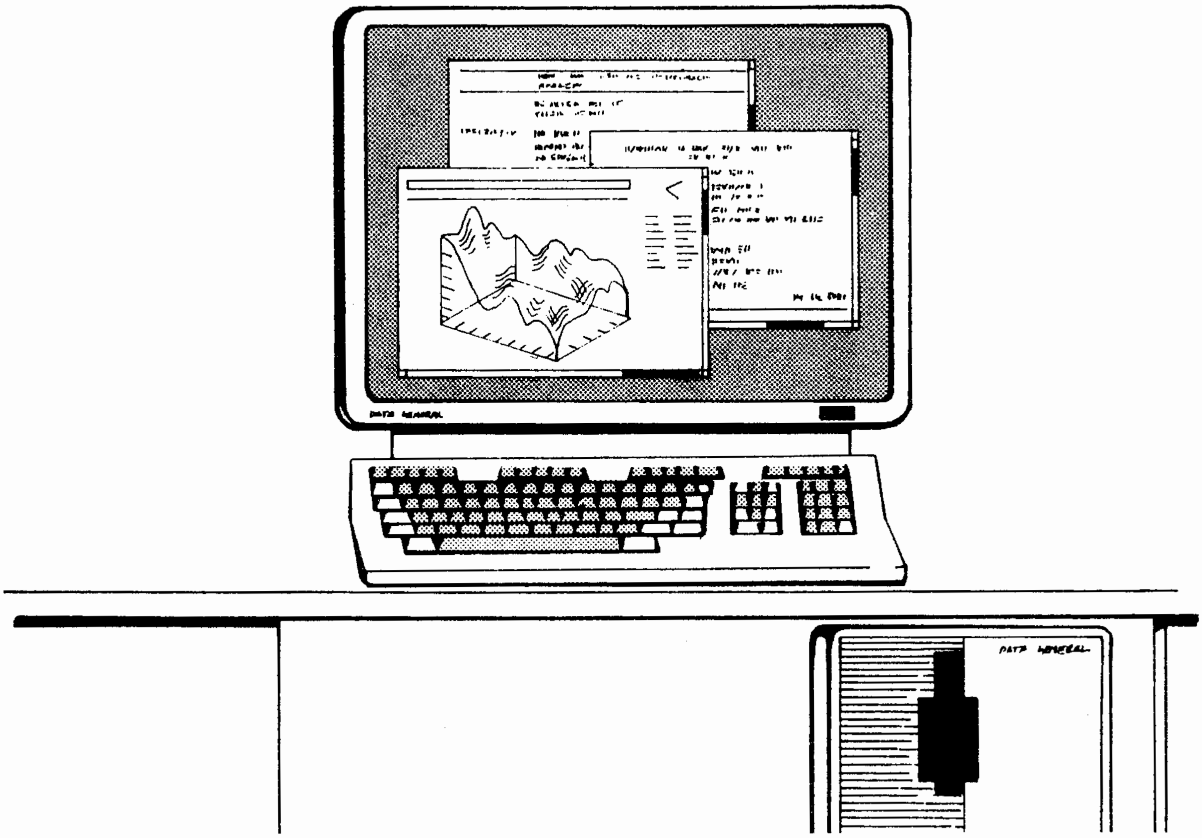


Figure 1.—Workstations will provide a windows environment and an increased use of graphics.

So, Are Workstations for Everybody?

Not today. A goal is to have a computing device readily accessible for everyone by 1995. The bulk of these devices will still be "dumb" terminals or microcomputers. Gradually, workstations, as they are more clearly integrated, will appear and become the access tool of choice. The shift should be orderly, and the variety of tools available should be adequate to meet varying user needs. So, workstations are likely to be for everybody in time. More importantly, rather than worry about the type of device we might use, we would be well advised to concentrate on what we need today. Define the information you need to do your job and how it is to be shared. Then look for the best solution to meet that need. In this way, you will aid in the evolution of workstations to help us all.

California Park Road Reconstruction Project of the Routt National Forest

Rex Blackwell
Forest Engineer
Routt National Forest, Region 2

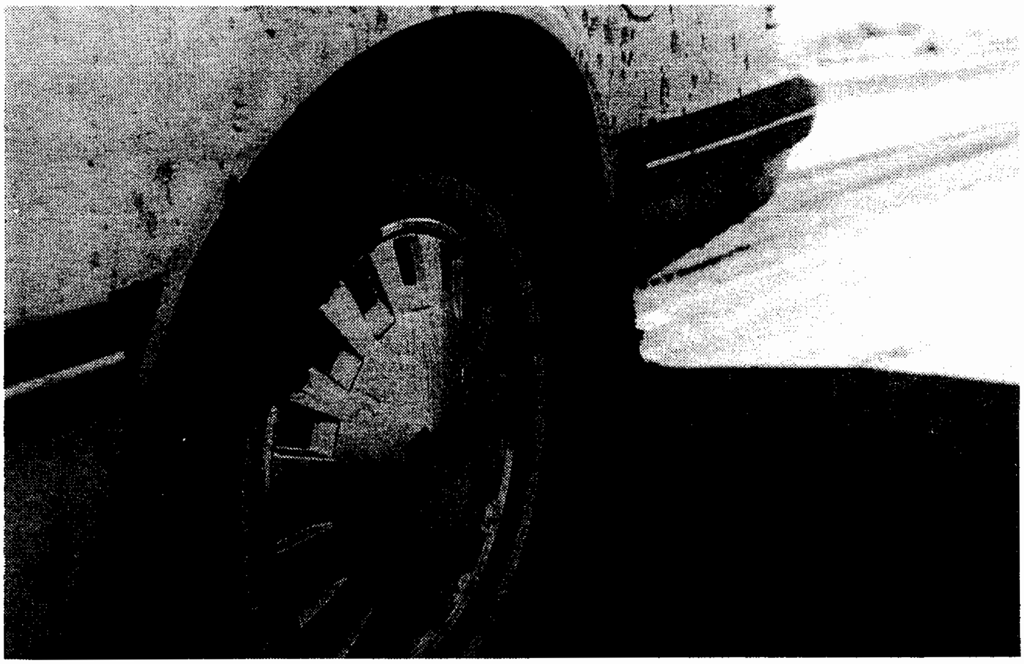
Project Description

This project is a cooperative venture between the Routt National Forest and Routt County, Colorado. The purpose is to reconstruct 9.4 miles of the existing California Park Road (FDR 150 and Routt County Road #80). This is an arterial road that connects Highway 40 to the Forest boundary north of Hayden, Colorado. The road is considered an important transportation link to both parties.

Condition of Existing Road

The existing road subgrade varies in width from 20 to 35 feet. Native soils in this area are extremely weak clay overburden, derived primarily from underlying Lewis shale. The county has placed competent shale ripped from a local pit on the road in various places to strengthen the subgrade. This

Spur road subgrade of unprotected native clay soil. Same soil on California Park road is covered with 6 to 10 inches of pit-run shale. Rutting shown on spur road was caused by one trip of a light sedan.



Rollup of clay soil on wheels of sedan after traveling approximately 150 feet of unprotected clay subgrade.

material is thin tabular platey chunks in appearance. As the surface of this shale layer is exposed to the weather, it deteriorates to a montmorillonitic clay and becomes very slick when wet, similar to the native soils in the area. Unfortunately, there are no other borrow sources of better material available within reasonable haul distance of the project.

Design

A value analysis was performed for this project in the spring of 1987. This analysis indicated that, with further testing, a design based on the use of shale base course and crushed aggregate surfacing could prove to be the most feasible and that a cooperative venture with the county would be the most cost-effective. Resistance tests (AASHTO T-190) were run on the native soil material and the shale from the borrow source. R-values of less than 2 were obtained for the native soil, while the in-bank shale fared slightly better with a value of 23.

One design alternative determined that an aggregate thickness of about 16 inches would be necessary without any base course. Use of the shale as a base material was then considered to reduce the depth of expensive crushed material needed. The county indicated that it had used layers of shale as base course material in the past and had drastically improved the structural capabilities of the road. To verify the usability and durability of the shale, several holes were excavated in those sections of the road where the shale had been in place as long as 15 to 20 years. The shale was found to be deteriorated only on the surface that was exposed to the weather and was quite competent otherwise. Apparently, the 1- to 2-inch clay surface layer seals the remaining shale and retards further degradation. The resulting design hypothesis was that inexpensive, but previously thought useless, low-grade shale material could be used for the road base course and the more expensive crushed aggregate reserved for the surface course. In addition to serving as a traction and structural layer, the crushed surfacing also will act to "seal" the shale from exposure to the weather.

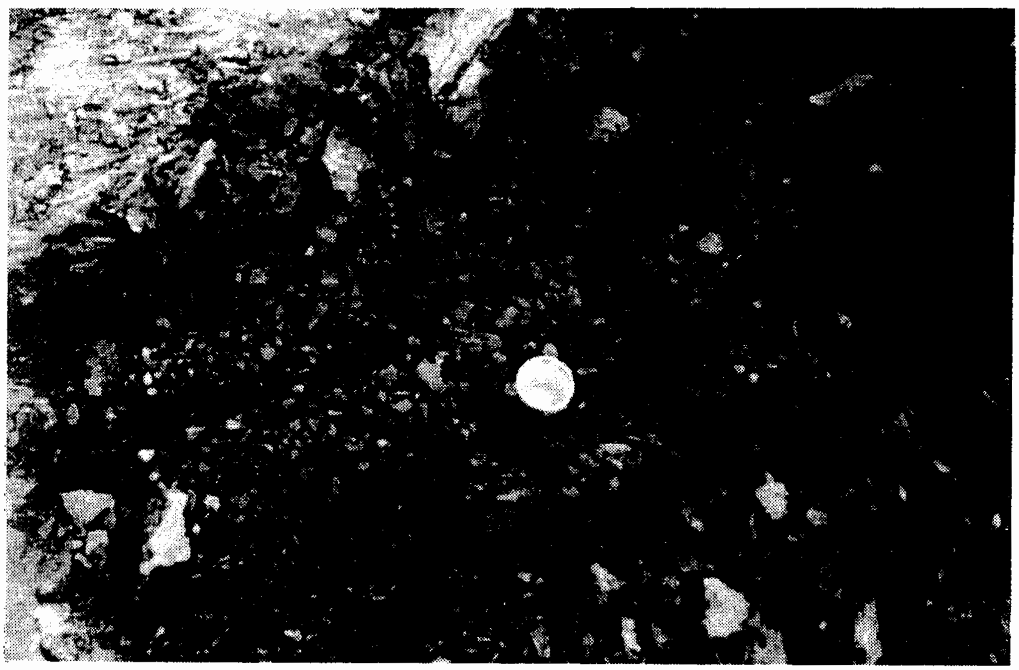
The final design consists of 12 inches of the shale base course (compacted depth) and 8 inches of 1-inch minus crushed aggregate (compacted depth). The final road template will be single lane (14-foot top) in the tangent sections and double-lane turnouts (24-foot top) through the curves.

Project Cost

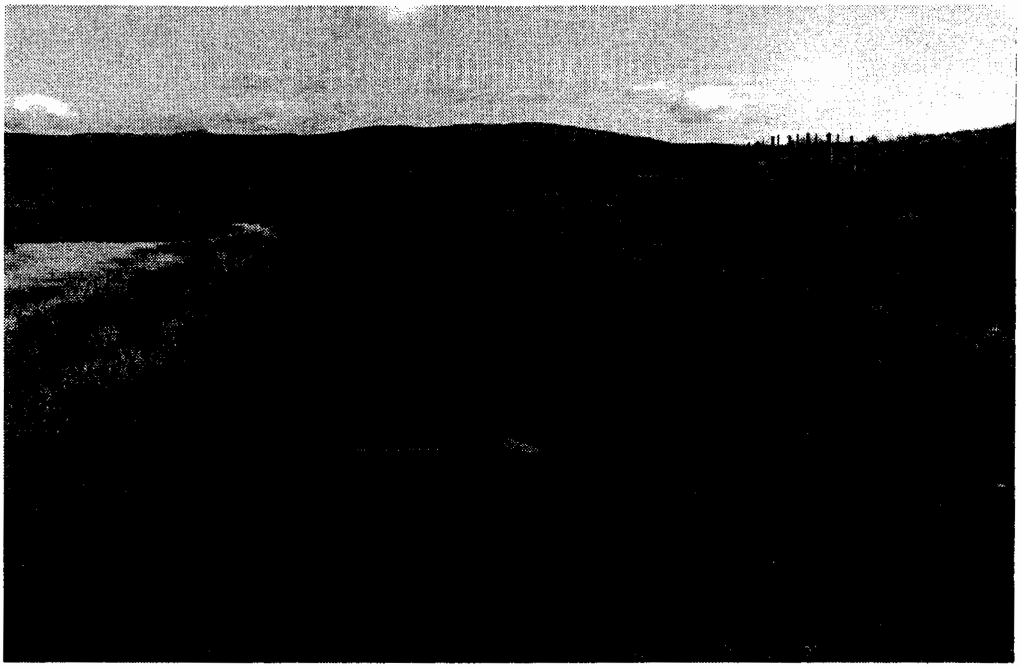
This project was originally submitted as a Capital Investment Project (RT709). Estimated cost of furnishing and placing 8 inches of crushed aggregate on the road, without any base course, by the Forest Service alone was $435,000. By working with Routt County to share costs, the Forest Service portion was reduced to $195,753 for a much more serviceable end product. These are total project costs, including engineering.

Conclusion

This project is expected to demonstrate that low-grade shale materials that are locally available can successfully be used in road construction for base course if they are protected from the elements by an immediate covering of more weather-resistant crushed aggregate material.



Upper surface of shale base course has degraded to clay. Below this 1- to 2-inch clay layer, the shale is in good condition.



Shale base course compacted by traffic. Five to six loaded log trucks per day were using the road.

For further information, contact Rex Blackwell, 29587 West U.S. 40, Suite 20, Steamboat Springs, CO 80487, (FTS) 879-1722, (303) 879-1722, DG: R02F11A.

Allowable Fill Height on Trees

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Introduction

A large proportion of road construction costs is attributed to clearing and grubbing. The Road Technology Improvement Program (RTIP) developed the "Guide for Selecting Clearing Widths" to provide information for determining clearing standards (widths) necessary to accommodate various resource concerns and road activities. Clearing widths often vary among Forest Service Regions and, in some cases, among National Forests within a Region. Standards may be based on Regional or local policies, personal preferences, or past experiences—rather than on an evaluation of economic or environmental effects. During the development of the guide, it was found that some information important to the selection of clearing widths was not available. It was recommended that data be compiled that would be useful in determining clearing widths.

Clearing costs may be decreased by filling against existing trees and reducing the clearing width. Embankment material sometimes partially covers trees near the clearing limits. These trees might be susceptible to dying and could become a road hazard and cause additional clearing costs. When filling against existing trees to reduce clearing widths, the road designer must be careful not to exceed tolerable fill heights, which would kill the trees, thus offsetting any cost savings.

The RTIP identified a need to determine the allowable road fill height on trees for different species and site conditions to provide information to road designers when selecting clearing widths. No uniform policy exists on the allowable fill height on trees. In fact, little information has been available to decisionmakers for developing guidelines and policy. Reducing clearing widths by filling against trees can substantially decrease road construction costs without affecting road maintenance costs if decisions on amount and location are based on good information.

The purpose of this San Dimas Technology & Development Center project was to collect and compile into one reference guide all available data pertaining to allowable fill height on different species of trees in varying conditions to assist in road construction decisionmaking and to determine whether additional information is required.

Literature Search

The project plan specified that all available information on the limitations of filling against trees be collected with the intention that, once collected, this information would be tabulated for road designers. An extensive literature search found little information available on filling against trees. According to plant pathologists, symptoms of tree damage from grade changes occur several months to several years after the damage occurs. Initial symptoms generally appear in the crown area and include: delayed budbreak, reduced growth, light green-to-yellow leaves, thinning crown, premature fall color, and loss of resistance to insects and disease.

Tree death may occur 5 to 7 years after the original damage. The amount of damage, tree species, and soil type will determine how long it will take initial symptoms to occur. Such species as the burr oak and cottonwood have deep roots and are able to live for long periods in compacted soils in which other species cannot survive. The severity of damage depends on the extent of grade change, along with the age, size, initial vigor, and species of the tree. Damage can be the result of lack of water, excess water, breakage or injury of vital root systems, changes in pH (soil acidity), soil compaction, or a lack of nutrients.

The Intermountain Forest and Range Experiment Station (INT) conducted the only known structured Forest Service evaluation of the effect of filling against trees on a study area on the Coram Experimental Forest in northwest Montana. The trees evaluated were along a 13-year-old road specifically designed to reduce clearing widths. Five species—western larch, Engelmann spruce, subalpine fir, lodgepole pine, and Douglas-fir—were filled against up to heights of 4 feet. The fill seemed to have little, if any, effect on tree vigor or mortality. Only 9 trees were found dead, but it could not be determined whether they had been dead or were already dying before road construction. However, the unhealthy trees were all small, understory growth, which most likely would have died despite any disturbance by filling. The remaining 128 trees studied were alive and healthy, which supported observations of trees in other locations. About 42 percent of the growth showed signs of scarring on the uphill side—possibly from rocks and debris; however, the trees seemed to have "healed over" well in the 13 years since initial road construction.

In a recent study, the Saasveld Forestry Research Centre of the South African Forestry Research Institute evaluated the effects of road-building on the survival of natural mixed evergreen forests of the southern Cape Province of South Africa. It was found that, in relation to the total forest area, the short-term mortality of trees along clearing limits was minimal. Tree mortality was attributed to ponding and sedimentation from insufficient drainage, additional soil from fills, soil compaction from construction equipment, and rock blasting. Changes in tree exposure seemed to have little effect on the vigor of trees. However, the mortality of individual trees varied according to tree species.

The Iowa Department of Transportation has observed that placing fill against a tree will not kill the tree but will stress its vigor. This increases the susceptibility of the tree to insects and disease, shortening the life of the tree. Tree roots are sensitive to any changes in aeration or moisture, largely in the upper 2 feet of soil. The extensive root system of a tree extends laterally from the trunk to approximately the same spread as its branches. The fine feeder roots, which are most sensitive to changes in the environment, develop primarily within the top 2 feet of soil. When adding fill material, the volumes of air and water delivered to the root system must be maintained. Iowa State University has a chart that classifies various tree species according to their tolerance to root damage (table 1). Trees are described as being "very sensitive," "moderately sensitive" (cannot withstand more than 10 percent of the total root area being disturbed), and "fairly tolerant" (can withstand as much as 50 percent root damage). It is not known whether scientific data exist to support this information.

Fill Height Data

With little available research data to be found on the topic, the best base of information was from actual Forest Service field experience. During the summer of 1986, questionnaires were distributed to all Regional Preconstruction Engineers and Silviculturists to share any field experience with fill against trees within Regions.

Table 2 summarizes the information gathered from the data sheets that were distributed and classifies the data according to tree species. Of the 22 species reported, 4 (white pine, white fir, true fir, and white oak) were identified in which death may have occurred from filling against individual trees. From the data provided in table 2, no conclusions can be drawn as to whether or not these species are more susceptible to death if filled against. The number of fatalities reported is only a small percentage of the total number of trees identified. However, it is highly likely that the number of fatal incidents reported is not a representative sample because unhealthy trees are rarely seen within clearing limits; they are either salvaged by woodcutters or removed by road maintenance crews for safety reasons.

Table 1.—Tree tolerance to root damage, by species.

Very Sensitive	Moderately Sensitive	Fairly Tolerant
Oaks, all	Sugar maple	Silver (soft) maple
Hickories, all	Black maple	Basswood
Honey locust	Ash, all kinds	Cottonwood
Kentucky coffee	Walnut	White poplar
Larch	Sycamore	Willow, all kinds
White bark birch	Red maple	River birch
Horse chestnut	Hackberry	
All conifers (pine, spruce, fir, etc.)	Cherry	
Serviceberry	Hawthorne	
Redbud	Ironwood (both muscle-wood and Ostrya)	
	Pagoda dogwood	

Table 2.—Compilation of results, fill height data sheet questionnaire.[1]

Tree species	Region No.[2]	Fill ht. (ft)	Fill age (yr)	Soil cond.[3]	Drainage[4]	Root sys. cvrd. (%)	Dbh (in)	Exposure
Pine-White	1,3,6	0-6	2-45 D=30	R,60%;G;D=SM	SP;P	100	8-17 D=17	all
-Lodgepole	2,6,INT	0-7	0-20	G;GT;SL;P	SP;P	50-100	1-24	all
-Ponderosa	1,3,6	0-20	2-100	R,0-55%;G;GT;ML	SP;P	50-100	12-38	all
Fir-Douglas	1,3,5,6,INT	0-8	1/6-45	R,0-50%;G;GT;DG;SM;P	SP;P	50-100	1-40	all
-Grand	1	0-3	2-15	R,0-50%;G;GT	SP;P	100	4-24	all
-Alpine	1	0-2	0-15	GT	SP;P	50-100	6-18	varied
-Subalpine	6,INT	0-2	13-15	GT;SM	SP	65-70	2-20	NE,E,mod.shade(mod.dense)
-White	3,6	2-5	8-100 D=8	R,55-75%;G;D=M	SP;D=P	50-100	12-17	E,W,sun,shade(lt-to-dense)
-True	6,9	3-5	27	SM;P	SP;P	50-70	6-24 D=6-12	E,S,shade
-Red	6	0-6	8	R,50%;M	SP	90	to 24	W,shade,dense
Wstrn. Larch	1,6,INT	0-8	2-27	R,50%;G;GT;SM;L	SP;P	50-100	3-40	S,N,W,sun,shade(mod.dense)
Hemlock	1,6	0-3	2-15 D=8-15	G;SL;D=P	SP;P	70-100	12-28	all,W,shade,D=sun
Cedar	1	0-3	2-15	G	SP	100	---	all
Wstrn. Red Cedar	6	2-6	5-30	SM;SL	SP;P	50-100	12-24	NW,SE
Spruce	1,3	0-3	2-15	G	SP;P	50-100	6-18	all
Engelman Spruce	INT	0-1.5	13	GT;L	SP	65	7-14	E,mod.shade
White Oak	5,8	3-4 D=3	13-25	R,30-50%;SL;D=S	SP;P	100	6-31 D=6-12	N,S,sun,shade
Chesnut	8	3	20	S	FR	100	7-8	---
Maple	9	2	1	R,40%;C;G	P	100	6	N,shade(mod.dense)
Tulip Poplar	9	0-1.5	1	R,40%;C;G	FR	100	11	N,shade(mod.dense)
Quaking Aspen	6	6-10	3-20	R,25%;SM;SL	SP	50	6-10	NW,shade,part sun

[1] "D =" are values for trees that died; the condition of all trees reported on was healthy--except in those cases noted by "D."

[2] 1=Northern, 2=Rocky Mtn., 3=Southwstrn., 4=Intermtn., 5=Pacific Southwest, 6=Pacific Northwest, 8=Southern, and 9=Eastern.

[3] R = rock, G = gravel, GT = glacial till, SM = silty sand, SL = sandy loam, DG = decomposed granite, M = silt, ML = silty loam, P = pumice, L = Loam, S = shale, C = clay.

[4] SP = Semiporous, P = Porous, FR = fast runoff.

Forest Service Policies & Practices

Currently, standards and practices for filling against trees vary not only from one Region to the next but also among individual National Forests within any particular Region. Because they had no known examples of filling against trees, no comments were obtained from the Rocky Mountain, Intermountain, or Alaska Regions. Table 3 summarizes the observations and experiences of the other six Regions and INT with filling against trees.

Figure 1 shows a spruce on the Carson National Forest in Region 3, while figure 2 shows a fir on the Six Rivers National Forest in Region 5. The trees have different fill heights and ages.

Conclusions

Because of limited literature and field experience and inconsistencies in opinion regarding the practice of filling against trees, no standard guidelines can be developed from the information available. According to the information provided in table 3, the practice of filling against trees could be a successful means of decreasing clearing costs if consideration is given to tree species, tree size, embankment materials, fill heights, and road construction

Figure 1.—A spruce in the Southwestern Region on the Carson National Forest, New Mexico, with a 3-foot fill height and a 2-year fill age.

Table 3.—Filling against trees—Regional policies (as of summer 1986).

Region	Fill height (ft)	Fill age (yr)
Northern (R-1)	0 to 3	2 to 15

Comments/Observations: Reduced vigor (not significant), due to less oxygen to root system, observed. Mature trees do well; young trees questionable. Both bark thickness (thick vs thin) and stem diameter (6 in min.) affect reponse. Thin-barked, small-diameter trees affected more by filling than thick-barked, larger diameter trees.

Region	Fill height (ft)	Fill age (yr)
Southwestern (R-3)	3 to 6	2 to 100

Comments/Observations: Unaware of road construction projects in R-3 where specifications allowed filling against trees. But trees were filled against when CCC built roads in late 1930's. Information provided is on these trees. No known instances of dead trees.

Region	Fill height (ft)	Fill age (yr)
Pacific Southwest (R-5)	0 to 5	0 to 30

Comments/Observations: No effect on tree health.

Region	Fill height (ft)	Fill age (yr)
Pacific Northwest (R-6)	0 to 12	0 to 27

Comments/Observations: Little effect on tree vigor. Specialists on four R-6 national forests felt that filling against trees was not beneficial, since it would cause an increase in resource damage and a decrease in safety, and these would not be offset by the small cost savings. A silviculturist on the Fremont National Forest, OR, felt that thin-barked trees are more susceptible to death than thick- barked ones. Shallow-rooted trees are also more susceptible to death. The most susceptible species to damage is aspen, while the least is the Ponderosa pine (based upon opinion and past experience). Mt. Baker-Snoqualmie National Forest, WA, personnel felt that a combination of road construction methods, tree species (coniferous), and soil types would not lend itself to filling against trees since compaction would deplete aeration and drainage, killing the trees.

Region	Fill height (ft)	Fill age (yr)
Southern (R-8)	0 to 3	0 to 20

Comments/Observations: Opinions vary. Silverculturists lean toward "no fill on trees," claiming that the trees eventually die and cause more expense to clear. On the Monongahela National Forest, WV, it was found that more problems resulted with damage to trees on the cut side than on the fill side due to severe pruning, disturbance, or root exposure from sloughing. Oak and maple are more susceptible to root damage. Narrow clearing limits would be detrimental in this forest because they need to open up the road to sun and airflow to dry it out.

Region	Fill height (ft)	Fill age (yr)
Eastern (R-9)	0 to 5	0 to 5

Comments/Observations: On the Allegheny National Forest, PA, reduce clearing limits to 20 to 25 feet, since the introduction of Level D roads with minimum damage to trees (most damage caused by equipment scraping).

Region	Fill height (ft)	Fill age (yr)
INT (Research)	1 to 4	0 to 13

Comments/Observations: See summary of study on Coram Experimental Forest in the "Literature Search" section of this report.

Figure 2.—A fir in the Pacific Southwest Region on the Six Rivers National Forest, California, with a 5-foot fill height and a fill age of 13 years.

methods. Questionnaire responses (table 2) indicate that decisions pertaining to filling against trees depend more on current local practice than scientific fact.

On the average, fill heights against trees ranged between 0 and 3.5 feet. The average reported in-place age of fill for healthy trees was 21 years, with a maximum age of 100 years. Only five instances were reported in which individual trees had died apparently from filling to heights of 3 feet that covered 60 to 100 percent of the root system. In all cases, the individual trees were of small diameter (0 to 6 inches) and, according to table 1, classified as very sensitive. Based on this information, it seems that filling against trees can be successful in many instances; however, adequate criteria regarding tree characteristics (that is, size, species, and so forth), fill height, soil conditions, and site conditions first must be developed.

Recommendations

Decisionmakers must evaluate a wide range of variables when considering the practice of filling against trees as a means of decreasing clearing costs. It is not acceptable to base these decisions on "rules of thumb" or hearsay. Evaluating local conditions, tree species, and past experience is necessary to make sound economic and environmental decisions. The strategy of filling around trees is not acceptable in all cases. However, this strategy should not be dismissed by blanket prohibitions. Because adequate scientific facts are not available, professional judgment must be used to determine areas where it is and where it is not appropriate. Considerable cost savings can be, and are being, realized by appropriate use of the technique. On the other hand, considerable headaches and cost can result from inappropriate use.

Based on facts presented in this article and in documents searched, road designers should be aware of conditions where filling against trees might be acceptable. Test sections can be prepared for ongoing road projects but should be monitored for a period of years to determine success or failure. Results from tests and monitoring of past projects should be forwarded to John Holt, Washington Office Engineering Transportation Development Engineer, so that the information gathered can be distributed Service-wide.

Douglas A. Williamson
Engineering Geologist (Retired)
Willamette National Forest, Region 6

Introduction

The relative density probe is a simple exploratory device that is used to determine the distribution and estimated strength of subsurface soil units and decomposed rock units. The drive probe also can be used to determine the presence of water and subsurface water levels. The drive probe does require some equipment and moderate work effort but does define strength parameters of the soil units. Once set up, it is much quicker than hand-augering, but it does not determine plasticity. One or more auger holes can be used to classify the subsurface materials, and the drive probe can be used to define the subsurface for the rest of the project area.

The equipment is relatively inexpensive (less than $500) and can be either specified and ordered or fabricated in-house. The drive probe is most effective when used in conjunction with conventional geotechnical soil exploration to inexpensively extend the known conditions revealed by drilling. The drive probe also can be used alone and has been found to be accurate and discrete in defining subsurface conditions for low-risk projects. It is a proven geotechnical method employed over a period of more than 4 years.

Relative density in this article is the estimated strength of subsurface materials determined by the resistance to penetration. The resistance to penetration is measured in blows-per-foot of an 11-pound circular hammer freely falling 39 inches and driving a 1-inch diameter end area. Note that the 39 inches is the distance between couplings on a 4-foot pipe length minus the length of the hammer. The "solid end area" is a 1/2-inch pipe coupling with a 1/2-inch plug in it.

Equipment

The equipment for the drive probe consists of segments of 1/2-inch galvanized pipe (3/4-inch OD), cut into 4- and 5-foot lengths and threaded on each end. Commercial 1/2-inch galvanized pipe comes in 21-foot lengths so the pipe is cut into one 5-foot length and four 4-foot lengths to eliminate waste. Smooth-walled pipe couplings with full threads (1-inch OD) are used to join the pipes as the hole is advanced. The 5-foot segment is used for the initial drive. The starting 5-foot segment is randomly drilled with 3/16-inch diameter holes to allow water to enter the pipe as it is driven into the ground. The "driving end" of the pipe is a coupling with a pipe plug in it (figure 1). A circular mild steel hammer of 11-pound weight is used, with a central 3/4-inch diameter hole that will slide on the pipe (figures 2 and 3).

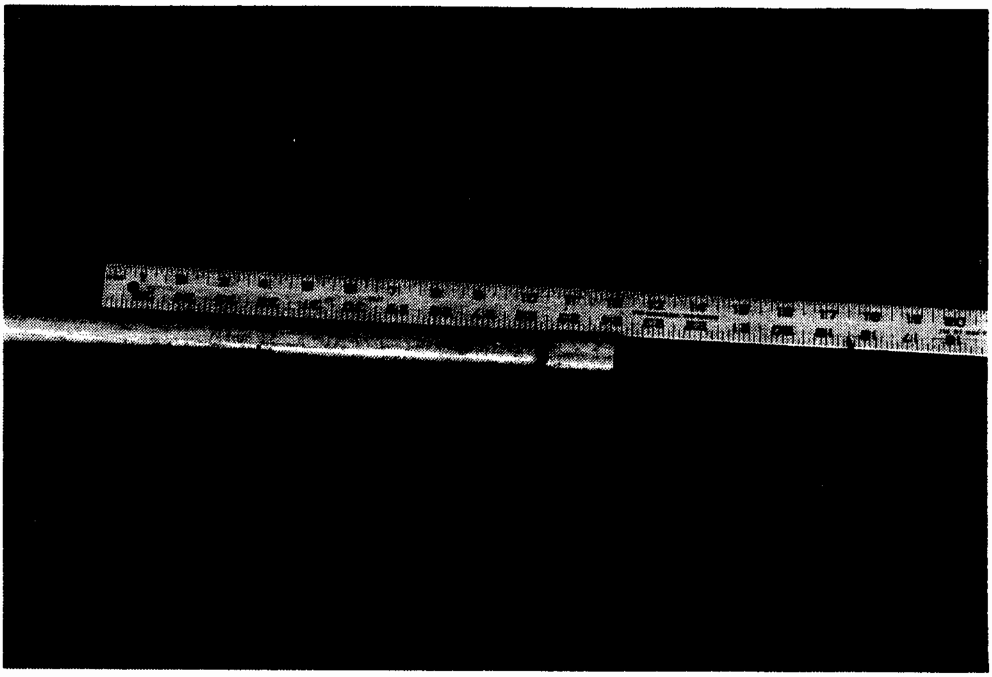

Figure 1.—Drive probe tip. Note 3/16-inch diameter hole, coupling with plug inserted.

The hammer is about 1 foot long and has "hand guards" on each end made from 1/4-inch steel plate, slightly larger in diameter than the hammer.

It is critical to the operation that the threads on the ends of the pipe be no longer than that which will "meet" in the center of the couplings when two pipe lengths are joined (figure 4). This means the driving force will be transmitted through pipe ends and not through the threads. The pipe segments can be made up in advance with a coupling on one end, ready for driving. Pipes should be reamed smooth on the inside to allow for the free passage of water-measuring devices.

Additional equipment that is needed consists of two pipe wrenches (preferably rigid brand) of the magnesium-aluminum variety for convenient weight (figure 5); a plastic 5-gallon bucket to carry tools and equipment, to add water to the hole, or to stand on if necessary; an electric water-level-measuring device (M-scope) (figure 5); a funnel; a 5-foot measuring stick; yellow keel-type marking pencil; a field notebook and pencils; and a folding shovel. Several "extra" couplings also are convenient. A 1/2-inch pipe die and die stock, a pipe cutter, a pipe reamer, a pipe vise, and a 1/2-inch "easyout" for removal of broken pipe threads from couplings are recommended and economical in-house equipment. A supply of smooth-walled, full-thread pipe couplings should be kept on hand.

A drive probe is designed for a one- or two-man operation of either technical or nontechnical personnel. Depths of up to 30 feet have been achieved without unusual effort. When "refusal" is reached with the "free-falling"

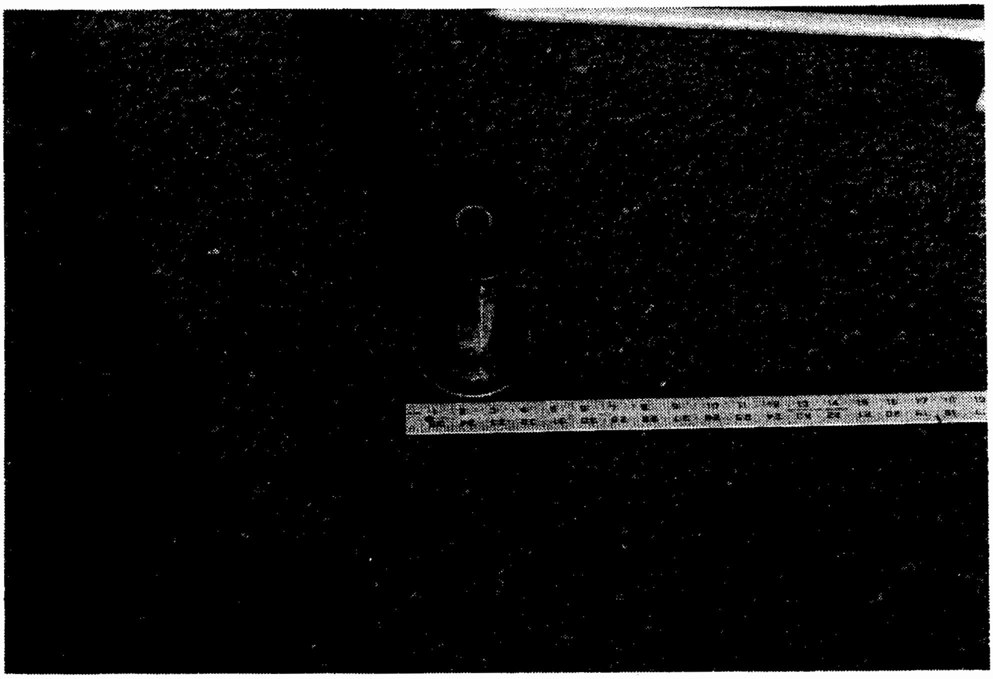

Figure 2.—Drive hammer, end view.

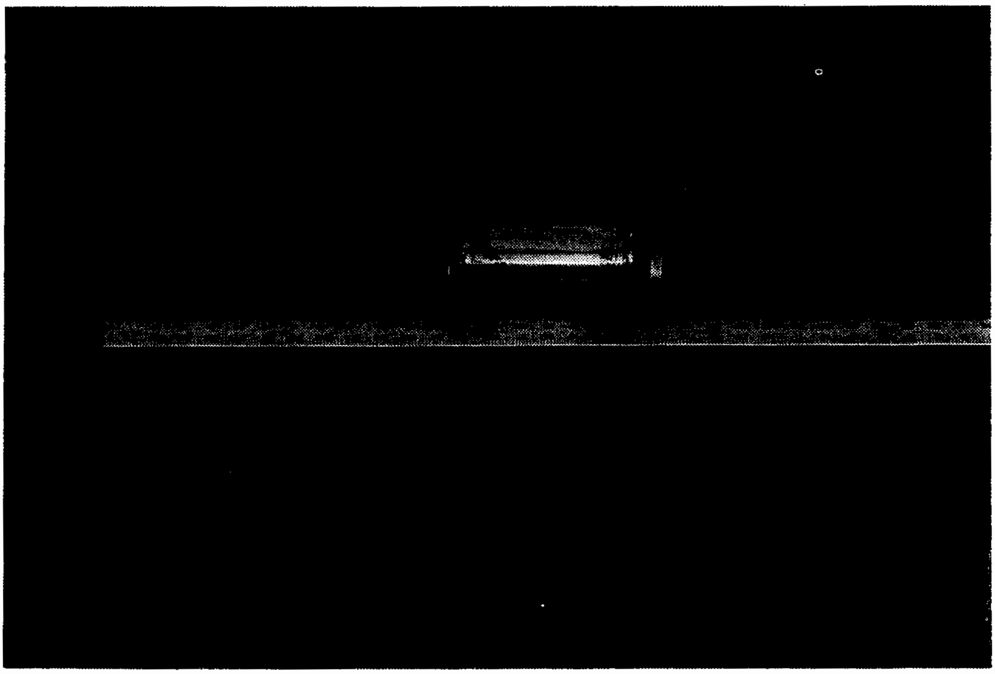

Figure 3.—Drive hammer, side view.

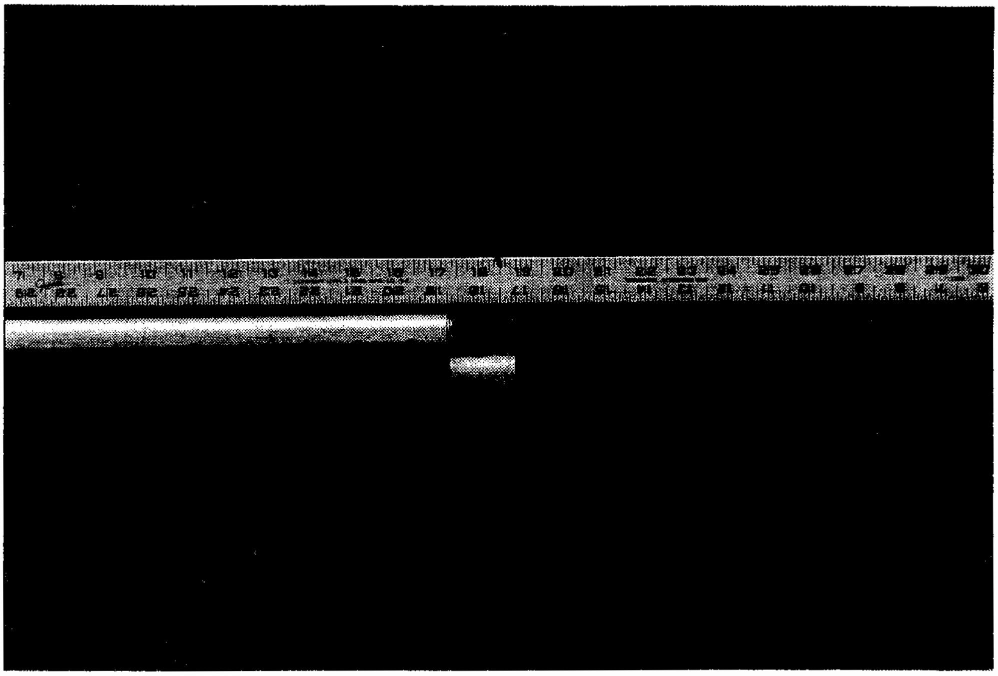

Figure 4.—Coupling and pipe threads showing thread length relative to coupling length.

method, the hole can be continued by "hand-driving" methods to "absolute refusal."

Procedure

The site selected for the probe is cleared of surface duff or organic material to expose the upper surface of the soil. The starting 5-foot pipe segment is measured and marked with the keel in 1/2-foot intervals. The 4-foot segment with the drive hammer on it is screwed into the top of the 5-foot segment. The hammer is then raised to the coupling on the upper end of the 4-foot segment and allowed to fall freely and strike the coupling on the end of the 5-foot segment. A coupling should be screwed into the top of the pipe segment to prevent the hammer from flying off the top of the pipe when raising the hammer.

As each segment is driven, the number of blows required to advance the hole for each 6 inches is recorded. After driving 5 feet, the amount of open hole is measured and the hole checked for the presence of water. The 4-foot pipe segment is unscrewed, and the hammer is moved to the uppermost pipe as each additional 4-foot segment is added to the "string" (figure 6). The bottom pipe segment is marked each time, and the hole is then advanced another 4 feet. The open hole and water level is again checked, and so on, until "refusal."

The friction of the pipe in the hole is primarily between the couplings and the sides of the hole rather than all of the pipe in the hole. This allows easier advancement of the hole than if all the pipe were in contact. It is recognized that friction increases slightly with each additional coupling in the hole, but with this type of operation it is negligible. In granular soil materials, all of the pipe is probably in contact with the sides of the hole.

The pipe lengths can be removed from the hole for inspecting thread conditions, for cleaning and removing soil material in the pipe, or for recovering the pipe for further use. The hammer is driven "upward," striking the coupling on the top of the uppermost pipe. Repeated blows remove whatever length is desired. It may help to have a 2-foot segment for pipe removal for a more convenient driving length. Shorter people may have to stand on the bucket when starting the hole or when removing pipe from the hole. The pipes can be either retrieved or left in the hole for later water measurements.

Field Notebook

The headings for the information to be recorded in the field notebook are as follows: Project, Date, Hole Location and Elevation, and Crew. The following are the page headings: Depth (with subheadings From and To), Interval, Blows, Blows-per-Foot, and As Each Pipe Is Added (with subheadings Open Hole and Depth to Water). "Write in the rain"-level books are recommended.

Calculations

When doing drive-probe exploration, the blows needed to advance the hole for the 6-inch interval are doubled to get blows-per-foot. This represents the strength of the material for that interval. Six inches are driven to ensure detecting a layer 1 foot or less in thickness. The longer the interval is driven, the less likely that "thin" layers will be detected. Any depth interval can be driven and converted to blows-per-foot for that interval. In all cases, whatever interval is advanced, the blows-per-interval are converted to

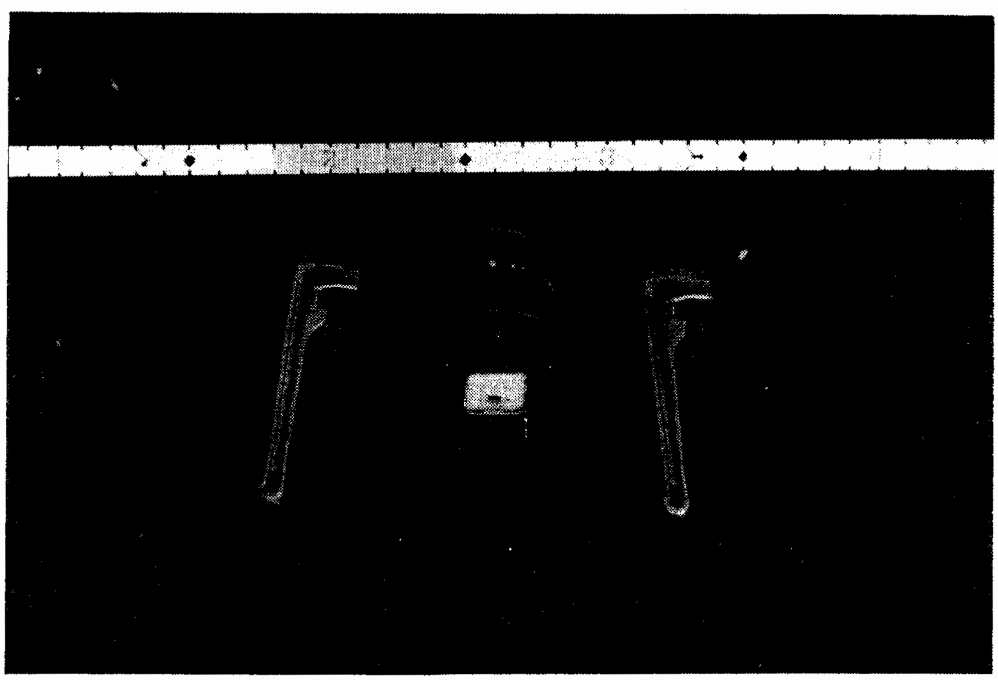

Figure 5.—M-scope water-measuring device and lightweight pipe wrenches.

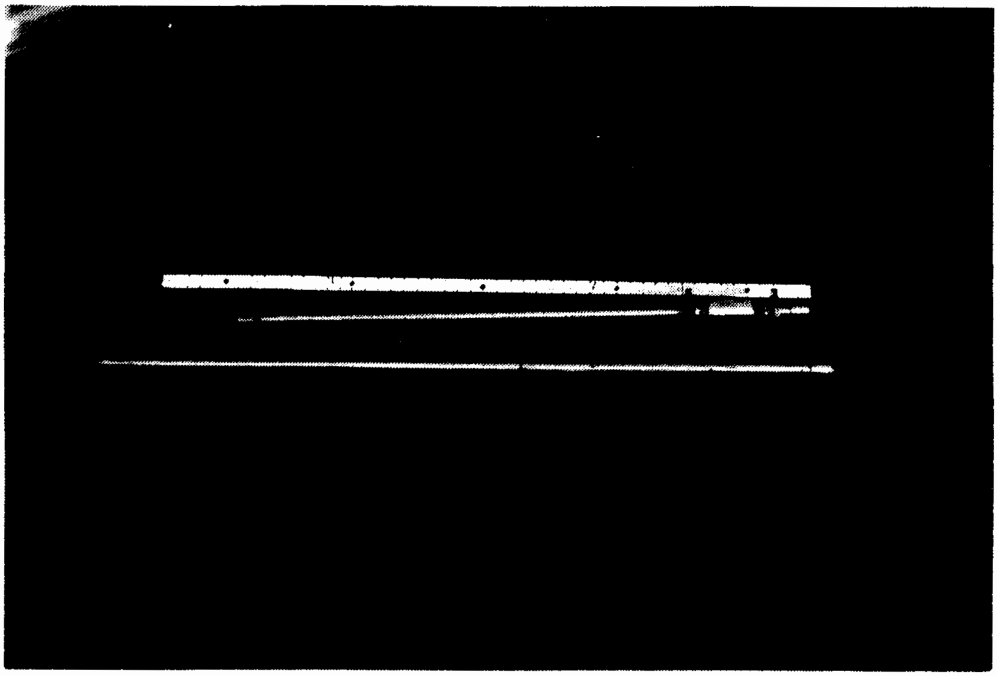

Figure 6.—Drive probe "string," with 5-foot tip and 4-foot segment and drive hammer.

blows-per-foot, which is the "standard of comparison" for that given material. The blows-per-foot has been found to be a discrete, reproducible, and reliable means of correlating between drive-probe holes.

When a hole is drilled into the ground using geotechnical driving methods, there is a typical anticipated result, namely, that the number of blows-per-foot necessary to advance the hole will increase with depth to a point that the hole cannot be advanced. In other words, soil deposits normally increase in strength and density with depth. When doing drive-probe drilling, the most important result of the subsurface strength assessment is the detection of a weaker layer revealed by a "blow-count reversal." This means that the blows-per-foot decrease rather than increase with depth. Blow-count reversal occurs when the blows-per-foot decrease, indicating that strength and density of the soil in that interval have decreased. It is this blow-count reversal that is most important in exploring foundations or slope-stability assessment.

When To Pave a Gravel Road

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Introduction

We frequently face the decision to pave or not to pave an existing aggregate road. The following Kentucky Transportation Center paper provides a structured, thorough process leading to this decision. Read "National Forest" where this paper says "county" or "local government," and these steps will apply well to Forest Development Roads. Each step builds on the last. Together they incorporate many principles we routinely emphasize (for example, having a road management system and standards, and considering safety, the user, and life-cycle analysis). These steps should be helpful in making Forest road system decisions.

—Skip Coghlan
Civil Engineer
Washington Office

Gravel or Paved: A Matter of Trade-offs

The decision to pave is a matter of trade-offs. Paving helps to seal the surface from rainfall, and thus protects the base and subgrade material. It eliminates dust problems, has high user acceptance because of increased smoothness, and can accommodate many types of vehicles such as tractor-trailers that do not operate as effectively on unsurfaced roads.

In spite of the benefits of paved roads, well-maintained gravel roads are an effective alternative. In fact, some local agencies are reverting to gravel roads. Gravel roads have the advantage of lower construction and sometimes lower maintenance costs. They may be easier to maintain, requiring less equipment and possibly lower operator skill levels. Potholes can be patched more effectively. Gravel roads generate lower speeds than paved surfaces. Another advantage of the unpaved road is its forgiveness of external forces. For example, today vehicles with gross weights of 100,000 pounds or

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more operate on Kentucky's local roads. Such vehicles would damage a lightly paved road so as to require resealing, or even reconstruction. The damage on a gravel road would be much easier and less expensive to correct.

There is nothing wrong with a good gravel road. Properly maintained, a gravel road can serve general traffic adequately for many years.

Should We Pave This Gravel Road?: A Ten Part Answer

When a local government considers paving a road, it is usually with a view toward reducing road maintenance costs and providing a smooth riding surface. But is paving always the right answer? After all, paving is expensive. How does a county or city know it is making the most cost-effective decision?

We will consider ten answers to the question "should we pave this gravel road?" In fact there are ten parts to one answer. If one of the ten is not considered, the final decision may not be complete. The ten answers taken together provide a framework for careful decision making.

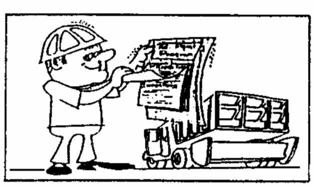
Answer #1—After Developing a Road Management Program

If the road being considered for paving does not fit into a county-wide road improvement program, it is quite possible that funds will not be used to the fullest advantage. The goal of a road management system is to improve all roads or streets by using good management practices. A particular road is only one of many in the road system.

A road management system is a common sense, step-by-step approach to scheduling and budgeting for road maintenance work. It consists of surveying the mileage and condition of all roads in the system, establishing short-term and long-term maintenance goals, and prioritizing road projects according to budget constraints.

A road management system helps the agency develop its road budget and allows the use of dollars wisely because its priorities and needs are clearly defined.

Through roadway management, local governments can determine the most cost-effective, long-term treatments for their roads, control their road maintenance costs, and spend tax dollars more wisely. Local governments that stick with the program will be rewarded with roads that are easier and less costly to maintain on a yearly basis. Pertinent information about all roads will be readily available for years to come instead of scattered among files or tucked away in an employee's head.



Steps in a Road Management Program:

(1) **Inventory the roads**—The amount of time and the miles of road in a county or city will determine how much detail to go into.

(2) **Assess the condition of the roads**—Develop simple and easy techniques to use each year. Maintain a continuing record of the assessed condition of each road so that changes in condition can be noted easily and quickly.

(3) **Select a road management plan**—Select the most appropriate treatment to repair each road, bridge or problem area.

(4) **Determine overall needs**—Estimate the cost of each repair job using generalized average costs and tally up the total. Establish long range goals and objectives that in turn will help the agency justify its budget requests.

(5) **Establish priorities**—Keep good roads in good shape (preventive maintenance) and establish a separate budget, or request a temporary increase, to reconstruct really bad roads.

Answer #2—When the Local Agency Is Committed to Effective Management

A commitment to effective management is an attitude. It is a matter of making sure that taxpayers' money is well spent—as if it were one's own money. It does not mean paving streets with gold but it does mean using the best materials available. It does not mean taking short cuts resulting in a shoddy project but it does mean using correct construction techniques and quality control. A commitment to effective management means planning for 5 or even 10 years instead of putting a band-aid on today's problem. It means using good management techniques instead of the "seat of the pants" method. It means taking the time to do things right the first time and constructing projects to last.

Consider a child's treehouse compared to a typical three-bedroom house in a Kentucky town. Because each protects people from the wind and rain each comes under the definition of a shelter. However, the treehouse was built with available materials and little craftsmanship. The other was planned, has a foundation, sound walls and roof and, with care, can last hundreds of years. One is a shack and the other is a family dwelling. Only one was built with a commitment to excellence.

Many roads are like the treehouse. They qualify under the definition but they are not built to last.

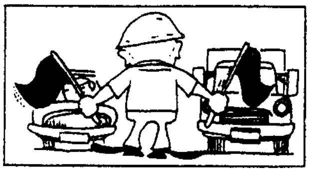
The horse-and-buggy days are over. We are in an age of travelers' demands, increasing traffic, declining revenues and taxpayer revolts. We are expected to do more with less. **Building roads to last requires an attitude of excellence.** Such an attitude helps to make better decisions, saves money in the long run, and results in a better overall road system.

Answer #3—When Traffic Demands It

The life of a road is affected by the number of vehicles and the weight of the vehicles using it. Generally speaking, the more vehicles using a road, the faster it will deteriorate.

The **average daily traffic** volumes (ADT) used to justify paving generally range from a low 50 vehicles per day to 400 or 500. When traffic volumes reach this range, serious consideration should be given to some kind of paving.

Traffic volumes alone are merely guides. **Types of traffic** should also be considered. Different types of traffic (and drivers) make different demands on



roads. Will the road be used primarily by standard passenger cars or will it be a connecting road with considerable truck traffic? Overloaded trucks are most damaging to paved roads.

The **functional importance** of the highway should also be considered. Generally speaking, if the road is a major road, it probably should be paved before residential or side roads are paved. On the other hand, a residential street may be economically sealed or paved while a road with heavy truck usage may best be surfaced with gravel and left unpaved until sufficient funds are available to place a thick load-bearing pavement on the road.

Answer #4—After Standards Have Been Adopted

Written standards in the areas of design, construction and maintenance define the level of service we hope to achieve. They are goals to aim for. Without written standards there is no common understanding about what a local government is striving for in road design, construction and maintenance. In deciding to pave a gravel road, is the local government confident it would be achieving the desired standards?

Design and construction standards do not have to be complex. It takes only a few pages to outline such things as right-of-way width, traveled way width, depth of base, drainage considerations (such as specifying minimum 18" culvert pipe), types of surfacing and the like.

Maintenance standards address the need for planned, periodic maintenance. A good maintenance plan protects local roads which, for most counties, represents many millions of dollars of investment. It also is an excellent aid when it comes time to create a budget.

Considerations include: How often shall new gravel be applied to a gravel road? (Some roads require it more than others.) How many times per year are roads to be graded? How often and in what locations should calcium chloride or other road stabilizers be applied? What is our plan for checking road signs? (Because of legal liability, a missing sign can be very costly if not replaced.) What is our plan for ditching and shouldering?

Answer #5—After Considering Safety & Design

Paving a road tempts drivers to drive faster. As speed increases, the road must be straighter, wider, and as free as possible from obstructions for it to be safe. Paving low volume roads before correcting safety and design inadequacies encourages speeds which are unsafe, especially when the inadequacies "surprise" the driver. Because of the vast mileage of low volume roads it is difficult to reduce speeds by enforcement.

Roads must be designed to provide safe travel for the expected volume at the design speed. To do this a number of physical features must be considered:

- Sight distance
- Alignment and curves
- Lane width
- Design speed
- Surface friction
- Superelevation

It may be necessary to remove trees or other obstructions such as boulders from the road's edge. Some engineers insist that no road should be paved that is less than 22 feet wide. If this standard is accepted, gravel roads must be widened before paving. Bridges may need widening. Considering these and other safety and design factors in the early stages of decision making can help to achieve the most economical road and one that will meet transportation needs. It makes no sense to pave a gravel road which is poorly designed and hazardous.

Answer #6—After the Base & Drainage Are Improved

"Build up the road base and improve drainage before paving." This cardinal rule cannot be stressed enough. If the foundation fails, the pavement fails. If water is not drained away from the road, the pavement fails. **Paving a road with a poor base or with inadequate drainage is a waste of money.** It is far more important to ask "does this road need strengthening and drainage work?" than it is to ask "should we pave this gravel road?"

Soil is the foundation of the road and, as such, it is the most important part of the road structure. A basic knowledge of soil characteristics in the area is very helpful and can help avoid failures and unneeded expense. Soils vary throughout Kentucky. For highway construction in general, the most important properties of a soil are its size grading, its plasticity, and its optimum moisture content.

There is a substantial difference in the type of crushed stone or gravel used for a gravel road riding surface versus that used as a base under a pavement. The gravel road surface needs to have more fines plus some plasticity to bind it together, make it drain quicker and create a hard riding surface. Such material is an inferior base for pavement. If pavement is laid over such material, it traps water in the base. The high fines and the plasticity of the material make the wet base soft. The result is premature pavement failure.

For help in a given situation the Kentucky Highway Department should be contacted. This can be helpful in determing its adequacy as road material.

Answer #7—After Determining the Costs of Road Preparation

The decision to pave a gravel road is ultimately an economic one. Policy makers want to know when it becomes economical to pave.

There are two categories of costs to consider: **total road costs and maintenance costs.**

Local government needs to determine what the costs are to prepare a road for paving. Road preparation costs are the costs of construction before paving actually takes place.

For example, if standards call for a traveling surface of 22 feet and shoulders of two feet for a paved road, the costs of new material must be calculated. Removing trees, brush or boulders, adding new culverts or other drainage improvements, straightening a dangerous curve, improving slopes and elevations, constructing new guardrails, upgrading signs and making other preparations—all must be estimated.

Costs will vary greatly from project to project depending on topography, types of soils, availability of good crushed stone or gravel, traffic demands and other factors. One important factor is the standards. That is one reason why we should carefully consider what is contained in the road policy (#4 above).

For larger projects it may be desirable to hire an engineering consulting firm (another cost) to design the road and make cost estimations. For smaller projects construction costs can be fairly closely calculated by adding the estimated costs of materials, equipment and labor required to complete the job.

Answer #8—After Comparing Pavement Costs, Pavement Life, & Maintenance Costs

A second financial consideration is to compare maintenance costs of a paved road to maintenance costs of a gravel road. To make a realistic comparison we must estimate the years of pavement life (how long the pavement will be of service before it requires treatment or overlay) and the actual cost of paving.

It is at this point that we can begin to actually compare costs between the two types of roads.

Consider the following maintenance options:

(A) For both paved and gravel roads, a local government must: maintain shoulders - keep ditches clean - clean culverts regularly - maintain roadsides (brush, grass, etc.) - and replace signs and signposts.

(B) **PAVED** roadways require: patching - resealing (chip, slurry, crack seal) and striping.

(C) **GRAVEL** roadways require: regraveling and grading and stabilization of soils or dust control.

Since the maintenance options in "A" are common to both paved and gravel roads, they do not have to be considered when comparing maintenance costs. These costs for either type of road should be about the same. But the costs of the maintenance options in "B" and "C" are different and therefore should be compared.

Figure 1 shows costs for maintaining gravel roads over a six-year period in a hypothetical situation. If records of costs are not readily available, you may use a "best guess" allowing for annual inflation costs.

Three paving options are listed in Figure 2. Each includes estimated costs for paving and an estimated pavement life. You should obtain up-to-date cost estimates and expected pavement life figures for these and other paving options by talking to the Kentucky Department of Highways, contractors, and neighboring towns and counties.

Let's consider the cost of a double surface treatment operation and the projected cost of maintaining it before anything major has to be done to the pavement (end of pavement life). We see in Figure 2 that the estimated cost

	Year						
	1	2	3	4	5	6	Totals
Grading							
Equipment	270	280	290	300	310	320	1,770
Labor	90	100	110	120	130	140	690
Regravel							
Materials	—	—	4,000	—	—	—	4,000
Equipment	—	—	2,500	—	—	—	2,500
Labor	—	—	2,300	—	—	—	2,300
Stabilization/dust control							
Materials	800	900	1,200	920	950	975	5,745
Equipment	30	35	70	40	50	60	285
Labor	100	110	150	125	140	150	775
Totals	1,290	1,425	10,620	1,505	1,580	1,645	$18,065

Figure 1.—Gravel road maintenance per mile.

to double surface treat one mile of road is $20,533. Estimated maintenance costs over a six-year period could be:

patching	$1,800
striping	$ 500
sealing	$2,000
	$4,300
Total Maintenance	$ 4,300
Construction	$20,533
Total cost over six years	$24,833

When we compare this cost to the cost of maintaining an average mile of gravel road over the same period of six years ($18,065), we find a difference in dollar costs of $6,768. It is not cost beneficial to pave in this hypothetical example, even without considering the costs of road preparation (#7).

This is not a foolproof method, but it does give us a handle on relative maintenance costs in relation to paving costs and pavement life. The more accurate the information the more accurate the comparisons will be. The same method can be used in helping to make the decision to turn paved roads back to gravel.

Answer #9—After Comparing User Costs

Not all road costs are reflected in a highway budget. There is a significant difference in the cost to the user between driving on a gravel surface and on a paved surface. User costs, therefore, are appropriate to consider in the pave/not pave decision. By including vehicle operating costs with construction and maintenance costs, a more comprehensive total cost can be derived.

Option	Life (years)	Cost per mile ($)	Cost/mile per year ($)	Calculations	Maintenance per mile/year
Chip seal—double-surface treatment	6	20,533	3,422	Based on price of $1.75 per square yard, 20 ft. wide by 5,280 ft. = 105,600 square ft. 105,600 square ft. ÷ 9 = 11,733 square yards × $1.75 = $20,533	?
Bituminous concrete—hot mix	12	58,080	4,840	Based on estimated price of $30 per ton, 1 square yard of stone and hot mix/cold mix 1 inch thick weighs about 110 lbs. Therefore 3 inches = 330 lbs. per square yard. 11,733 square yards (1 mile of pavement) × 330 lbs. = 3,871,890 lbs. 3,871,890 lbs. = 1,936T × $30 = $58,080	?
Cold mix	8	48,390	6,048	At $30 per ton, using same formula as hot mix, 2.5 inches of cold mix equals 1,613T × $30 = $48,390	?

Note: These costs must be determined before any conclusions can be reached regarding the most cost-effective pavement method. The thinner the pavement, the greater the maintenance cost. Traffic, weather conditions, proper preparation before paving, and many other factors can affect maintenance costs. No Kentucky data exist on which to base estimates of maintenance costs on low-volume roads of these three paving options; therefore, we offer no conclusion as to the "best" way to pave.

Figure 2.—Paving options (costs and road life are estimates and may vary).

Vehicles cost more to operate on gravel surfaces than on paved surfaces, often 2 or 3 times greater than for bituminous concrete roads in the same locations. There is greater rolling resistance and less traction which increase fuel comsumption. The roughness of the surface contributes to additional tire wear and influences maintenance and repair expenses. Dust causes extra engine wear, oil consumption and maintenance costs. Figure 3 from AASHTO'S "A Manual on User Benefit Analysis of Highway and Bus-Transit Improvements" shows the impacts of gravel surfaces on user costs. For example, an average running speed of 40 MPH on a gravel surface will increase the user costs of passenger cars by 40% (1.4 conversion factor). The general public is not aware that their costs would actually be less if some of these roads were surface treated.

Add to the gravel road maintenance the user costs over a six-year period. Estimate an average daily traffice (ADT) of 100 cars and 50 single unit trucks, traveling at 40 mph. Estimate that it costs 25¢ per mile to operate the vehicles on pavement. Using the chart in Figure 3, we see it costs 1.4 times as much (or 35¢) to drive a car 40 mph one mile on gravel road and 1.43 times as much (or 36¢) to drive a single unit (straight frame) truck 40 mph one mile on gravel road.

100 cars × 365 days × 10¢ added cost × 1 mile = $3,650

50 trucks × 365 days × 11¢ added cost × 1 mile = $2,008

To use this chart, determine the type of vehicle, the speed and the type of road surface. Follow the speed line vertically to the vehicle type. Go horizontally to multiplier factor of road surface. Multiply the cost of travelling on a paved surface by this number to determine the cost of operating the same vehicle on gravel surface of dirt surface. Example: If it costs 28¢ per mile to operate a passenger car* at 40 mph on pavement, it will cost 39¢ per mile to operate it on a gravel road at the same speed and 50¢ per mile on a dirt road.

*1984 Federal Highway Administation Statistics quotes an operating cost of 28¢ per mile for an intermediate size passenger car traveling on average suburban pavement. You must determine your own vehicle operating costs on pavement in order to use these multiplicative factors to calculate operating that vehicle on gravel roads.

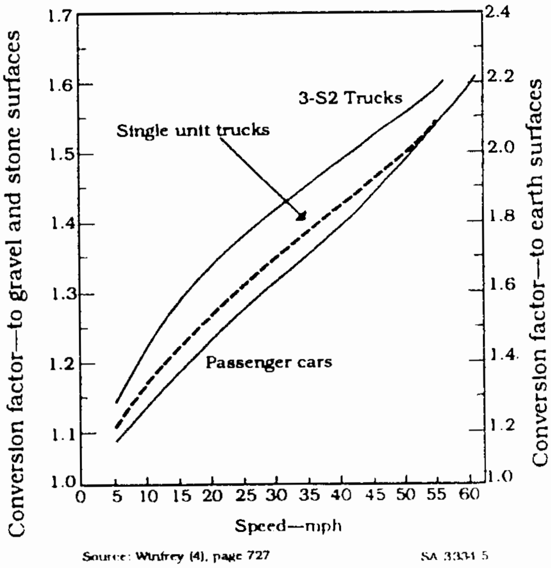


Figure 3.—The above chart shows the impact of gravel surfaces on user costs—from AASHTO's "A Manual on User Benefit Analysis of Highway and Bus Transit Improvements."

User costs for the gravel road is $5,659 per year, or $33,954 for a six-year period. Assuming we still do not consider road preparation costs, it now appears justified to pave the road. Such an approach can be used to establish a "rule of thumb" ADT. For example, some agencies give serious consideration to paving roads with an ADT above 125.

Answer #10—After Weighing Public Opinion

Public opinion as to whether to pave a road can be revealing, but it should not be relied upon to the exclusion of any one of points 1–9 already discussed. If a decision to pave is not based on facts it can be very costly. Public opinion should not be ignored, of course, but there is an obligation by government leaders to inform the public about other important factors before making the decision to pave.

Stage Construction

Local government may consider using "stage construction design" as an approach to improving roads. This is how it works. A design is prepared for the completed road, from base and drainage to completed paving. Rather than accomplishing all the work in one season, the construction is spread out over three to five years. Paving occurs only after the base and drainage have been proven over approximately one year. Crushed gravel treated with calcium chloride serves as the wearing course for the interim period. Once all weak spots have been repaired the road can be shaped for paving.

There are some advantages to keeping a road open to traffic for one or more seasons before paving:

(1) Weak spots that show up in the subgrade or base can be corrected before the hard surface is applied, eliminating later expensive repair.

(2) Risky late season paving is eliminated.

(3) More mileage is improved sooner.

(4) The cost of construction is spread over several years.

Note: Advantage may disappear if timely maintenance is not performed. Surface may deteriorate more rapidly because it is thinner than a designed pavement.

Summary

Some local roads are not well engineered. Today, larger volumes of heavy trucks and other vehicles are weakening them at a fast rate. Paving roads as a sole means of improving them without considering other factors is almost always a costly mistake. Counties and cities should consider ten points first. Carefully considering them will help to assure local government officials that they are making the right decision about paving a gravel road.

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