Environmentally Sensitive Maintenance
For
Dirt and Gravel Roads

Chapter 1: Introduction

1.1 Manual Mission & Scope

1.1.1 The Mission. The development of our national road system and the need to sustain it dictated governmental ownership from the start. Today, our state and local governments maintain the vast majority of roads. But our roads are part of our total environment, and just as we are the governmental trustees of our road system, we are also the trustees of our environment and all its resources.

1 - 01 Our roads are part of our total environment.

Beyond this trusteeship lies a greater calling: to be responsible stewards of our environment. The environment is under assault on many fronts, and many of those battles must be fought at the national and international level. But roads and their relationship to the environment are perhaps the one area where state and local governments can make a difference.

Unwanted sediments choke many streams and waterways, representing one of the largest pollution problems in North America. The culprits in many cases are dirt and gravel roads. Our mission, then, is to present proven methods of maintaining our dirt and gravel roads that reduce the erosion, sediment and dust that pollute our streams.

1.1.2 Scope. This manual's mission and philosophy are rooted in the Pennsylvania Program on "*Environmentally Sensitive Maintenance for Dirt and Gravel Roads*." (This Commonwealth program provides funding, training, and technical assistance and is highlighted as a case study for "Essential Programs" in Appendix 1 at the end of this chapter.)

Based on the Pennsylvania model, the practices presented in this manual focus on dirt and gravel roads in forested areas, recognizing that, with only minor research and development, many of the concepts and practices can be applied in various types of environments.

1 - 02 Roads exist as unnatural structures in the natural environment.

This manual will show that our *road system is part of our overall environment, that there is a vital connection between the two,* and that this connection needs to be considered when we construct and maintain our dirt and gravel roads. By doing so, we will be able to preserve our environment and prolong the life of our transportation system.

Roads exist as unnatural structures in the natural environment. Natural forces continually take their toll on our roads, often resulting in degraded roads and environmental damage. The challenge rests in simultaneously preserving our roads and streams in a safe and cost-effective manner. Using a combination of natural systems and road maintenance principles, environmentally sensitive maintenance practices can be integrated into an effective and efficient approach benefiting both the environment and our road transportation system.

Although this manual addresses environmentally sensitive maintenance for dirt and gravel roads, many of the practices, particularly in terms of drainage and vegetation, can be transferred to paved roads and result in benefits to both the paved road and the environment.

1.2 The Importance of Dirt and Gravel Roads

Over 1.6 million miles of dirt and gravel roads criss-cross rural areas of the United States, providing a vital service as part of the nation's transportation system. In many cases, our unpaved roads are the main access for major industries. Unpaved roads provide essential market access for farms, foresters depend on dirt and gravel roads to remove timber from the

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forest, and the mining industry could not get minerals out of the mines without these valuable pathways.

In many areas, dirt and gravel roads play a major part in tourism, adding to the economic wealth of the region. Dirt and gravel roads also directly serve millions of rural residents living along them.

Many of our dirt and gravel roads remain unpaved for economic reasons, but, in many areas, residents do not want paved roads, desiring to preserve the rural nature of their area. Dirt and gravel roads are considered the lowest service level in any functional road classification system, usually serving the lowest volumes of traffic. But even as their numbers decline, giving way to more and more paved roads, dirt and gravel roads continue to be a significant part of our road system.

In fact, traffic on dirt and gravel roads is increasing. Further, the vehicles and equipment using these roads are getting larger, meaning the most safe, effective and efficient maintenance practices must be employed to keep pace with the stress these larger vehicles place on the roads.

1.3 The Problem: Roads and the Environment

1.3.1 A Historical Perspective. Read our country's history books and the accounts of our discoverers, trailblazers, pioneers, and early settlements and it becomes clear that roads and streams are connected by their imminent proximity.

1 – 04 Historical development dictated the close proximity of roads and streams.

Early settlements were built next to streams that became the essential water source for drinking, washing, domestic animals, crops, and power generation for sawmills or gristmills. Streams were also used as transportation corridors to haul goods between homesteads. Footpaths developed along these streams to connect the settlements by land. Streamside terrain offered relatively easy slopes for construction and subsequent use by horses and wagons. These footpaths became the roads, many of which survive today as our dirt and gravel roads. *This close proximity of roads and streams, dictated by historical development, began the conflict of erosion and sediment degradation affecting both roads and streams.*

1.3.2 The Connection. Erosion is a natural occurrence in the environment. When roads are constructed, however, they create an interference with the natural systems and collect water, increasing its volume and velocity, resulting in accelerated erosion.

1.3.2.1 Factors Affecting Roads. When we look at all the factors affecting the life of our roads (Figure 1-1), water has to top the list. Alone or combined with other factors, water can be disastrous. The subgrade of the road is what it is built on, the soils. If this foundation is poor, the road's life will be significantly reduced. If the subgrade is water saturated, the condition will be worse.

Most maintained dirt and gravel roads are quite old. Current maintenance crews were not involved in the construction. If poor quality materials were used or the workmanship was substandard, maintenance crews inherit numerous headaches with the road. And even when materials and workmanship are up to standards, the road may not have been built to handle today's heavier traffic loads. Traffic volumes and weights have both increased substantially in the last 20 years. The combination of water and increased traffic loads is potentially disastrous for our roads. That is why maintenance practices are so important. Poor maintenance equals poor roads. If there are drainage problems, however, even the best maintenance is doomed unless drainage problems are taken care of first.

The environment and climate also affect road conditions. The environment, as defined here, refers to vegetation, soil, sand, rocks, drainage conditions, and the overall stability of the area. Climate dictates the local weather conditions. Weather includes rain, freeze-thaw cycles, and hot sun that can dry out soils and road materials.

Looking at all these factors affecting roads, we should ask ourselves "What can we control?"

1.3.2.2 Factors Affecting the Environment. The same factors that affect the road affect the environment. Water feeds vegetation and streams and creates habitats, but also causes erosion, flooding, and sedimentation.

Our roads certainly affect the environment along with our maintenance practices. Poor road structure and material quality, increased traffic levels, and proximity to waterways lead to erosion, sediment and dust pollution problems.

Again, we should ask, "What can we control?"

1.3.2.3 The Road-Environment Relationship. Road conditions are deeply intertwined with the surrounding environment. Concentrated water flows accelerate erosion, overloading natural systems. Excess sediment clogs our streams. Dust becomes sediment in our streams, generates complaints from residents and harms plants, animals, people and equipment. Chemical contamination complicates the picture even more because oils, nutrients, pesticides, herbicides, and other toxic substances bind to dust and sediment and go along for the ride to pollute our streams and waterways.

1 – 05 Dirt and gravel roads are a major source of erosion and sediment.

Dirt and gravel roads are a major potential source of these pollutants. Many roads have unstable surfaces and bases. Roads act like dams, concentrating flows that accelerate erosion of road materials and roadsides. Both unstable surfaces and accelerated erosion then lead to sediment and dust.

The close proximity of roads and streams thus establishes the connection. Because road systems are situated close to streams within the natural environment, they affect the natural systems as they are in turn affected by the natural processes that take place there. The two systems – roads and the environment – are interrelated. Thus, in order to fix road problems, we must understand some things regarding each system to find a solution beneficial to both our roads and the environment.

In addition, not only is there a relationship between the roads and the environment, but both the roads and the environment also have an effect on the overall quality of life within your region. John Muir, who has been called the father of our National Park system, summed it up in this statement: **"When we try to pick out anything by itself, we find it hitched to everything else in the universe."**

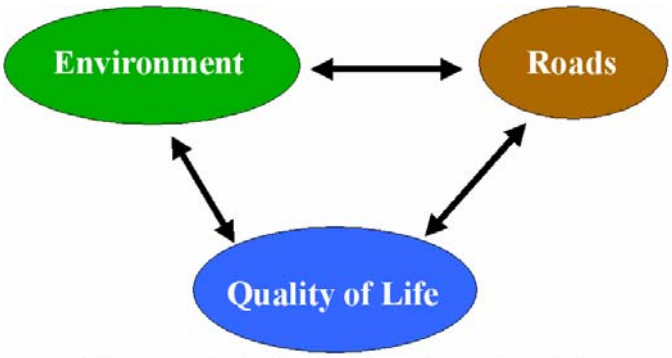

Figure 1-3: Relationship & Effect

1.3.3 Traditional Maintenance Practices. Even though the goal of road maintenance personnel is to maintain good roads, accepted maintenance practices do not always adequately address the road's relationship to the environment.

Why do we do what we do? Because we've always done it that way? There are many things that we do that may not be the best way for the environment or the road. In fact, many existing practices cause damaging sediment pollution, impacting both the road and the environment.

Vegetation management is a major example where many existing practices become counterproductive. Traditional "daylighting" exposes bare soil, disrupts ecological succession and eliminates soil-stabilizing roots, all of which increase erosion and sedimentation, damaging both the road and the environment. In addition, excessive sunlight can dry the roadbed, leading to excessive dust generation. Maybe we should consider leaving existing root structures undisturbed, thinning canopy cover to allow moderate sunlight, and avoid clearing banks just because they are there. Using nature's patterns and forces can result in better roads, less erosion and sediment pollution and lower maintenance costs.

Bank cutting and undercutting results in extensive sediment runoff, blocked ditches, and increased cyclical maintenance. On the other hand, refraining from cutting the toe of slopes, using headwalls to reduce pipe inlet and bank erosion, and using diversion or intercepting swales preserve both road quality and the environment.

Conveying road and ditch runoff to the nearest stream using the most direct route possible has long been an established practice. Any type or amount of sediment being carried by that runoff is also dumped directly into the stream. But directing culvert and ditch outlets (turnouts, bleeders) into a vegetative filtering area will help filter out the sediment, allow water infiltration and groundwater recharge, and protect the stream ecology.

Road aggregate quality directly impacts both the survival of the road and the environment. *Covering the road with poor 'low-bid' material that may wash away is*

another way of paying for sediment pollution, not to mention increased road aggregate replacement costs. Using a good road material that remains in place and prolongs road life will also benefit the total environment.

Undersizing and oversizing water channels, bank armoring, and flow redirection can disrupt stream energy, increasing maintenance costs and causing environmental harm. Understanding stream flows and the natural forces can help to establish better practices to again protect both the road and the environment.

Clearly, many traditional practices are counterproductive. They should be replaced with more productive measures that incorporate our knowledge of roads and natural systems. The result will be better roads, less sediment pollution, and lower maintenance costs.

1.3.4 Combining Goals. The goal of road maintenance personnel has always been good roads through proper maintenance at the lowest cost. We want to keep this goal, but expand our vision. We need to take a different look at our roads and see the total environment in which our roads are contained. This environment affects the life of our roads just as the road affects the environment.

If our goal within this project is to protect the environment through reduction of erosion, sediment and dust pollution, then let's combine our goals. Let's use additional and improved maintenance techniques and practices that benefit both the roads and the environment.

1.3.5 Road Safety. Any effective road maintenance program needs to consider and address safety. A safe transportation system is essential and remains part of our overall goal. Maintaining our roads and environment, however, need not come at the expense of safety. In fact, roads maintained in an environmentally friendly way have more structural strength, suffer less deterioration, and have fewer defects, and, thereby, are also safer. The goals of low-cost, environmentally sensitive maintenance and improved road safety can be combined seamlessly.

1.4 The Manual: Philosophy, Objectives and Contents

1.4.1 The Manual Philosophy. This manual is titled ***Environmentally Sensitive Maintenance for Dirt and Gravel Roads***. The mission, as stated, is to address the pollution problem of erosion, sediment and dust stemming from our dirt and gravel roads and affecting our streams. To meet this mission, the manual centers on an important philosophy or rationale.

To municipal road maintenance personnel, the road has been "sacred." Everything they have been taught about road maintenance has centered on what is good for the road, which has proven at times not to be correct. We need to initiate a change in this thinking. We can no longer afford to think only about the road. We need to understand the relationship between the road and the environment, that everything is interconnected, and

that there are practices that can be implemented that are not only good for the road, but also good for the environment. In addition, we need to make the connection that both good roads and a good environment are important to the welfare of local governments and their residents.

Only when this thinking changes can it be converted into action. In presenting "environmentally sensitive practices," this manual will illustrate to the users how easy these practices are to use and how useful and beneficial they become in prolonging the life of the road and protecting the environment. To accomplish this, however, the practices need to be simple, practical, and easy to incorporate into a routine road maintenance program.

The manual will give the users a "tool box" full of environmentally sensitive maintenance 'tools' or practices, recognizing that no one tool or practice can fit every situation or site or solve all their problems. Because every road and every site along that road is different, we need a toolbox from which we can select the appropriate tool or tools to help solve whatever situation we encounter.

1.4.2 The Manual Objectives. To meet the mission and put "punch" into our philosophy, we set our objectives as follows:

1. Enable the user to recognize the connection between road maintenance and the environment and the importance of good roads and a good environment for good government.
2. Enable the user to recognize sources of erosion, sediment, and dust pollution associated with roads and the importance of preventing these pollution sources.
3. Enable the user to recognize that standards cannot fit every situation and that sound decisions require proper knowledge of basic principles and practices. (Most standards, although often dictated as requirements, should be presented as only guidelines that need to be adjusted or revised to fit each particular site or problem area in the field. To know, however, what "tool" to use or what adjustment is needed, one needs to recognize basic principles and practices not only related to road maintenance but also to the natural systems that influence these roads, leading to our 4th objective.)
4. Arm the user with knowledge on basic principles of nature and natural systems as applied to road maintenance and a healthy environment and on basic road maintenance materials and techniques. (The user needs to know the basics of nature and the natural forces, and how they can be applied to help establish good roads and protect the environment. In addition, to make sure we are "on the same road"; we want to cover the road basics of good materials and techniques.)
5. Arm the user with knowledge on environmentally sensitive maintenance practices and the effective use of these practices in road maintenance. (This is where we provide the "tools" for their toolbox – a variety of simple, practical environmentally sensitive maintenance practices and the means of using these

practices in routine road maintenance to keep both good roads and a good environment.)

1.4.3 The Manual Contents. To accomplish this comprehensive list of objectives, the manual contains 7 chapters.

Chapter 1 – Introduction: Chapter 1 is simply an introduction to the manual. The mission and scope of the manual is introduced, followed by a discussion on the importance of dirt and gravel roads. We then start to make the connection between roads and the environment and discuss the shortcomings of traditional road maintenance practices. The chapter then shows the value of combining the goals of good roads and a good environment. The manual philosophy is then discussed, followed by the objectives and this description of contents. To close, the need for essential programs is covered, with an appendix to describe the Pennsylvania program as a case study.

Chapter 2 – Geology and Soils: This chapter discusses geologic time and relentless natural forces, looking at geological regions, topography, weather, rocks and soils. The chapter demonstrates how geology and natural forces give us what we have to work with and the conditions under which we have to work. Geology dictates the aggregates available for road materials and the soils available to support the natural vegetation.

Chapter 3 – Water, Erosion, Drainage and Road Basics: This chapter starts with basic principles of erosion and how roads cause accelerated erosion and increased sediment and the importance of preventing this pollution, showing the connection between roads and the environment. This module hits hard on the importance of good drainage, discussing the characteristics and effects of water on roads. Discussion then turns to road materials, what's being used and what we need to be concerned with. We then review basic road maintenance techniques for dirt and gravel roads – basic grading operations, road crown, etc. – and end with a discussion on winter maintenance operations.

Chapter 4 – Basics of Natural Systems: This chapter sets the basics on the natural side, presenting guiding principles by defining ecology and discussing three distinct ecosystems: the streams, wetlands, and forests or uplands. We stress the important benefits of these areas and set the stage to discuss, in a later module, how we can use these systems to help in road maintenance. This is unfamiliar area to most road maintenance personnel. The user should read this chapter with an eye to relating roads and road maintenance to natural systems.

Chapter 5 – Environmentally Sensitive Maintenance Practices: Having set the basics for both roads and the natural systems, this chapter presents the environmentally sensitive maintenance practices, with emphasis on road profiles, ditches, culverts, and bridges. Simple, straightforward, easy to implement practices are presented – some of which may already be familiar, or some that may be just tweaking something already in use. Others may be new, but still simple and easy to implement.

We start to fill the user's toolbox with the tools, emphasizing that not one tool or practice or technique will solve all their problems, but a toolbox full of tools will help greatly.

Chapter 6 – Roadsides and Streams: This chapter discusses the value of roadside vegetation management and the important factors affecting bank stability. The chapter then builds on this discussion to show how we can use the forests and natural systems to help reduce road maintenance, introducing more environmentally sensitive maintenance practices. We review common practices and the associated problems that can be detrimental in the long term for both roads and the environment, followed by alternative methods to improve or enhance the existing conditions (e.g., traditional clearcutting practices, stream channel clearing practices). This leads to more environmentally sensitive maintenance practices for vegetation management and bank stabilization, ending with an introduction to a variety of bioengineering techniques for stream banks.

Chapter 7 – Additional Maintenance Techniques: Chapter 7 continues to add tools to the toolbox, discussing three specific areas: dust control, road stabilization (full-depth reclamation), and the world of geosynthetics. The geosynthetics section emphasizes geotextile separation fabrics along with other geosynthetics used in actual road projects including a drainage pipe project case study, demonstrating the variety of functions and uses that geosynthetics play in road maintenance.

1.5 Essential Programs

To successfully fulfill our mission of addressing the national problem of erosion and sediment pollution from our dirt and gravel road system affecting our streams, there is a need not only for a manual but also for comprehensive state programs providing funds, education and training, and technical assistance to the nation's road maintenance personnel.

No change in our environment will occur without a change in thinking. Roads do not exist in isolation. They are an integral part of the environment. A change to the road changes the environment. An environmental shift has consequences for the road. Until those performing maintenance on our roads understand this relationship, both the roads and the environment will continue to suffer.

The way to change thinking is through training and technical assistance, coupled with funding. The message must be clear, simple, and easy to administer. It must be targeted at local and regional road maintenance managers.

As a case study, Appendix 1 presents Pennsylvania's Program as a successful model and resource for other states in meeting this mission. Appendix 1 is a description of the program development and implementation, with a discussion of the essential criteria for a successful program.