Correction and Repair of Road Edge Scour for Grassed Shoulders on Parkways

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The problem of road edge scour on grassed shoulders is discussed. The focus is on the edge scour problem located in the National Park Service units, especially the roads making up the category of parkways. The literature pertaining directly to edge scour is limited to only a few items. In contrast, the literature that addresses the roadside landscape is considerable. Many of the findings came about in the 1930s. The origin of the parkways in the 1920s was the basis for many of the design philosophies followed today. Although design standards and maintenance practices have been refined, edge scour still occurs. Edge scour is most prevalent in parkways that were designed in the 1930s and that have not been improved to accommodate today's traffic conditions. With an almost 50-year construction cycle, many parkways and similar park and recreational roads exhibit the problem. To illustrate the current problem and current maintenance practices in the national park system, maintenance practices and the extent and treatment of edge scour are described for several national parks. The description includes the type of study zone—tropical, low altitude temperature, eastern high altitude, and the western high altitude. These four zones form the basis for site-specific considerations and recommendations.

Road edge scour damage is the erosion of unpaved turf shoulders and adjacent roadsides caused by vehicle traffic. It is characterized by destruction of the vegetative cover, rutting of the shoulder, and development of a turf dike. If it is not corrected, it may be followed by fractures and failure of the pavement edge. Edge scour damage is primarily associated with older roadways that are experiencing an increased volume of longer, wider, and heavier vehicles. These roads are most frequently those that have not been updated to reflect modern design standards.

Edge scour damage was extensively studied in the 1950s. There is, however, an increase in observed damage. Also there have been advances in design standards, development of new products and techniques, and a large volume of research concerning vegetation selection, establishment, and maintenance. All of these factors may contribute to the correction or prevention of edge scour damage. This paper focuses on the edge scour problem located within the national park system, specifically, the "parkway" (*1*).

HISTORICAL OVERVIEW

The first recreational parkway, the Bronx River Parkway, was completed in 1923. Skyline Drive, completed in 1934, became the first parkway to be incorporated into the national park system (*2*).

The earliest studies concerned with the performance of turf shoulders appeared in the 1950s. Dubois (*3*) discussed results of extensive tests on rutting of turf shoulders. He concluded that properly stabilized shoulders with adequate load-bearing capacity served to resist rutting on sites with moderate vehicle use. In such cases it was possible to establish turf on the stabilized shoulder, and the turf itself helped resist rutting (*4*).

Brant (*5*) identified the difference between stabilized turf shoulders and turf shoulders as the ability of stabilized turf shoulders to carry the weight of a vehicle. He further identified the potential for use of stabilized turf shoulders as a satisfactory, economical alternative to other types of shoulder, providing the shoulder is properly compacted and vehicle use is moderate.

Buchanan (*6*) discussed design and construction of stabilized turf shoulders along the Natchez Trace Parkway. The project's goal was a satisfactory compromise between shoulder stabilization and establishment of turf coverage. Turf was successfully established on a stabilized shoulder able to accommodate the weight of passenger vehicles without rutting, even after heavy rain.

Edge scour damage and associated problems are visually unappealing and may be a safety problem. For example, Vance (*7*) indicates that the greatest number of state liability cases concerning highway shoulders occur because a shoulder has not been brought up level with the resurfaced pavement. However, the small shoulder width and associated edge scour condition exhibited by some parkways appeared not to increase the frequency of accidents.

Newton (*2*) describes the early historical development of recreational parkways. The first parkways were designed to be extremely pleasant to drive and yet to be functionally efficient for commuting traffic. Manning (*8*) describes the intrinsic beauty of these parkways.

Skyline Drive is a highway built in this early scenic parkway tradition. The design standards for this parkway were developed to accommodate traffic moving at approximately 40 mph and presented a new set of design and construction issues.

The 1930s technical information was concerned with the roadside. Waugh (*9*) described special landscape ecological characteristics of roadways. He noted nine basic physical zones in a cross section of highway from the centerline to the surrounding countryside. He described the interaction of vehicle disturbance with vegetation and the resulting zonation of vegetation near the pavement and on the unpaved shoulder.

The distribution of vegetation along the roadside was affected by regional differences. In 1936, Waugh continued his

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roadside landscape ecological descriptions with an article concerning Californian roadside ecology (*10*). He noted that the drier western landscape did not contain the striking zonation of the northeastern American landscapes. Boddy and Taylor (*11*) wrote one of the earliest published descriptions of landscape architectural specifications for roadside improvement.

By the 1940s, there appeared articles addressing specialized roadside applications. Curtiss (*12*) wrote about roadside concerns in national forests. Bell (*13*) described roadside standards for western scenic areas. Dupre (*14*) reviewed accomplishments and progress of roadside development in Ohio. After the 1930s and early 1940s, the literature addressing roadside issues decreased in frequency (*15*).

In 1966, the Department of Commerce published a booklet describing a program for scenic highways (*16*). Pragnell (*17*) authored a report concerning scenic roads in forested lands.

The Highway Research Board (*4*) described a research experiment where traffic disturbances were tested on a turf shoulder. The study noted that after 32 passes with a load bearing 3-ton dump truck, points in the shoulder had deflections ranging from 0.5 to 0.875 in. Dunbrook (*18*) indicates that turf shoulders require regrading once every 3 to 4 years. He also found the most effective method to repair the shoulder was to trench out the shoulder and then fill the shoulder with pit-run or pressed gravel with an asphalt cutback or emulsion. The filled trench must be rolled and cured. Power et al. (*19*) discuss cost-effective methods to repair shoulders through reshaping without adding material, reshaping with material added, and pavement widening in selected locations.

Traffic lane design, roadway alignment, and paved shoulder width are other design issues that may alleviate or aggravate the edge scour condition. Gericke and Walton (*20*) indicate that wider shoulders are required to accommodate longer vehicles.

By 1980 standards, the effects of edge scour are diminished by designing new roads with wide lanes and road alignments that keep fast and large moving vehicles in the center of the lane. However, on national park roads and older roads that are designed using different alignment criteria, and where the existing parkway alignment and roadside character are of national historic value, the highway cannot be readily improved to 1980 standards. These national park roads exhibit the effects of edge scour.

From its modern inception in the mid-1920s and early 1930s, roadside development has progressed from the application of many impractical vegetation treatments to the use of proved standard implementation and maintenance practices. In the future, practical site-specific vegetation treatments and maintenance practices may be further refined.

Considering the large area of American landscape devoted to the roadside, the volume of journal literature specific to vegetation treatments and shoulder conditions is relatively small.

DEVELOPMENT OF EDGE SCOUR DAMAGE

Edge scour damage is caused by vehicles traversing the unpaved shoulder surface. The cause of this vehicle movement varies from intentional pulloff to vehicle wandering as a driver responds to road conditions.

A substantial portion of the edge scour damage is caused by large, heavy vehicles such as recreational vehicles (RVs). An increased number of vacationers are taking large vehicles on parkways designed for smaller, slower vehicles. These large vehicles are often not well suited to the roadway design of the 1930s. Also, there is a high presence of older drivers.

The problem of edge scour is associated with the disturbance of the vegetated highway shoulder by vehicle tires, which destroy the vegetation and contribute to the development of ruts within the shoulder. Repetitive vehicle damage deepens the ruts. Shoulder material may be pushed toward the roadside and eventually enough material may be collected to form a turf dike. This may restrict proper drainage, causing the shoulder to become wet and soft and aggravating the damage. Eventually, ruts may become deep enough to allow vehicle axles to drag on the pavement edge, causing fractures or destruction of the pavement. This in turn can be aggravated by moisture. This rutted shoulder condition, with or without pavement damage, is defined as road edge scour. Edge scour damage tends to occur in the same location repeatedly. Figure 1 shows the physical characteristics of edge scour.

The situation reflects a more extensive problem than simply edge scour and rutting on National Park Service roads. The edge scour damage and rutting arise from the vehicle tire leaving the roadway and traversing the grassed area. A number of repetitive tire passes over the same point kills the grass. Repetitive passes also compress the soil and with the presence of moisture can result in rutting. The grass and soil are unable to support the vehicle tire loads with moisture present.

The edge scour problem is a conflict between old roadway design standards and modern roadway use. The issue has not

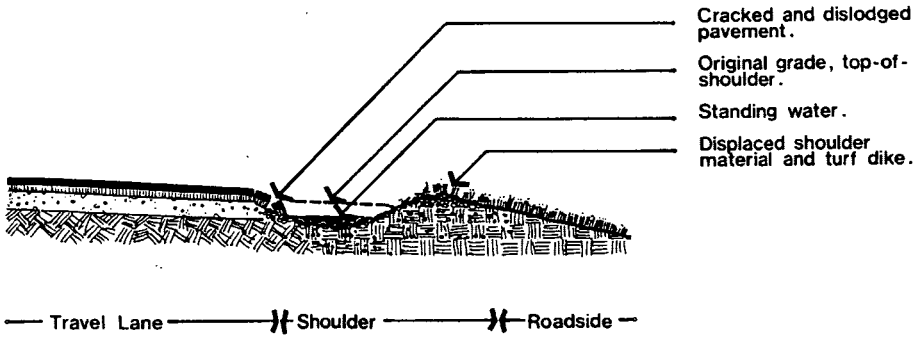

FIGURE 1 Typical edge scour section.

been extensively studied. With the exception of older, intentionally, and historically preserved parkways, the problem is easily solved by improving the roadway to match modern performance criteria.

DESIGN STANDARDS

From the period starting with the early development of the parkway system to the 1980s, design standards were constantly improved and revised. Thus, the design standards of the 1930s were quite different from the design standards exemplified by the Federal Highway Administration (*21*). The design standards of the 1980s allow for highways to accommodate greater vehicle speeds, greater traffic volumes, and greater vehicle sizes.

ROADWAY DEVELOPMENTS

Complementing the changes in general roadway standards, other issues concerning roadway development were addressed from the 1960s through the 1980s. These issues include vegetation selection and maintenance research, erosion control research, vegetation preservation, and vegetation prescriptions.

Vegetation Selection and Maintenance Research

Interest in roadside vegetation treatment and maintenance has led to improved methods in revegetating the roadside. In the 1930s, roadside design transformed from casual landscaping attempts to install roadside vegetation. These solutions emphasized low maintenance treatments that could endure the harsh conditions of the roadside landscape. In time, roadside maintenance methods were developed to manage these landscape treatments (*22*).

It was not until the late 1960s and early 1970s that literature concerning turf selection and vegetation maintenance was well documented. In 1968, White and Bailey (*23*) documented issues associated with maintenance equipment and the management of roadside turf grasses. From this work, Smithberg and White published reports describing recommendations for roadside turf methods and materials (*24,25*).

Erosion Control and Slope Stabilization Research

Vegetation (softscape material) and pavement (hardscape material) have been recently combined in various grid patterns to create a durable surface with the aesthetic features of vegetation. Several of these products are commercially available. These erosion control and slope stabilization techniques may have useful applications in reducing edge scour.

Vegetation Preservation

Preservation of existing stands of vegetation has been given some attention in the literature. Presently, vegetation preservation along roadsides has been primarily concerned with protecting woody plants and may have little application in reducing edge scour.

Vegetation Prescriptions

General roadside vegetation treatments may not always be appropriate for some roadside conditions. Therefore, site-specific vegetation prescriptions have been prepared and implemented. With increased understanding of native vegetation associations, these relationships have been applied to roadside vegetation prescription situations.

Each prescription is confined to the landscape ecological setting of the region. Bailey (*26*) describes the basic biological regions in the United States. Within each region a basic set of native biological associations exists. These biological associations make up the regional plant material palette.

These approaches are considered prescription approaches because they prescribe native plant materials to specific environmental conditions such as wetlands or xeric landscapes. Further developments and research in site-specific roadside prescriptions may assist in reducing localized edge scour damage.

CURRENT PRACTICES IN THE NATIONAL PARK SYSTEM

To study the current practices in the national park system, the park system was divided into study zones. The study zones are based on the concept that the national park system units can be classified according to edge scour characteristics. The parks can be divided into four basic types. The first type is the tropical national park (i.e., parks with tropical vegetation). During rainy seasons, the vegetation can grow very quickly and revegetate disturbed ground. The second type is the low altitude temperature zone. In this zone, vegetation grows at a moderate pace. The third zone is the eastern high altitude zone. Vegetation is restricted by cold stress. Vegetation of the fourth zone, the western high altitude zone, is restricted by cold and low moisture stress.

Parks and parkways in the four zones were visited in 1987 and 1988. Roadsides were examined for edge scour symptoms and the extent of edge scour. Discussions were held with maintenance personnel to obtain their perception of the issue, and current practices to correct edge scour were documented.

Tropical Zone: Everglades National Park

Edge scour is present. The most prominent scouring occurs on the outside edge of some roadway curves and at intersections of roadways. The edge scour disturbance occurs annually in the same locations.

Edge scour can also occur on roadway horizontal tangent lines near sign locations. Drivers may inadvertently let their vehicles drift as they read the sign. Edge scour is associated with both informational directional signs and with posted speed limit signs that require a reduction of vehicle speed.

The repair technique is to fill edge scour ruts with marl material. This material is obtained from a local crusher operation that produces excess material ranging in size from 3/

4 in. to fines. The ruts that occur associated with edge scour are filled in before the ruts get deeper than 3 in. Often the material is not compacted during installation. If compaction is performed, maintenance truck wheels are used to compact the marl. The marl is not reseeded. Existing nearby grass, next to the disturbed area, quickly covers the marl during the rainy summer season.

Placing sod over the marl fill can be effective. Sod is often torn apart by vehicle wheels before the sod can be established.

The color of the marl material is white and contrasts noticeably with undisturbed shoulder material. This contrast can be aesthetically unappealing. However, there is no evidence that the public considers these repairs unsightly.

As edge scour develops and ruts occur, the removed shoulder material is deposited further from the centerline of the roadway and creates a raised shoulder condition. This raised shoulder is removed approximately every 3 years.

Several alternatives have been explored concerning the repair of consistently recurring edge scour locations. One approach is to use concrete blocks (turfstone). The blocks have been effective in reducing edge scour. Grass cover in these blocks has been good. The color of these treated areas is noticeably different from that of existing turf shoulders.

Another approach has been to widen the paved road surface with a 1-ft-wide linear patch. This patch can be visually unappealing.

The Everglades National Park experiences occasional off-road informal use of vehicles. Damage to shoulders appears minimal because the use occurs during the dry winter season, and the shoulders are relatively hard and resistant during this period.

Low Altitude Temperature Zone and Eastern High Altitude Zone: Blue Ridge Parkway, Great Smoky Mountains National Park, and Shenandoah National Park

These parks are in the eastern high altitude zone with portions in the low altitude temperature zone. Edge scour is present. In some locations, the presence is extensive. Both inside and outside curve edges exhibit scour damage. Often the vertical curve alignment and the superelevation geometrics determine the location of the scour. Curves that throw the vehicle to the outside will have outside radius damage. Some curves throw the vehicle into the center of the curve. These curves will have inside damage.

In addition, shoulders near bridges exhibit edge scour. Edge scour near bridges occurs where the bridge lane width is greater than the nonbridge lane width. Once the vehicle is on the bridge, the vehicle may drift as the driver adjusts to the wider lane width. Once past the bridge, the vehicle may not be in a position to traverse the pavement properly. Before the driver can correct the vehicle, the vehicle may traverse the shoulder, resulting in edge scour.

Edge scour ruts often appear substantial. These ruts may be greater than 18 in. wide and greater than 8 in. deep. The large width of the rut is caused by trailer or motor home dual tires drifting off the pavement. In addition, the shoulder may be wet and therefore soft. The frequent impact of the tires can cause a deep rut. Once the rut has substantial depth, the vehicle's axle prevents further depth penetration; however, the dragging axle then begins deteriorating the edge of the pavement (Figure 2). Numerous edge scour locations exhibit pavement edge deterioration from fatigue cracking. The deep ruts also collect more moisture and aggravate the problem.

There is concern that these edge scour ruts may lead to vehicle accidents and park liability. At present, no identifiable claims have been made.

Edge scour repair is conducted by placing a 50 percent loam and 50 percent aggregate mix into the edge scour rut. The material will then be seeded. Repairs are made during the spring and late fall. Edge scour repairs made during the summer can pose a danger to maintenance crews because of the number of traffic conflicts and heavy visitation.

Turfstone has been used in some locations. However, on soft shoulders the turfstone can be ineffective. The turfstone is forced down into the soil and is often demolished. On shoulders with ample support and with only occasional edge scouring, the turfstone has been effective in reducing damage. Several park personnel mentioned that the turfstone does not blend visually with existing grassed shoulders.

Rolled asphalt curing has been used on roadways near metropolitan areas or for drainage. Near metropolitan areas, traffic volumes can be very high, vehicle loads can also be high, and traffic speeds are often at their legal maximum. This type of edge scour treatment has been very effective. However, this

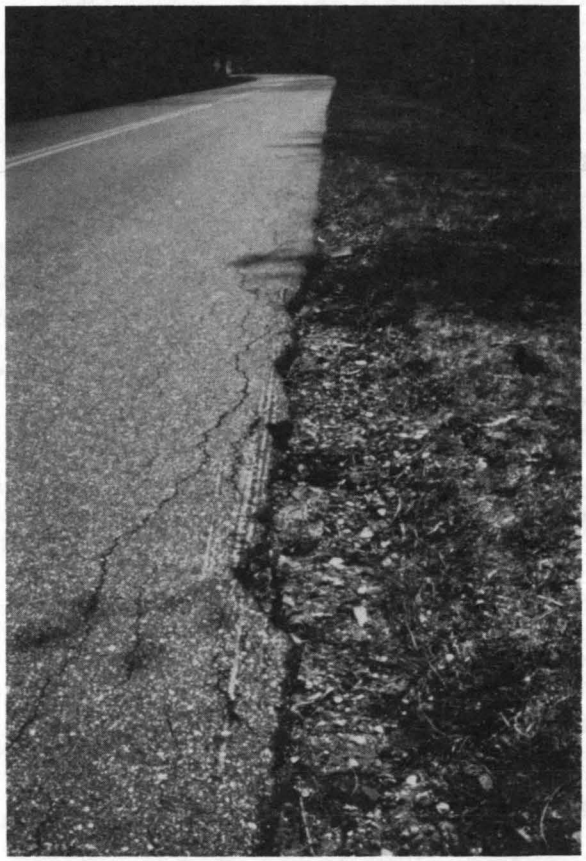

FIGURE 2 Extreme edge scour conditions, Blue Ridge Parkway.

treatment requires additional drain inlets and subsurface drainage. To reduce the need for drainage structures, split-block curbing has been suggested. Although curbing will not prevent informal off-road use, it seems to be effective in reducing vehicles drifting past the pavement.

Turf diking is also a problem that can aggravate edge scour by softening the shoulder. Shoulder accumulations are scraped off every 5 to 7 years.

In these national parks and parkways, the design standards were developed in the 1930s. The design speed, expected vehicle loads, and expected traffic volumes are different from what the parks are experiencing today. With the development of the RV, vacationers are taking large vehicles on parkways designed for leisurely experiences. These large vehicles are often not well suited to the design standards of the 1930s. Roadway geometrics and RV driver habits may contribute to edge scour development. With oncoming traffic, the RV driver will reposition the vehicle such that runoff on the shoulder is common.

Western High Altitude Zone: Rocky Mountain National Park

Edge scour was not present. Several conditions may contribute to the absence of edge scour. First, many of the roadways are edged with rolled bituminous curbing. The curbing can prevent vehicles from drifting off the pavement. Also, continuous paving from the pavement edge to the paved ditch has been used. This means that the roadside vegetation begins on the nontraffic side of the ditch. Vehicles and vegetation rarely come in contact with a continuous paving roadside treatment. Thus there is no edge scour problem.

Second, because of infrequent rainfall, gravelly substrate may not contain high moisture levels during periods of high use, and the shoulder may have a structurally high bearing capacity.

Third, the design standards for some of these roads are similar to modern 1980 standards. These modern standards can assist the vehicle driver in preventing vehicles from drifting off the pavement.

In addition, groundplain vegetation is often present in low surface coverage levels. Thus, it is natural to see shoulders and adjacent landscapes with little or no groundplain vegetation. Repair of shoulders in a visually sensitive manner can often be easily accomplished.

Revegetation recover rates can be extremely slow in alpine tundra life zones. Even the plant growth rates in the lower elevations of the lodgepole pine and ponderosa pine forests can be slow. However, the careful placement of substrate, boulders, and natural groundplain mulches and debris can visually integrate the shoulder with the parkland.

SUMMARY

The scientific literature pertaining directly to edge scour is limited to only several articles. The literature addressing the roadside landscape is considerably larger. Modern roadside development was initiated with the construction of parkways in the 1920s and 1930s.

Edge scour is more prevalent in 1930 parkways that have not been improved to accommodate 1980 traffic conditions. Numerous corrective measures have been implemented to reduce edge scour. Typical corrective measures include allowing the shoulder's turf to recover in the off season, shoulder regrading, shoulder paving, shoulder and ditch paving, installing turf-concrete matrixes, and curbing.

Design recommendations to correct edge scour conditions are site specific as indicated in the discussion of the site visits.

All of these treatments that are nonstructural have not been successful or have visual trade-offs. The presence of shoulder edge scour is common. In the site visits, observations of adjacent state and county highways and discussion with park maintenance personnel indicate that edge scour occurred on these roads also.

Shoulder edge drop-off/depressions have been a major reason for state liability suits, but this has not been experienced yet in the national parks. Two reasons probably account for this. One is the lower speed, especially in the peak visitation periods. The other is the presence of the roadside clear zone adjacent to the pavement, which probably causes the drivers to ride off any drop-off instead of attempting to return to the roadway immediately.

Thus, a reason for the longer edge scour locations is that drivers, once they drop a tire off the pavement edge, will stay in the rut until they can naturally come back on the pavement.

Once the shoulder has been disturbed by tire action, the shoulder material is soft and subject to deeper and more extensive rutting. As edge scour develops and fill is added and then displaced by the tire action, ruts occur. The dislodged shoulder material is deposited further from the pavement edge and creates a raised shoulder condition or contributes to the creation of turf diking.

This raised shoulder cumulative condition presents problems in terms of ruts and road drainage. Constant maintenance results.

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