CHAPTER 10: ROADSIDE MANAGEMENT AND MAINTENANCE: BEYOND VEGETATION

Highway agencies manage over six million hectares (17 million acres) of land in the U.S., approximately one percent of states with more dense road networks. Due to the tendency of the highway system to follow streams, coastlines and other natural landscape features, this land is often located within, over, and/or adjacent to many environmentally sensitive resources. All ROWs are managed with the general goal of providing for safe and reliable transport. In most all ROW scenarios, active management is needed to create specific vegetation and related environmental conditions. Roadside management objectives vary with the zone that is being addressed. Typically the gravel shoulders of roads are maintained as a vegetation-free area, to allow surface water drainage off the pavement and into the drainage ways. Off the shoulder, an operation zone of grass or small trees and shrubs is maintained through mowing to allow for visibility of signs and traffic at interchanges and curves. Large trees are removed for safety in case vehicles accidentally leave the road. Herbicides are used very selectively for control of noxious weeds and sometimes for brush control. A wider buffer zone beyond that area is commonly maintained in natural or native, low-maintenance vegetation.

Common objectives for management of the ROW include:

- Managing the immediate shoulder for use as a recontrol zone for errant vehicles and to inhibit weeds from growing into the pavement.
- Preserving sight distances for reading signs and for cornering.
- Offering space for utilities.
- Screening on-coming traffic on divided highways.
- Maintaining slope stability, encouraging drainage of water off the roadway, protecting water quality, protecting habitat for wildlife and preserving or restoring native plant communities.
- Maintaining open space, green corridors, or a refuge for biodiversity.
- Protecting roadside areas against infestation and spread of noxious weeds.
- Keeping vegetation back from the edge of the road to improve visibility of wildlife and reduce chance of road kill.
- Providing on-site area for wetland mitigation.

This chapter focuses on non-vegetative environmental stewardship practices for management of the ROW.
10.1. ENVIRONMENTAL ENHANCEMENT PRACTICES AND PARTNERSHIP EFFORTS

Water Quality Retrofit Programs

Most DOTs have developed or utilize existing design manuals for runoff control and stormwater quality. Increasingly, DOTs have to decide where stormwater quality retrofits may be sufficiently valuable to implement, and in what order these investments should be prioritized. In addition to extensive design guidance available in both manual and on-line formats, a number of BMP selection and evaluation systems are emerging. NCHRP 25-20(01) “Evaluation of Best Management Practices for Highway Runoff Control” is designing a BMP effectiveness and evaluation system that will be available in late 2004.

MDSHA’s Water Quality Improvement and Retrofit Program

MDSHA’s NPDES program was implemented as part of mandated EPA regulations; however, the program’s many activities have exceeded the regulatory requirements due to MDSHA’s environmental policy to go beyond the basics and explore new ways to implement environmental stewardship in the context of the sensitive Chesapeake Bay Watershed. The agency leadership and staff have become very active in advancing the cause of the environmental protection through technology development and enhancement. Funds have been provided and partnerships have been forged to leverage the state dollars and maximize the best management practices (BMPs) at an unprecedented level.

As part of the agency’s environmental quality improvement efforts, MDSHA has implemented a very structured improvement program for the 1,500 stormwater management facilities owned by MDSHA, with inspection teams of trained staff who identify further environmental improvements that can be made. MDSHA has complimented this work by mapping the entire state for opportunities for retrofitting BMPs, for pollution prevention and stream restoration beyond requirements, and for development of a plan for systematic implementation of those improvements.

The grade-based rating system for stormwater management facilities include an inventory, database, and photo record of all facilities statewide and their maintenance status. Under the rating system, those graded A or B are considered functionally adequate. As of late 2003, between 73 and 75 percent of MDSHA stormwater were functionally adequate (A=everything fine, working fine, no maintenance required, B=minor maintenance, need mowing or trash removal), leaving approximately 25 percent needing maintenance or retrofitting to achieve functional adequacy. MDSHA aims to have 80 percent or more of their stormwater management facilities rated functionally adequate by 2006, and 95 percent of facilities by 2010.

With continuous improvement as an inherent strategy, the NPDES team has accomplished many major goals since its inception in 1999:

- Developed NPDES Strategic and Timeline Plan to guide the overall implementation effort.
- Developed several pilot projects to streamline the integration of technology into the field data collection and analysis process.
• Established field inspection protocols and tools for data collection, including a Standard Procedures Manual to streamline the database development, inspection protocols, and training program for inspecting stormwater management facilities.
• Established auxiliary programs and management structures to support the goals of the NPDES program.
• Partnered with several local jurisdictions in their watershed assessments and restoration efforts – MDSHA is now partnering on eight different watershed improvement plans.
• Constructed multitude of stormwater retrofit and enhancement projects throughout Maryland with immediate benefits to the environment. Many more are underway.
• Developed many cutting edge technologies for stormwater management such as Low Impact Development (LID) for highway environment and out-of-kind stormwater mitigation such as stream restoration.
• Developed the nation’s first and only Visual and Environmental Quality Guidelines for Stormwater Management Facilities. Implementation of the draft guidelines already resulted in facilities that benefited from this context-sensitive approach.
• Developed a Geographic Information System (GIS) for drainage infrastructure.
• Developed Geographic Information Management System (GIMS) for systematically inspecting and maintaining the performance of stormwater management facilities.
• Initiated efforts to develop new state-of-the-art BMP remediation technology.
• Developed a work delivery system using operating and capital programs.
• Developed a flow chart for SWM facility remediation action along with cash flow estimates.
• Developed a budgetary cash-flow estimation system with the help of pilot projects.
• Developed training for designers on stormwater management based on data found in the inspection program.
• Performed Discharge Characterization of stormwater to analyze quality of highway runoff.
• Prepared a report on MDSHA’s on-going Public Education and Outreach Programs and initiated new efforts (Environmental Responsibility Booklet, Cable-broadcast video, informational presentations).
• Established Pollution Prevention Teams at all 35 MDSHA Maintenance Facilities to implement the Stormwater Pollution Prevention Plan in an environmentally responsible manner – includes pollution prevention training to personnel.
• Customized pollution prevention plans and strategic retrofit plans for all MDSHA maintenance facilities to systematically upgrade them to perform at an environmentally acceptable level.
• Initiated technology transfer and guidance to other Maryland Department of Transportation (MDOT) modals.

The Managing for Results (MFR) portion of MDSHA’s business and stewardship plan is being used to measure the progress and success of the NPDES program and define timelines and milestones for the numerous elements of the program. Using the MFR approach, progress is measured every month for each of the major elements, and every six months for all the elements of the program. An example of this is the tracking of the required number of source identification efforts that needed to be completed: The strategic plan as well as the MFR goals called for measurable completion of work in specified counties by a prescribed date. Another example is the stormwater management retrofits that needed to be completed by December 2003. The retrofit completion progress was tracked every month and new strategies were developed continuously. As a result, this requirement was exceeded by 300 percent. Individual projects, such as watershed retrofits, stormwater improvements and watershed partnerships that are generated as a part of the program are managed using MS Project and milestone reviews. For maintenance facilities, the discharge sampling of the outfalls is a direct method for measurement of success, which is defined based on state and federal requirements. As a stewardship measure, MDSHA tracks implementation of strategic upgrades to the facilities identified during the pollution prevention plan development and needed changes in systems identified by the independent inspection program.

Charts are developed for all the major programs to visually demonstrate successes and progress. Once a year, an annual report summarizing all the activities, including compliance with the NPDES program is prepared and submitted for review to the Maryland Department of the Environment (MDE). So far, every report was thoroughly reviewed and approved by MDE, which means MDSHA remains in compliance and is actually being commended for showing stewardship by exceeding the permit requirements. A copy of the recent annual report is attached.

Outfall Categorization and Improvement at Florida and Washington State DOTs
In the late 1990s WSDOT and FDOT developed systems for categorizing and improving outfalls. In the case of WSDOT, assessing which projects provide the best return on investment in terms of environmental effectiveness and pollution reduction. WSDOT’s system included a condition indexing methodology and support program that enables users to quickly evaluate and compare projects and generate benefit-cost ratios for projects.

Further information on outfall improvements is available in descriptions of WSDOT’s program, as well as that of Oregon DOT, in section 3.5, Culverts and Fish Passage.

Wetland Enhancement

PennDOT Staff Partner to Enhance Local Wetlands
PennDOT construction and maintenance workers are involved in a pilot program to improve eight wetlands in the state’s District 9 territory. In 1995, the six-county region was chosen as the lead for PennDOT’s wetland banking program to help save the state’s natural resources. Working with several organizations — including EPA, the Army Corps of Engineers and FHWA — PennDOT and the agencies are identifying wetland
enhancement sites, some of which may serve as compensation for past and future wetland impacts. The largest restoration area thus far is a 40-acre site prepared by PennDOT staff. In the summer of 2000, PennDOT workers, with assistance from the state’s game commission, removed all of the drains and constructed berms to hold in water. Workers planted trees, warm-season grasses and thick, shoulder-high shrubs and brush to attract wildlife. The game commission donated bird, duck and bat “boxes” (houses). Ducks, pheasants, shorebirds, turtles, deer, muskrats and other species are flourishing in restoration area and predators such as coyotes, foxes, and an assortment of snakes have returned. The project cost less than $3,500 per acre to complete; the agency estimated the project would have cost an extra $1.4 million if a contractor had been assigned to do the work, as $100,000 per acre is a going price. Schools became involved in the planting, saving taxpayer dollars, and students return to the area on field trips.

**Terrestrial Habitat Enhancement**

Native habitats and populations of native cavity nesting birds have been in long-term decline across the country. Loss of suitable nesting sites and competition from non-native birds are the major factors in these population declines. Some DOTs are taking this problem on by trying to enhance the habitat under DOT ownership. These extend from large-scale efforts to help state resource agencies and the governor’s office implement greenway plans in Maryland, Florida, and Pennsylvania, to DOTs placing nesting platforms for ospreys in the right-of-way.

**NYSDOT’s Guidance for Placing Nest Boxes in ROW**

NYSDOT has estimated that the agency owns and maintains approximately one percent of the state’s land area and thus that the DOT has the potential to enhance nesting opportunities for native cavity nesting birds through well-considered design and placement of nest boxes. Nest boxes must be of the appropriate type, placed in suitable habitat and monitored on a regular basis during the nesting season, as failure to consider these factors can result in inadvertently enhancing nesting opportunities for non-native birds and further erosion of the ecological niches of native species. NYSDOT developed a bulletin on [Nest Boxes for Native Cavity Nesting Birds](#) that provides basic information and recommendations regarding the proper use of nest boxes on and adjacent to NYSDOT property. The guidance provides [Attachment A: Reference](#) and [Attachment B: Internet Sites for Nesting Box Designs](#).

NYSDOT Region 6 environmental and maintenance staff developed a program that involves a federally licensed bird bander and volunteers to manage a roadside trail of 15 artificial nest boxes. NYSDOT maintenance workers constructed nest boxes for the American Kestrel and installed them on the support posts of existing large expressway signs. Environmental staff and volunteers regularly monitor the boxes and NYSDEC biologists band the hatchling kestrels to collect scientific information.

**DOT Bat Boxes**

Bat roost enhancement projects for roadways can often be conducted onsite. Commercially produced bat houses are available that can accommodate up to tens of thousands of bats. Retrofitting options for bridges are discussed in section 7.2, Avoiding and Minimizing Impacts to Fish and Wildlife and Enhancing Habitat.
Best practices for constructing or buying bat houses are outlined below, excerpted and summarized from *The Bat House Builder’s Handbook*, based on 12 years of bat house research conducted across the U.S, Canada, and the Caribbean. 

- **Design** — All bat houses should be at least 2 feet tall, have chambers at least 20 inches tall and 14 inches wide, and have a landing area extending below the entrance at least 3 to 6 inches (some houses feature recessed partitions that offer landing space inside). Taller and wider houses are even better. Rocket boxes should be at least 3 feet tall and have at least 12 inches of linear roost space. Most bat houses have one to four roosting chambers—the more the better. Roost partitions should be carefully spaced 3/4 to 1 inch apart. All partitions and landing areas should be roughened. Wood surfaces can be scratched or grooved horizontally, at roughly 1/4- to 1/2-inch intervals, or covered with durable square, plastic mesh (1/8 or 1/4 inch mesh). Include vents approximately 6 inches from the bottom of all houses 24 to 32 inches tall where average July high temperatures are 85º F or above. Front vents are as long as a house is wide, side vents 6 inches tall by 1/2 inch wide. Houses 36 inches tall or taller should have vents approximately 10 to 12 inches from the bottom.

- **Construction**—For wooden houses, a combination of exterior plywood (ACX, BCX, or T1-11 grade) and cedar is best. Plywood for bat house exteriors should be ½-inch thick or greater and have at least four plies. Do not use pressure-treated wood. Any screws, hardware or staples used must be exterior grade (galvanized, coated, stainless, etc). To increase longevity, use screws rather than nails. Caulk all seams, especially around the roof. Alternative materials, such as plastic or fiber-cement board, may last longer and require less maintenance.

- **Wood Treatment**—For the exterior, apply three coats of exterior grade, water-based paint or stain. Available observations suggest that color should be black where average high temperatures in July are less than 85º F, dark colors (such as dark brown or dark gray) where they are 85 to 95º F, medium colors where they are 95 to 100º F and white or light colors where they exceed 100º F. Much depends upon amount of sun exposure; adjust to darker colors for less sun. For the interior, use two coats dark, exterior grade, water-based stain. Apply stain after creating scratches or grooves or prior to stapling plastic mesh. Paint fills grooves, making them unusable. Darker colored bat houses are recommended in northern climes.

- **Sun Exposure**— Houses where high temperatures in July average 80º F or less, should receive at least 10 hours of sun; more is better. At least six hours of direct daily sun are recommended for all bat houses where daily high temperatures in July average less than 100º F. Full, all-day sun is often successful in all but the hottest climates. To create favorable conditions for maternity colonies in summer, internal bat house temperatures should stay between 80º F and 100º F as long as possible.

- **Habitat**—Most nursery colonies of bats choose roosts within 1/4 mile of water, preferably a stream, river or lake. Greatest bat house success has been achieved in areas of diverse habitat, especially where there is a mixture of varied agricultural
use and natural vegetation. Bat houses are most likely to succeed in regions where bats are already attempting to live in buildings.

- **Mounting**—Bat houses should be mounted on buildings or poles. Houses mounted on trees or metal sidings are seldom used. Wooden, brick, or stone buildings with proper solar exposure are excellent choices, and locations under the eaves often are successful. Single-chamber houses work best when mounted on buildings. Mounting two bat houses back to back on poles is ideal (face one house north, the other south). Place houses 3/4 inch apart and cover both with a galvanized metal roof to protect the center roosting space from rain. All bat houses should be mounted at least 12 feet above ground; 15 to 20 feet is better. Bat houses should not be lit by bright lights.

- **Protection from Predators**—Houses mounted on sides of buildings or on metal poles provide the best protection from predators. Metal predator guards may be helpful, especially on wooden poles. Bat houses may be found more quickly if located along forest or water edges where bats tend to fly; however, they should be placed at least 20 to 25 feet from the nearest tree branches, wires or other potential perches for aerial predators.

- **Avoiding Use by Other Species and Waste Accumulation**—Wasps can be a problem before bats fully occupy a house. Use of 3/4-inch roosting spaces reduces wasp use. If nests accumulate, they should be removed in late winter or early spring before either wasps or bats return. Open-bottom houses greatly reduce problems with birds, mice, squirrels or parasites. Furthermore, guano does not accumulate inside.

- **Timing**—Bat houses can be installed at any time of the year, but are more likely to be used during their first summer if installed before the bats return in spring. When using bat houses in conjunction with excluding a colony from a building, install the bat houses at least two to six weeks before the actual eviction, if possible.

- **Importance of Local Experimentation**—It is best to test for local needs before putting up more than three to six houses, especially comparing those of different darkness and sun exposure.

DOTs have contributed to bat conservation and recovery through assisting mine gating efforts. Sealing abandoned mines without first evaluating their importance to bats is one of greatest threats to North American bat populations, which use caves as hibernacula.

**Bridge Related Enhancements**
Techniques to minimize construction and maintenance impacts on bats are discussed at length in Chapter 7 on Practices in Bridge Construction and Maintenance. Impacts to birds and practices to benefit birds are discussed in that section as well, to a lesser extent. Practices that benefit ground-nesting birds are discussed in Chapter 9, in particular, those related to Reduced Mowing in section 9.5.
Reduced Mowing at DOTs to Conserve Resources, Bird Habitat, and Native Species
As part of their Integrated Roadside Vegetation Management or other conservation plans Colorado DOT, Iowa DOT, Mn/DOT, WisDOT, NYSDOT, and Utah DOT have implemented mowing reductions to conserve resources and benefit native species. In most cases, these programs preserve habitat for ground-nesting birds and other native species by limiting mowing to one mower width along the roadway. For more information see Chapter 9 of this report.

Iowa DOT Roadside Native Species Restoration Program in Maintenance
While many state DOTs have begun to mandate use of native species when revegetating construction sites, Iowa DOT has extended their landmark IRVM program to revegetate approximately 2,200 acres annually of targeted roadside areas not connected to any construction projects. Another 3,200 acres of roadside on construction sites are seeded annually with native grasses and forbs. The state’s transportation commission actively supports the program.

Identifying and Implementing Aquatic Connectivity (Fish Passage) Improvements

Oregon DOT Culvert Retrofit and Replacement Program Agreement
In 2001, the Oregon Department of Transportation (ODOT) and the state Department of Fish and Wildlife (ODFW) signed a Memorandum of Understanding (MOU) that repairing or modifying ODOT-maintained culverts is a priority for the agencies that will take decades to resolve. The ODFW completed culvert inventories for the entire state of Oregon in 1999 and found that 96 percent of the barriers identified were culverts associated with road crossings. The project also identified high priority culverts for fish passage remediation.

ODOT has an ongoing program of culvert installation and maintenance, with the goal of making all ODOT culverts passable to fish. After research monitoring results demonstrated the effectiveness of baffle and weir designs in culverts, ODOT modified their culvert replacement programs to use these designs, significantly reducing the cost of improving fish passage at ODOT culverts. The designs improve fish passage by slowing water velocity and raising stream elevations to reduce entry jump heights or backwater culvert outlets. Use of retrofit designs are allowing culverts that are otherwise in good physical condition to be retrofitted until their service integrity is compromised, at which time they will be replaced with designs that more fully meet fish passage criteria and standards. Use of retrofits allows many more culverts to be remediated each year, increasing the scope and pace of ODOT’s contribution to salmon recovery in Oregon. The baffle and weir retrofits provide ODOT an alternative to fish ladders, which have become increasingly problematic for ODOT from a maintenance standpoint.

According to the MOU, ODOT will continue internal education regarding the needs and requirement of fish passage and prioritize its resources and culvert modification needs on an annual basis, demonstrating good faith in addressing culvert passage problems. On replacement culvert projects, ODOT will strive to simulate a natural stream and will determine if changes in culverts result in flows detrimental to fish passage. ODFW is supporting ODOT’s efforts by providing the master inventory of culverts that do not
provide adequate passage, along with technical assistance on educational activities, design, and construction techniques.

**Installation/Improvement of Public Fishing Access**

**NYSDOT Public Access Enhancement and Partnership**

NYSDOT has been exploring and extending the highway system’s larger role of connecting people and places of interest. Looking out for these needs, the NYSDOT Niagara County maintenance staff took the lead in forming a partnership with local business, the NYS Office of Parks Recreation and Historic Preservation and the New York State Department of Environment Control, to provide a public fishing access site and picnic area at a popular salmon and trout stream — Keg Creek. Anglers formerly parked haphazardly along the state highway and traversed a very steep, slippery and dangerous ravine to fish for Lake Ontario’s world famous migrating trout and salmon. This created a safety problem for passing motorists and for the anglers themselves. NYSDOT maintenance crews designed and constructed a paved parking area, a series of wooden stairs and a picnic area with lumber donated by a local company and tables donated by the State Parks Department. (vii)

**Extending Highway Maintenance Activities to Bicycle Trails**

Under the “Livable Delaware” Plan, Delaware DOT is extending Highway Operations Maintenance Policy to care for an increasing number of bicycle paths and sidewalks. Until the recent past, there have been relatively few bicycle paths and sidewalks within the state’s right-of-way. Public input was relatively minor, requests for service were handled individually, and actions were very specific to satisfy only the scope of the complaint being responded to. DelDOT assessed the current situation and is implementing the following practices for bicycle paths: (viii)

- For those bicycle paths which have been, or will be created within the paved surface of the roadway, and designated by paint striping, cleaning and repair of these facilities will be accomplished within the existing established procedures and policies governing highway sweeping and pot hole repair.

- Develop policy guiding frequency of cleaning and standards defining an acceptable level of maintenance where bicycle paths are constructed as separate, stand-alone facilities.

- Obtain specialized equipment not currently in the Department’s inventory or contracted services to properly maintain separate paths. Existing equipment is designed for roadway service and is too large and heavy to be utilized on stand-alone bikeways without damaging the physical structure of the path.

DelDOT noted that sidewalks located within the state’s right-of-way along maintenance numbered roadways outside of municipal boundaries have long been given minimal attention, and that no standards or policies define frequency of cleaning or serviceability. Where failures occur, they are not addressed unless significant public input
is received. DelDOT has formed a committee to develop overall maintenance policies for sidewalks outside of subdivisions in general. The committees for bicycle paths and sidewalks were appointed by the Directors of Highway Operations, Pre-Construction, and Planning since planning and design considerations must be considered in development of an adequate and rational maintenance policy; e.g., where a sidewalk and/or bicycle path is placed relative to the roadway will have significant impact on the ease of cleaning and maintaining the facility, requiring that these long-term activities be fully considered in the project development phase. The Delaware Bicycle Council, County governments, and numerous municipalities are feeding into the process.

10.2. PROTECTION OF HISTORIC AND OTHER CULTURAL RESOURCES

Federal and state laws provide varying levels of protection to historic properties and other cultural resources during routine maintenance work. Where federal funding is involved, the requirements of the National Historic Preservation Act and other federal laws govern how certain types of cultural resources – historic properties eligible for the National Register of Historic Places – are treated. Other federal laws may apply in such circumstances as well. Where federal funding is not involved, State law, or standard operating procedures within State DOTs, often prescribes how to treat places and things that have historic and cultural importance. Specific laws often apply to specific types of resources, such as archaeological sites and human burial places. Even if no law applies, places of cultural and historic sensitivity are often of great importance to local people, and damaging them through maintenance work can spark controversy.

To protect cultural resources from such damage, and to be in compliance with relevant laws, maintenance planning should be coordinated with the DOT’s historic preservation experts. Special attention should be given to maintenance activities off the pavement in rural areas, and within older commercial, industrial, and residential urban areas, as well as activities involving the use of or material sites, whether existing or new.

NYS DOT’s environmental handbook for maintenance lists the following examples and practices: (ix)

Example 1: NYS DOT Maintenance Practices in Areas with Cultural Resources

Excavation and related work

Work areas are inspected and the DOT Cultural Resources Coordinator (CRC) is contacted if 1) the ground looks as if it has never been disturbed, 2) you believe the area was the location of an early building or archaeological site, 3) you see building or foundation remains or if you find arrowheads, ceramics, bottles or other; or 4) If you find unusual whole or broken historic artifacts.

Work in front of a building greater than 50 years old

Notify the CRC before you remove any mature living trees, stone sidewalks, fence or walls, lights, or other landscape features near a building that appears to be over 50 years old. Such buildings may be eligible for listing on the National Register of Historic Places and the above mentioned features may contribute to the importance or historic value of the building.

Bridges

Many bridges that are greater than 50 years old have decorative railing or lighting. Before removing or replacing any features that could be considered historic, contact the CRC to determine which bridges are eligible to be or are listed on the National Register of Historic Places.
Buildings on state canal lands and canal features
For State Canal Systems eligible for listing on the National Register of Historic Places consult with State Office of Parks, Recreation and Historic Preservation before altering or renovating these canal-related bridges, buildings or features.

Parkways
For Parkways eligible for listing on the National Register of Historic Places. CRCs call before doing work that alter or remove features that may contribute to the character of these parkways, such as historic guide rail, lights, bridges, turf shoulders, stone curbing, medians, signs or landscape features.

Stream Corridors
Since stream corridors have been a powerful magnet for human settlement throughout history, it is not uncommon for historic and prehistoric resources to be buried by sediment or obscured by vegetation along stream corridors. It is quite possible to discover cultural resources during restoration implementation (particularly during restoration that requires earth-disturbing activities).

1.1. MAINTENANCE IN WETLANDS
Compensatory mitigation sites are often retained by the DOT and maintained according to a management plan, or as needed, based on the monitoring report. Except for the plant establishment period and trash pickup, no maintenance activities take place in created wetlands unless otherwise stated in the management plan, the contingency plan for the wetland, or the wetland monitoring report. In most cases this restriction on maintenance activities also applies to the designed upland buffer around the wetland. In wetland mitigation sites, some vegetation management may be performed in accordance with management or contingency plans for the site. Long-term maintenance required in the management plan may include:

- Repairing damage to the site from vandalism, storms, or fire.
- Control of exotic and invasive weed species.
- Eradication of state-listed noxious weeds.
- Plant replacement, if necessary, to meet permitting requirements.
- Selective removal of some types of trees to facilitate the natural succession of desirable plant communities. This decision is made in conjunction with the DOT Biologist and Landscape Architect.
- Other activities required to maintain a functioning wetland as determined by the DOT environmental specialists.

Primary environmental stewardship practices for maintenance of wetlands include the following:

- Develop a long-term maintenance plan with the cooperation of DOT Maintenance, Biologists, and Landscape Architects.
- Establish a feedback loop for typical maintenance problems that might arise specific to the selected site. Include the region’s Environmental Office, the design Biologist, and the Landscape Architect in that loop.
- Wetland vegetation should not be sprayed, mowed, or cleared except when necessary to maintain designated roadside ditches or detention ponds.
• Designate herbicide restrictions near wetlands. Application of herbicides in wetland mitigation sites requires an aquatic certification on the applicator’s license.

All emergency actions in or adjacent to streams, wetlands, lakes, ponds or other water bodies, or historic resources require some form of environmental review and notification to regulatory agencies and thus are coordinated through the environmental staff. Typical maintenance environmental stewardship practices in emergency situations include: (xii)

• Written notification of emergency work includes a description of the proposed action; a location map and plan for the proposed project; and reasons why the situation is an emergency.

• Emergency projects that require authorization from the USACOE are coordinated appropriately.

• All emergency work should be performed to cause the least modification, disturbance, or damage to the course or bed of a stream and its banks, or any adjacent wetlands.

• No equipment should be operated in the water unless it has been approved by the state’s Department of Environmental Conservation.

• When conducting emergency work, all general and special permit conditions should be followed.

• When significant project modifications occur during construction, such changes should be coordinated with environmental staff and/or the permitting agencies.

10.3. MAINTENANCE NEAR WATERBODIES

Maintenance activities occasionally require equipment or personnel to enter a stream, river, channel, wetland or other water body. Cleanup/Repair, Drainage Ditch and Channel Maintenance, Bridge Repairs and Draw Bridge Maintenance are among that maintenance work items that can require work in or near a water body. In maintenance work near waterbodies, the following environmental stewardship practices should be followed.(xiii)

• Maintenance equipment should not enter a water body without the required regulatory permits (e.g., Army Corps of Engineers Clean Water Act Section 404 permit, State Clean Water Act Section 401 Water Quality Certification). A DOT environmental specialist or stormwater coordinator should be contacted to identify the appropriate permits.

• Evaluate alternatives to performing work in the water body.

• Tires should be cleaned before entering a water body.

• Heavy equipment driven into a water body to accomplish work should be clean of petroleum residue.

• Water levels should be below the gearboxes of the equipment in use, or equipment lubricants and fuels should be sealed such that inundation by water would not result in leaks.
Kentucky Transportation Cabinet’s New BMP Manual for Maintenance Activities In and Around Streams

The Kentucky Transportation Cabinet (KYTC) developed a manual of *Best Management Practices (BMPs) For Maintenance Activities In and Around Streams*. The manual was developed to introduce the Army Corps of Engineer’s state programmatic general permit for highway maintenance, and to give engineers and maintenance personnel practical guidelines when performing activities in and around streams. The guidelines were endorsed not only by the Corps but by multiple state agency divisions and several KYTC maintenance districts. Though activities deemed detrimental to the environment or damaging to the general public interest may be revoked from coverage by the Corps’ District Engineer, the effort is clarifying expectations and improving performance on a programmatic level.

The manual prohibits stream channelization or channel deepening as part of cleanup operations and avoids placement of equipment in-stream, whenever possible. Work is to be performed during low-flow conditions whenever possible and disturbance to existing stream bank vegetation is not to occur “unless absolutely necessary.” Removed material must not be placed on the streambanks or in the floodway, and disturbed areas must be seeded and mulched.

The maintenance activities covered under the state programmatic general permit, and in the BMP manual include:

- Drift Removal from Bridges and Culverts
- Beaver Dams
- Stream Clean-out/Culvert Sediment Removal
- Embankment Repair and/or Protection
- Scour/Erosion and Miscellaneous Repairs to Bridge Elements
- Bridge and Culvert Replacement
- Erosion Control and Project Restoration
- Bioengineering

Activities not covered under the general permit are: bulldozer work, work areas in excess of 200 linear feet of stream, and work in “Outstanding Resource Waters” or designated components of national or state Wild and Scenic River Systems or wildlife management areas. This and other work that cannot be accomplished according to the conditions in the permit require submittal of a “Site Specific Project Sheet.” Permits for disposal of debris or excavated material occur separately.

10.4 MAINTENANCE OF STRUCTURES FOR WILDLIFE

NCHRP Project 25-27, Evaluation of the Use and Effectiveness of Wildlife Crossings, will explore methods used by state transportation agencies in tracking and funding maintenance needs, tracking wildlife-vehicle collisions, and the extent to which such information is eventually used in identifying sites for mitigation measures. One of the best sources of existing information is NCHRP Synthesis 305, *Interaction between Roadways and Wildlife Ecology: a Synthesis of Highway Practice*, which reviews a
number of opportunities and best practices related to maintenance of structures. These
are excerpted as follows: (xiv)

*Bats and Birds in Bridges*
An emerging area for maintenance related to wildlife concerns bats in bridges. Keeley
and Tuttle (1996) describe the use of highway bridges and culverts as bat habitats and
provide guidance for maintenance and demolition of bridges occupied by bats. They
report that some states, such as Texas, are managing bridges for bats with great success.
Washington State DOT has developed tracking programs for birds in bridges and
maintenance inspection personnel. Maintenance personnel must be aware that some
species of bats and birds are listed as threatened or endangered. It is usually necessary to
bring in environmental professionals when bats and birds are founds.

*Culverts*
Materials used in modern culvert construction (concrete and metal with protective
coatings) and the actual design (corrugated) can result in a structure with a long life span
and potentially little maintenance. Several states have developed manuals to address the
problems associated with culvert maintenance. A common problem with the
maintenance of ordinarily dry culverts in upland areas is the control of vegetation in
keeping the structure open and accessible. Deposition soil around the mouth of small
pipe culverts as a result of wind and rain can result in decreased effectiveness for wildlife
movement.

*Underpasses*
Because wildlife underpasses are essentially bridges over land and water, maintenance
personnel can expect routine structural inspection and maintenance activities as for any
bridge structure. Slope maintenance around these crossings is often problematic because
of the need to maintain a built-up fill section for an elevation that provides for a smooth
transition into the bridge while maintaining suitable conditions for animal movement
under the bridge. Slope stabilization with headwalls, riprap, reinforced earth, or
vegetation can greatly reduce maintenance frequency, expense, and disturbance to the
wildlife underpass. Many underpasses are large enough that maintenance of the cross-
sectional opening is not as problematic as it can be in some drainage culverts. It is
important that cover for animals be a consideration in the maintenance plan for the
structure. If organisms sensitive to the need for cover are to use the structure,
maintenance of sufficient cover will be required. Research from Europe has indicated
that cover, such as rows of debris under the crossing, can facilitate small mammal and
reptile/amphibian movement under the crossing.
To assure visibility of the crossings for animals, vegetation control is the primary
maintenance function for these structures. Therefore, it may be necessary to size
structures so that mowers can move through the underpass and the area in and around the
structure. Graffiti and vandalism are also maintenance problems in areas that have access
to humans.

*Overpasses*
Overpasses for wildlife are so recent in the United States that good information about
their maintenance is not available. In Europe, maintenance on overpasses is performed
for native vegetation and even wetland systems, similar to that for adjacent roadside communities. Various structures for wildlife cover, including large rocks and stumps, are maintained on European overpasses. With the exception of planting and maintenance of native vegetation, Europeans do little else to maintain their wildlife overpasses. In Canada, one innovative measure being used in Banff National Park involves the placement of piles of used Christmas trees to provide cover for habitat and movement of small animals across the overpasses.

Fencing
Fence maintenance can be one of the most expensive activities for wildlife mitigation techniques. Run-off-the-road vehicles and falling trees often damage fences and unless quickly repaired animals will find their way through these breeches and on to the rights-of-way. Vegetative growth along fences can also present a maintenance problem. Spraying with herbicides seems to be the most popular maintenance measure, although this can present problems in particularly sensitive aquatic areas and areas with listed protected plants.

10.5 MAINTENANCE OF STORMWATER FACILITIES

Thirty percent of state DOTs have produced manuals or internal guidance for stormwater protection at non-highway maintenance facilities. General practices for maintenance of stormwater facilities include the following:

- Maintenance Supervisors should be charged with line responsibility for inspecting stormwater drainage systems and assessing the need for cleaning or clearing.
- The DOT should observe culverts and drain inlets annually in the fall and throughout the winter as needed to determine if cleaning or repairs are required.
- Culverts should be cleaned when sediment impairs culvert function.
- Ditches should be cleaned prior to the rainy season to maintain the hydraulic capacity of the ditch.
- Ditches and gutters should be sealed or repaired when structural integrity is endangered.
- Downdrains should be inspected annually and cleaned or repaired as necessary.
- Solid and liquid wastes generated by the cleaning of stormwater drainage system facilities should be disposed of in accordance with federal, state and local liquid and solid waste disposal regulations.
- Baseline inspection and cleaning activities should be reported annually by section of highway and information used as a tool to evaluate the program.

State DOT Inventory, Tracking, and Prioritization Systems

MDSHA Inventory System for Water Quality Improvement/Retrofitting
MDSHA has mapped the entire state for opportunities for retrofitting BMPs, for pollution prevention and stream restoration beyond requirements. The agency has developed a thorough and duplicable grade-based rating system for stormwater management facilities.
and has developed an inventory, database, and photo record of all facilities statewide and their maintenance status. Inspection teams of trained staff identify further environmental improvements that can be made. Under the rating system, those graded A or B are considered functionally adequate. As of late 2003, between 73 and 75 percent of MDSHA stormwater were functionally adequate (A=everything fine, working fine, no maintenance required, B= minor maintenance, need mowing or trash removal), leaving approximately 25 percent needing maintenance or retrofitting to achieve functional requirements. The state is developing and implementing a plan for systematic implementation of those improvements. By 2010 MDSHA is aiming for 95 percent of facilities functioning adequately. 

**Minnesota DOT System for Inventorying Hydraulic Conveyance Structures**

Mn/DOT system for inventorying hydraulic conveyance structures, a requirement in many states for NPDES Phase II, is called “HYDRINFRA.” Mn/DOT plans to add an inventory of ditches and erosion problem areas to the database in the future. Mn/DOT employs consultant services for three levels of inspection, location, and repair of hydraulic structures.

- **MS4/HydrInfra Inspection** may include inspection, GPS location of hydraulic structures, and/or development of an electronic map (“stick map”) showing all hydraulic structures located during either the inspection and/or cleaning. The map will also show flow connection and direction for all structures as listed above and rating/evaluation of hydraulic structure condition. Any indicators of illicit discharges to the system are noted on reports.

- **Video Inspection** is completed for hydraulic structures (pipes, culverts, manholes, catch basins, drop inlets, etc.) and is conducted using remote controlled, self-propelled, explosion-proof video cameras. Video inspection includes providing video of the entire damaged structure. Defects along the pipe are identified, indexed, and stamped on the screen to allow for easier processing by Mn/DOT personnel. Video must be provided in digital (MPEG-1) format for use of storage and filing.

- **Hydraulic Structure Cleaning** includes removal and proper disposal (including certification) of material from all types of hydraulic structures.

**Michigan DOT and Local Studies to Prioritize Funding of Stormwater Retrofits**

Road-stream crossing features contribute varying amounts of sediment and non-point source pollutants to rivers and streams. In an effort to combat the influx of these types of pollutants, the Michigan Department of Transportation (MDOT) used federal Transportation Enhancement funds to support planning studies that inventory road-stream crossings in several locations throughout the state. These studies are used to prioritize funding for additional efforts to mitigate pollution from highway runoff. One such inventory was the Ionia County Road Commission’s planning inventory of all bridge and culvert road-stream crossings in the county. As a preventative measure the study was intended to highlight potential problem locations and increase

![Figure 1: Field Crews Collect Information on Stormwater Retrofit Needs at MDOT Stream Crossings](image)
reaction times in resolving water impairment issues. Field crews from a local university collected site data from more than 700 locations. The sites were ranked and the data was entered into a Geographic Information System (GIS) that included information on soils, land use, drains, school districts, and road ratings. The project was the cooperative effort of several county agencies, MDOT, and Grand Valley State University. (xvi)

10.6 MAINTENANCE OF ROADSIDE PUBLIC FACILITIES

Roadside public facilities include safety roadside rest areas, weigh stations, park and ride lots and vista points. Maintenance of such facilities includes a range of custodial responsibilities that may include restrooms, fountains, picnic areas, and other public facilities. Maintenance of appurtenances such as roadway surfacing, signs, pavement markings, buildings, landscaping and electrical installations may also occur in conjunction with maintenance of these facilities.

Potential Pollutant Sources and Environmental Stewardship Practices

Potential pollutant sources at public facilities can include trash, litter, sewage, chemical vegetation control, erosion, illegal dumping, graffiti, spills and leaks, resulting in sewage, pesticides, sediment, sandblast grit, paint, fuel, hydraulic fluid and oil entering the environment. To prevent such pollution, recommended environmental stewardship practices include illicit connection/discharge reporting and removal, scheduling and planning, safer alternative products, illegal spill discharge control, vehicle and equipment fueling, vehicle and equipment maintenance, solid waste management, liquid waste management, sanitary/septic waste management, concrete waste management, spill prevention and control, material use, material delivery and storage, maintenance facility housekeeping practices, litter and debris, sweeping and vacuuming, anti-litter signs, potable water/irrigation and water conservation practices. (xvii)

Graffiti Removal

The following environmental stewardship practices are recommended for graffiti removal: (xviii)

- Schedule graffiti removal activities for dry weather.
- Protect nearby storm drain inlets prior to removing graffiti from walls, signs, sidewalks, or other structures needing graffiti abatement.
- Clean up afterwards by sweeping or vacuuming thoroughly, and/or by using absorbent and properly disposing of the absorbent.
- When graffiti is removed by painting over, implement the procedures under Painting and Paint Removal.
- Direct runoff from sand blasting and high pressure washing (with no cleaning agents) into a landscaped or dirt area. If such an area is not available, filter runoff through an appropriate filtering device (e.g. filter fabric) to keep sand, particles, and debris out of storm drains.
• If a graffiti abatement method generates wash water containing a cleaning compound (such as high pressure washing with a cleaning compound), plug nearby storm drains and vacuum/pump wash water to the sanitary sewer.

• Consider using a waterless and non-toxic chemical cleaning method for graffiti removal (e.g. gels or spray compounds).

**Electrical Maintenance**

The electrical area of activities includes all work performed on highway facilities used for control of traffic (e.g., traffic signal systems, highway and sign lighting systems, toll bridge electrical systems and other related systems). Detector loops are electrical sensors used to trigger a traffic control signal at an intersection and/or for long-term traffic counts. Installation of detector loops is accomplished by cutting into the road surface with a concrete saw, inserting electric wire into the cut and sealing the cut with loop sealant. Subtasks include support vehicle operation, sawcutting, hauling and disposal and pavement repair. Pollution control activities focus on ensuring that debris and maintenance and repair materials remain controlled and are not released to the environment.

• Control potential pollution from concrete, sealant, fuel, hydraulic fluid and oil. Utilize stormwater protection practices, including illicit connection/illicit discharge reporting and removal, scheduling and planning, illegal spill discharge control, vehicle and equipment fueling, vehicle and equipment maintenance, solid waste management, concrete waste management, liquid waste management, material use, water conservation practices and sweeping and vacuuming.

• Water applied during sawcutting operations should be controlled to prevent unpermitted non-stormwater discharges.

**10.7 MANAGEMENT OF PORTABLE SANITARY/SEPTIC WASTE SYSTEMS**

Sanitary/septic waste management procedures and practices are designed to minimize or eliminate the discharge of sanitary/septic waste materials to storm drain systems or watercourses and should be implemented for all maintenance activities that use portable sanitary/septic waste systems.(xix)

• Sanitary facilities should be located away from drainage facilities and watercourses. When subjected to risk of high winds, sanitary facilities should be secured to prevent overturning.

• Wastewater should not be discharged (unless the discharge is to a permitted leach field or pond) or buried within the highway right-of-way.

• Sanitary/septic waste should be discharged to a sanitary sewer or managed by a licensed hauler.

• Sanitary/septic waste storage and the disposal procedures should be managed to prevent non-stormwater discharge.
• A foreman and/or construction supervisor should monitor on-site sanitary/septic waste storage and disposal procedures.

• For emergency procedures related to large spills, review the District Hazardous Materials Spill Contingency Plan.

10.8 MAINTENANCE OF SHOULDERS AND ROADWAY APPURTENANCES

Areas adjacent to surfaced and unsurfaced road shoulders require maintenance to prevent the loss of lateral support, to prevent the deterioration or failure of the road edge and to maintain roadside drainage patterns, and to prevent excessive sedimentation and pollution from applied abrasives. Potential pollutant sources may include disturbed soil, leaks, and wind erosion which can then release pollutants like sediment, fuel, hydraulic fluid and oil.

• Water applied during sweeping operations should be controlled to prevent unpermitted non-stormwater discharges.

• Use applicable water quality management practices such as illicit connection/illicit discharge reporting and removal, scheduling and planning, illegal spill discharge control, vehicle and equipment fueling, vehicle and equipment maintenance, compaction, material use, spill prevention and control, sweeping and vacuuming, and water conservation practices. Subtasks include equipment operation, grading, rolling, import and fill, and post-sweeping. (xx)

Cleaning/Sweeping of Shoulders

Sweeping operations remove litter and debris from the traveled way and shoulder to reduce traffic hazards and improve aesthetics. Subtasks associated with highway sweeping operations include operation of support vehicles, sweeper operation, stockpile management, and material disposal. Potential pollutant sources include spills, leaks, and stockpiles.

The following environmental stewardship practices are utilized on the municipal level and may be used by state DOTs: (xxi)

• Care should be taken to minimize dust as much as possible.

• Water applied during sweeping operations should be controlled to prevent unpermitted non-stormwater discharges.

• Stormwater quality control measures should be employed, including illicit connection/illicit discharge reporting and removal, scheduling and planning, safer alternative products, illegal spill discharge control, vehicle and equipment fueling, vehicle and equipment maintenance, solid waste management, liquid waste management, sweeping and vacuuming and water conservation practices. (xxii)

• Equipment should be in good working order and contain filters and/or other controls as feasible.

• Avoid wet cleaning or flushing of street, and utilize dry methods where possible.
• Consider increasing sweeping frequency based on factors such as traffic volume, land use, field observations of sediment and trash accumulation, proximity to water courses, etc. For example:
  o Increase the sweeping frequency for streets with high pollutant loadings, especially in high traffic and industrial areas.
  o Increase the sweeping frequency just before the wet season to remove sediments accumulated during the summer.
  o Increase the sweeping frequency for streets in special problem areas such as special events, high litter or erosion zones.
• Maintain cleaning equipment in good working condition and purchase replacement equipment as needed. Old sweepers should be replaced with new technologically advanced sweepers (preferably regenerative air sweepers) that maximize pollutant removal.
• Operate sweepers at manufacturer requested optimal speed levels to increase effectiveness.
• To increase sweeping effectiveness consider the following:
  o Institute a parking policy to restrict parking in problematic areas during periods of street sweeping.
  o Post permanent street sweeping signs in problematic areas; use temporary signs if installation of permanent signs is not possible.
  o Develop and distribute flyers notifying residents of street sweeping schedules.
• Regularly inspect vehicles and equipment for leaks, and repair immediately.
• If available use vacuum or regenerative air sweepers in the high sediment and trash areas (typically industrial/commercial).
• Keep accurate logs of the number of curb-miles swept and the amount of waste collected.
• Dispose of street sweeping debris and dirt at a landfill.
• Do not store swept material along the side of the street or near a storm drain inlet.
• Keep debris storage to a minimum during the wet season or make sure debris piles are contained (e.g. by berming the area) or covered (e.g. with tarps or permanent covers).

Shoulder Grading, Widening, Blading, or Rebuilding

Shoulder Blading/Rebuilding includes shoulder blading and rebuilding to correct rutting and buildup of materials, to remove weeds, for safety, and to maintain proper drainage. This activity can be similar to ditching, and has similar stewardship practices to avoid and minimize environmental impacts. Environmental stewardship practices include the following recommendations: (xxiii)
• When conducting shoulder maintenance activities in areas with narrow shoulders or steep slopes, inspect the area and/or consult with environmental support staff to determine if there are wetlands, waterbodies, or sensitive cultural resources (such as historic buildings or parkways) in the area.

• Where appropriate, permanently stabilize disturbed soils using BMPs (seeding, plants, etc.).

• Evaluate sensitive areas for alternatives to blading, such as berming, curbing or paving shoulders.

• Where practicable, evaluate the width of the blading activity and if appropriate, modify the width to minimize disturbance of vegetation.

• Where possible, blade in dry weather, but while moisture is still present in soil and aggregate (to minimize dust). Special precautions may be necessary in PM-10 air quality non-attainment areas.

• Where appropriate, permanently stabilize disturbed soils using BMPs (seeding, plants, etc.).

• Contact environmental support staff before placing excess material to widen the shoulders or smooth out the slopes.

• Install check dams to protect sensitive resources, when appropriate.

• Incorporate this activity into local IVM plans to consider and minimize impacts of this activity on streams.

Dust Abatement for Blading and Shaping Gravel Surfaces
Dust abatement involves application of a dust palliative to non-paved road surfaces to temporarily stabilize surface soils, leading to a reduction of dust during the dry season. Palliatives are typically applied in liquid form and could include magnesium chloride, calcium chloride, emulsified asphalts, or lignon sulfonates. Environmental stewardship practices include the following recommendations: (xxiv)

• During preparation for application of dust palliatives, construct gravel berms at the low shoulders of the roadway to inhibit liquid palliatives from entering surface waters.

• Do not apply dust palliatives during rain.

• Do not apply materials in a manner that is not detrimental to either water or vegetation.

• Carry adequate spill protection, such as kitty litter, shovels, etc.

• Use environmentally sensitive cleaning agents.

• Dispose of excess materials at appropriate sites.

Guardrail Maintenance and Replacement
Guardrail replacement involves repair and replacement of existing guardrail sections and cleaning of accumulated material from under the guardrail. To avoid and minimize environmental impacts:
• Cleaning under the guardrail in or near riparian areas should consider the pickup and removal of material. Material should not be pushed down slope.

• Consider using large capacity vacuum trucks, to clean abrasives from bridge decks and under guardrails in sensitive areas.

• Consider new technologies in guardrails such as wire rope safety fence (WRSF) can both improve safety, hasten repair times, and reduce material usage and disposal issues. Furthermore, during repair, guardrail usually requires heavy equipment and a lane closure greatly slowing traffic (fuel and emissions). WRSF can be repaired with one man in a pickup without a lane closure in normally less than 30 minutes. The design allows small animals to pass through and can minimize snow accumulation. WRSF can also blend into surroundings and help minimize the approach slope needed; concrete barrier and guardrail require 10 to 1 approach slopes while WRSF can have 6 to 1 slopes, adding a land consumption benefit in some cases.\textsuperscript{(xxv)}

• In unstable situations, protect areas downslope from guardrail replacement with erosion control measures (silt fences and other appropriate devices) where appropriate to minimize additional sediment loadings into aquatic systems.

\textbf{Attenuator Maintenance}

Attenuator Maintenance involves service, repair, replacement, and realignment of damaged attenuators (physical systems that are strategically placed along exit ramps, bridge abutments, etc. to minimize impacts and cushion vehicles). Following impact, attenuators compact, releasing fluid (often ethylene glycol) which can flow directly to drainage systems. Practices to avoid and minimize such impacts include: \textsuperscript{(xxvi)}

• Use non-chemical systems when installing new attenuators.

• When replacing attenuators, install those devices found to be the most environmentally sound.

• Use absorbent dams or diapers around attenuators during repair or maintenance.

• Identify and close inlets (if appropriate and can be done safely) during attenuator maintenance.

\textbf{Luminaire Replacement to Reduce Light Pollution and Increase Energy Efficiency}

Roadway lighting is an important part of a highway system. It contributes to a safe environment and facilitates traffic flow for the traveling public during evening or nighttime driving. Lighting shows drivers changes in direction, obstacles, and roadway surface conditions. Exterior lighting may also have a significant impact on economic development. At present, roadway lighting standards are based almost exclusively on traffic safety. The impact of roadway lighting practices on the surrounding environment is of increasing concern to the public and DOTs, out of concern for impacts on wildlife as well as energy
efficiency and cost. Light pollution is an unwanted consequence of outdoor lighting and includes such effects as skylight, light trespass, and glare. “Sky glow” is a brightening of the night sky caused by natural and human-made factors. “Glare” is an objectionable brightness or reflection of light and a driving hazard especially bothersome for older drivers. “Light trespass” is the actual light that falls off the right-of-way and can be measured and quantified. In fact, many professional lighting designers have been obliged to go out at night and take measurements of the light that is falling off the right-of-way and onto a concerned citizen’s property.

Cities and states in some cases have responded with lighting ordinances and requirements regarding certain types of fixtures, minimum and maximum lighting levels, lumen/acre limits, and eliminating lighting in some cases. Legislation has been adopted in Arizona, California, Connecticut, Colorado, Maine, New Mexico, Texas, Georgia, and New Jersey. Such legislation has been proposed or introduced in New York, Iowa, Massachusetts, Michigan, New Hampshire, Maryland, Pennsylvania, Rhode Island, Virginia, and Wyoming. Environmental impacts of lighting are of increasing concern to biologists and members of the public concerned about wildlife as well. These issues are described in greater detail in the Design section on Lighting Control and Minimization, section 3.14. which also includes sections on Common Lighting Approaches and Deciding How Much Light Is Enough; Practices in Assessing Lighting Needs; Comparison of Lighting Sources, Issues, and Costs; and Research to Improve Lighting Practices.

**Light Minimization and Energy Efficiency Practices**

- Realign the fixture (change angle of mounting arm or rotate fixture head) so the source of light is not directly visible outside the ROW.
- Apply a shield to a drop globe fixture.
- Change an open bottom or drop globe fixture to a cutoff fixture.
- Apply a shield to a cutoff fixture.
- Reduce the mounting height of the fixture.
- Reduce the lamp wattage.
- Change the lamp socket position in the fixture to compress the lighting footprint.
- Change to a fixture with a different type of reflector providing a more favorable lighting footprint.
- In addition to other shielding and light reduction measures: Install a flat 2422 acrylic amber lens in a cutoff fixture with an HPS lamp of 70 watts or less (e.g., GELS 70W M250).
- Turn the light off
- Remove the fixture.
- Relocate the fixture to block light from extending to sensitive resources.
- Change to an LPS fixture (if the light is customer-owned).
- Create a vegetated berm/buffer or other light shield between the roadway and the sensitive resource.

Electric utilities can generally provide the following options:
- Seasonally turn the lights off,
- Relocate or redirect the light fixture,
- Change a drop globe fixture to a cutoff style fixture,
- Remove the fixture,
- Lower mounting height,
- Reduce wattage,
- Selectively install amber-colored filtering lenses (on cutoff fixtures of 70-watts or less and only in addition to other modifications), and
- Install a light shield.

An overview of roadway lighting fixtures is available at the MetroLux Lighting website.(xxvii)

**Oregon DOT Illumination Reduction Practices**

Oregon DOT (ODOT) involved all District and Regional Managers in response to possible energy shortages in the Pacific Northwest and directives from the Governor’s office that all state agencies review power usage and develop conservation measures. Specifically, ODOT considered reducing highway illumination as a temporary measure, and undertook case studies to assess any differences that occurred with lighting reductions.

Region Traffic Engineers and District Maintenance staff worked together to determine specific luminaries to be turned off. The Traffic Management Section assisted in reviewing specific requests to assure the state continued to meet AASHTO standards for lighting on a statewide basis. In addition, ODOT’s Traffic Engineering Services Unit conducted a comprehensive crash analysis, including a field review during both dark and dark/wet conditions, of the freeways in the Portland metro area. The crash analysis indicated no significant difference in the ratio of night-to-day crash rates by lighting condition. In fact, in most sections the night crash rate was substantially lower than the day crash rates. As a result of their research, ODOT developed the following guidelines for reducing illumination that may be utilized as practices for consideration by other state DOTs.

**Lineal Lighting**

ODOT’s practices specified that lineal lighting along freeways and freeway-like facilities could be turned off unless the facility has the following characteristics:
- Inadequate outside and median shoulders.
- Vertical or horizontal alignments such that illumination may be beneficial to driver safety.
- A crash analysis indicates that the night-to-day crash rate ratio is greater than 1.0
• Section of highway has high levels of pedestrian and/or bicycle activities during times of darkness.
• Sections where there are three or more successive fully-illuminated interchanges located with an average spacing of one mile or less between successive interchanges: (Note: This exception does not apply if the interchanges are partially illuminated. That is, if interchanges are partially illuminated, lineal lighting should be turned off regardless of spacing.)
• Pavement markings and delineation should be in good condition when deciding to turn off lineal lighting. Durable striping is desirable.
• Under certain designs (such as narrow median widths) it may be possible to reduce the lighting to only one side of the highway.

Interchange Lighting
Full interchange lighting should be reduced to partial interchange lighting unless the interchange has the following characteristics:
• Ramp and/or interchange alignment and grade is complex or unusual.
• Interchange area has high levels of pedestrian and/or bicycle activities during times of darkness.
• Interchange that contains important decision point(s) and/or existing roadside hazard areas that would not be covered with partial illumination.

General Guidelines in Considering Luminaires to Turn Off
• On Ramps - Standard of three continuous poles as a group on gore and merging sections minimum coverage is 150 meter (500 feet). Ramps with high truck traffic and/or longer acceleration lanes may need more coverage.
• Off Ramps - Standard of three continuous poles as a group for gore (decision making point) including a ‘pull through’ light. Highway alignment may require four poles to make a group.
• Ramp Terminals - Standard of two poles on opposite corners of the intersection. At a rural intersection with a two-lane facility without a designated crosswalk, one pole at the intersection may be sufficient.
• Underdeck Illumination - Should be turned off if no pedestrian and/or bicycle activity is expected and there is no current safety problem.

ODOT’s illumination reductions were implemented as a temporary measure as a means to reduce energy consumption; however, the agency is considering permanent reductions if safety is not impacted. Assessment of reduced lighting is continuing. Changes from whole to partial interchange lighting at the entry and top of ramp and reductions in high tower illumination were the most common changes. Meanwhile ODOT produced a Traffic Lighting Design Manual in January 2003, which implements some lighting reductions, including a study on whether light removal would be possible.
Use of Light-Emitting Diode (LED) Traffic Signals to Reduce Energy Usage

The California Department of Transportation (Caltrans) reduced agency-wide energy consumption by 21 percent in response to threats of rolling blackouts in 2001. More energy-efficient facilities such as the new building in downtown Oakland are one source of savings. Another is the award-winning light-emitting diode (LED) traffic signal upgrade effort, which, when complete, will reduce signal grid demands by 92 percent. Lighting plans can make better use of lights, conserve energy and make roadways safer by reducing the number of poles and fixtures. The department also contracted with a private company to conduct energy audits and implement efficiencies under a savings-sharing system. After examining other areas, such as bridge and tunnel lighting, bulk energy procurement and roadway sign lighting, Caltrans has realized about $181 million over 10 years in savings.(xxviii)

10.9 Sweeping and Vacuuming of Roads, Decks, Water Quality Facilities, and Bridge Scuppers

Sweeping and vacuuming are performed to remove litter, debris and de-icing abrasives from paved roads and shoulders. Sweeping to reduce track-out generally involves manual sweeping or use of small equipment, but does not exclude the use of sweepers should the need arise (e.g., for slides and slipouts). Curbs and bridge decks may also be flushed or swept to remove dirt and debris, and scupper (weep holes or direct drains on bridges) cleaning. Materials are recovered and disposed of or in some cases sidecast. General practices for structure repair include: (xxix)

- Placing refuse material above the bank, away from waterways and wetlands.
- Ensuring that the active flowing stream will not come into contact with fresh, dissolvable concrete.
- Disposing of material in appropriate locations.
- Providing a stable, appropriate concrete truck chute clean-out area and requiring the contractor to use it, to keep material from being deposited in riparian corridors.
- Using cofferdams for structural repairs, as appropriate.
- Containing saw chips where feasible.
- Avoiding use of creosote or “Penta” treated wood for permanent structures.

Stewardship practices for minimizing water quality impacts from highway, bridge deck and scupper sweeping include the following recommendations from Caltrans and Oregon DOT: (xxx)(xxxii)

- Store/dispose of removal materials at an appropriate site in an appropriate manner as part of the local material disposal plan. Removed material may be temporarily stored in stable locations to prevent the material from entering wetlands or waterways.
- Recycle sweeping materials where appropriate.
• Where feasible, schedule sweeping during damp weather, to minimize dust production.

• Remove sweepings produced within 25 feet of identified sensitive spawning areas as identified in coordination with resource agencies, if the design of the facility allows.

• Where appropriate and practical, place sediment barriers in site-specific locations along stream routes or direct drainage routes, route sweeping material away from watercourse.

• Scupper cleaning involves sweeping of material away from clogged scuppers. Clogged scuppers are normally freed using a steel rod.

• Use water (as needed) to reduce dust during sweeping.

• Where feasible, coordinate crews to follow sweeping/flushing with bridge drainage cleaning.

• Sweeping and vacuuming operations are appropriate for removing de-icing abrasives, material from small slides, litter and debris. Sweeping and vacuuming may be implemented anywhere sediment is tracked from off-road maintenance activity sites onto public or private paved roads typically at the points of egress.

• Do not sweep up any unknown substance that may be potentially hazardous. If a substance is known to be hazardous, suspected of being hazardous or cannot be identified, notify the District Maintenance HazMat Manager immediately.

• If an illegally dumped substance within the DOT ROW has the potential of entering a municipal drain system, the immediate supervisor and the District Stormwater Coordinator must be notified so that the downstream municipality can be contacted.

• Adjust brooms to maximize the efficiency of sweeping operations.

• Do not load hoppers beyond their capacity.

• Dispose of waste to a landfill or approved site in accordance with local regulations and solid waste management best management practices (see Chapter 3 on Design for Recycling and also section 10.13). Clean materials may be incorporated into the maintenance activity area.

• Where possible, recycle abrasives for use in roadside berms instead of putting it in landfills.

10.10 MAINTENANCE STEWARDSHIP PRACTICES FOR SLOPES, DRAINAGE DITCHES, SWALES, AND DIVERSIONS

Maintenance activities related to slopes, drainage and associated vegetation include repair, replacement and clearing of channels, ditches, culverts, underdrains, horizontal drains and other elements of the stormwater drainage system. Protective measures such as soil stabilization using vegetation or rock on stream banks, slopes, benches or ditches are also part of the these activities.
**Drainage Ditch and Channel Maintenance**

Channels and drainage ditches are maintained to avoid obstruction and maintain flow. Ditch cleaning includes use of equipment for cleaning and reshaping of ditches including loading, hauling, and disposing of excess materials. Vegetation located in the ditch is removed during cleaning. Material is removed to an appropriate location for disposal or storage. Subtasks include vehicle operation, mechanically cleaning, and stockpiling and disposal of removed material. Fill material may be imported to repair eroded channel walls.

- Use water quality management practices to control potential pollution from disturbed soil, leaks and stockpiles, and release of pollutants such as sediment, litter, fuel, hydraulic fluid and oil. Such pollution prevention practices may include scheduling and planning, illegal spill discharge control, illicit connection/illicit discharge reporting and removal, vehicle and equipment fueling, vehicle and equipment maintenance, solid waste management, liquid waste management, concrete waste management, contaminated soil management, sanitary/septic waste management, sandbag or gravel bag barrier, straw bale barrier, fiber rolls, check dam, hydroseeding/handseeding, compaction, clear water diversion, material use, tire inspection and sediment removal, baseline stormwater drainage facilities inspection and cleaning and water conservation practices.

**Ditch Cleaning Practices**

A summary of other state DOT environmental stewardship practices for ditch or swale cleaning are outlined below:

- Maintenance ditch cleaning is only done in areas where the ditch’s function is impaired. The ditch length, width and height should be dredged back to its original dimensions. At NYSDOT, ditches are mowed to control vegetation rather than mechanically cleaning ditches with heavy equipment because mowing causes less erosion of exposed soil and can result in improved water quality.

- In general, culverts and ditches are cleaned, repaired or replaced only during periods of low water flow and not during intense rainfall events.

- Dredging should be conducted during low water periods and during dry weather, avoiding rainfall events.

- Evaluate and modify, where feasible and appropriate, existing ditch slopes to trap sediments, and support development of vegetation.

- Use best management practices identified in the local Integrated Vegetation Management plan.

- All efforts should be made to retain existing vegetation, especially along the ditch slopes to maintain slope stability.

- Consider excavating only the first three quarters of the ditch and retaining vegetation in the remainder. WSDOT assessed routine highway ditch cleaning alternatives or service levels for water quality benefits, surveyed biofiltration
swales to evaluate conditions promoting water quality benefits, and assessed
restabilization and revegetation options for use after ditch cleaning and for
restoring biofiltration swale vegetation. Of the options explored, the study found
the greatest water quality benefits when the first three quarters of the ditch were
excavated and vegetation was retained in the remainder. The ditch treated in this
manner was capable of reducing TSS by approximately 40 percent, total
phosphorus by about 50 percent, and total and dissolved Cu and Zn each by
roughly 20 to 25 percent. Analysis of survey data also showed that biofiltration
swales with broad side slopes, wide bases, and total storage volumes equivalent to
3 inches of runoff from the impervious drainage area consistently supported good
vegetation cover and showed few signs of damage. For assisting grass growth,
straw held in place with stapled jute mat had a clear advantage in effectiveness
over the alternatives and a slight economy advantage over the coconut mat.(xxxiv)

- Dispose of removed material above the bank line and not in any waterway or
  wetland. Recycle excavated material when feasible.
- Adequate siltation control measures should be in place before dredging operations
  begin. Use erosion control devices such as check dams, silt fences and other
  acceptable techniques, when the potential exists to have sediment or other
  materials enter a water of the State. Install check dams on steep slopes, as
  necessary, to slow water velocity reduce erosion and sedimentation. Consult with
  DOT Environmental Specialists if silt devices are inadequate to filter water prior
to draining to watercourses.
- When feasible, begin dredge at fixed flow elevation points (i.e. culvert
  inlets/outlets, catch basin inlets, etc.).
- Cleaned ditches should be seeded and mulched at the end of each work day.
  Monitor daily for subsequent erosion until area is stable. Repair as necessary.
- Temporary conveyances should be completely removed as soon as the
  surrounding drainage area has been stabilized or at the completion of
  construction.
- The measure should be inspected after every storm and repairs made to the dike,
  flow channel and outlet, as necessary. Approximately once every week, whether a
  storm has occurred or not, the measure should be inspected and repairs made if
  needed. Damages caused by construction traffic or other activity must be repaired
  before the end of each working day.
- Check the channel lining, embankments, and bed for erosion and accumulating
  debris and sediment buildup. Remove debris and repair linings and embankments
  as required.
- If channelized flow is too strong for the surrounding environment, energy
dissipaters may be needed. If vegetation or rock lined ditches reduces the ditch
flow capacity, the road may be endangered. Native material curbs, or berms can
be developed using a grader. Vegetating these berms will enhance the durability
of these constructed features. Hardened curbs such as asphalt or concrete will
require a construction crew and an engineer. The softest approach to developing
vegetated ditches is to not heel or pull the ditch with a grader, except when absolutely necessary. Roadside ditches should be large enough, and have adequate relief drain spacing, to carry runoff from moderate storms. Ditch gradient between 2 and 8 percent slopes are usually better performers. Slopes greater than 8 percent provide runoff waters with too much momentum and erosive force and will require more ditch relief. Slopes of less than 2 percent drain water too slowly, or not at all.

**Evaluating Ditches and Culverts for Water Quality and Function**

DOTs track the need to maintain and replace culverts before they contribute to flood damage on roads and bridges. To do so, many state DOTs rely on time-consuming manual systems to record information on inventory, condition, and work needs. Other agencies have no formal system in place and consequently find themselves reacting to immediate or impending problems, rather than proactively managing maintenance and replacement.

**Culvert Management Systems**

To help agencies manage their culvert inventories, condition assessments, and improvement programs, FHWA developed a computer-based “Culvert Management System” under the Local Technical Assistance Program (LTAP). The system provides an automated tool to facilitate the coordination of culvert maintenance and replacement operations on a system-wide basis. With the software, state DOTs can create an inventory of their culverts, assess them, and schedule repairs and replacements. It also helps agencies to develop maintenance plans and to estimate costs for installing, repairing, or replacing culverts. The system consists of five modules, which an agency can phase in individually. The inventory module enables the agency to record information about each culvert under its jurisdiction, such as size and location, while the condition module maintains a record of each culvert’s condition. The schedule module helps the agency develop a culvert work plan for the year. The work needs module enables the agency to define maintenance and rehabilitation options, determine costs, and rank work by type and priority. With the work funding module, agencies can project culvert deterioration over time and develop long-term work programs.

**Drainage Ditch Evaluation**

NYSDOT has developed the following rating system for drainage ditches and maintenance: (xxxv)

- **4** - Sides well shaped, clean, properly graded, smooth transition to inverts of culverts or drainage structures, environmentally friendly particularly in sensitive areas
- **2** - Slopes slightly oversteepened, minor erosion or material build-up around headwalls, end sections or structures, minor invert erosion, meets environmental guidelines
- **0** - Slopes significantly oversteepened, significant vegetation impacting flow, standing water, significant erosion or material build-up around headwalls, end

Chapter 10: Roadside Management and Maintenance: Beyond Vegetation
sections or structures, significant invert erosion, or one or more violations of the Department’s environmental guidelines.

Mn/DOT developed a Ditch Stabilization Matrix that identifies appropriate BMPs to stabilize different kinds and lengths of slopes and ditches:

**Figure 2: Mn/DOT Ditch Stabilization Matrix with Recommended Treatment Methods**

<table>
<thead>
<tr>
<th>Erosion Control Method</th>
<th>Ditch Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1% - 2%</td>
</tr>
<tr>
<td></td>
<td>0 - 500'</td>
</tr>
<tr>
<td>Permanent Seed w Cover Crop &amp; Type 1 Mulch</td>
<td>0.5</td>
</tr>
<tr>
<td>Sod Ditch Check w Strand &amp; Type 1 Mulch</td>
<td>-</td>
</tr>
<tr>
<td>3669 Type 1 Ditch Check</td>
<td>-</td>
</tr>
<tr>
<td>3668 EC SOD</td>
<td>1.0</td>
</tr>
<tr>
<td>3665 Cat 3, 4 Blanket</td>
<td>1.5</td>
</tr>
<tr>
<td>Sod w/ 3665 EC Netting Type 2</td>
<td>1.5</td>
</tr>
<tr>
<td>3669 Type 6 Ditch Check</td>
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<tr>
<td>3665 Cat 5 Blanket</td>
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<tr>
<td>3668 ES M Class 2</td>
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<tr>
<td>3669 ES M Class 4</td>
<td>6</td>
</tr>
<tr>
<td>3661 Type III, IV Fitreg</td>
<td>14</td>
</tr>
</tbody>
</table>

**Evaluation of Other Drainage Structures**

NYSDOT has developed the following rating system for other drainage structures and maintenance: (xxxvi)

**Drainage Structures**

- 4 - Clean and in very good structural condition, frames and grates in very good condition, no erosion or material build-up, environmentally compatible
- 2 - Some material present not affecting flow characteristics, some aging of structure or frame / grate – but not enough to pose structural problems, minimal scour or invert loss
- 0 - Significant material build-up or erosion impacting flow, significant structural loss, frame / grate separated or missing, undermining of frame / grate
**Closed Drainage System**

- 4 - Clean and in very good structural condition, invert at structures in very good condition, no erosion or material build-up
- 2 - Some material present not affecting flow characteristics, some aging of pipe, end sections or headwalls – but not enough to pose structural problems, minimal scour or invert loss
- 0 – from structure

**Litter and Debris**

- 4 - No appreciable litter present within segment
- 2 - Small concentrations of litter or two or more pieces of large debris present
- 0 - Significant concentrations of litter or debris exceeding 5 large pieces

NYSDOT developed an inspection form for open channels, as seen in the Appendix that also includes space to identify needed actions, further comments, etc.

**Drain and Culvert Maintenance for Water Quality and Fish Passage**

Drain and culvert maintenance includes the maintenance of under drains, horizontal drains, down drains, gutters, overside drains, scuppers and deck drains. Drains are maintained to prevent flooding and allow unobstructed flow. Subtasks include vehicle operation, cleaning (backhoe or Vactor™ may be used) and stockpiling and disposal of removed material.

- Use water quality management practices to control potential pollutant sources such as disturbed soil, leaks and stockpiles create the possible pollutants of sediment, litter, fuel, hydraulic fluid and oil. Recommended environmental stewardship practices include: illicit connection/illicit discharge reporting and removal, scheduling and planning, illegal spill discharge control, vehicle and equipment fueling, vehicle and equipment maintenance, solid waste management, liquid waste management, concrete waste management, contaminated soil management, sanitary/septic waste management, sandbag or gravel bag barrier, straw bale barrier, fiber rolls, hydroseeding/handseeding, compaction, baseline stormwater drainage facilities inspection and cleaning and water conservation practices. (xxxvii)

- Stenciling should be applied to urban drain inlets to discourage public dumping.
- Litter is a high priority pollutant in some receiving waters and is a pollutant listed on the CWA Section 303(d) lists for receiving waters in a few areas. Storm drain inlets that contain 12 inches or more of accumulated material should be cleaned.
- When Illicit Connection/Illicit Discharges are discovered, they should be referred to the District Maintenance or NPDES Stormwater Coordinator for initial investigation and reporting. Illegal dumping that may impact stormwater quality should be removed. All cleanup activities should be reported to the DOT or District Maintenance Stormwater Coordinator, as well as all illegal-dumping incidents found but not cleaned.
Drift removal is an aspect of culvert maintenance that involves either using boats to maneuver the drift, hydraulic tongs to reach over the side of the structure and dislodge the material, or pulling the drift from the side of the bridge (bank) and cutting it into pieces. Environmental stewardship practices for drift removal include:

- Cut and turn drift to allow it to flow through and under the structure only where doing so would not endanger any other crossing structures downstream.
- Repair and restore riparian areas temporarily impacted by machinery during drift removal. Coordinate long-term access for drift removal with the appropriate staff and agencies.

With regard to maintenance to ensure fish passage, post-construction evaluation of culvert improvements is important to assure the intended results are accomplished, and that mistakes are not repeated elsewhere. There are three parts to this evaluation: 1) Verify the culvert is installed in accordance with proper design and construction procedures. 2) Measure hydraulic conditions to assure that the stream meets these guidelines. 3) Perform biological assessment to confirm the hydraulic conditions are resulting in successful passage. Staff and resource agency biologists may assist in developing an evaluation plan to fit site-specific conditions and species. The goal is to generate feedback about which techniques are working well, and which require modification in the future. (xxxviii)

Any physical structure will continue to serve its intended use only if it is properly maintained. Hence the following practices should be employed.

- Ensure timely inspection and removal of debris for culverts to continue to effectively move water, fish, sediment, and debris.
- Inspect all culverts should be inspected at least annually to assure proper functioning. Summary reports should be completed annually for each crossing evaluated. An annual report should be compiled for all stream crossings and submitted to the resource agencies. A less frequent reporting schedule may be agreed upon for proven stream crossings. Any stream crossing failures or deficiencies discovered should be reported in the annual cycle and corrected promptly addressed.

**Evaluating and Ranking Slope Stability and Chronic Environmental Deficiencies**

**Washington State DOT Chronic Environmental Deficiencies (CED) Program & Rating to Prioritize Sites**

Washington State (WSDOT)’s Unstable Slope Management System helps rate and prioritize problem slopes. WSDOT has also developed a Chronic Environmental Deficiencies (CED) Program with a rating form to prioritize sites. The agency performs detailed inventories of roadside problem areas and other routine roadside vegetation maintenance needs. Corrective action is implemented with secured funding. WSDOT was the first agency in the United States to fully develop and implement an unstable slope management system (USMS), an internal WSDOT database and application designed for all participants in the unstable slope management process to
view and enter data pertaining to their respective job functions. In addition, data from other WSDOT databases such as TARIS (traffic and accident data) can be downloaded automatically into the USMS database, while other information required by other WSDOT databases, such as PATS (Priority Array Tracking System) can be uploaded from the USMS database. WSDOT’s system:

- Rationally evaluates all known unstable slopes along WSDOT highway facilities utilizing a numerical rating system for both soil and rock instabilities.
- Develops an unstable slope rank strategy, based on highway functional class that would address highway facilities with the greatest needs.
- Provides for early unstable slope project scoping, conceptual designs for mitigation, and project cost estimates that could be used for cost benefit analysis.
- Prioritizes the design and mitigation of unstable slope projects, statewide, based on the expected benefit.

**Slope Repair Practices**

Slope repair involves repairing water damage to roadway slopes, including import and shaping of material to restore slope and grade lines. In-water work can include replacement of riprap, rock or gabions which have been removed due to bank erosion. Slope repair may include repair of settlements/slide repairs done primarily when a road is in danger of collapse, and to forestall an emergency.

- Avoid changes or increases in the material profile, whenever possible.
- Place riprap within in-water work periods, in non-emergency situations.
- Consider use of bioengineering solutions where practicable. Practicable use areas include areas not shaded by bridge elements, outside of the two-year flood plain where success is probable and safety of the structural elements are assured.
- Coordinate any erosion repair activities (responses and cleanup of erosion problems, not the erosive action itself) which cause significant changes in the topography or vegetation within the riparian management area with DOT environmental staff and/or other regulating agencies. Also coordinate when placing riprap that is in addition to existing conditions and within the two-year floodplain of waters of the State.
- Dispose of removed material at appropriate stable sites so the material will not be washed into wetlands or waterways.
- Use erosion control methods in a timely manner, including seeding and mulching specific areas with non-invasive species, installing silt fences and installing other devices as appropriate.
- Take precautionary measures on erodible areas (chicken wire, chain link, rock matting) where eroding areas are identified, and where precautionary measures can be successfully and safely applied.
10.11 EROSION AND SEDIMENT CONTROL IN MAINTENANCE

Erosion and sediment control is a critical maintenance activity and should not only be considered on previous land-disturbing activities such as road construction, but also on any roadside land-disturbing activity, including slide or flood emergencies. Best management practices are available to effectively treat most yards, facilities, and roadside erosion and sediment problems. Consequently, maintenance staff should become familiar with their DOT’s Erosion and Sediment Control Manual. BMPs are available for perimeter, surface, slope, ditch, channel, and inlet and outlet protection, among others. Revegetation of disturbed or bare areas is the key component to long-term erosion and sediment control and should be used in most instances. Erosion and sediment control measures are used for all areas where maintenance activities involve clearing, grubbing, grading or excavating.

Information on environmental stewardship practice in erosion and sedimentation control and links to selection guidance, drawings, and implementation are included in the Design and Construction chapters; however, some basic environmental stewardship practices for erosion control in maintenance include the following:

- Use temporary vegetation to provide immediate ground cover until permanent landscaping is in place. It is desirable to re-seed and mulch any disturbed areas at the end of the day.
- Other “positive” erosion control measures (such as silt fence, check dam, etc.) should be installed prior to commencing work and left in place and maintained until the site is stabilized.
- Areas should be re-vegetated with native seed mixes that require minimal care.
- Temporary structural erosion control measures should be installed when cleaning culverts or cleaning ditches that discharge into streams, wetlands, lakes or ponds.
- When cleaning ditches, temporary check dams should be used wherever they are necessary and placed so that the crest of the downhill dam is at the same elevation of the toe of the uphill dam.
- Check dams should be left in place until the ditch is re-vegetated.
- Temporary sediment traps should be placed at the inlet of a culvert that drains into a stream, wetland or other water body. Sediment traps should be constructed by excavating an additional 1/3 meter (one foot) below the ditch invert for a distance of six meters (20 feet).
- Temporary turbidity curtains should be placed around culvert outlets in low water velocity situations for additional protection at, or close to, very sensitive sites, such as drinking water supplies, angler parking areas, or swimming facilities. Turbidity curtains should only be installed parallel to the shoreline and should never be placed across streams.
- After the project site is stabilized, any accumulated sediment should be removed before removing check dams or turbidity curtains.
- To improve habitat and reduce erosion, consult with the environmental staff regarding incorporation of appropriate soil bioengineering practices, such as live
willow cuttings/ stakes/posts and live willow wattles to stabilize disturbed and/or eroding stream banks.

- Sediment control structures should not be placed in streams
- The smallest practicable work zone is cleared to minimize erosion
- Length and steepness of slopes should be minimized. Place terraces, benches, or ditches at regular intervals on longer slopes.
- Maintain low runoff velocities in channels by lining with vegetation riprap, or using check dams at regular intervals, in addition to minimizing steepness and slow length.
- Trap sediment on-site. Many conventional BMPs are available, in addition to always evolving new ones.

DOT environmental staff, Roadside Managers, or Landscape Architects should be consulted for more detail or if problems arise. Links to existing erosion and sediment control resources and a brief overview of environmental stewardship practice related to erosion and sediment control is included under section 4.6, Erosion and Sedimentation Control.

**Evaluating and Ranking Roadside Erosion Control Problem Areas**

**PennState’s Dirt & Gravel Roads Center System for Identifying and Ranking Erosion Control Problem Areas**

Penn State University operates a Dirt & Gravel Roads Center with DOT support. The center has developed a system to identify and rank erosion control problem areas, based on the following criteria:

1. Ranking of road sediment in stream: None, Slight, Moderate, or Severe/Stream Encroachment.
2. Wet site conditions: Dry, Saturated Ditches, Roadside Springs, Flow in Ditches, Saturated Base.
4. Road slope/grade: <10 percent, 10-30 percent, or >30 percent.
5. Road shape: Good, Fair, or Poor.
6. Distance to stream: >100 ft., 50-100 ft., <50 ft. crossing.
7. Slope to stream: <30 percent, 30-60 percent, >60 percent.
8. Outlet to stream: None, Near Stream, Directly into Stream.
10. Road ditch stability: Stable, Fair, Poor, Unstable.
11. Road bank stability: Stable, Fair, Poor, Unstable.
12. Average canopy cover: Moderate, Minimal, Heavy.
10.12 RECYCLING IN ROADSIDE MAINTENANCE OPERATIONS

**Use of Compost to Stabilize Steep Slopes and Prevent Erosion and Sediment Control**

Research and field trials show that compost works effectively in stabilizing steep slopes, preventing erosion, and fostering germination. Composted organic material stimulates the chemical, physical, and biological characteristics of soil, adding texture and structure in a manner that resists erosion. Unlike many other erosion control best practices, compost can be left in place after construction as a soil amendment.

The absorbency and runoff control benefits of compost are particularly beneficial on steep slopes where the soil is too poor and nonabsorbent for vegetation to become established. Compost can absorb as much as the first 12.7 millimeters (0.5 inches) of a rainfall. Although hydroseeding (spraying a mixture of hay, straw, fiber mulch, water, fertilizer, agricultural lime, grass seed, and tackifier) helps control runoff as well, in some settings this mixture may not be as resistant to erosion as the compost method. Silt fences and straw bales are often used in conjunction with hydroseeding; however, compost berms are as good as or superior to silt fences or straw bales in filtering soil particles from stormwater and can allow more water to absorb into the soil. The compost mixture also stimulates the seeds to germinate more quickly and grow deep roots.

Compost has also proven beneficial to water quality. The EPA has characterized non-point source pollution as the leading cause of contamination in U.S. receiving waters and highways as a major contributor. In response to the issue, some DOTs have begun to pursue use of compost on highway embankments as a best practice in controlling pollutants in runoff from highways and a source of credit in meeting water quality requirements. Compost decreases pollutants by chemically binding substances, such as heavy metals and toxic organics (including hydrocarbons, pesticides, and herbicides), many of which are subsequently disposed of through bioremediation. As such, compost filters can be used to help clean stormwater discharge before it enters receiving waters. A Washington State DOT study on BMPs for stormwater runoff in confined spaces evaluated various filter media having potential for use in filtration vaults found that garden bark, peat moss, sand, and compost are the best filter media for treating stormwater runoff in vaults. These media have acceptable hydraulic properties to pass water through the filters and have good pollutant removal abilities. (38)

TTI conducted Research Study 0-1352, *Use of Compost and Shredded Brush on Rights-of-Way*, to determine for TxDOT the potential of compost and shredded brush to serve as erosion-control materials for use in highway rights-of-way. This effort was based on literature reviews and on field performance evaluations on 1:3 slopes and with up to 5-year rain events. The high performance of various compost test plots led TxDOT to include compost on the agency’s Approved Material List for Standard Specification Item 169 - Soil Retention Blanket and to conclude the cost savings were likely. TTI reported that research groups in the U.S. and around the world have effectively demonstrated the use of compost as an erosion control measure. In various tests, compost has shown to provide a physical barrier between rainfall and the surface soil, dissipating the effect of impact energy and minimizing erosive forces. To maximize water quality benefits from compost utilization, the Center for Transportation Institute-Texas Transportation
Institute, (TTI) of the Texas A&M University System, makes the following observations and recommendations for practitioners: (xl)

- High quality, mature compost will provide the most effective results. A low grade, immature or unstable compost can contribute to water contamination by leaching nutrients and/or heavy metals.
- Compost that is relatively dry (40 percent water content or less) effectively binds the elements and reduces leaching.
- A layer of compost can provide foot or vehicle access to slopes previously inaccessible as a result of mud created by heavy rains on clay soils. A layer of compost at the exit of a site will prevent mud from being tracked onto adjacent streets by vehicles leaving a construction site. Effective application thickness is an average of 7.6 cm.
- Application of compost with a moisture content of less than 25 percent will facilitate application and allow for better absorption of water during a storm event.
- A particle size of 19mm was most effective as an erosion control method and as a soil amendment. The larger pieces were less aesthetically acceptable for landscape purposes, and the finer grade was less effective as an erosion control method. Coarser grades are best for steeper slopes.
- Compost can be effectively used on slopes up to 70 percent (35 degrees)
- Extend compost cover for 0.61m to 0.92m above slope to reduce the velocity of flow or possibly construct a berm.
- Consider end use of area to determine which grade of compost will be best suited for the site. An area that will be landscaped may require a finer grade to avoid repeated application of finish grade compost for soil amendment.

The Federal Highway Administration’s Eastern Federal Lands Highway Division (EFLHD) tested compost in a very steep environment on a landslide site along the Blue Ridge Parkway near Asheville, NC. To EFLHD’s knowledge this project was the first time compost was applied to roadside terrain this steep; parts of the slope exceed a 45-degree angle and installers had to rappel down. EFLHD was operating under a number of other constraints in addition to very tight timeframe. Conventional equipment could not be used on such steep slopes and late May-early June was a sub-optimal season for establishing vegetation. Water quality and protection of artesian springs in the area were also priorities. EFLHD and the National Park Service wanted to establish a green, vegetated slope on the repaired section to prevent excessive runoff, and to prevent the introduction of noxious weeds through topsoil, straw, or hay. Partially installed compost withstood extremely heavy rainfall and shielded seeds during the following two months of drought until re-germination conditions improved. AASHTO’s FP-96 Section 713.05 specifications for mature compost were modified to fit the site conditions and meet appropriate compost tests in accordance with EPA and U.S. Composting Council requirements. (xlii)
Composting Deer Carcasses

The New York State DOT (NYSDOT) is addressing its obligation to remove dead animals from roadways and adjacent areas in an innovative and environmentally sound fashion by composting deer carcasses. In fiscal year 2001, NYSDOT responded to almost 25,000 deer mortalities. Notably high rates of deer/vehicle accidents occur in the lower Hudson Valley, where NYSDOT Region 8 reported approximately 8,000 dead deer in fiscal year 2000, even though the Region maintains only about 12 percent of the agency’s centerline miles. These disposal challenges have been accompanied by a decrease in the number of rendering companies available to collect and dispose of the carcasses. With growing developmental pressures and more stringent environmental regulations, fewer deer can simply be disposed of in wooded areas. Deer picked up during weekend hours must be kept at a yard site until transfer to a landfill or other disposal option is possible. Multiple handling of the deer carcasses causes additional hours of labor and adds to the disposal cost of deer. Moreover, deer that are stored at a yard for more than 12 hours start decomposing, making rehandling highly unpleasant for workers.

NYSDOT examined farm practices of composting of livestock mortalities with woodchips or sawdust. While decomposition is slow via a typical pit burial, total body decomposition can be achieved by composting within a few months. The compost end product, once deemed safe, has potential re-use within the highway environment. NYSDOT and the NYSDEC developed the Guidelines and basic steps to achieve optimal results and ensure human health and environmental protection. This example is noted as the Deer Carcass Composting – Practice Guidelines in the Appendix.(xlii)

Recycling and Reducing Waste/Emission

Herbicide reduction practices and examples are included in the vegetation management section. Reduced salt and sand usage practices and accomplishments are discussed in Chapter 8.

Missouri DOT’s Efforts to Reduce, Reuse, and Recycle

Missouri DOT offers the following list of areas for recycling applications in maintenance, many of which are applicable to other parts of the organization.(xliii)
Recycling and Reuse Activities

- Office paper
- Steel drums used for other purposes after emptied
- Automotive and Ni Cad and all rechargeable Batteries
- Sealed Lead Acid Batteries used for backup power at intersection lights
- Waste tires and tire scrap found along the highways
- Telephone books
- Used motor, gear and hydraulic oil
- Used Oil Filters
- All types of acceptable paper
- Aluminum highway road signs
- Salvage sign button copy (72% cost savings)
- Solvent recovery still to recycle solvents
- Antifreeze changed to extended life, no need to recycle
- Recycle Freon
- Scrap computer paper used for note pads
- Splice broken wood and metal sign posts
- Straighten and reuse damaged guardrails
- Reuse boxes for shipping highway signs
- Reuse damaged bridge structural steel
- Used rotomillings in mixed asphalt
- Aggregate placed under asphalt storage tank to absorb spillage, then used on roads
- Reuse concrete from roadway repair for erosion control
- Petroleum contaminated soil is cleaned and reused
- Reuse obsolete guardrail panels for cribbing and erosion control
- Use damaged metal posts for equipment storage racks
- Waste paint solvents are used as blended industrial fuel
- Metal scrap found along the highway
- Aluminum cans at rest areas and in the offices
- Lead Paint chips sent to lead smelter to recover the lead (all of the material including the shipping containers are used in the process)
- Recap equipment and truck tires
- Roadway rotomillings used in roadway rehabilitation projects
Waste Reduction Activities

- Completed statewide survey of all maintenance facilities for recycling and environmental concerns and finishing up on the remaining facilities
- Recycling all light bulbs statewide
- Abrasive recycling for sandblasting paint (waste reduction of about 80-90%)
- Switching to permanent Antifreeze
- All water based traffic paint is bought in recycled totes or in bulk, eliminating waste drums
- Bioremediate Petroleum contaminated soil instead of sending it to a landfill
- Recycle laser toner cartridges back to supplier
- Corrugated cardboard collected
- Scrap steel and aluminum from maintenance activities and roadside cleanup
- Recyclers pick up used oil
- Provide recycling information to about 5,200 Adopt-a-Highway groups
- Include a recycling tip column in the “Roadside Review” newsletter
- Purchased equipment to extend the life of nickel cadmium batteries
- Collect lead-acid batteries for resale or recycling
- Removed the word “Virgin” from non-structural plastic product specifications
- Duplexed copies
- Hazardous materials/waste survey maintained department-wide
- District pesticide inventory maintained to better distribute and use pesticides
- Steel shot and sand blast residue containing lead paint sent to lead smelter for reuse as a raw product
- Parts cleaner solvent collected by recycler or blended for industrial fuel
- Use biodegradable cleaners for parts and equipment
- Maintain a list of products with recycled materials
- Chip waste wood, tree limbs and brush for landscaping and compost
- Use biodegradable non-toxic degreaser on vehicles
- Recap loader and truck tires
- Rotomill old asphalt and use in place without removing instead of land filling
- Micro surfacing uses less material and prolongs a roadway surface
- Calcium sultanate to encapsulate lead paint on bridges
- Conducted tests on motor oil and extended the oil change time from every 2,000 miles to every 7,000 miles on most vehicles
- Use Soy Wash, a biodegradable soybean by-product and other non-hazardous biodegradable products to clean equipment
• Stripper cleaning fluid used in striping paint no longer used and switched to exclusively water based

Recycled Product Procurement
• Purchased recycled content paper, towels, toilet paper, envelopes
• Reclaimed rubber to use in asphalt on test project
• Promotional items with recycled content such as pencils, car litter bags, Frisbees, etc.
• Department news letter “Roadside Review” is printed on recycled paper
• Sawdust to cover crack pouring asphalt
• Wet bottom boiler slag (cinders) for snow removal
• Fly ash in concrete
• Waste roofing shingle granules for snow removal
• Recycled plastic wheel stops
• Recycled paper for printing of 3.5 million highway maps, brochures and newsletters
• Re-refined oil in department automobiles
• Expanded use of recapped tires
• Expanded use of sawdust and mulch for roadside beautification
• Fly ash for fill material and pavement grouting
• Lime Kiln dust for soil stabilization
• Truck tire sidewalls used for traffic cone ballast
• Used aluminum signs refurbished and used again
• Iron mountain chat by product in asphalt and on bridge decks
• Used oil heaters to heat shops
• Wet bottom boiler slag for traction surface on bridges
• Water base striping paint (reduces volatile emissions and hazardous waste generation)
• Water base bridge paint (reduces volatile emissions)
• Use lead mine tailings in concrete and pavement, removing it from the environment

On-going and Future Recycling Activities
• Working with carpet producers to recycle carpet and purchase recycled carpet
• Experimenting with recycling absorbent materials used to soak up oil, including paper towels and rags. The oil is extracted and the absorbent material returned for reuse
• Use compost from city recycle centers
• Use low growing grass to reduce mowing and spraying (waste and pesticide reduction)
• Waste wood products used as absorbent material to contain spills
• Encouraging contractors to use a high pressure, low volume water blast on bridges to further reduce the waste by as much as 99%
• Testing the use of plastic pilings made from recycled materials to stabilize highway slopes and embankments
• Experimenting with the use of crumb rubber from scrap tires to fill expansion joints on concrete highways.
• Experimenting with rubberized asphalt over lays of less than 1 inch thick made up of rubber and Styrofoam
• Testing new form of rubberized asphalt on highways around the state.
• Attend national and international seminars on use of recycled materials in highways.

Mass Highway’s Pollution Prevention Program for Construction and Maintenance
For the past several years, Mass Highway has undertaken efforts to prevent pollution through conservation and reduction programs relating to construction projects as well as operation of maintenance facilities. Mass Highway maintains a number of pollution prevention initiatives relative to air, energy, water, and solid waste and toxics reduction.

Table 1: Mass Highway Pollution Prevention Initiatives by Media

<table>
<thead>
<tr>
<th>Media</th>
<th>Initiatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Pollution Prevention</td>
<td>Fleet inspections to ensure vehicle emissions compliance; garage location consolidations to reduce overall fume emissions; and installation of vapor recovery systems for underground storage tanks.</td>
</tr>
<tr>
<td>Energy Conservation</td>
<td>Installation of high efficiency lighting systems.</td>
</tr>
<tr>
<td>Sold Waste Source Reduction</td>
<td>Waste reductions have been realized through the expanded use of recycled and re-manufactured products including the construction of salt sheds composed of 50 percent recycled plastic aggregate.</td>
</tr>
<tr>
<td>Water Conservation and Pollution Prevention</td>
<td>Installation of vehicle washwater recycling units at several maintenance facilities.</td>
</tr>
<tr>
<td>Toxics Use Reduction</td>
<td>The Pollution Prevention Task Force has prepared technical evaluations of products and made recommendations for reduction of the following substances: petroleum-based hydraulic and lubricating oils; automotive parts cleaning solvents and associated cleaning systems; perchlorethylene cleaning solvent and miscellaneous automotive lube/cleaning products. In response to these recommendations, the Department: switched to non-chlorinated solvent brake cleaner; eliminated solvent parts cleaner tanks in some districts, and; reduced automotive fluid use through the leasing and out-servicing of fleet vehicles.</td>
</tr>
</tbody>
</table>

Mass Highway is continuing to identify, evaluate and implement pollution prevention initiatives. Pollution prevention opportunities and activities under current consideration include:

Chapter 10: Roadside Management and Maintenance: Beyond Vegetation
• Eliminating solvent parts cleaners statewide.
• Upgrading maintenance garages to include state-of-the-art automated oil dispensing and quick drain capabilities.
• Use of vegetable-based diesel fuels to reduce heavy equipment air emissions.
• Purchasing low volume high pressure washers for vehicle/equipment cleaning to reduce water use.
• Purchasing aqueous brake cleaning systems to eliminate all brake solvent use and eliminate asbestos dust hazards.
• Use of vegetable based hydraulic oil.
• Use of neutral pH, non-oil emulsifying vehicle degreasing/washing detergents to eliminate caustic detergents and improve effectiveness of oil/water separators.
• Identifying specific areas within a given project for experimental or full usage of new products comprised of solid waste materials.
• Developing specifications and special provisions for incorporating recycled materials into construction projects.
• Developing and tracking test applications of recycled products and materials to document product effectiveness relative to standards for highway performance and environmental acceptability.
• Investigating and implement economically viable opportunities to reuse and recycle solid and hazardous waste generated by routine operations such as waste oil, street sweepings, catch basin cleanings, tires, construction and demolition debris, special waste, scrap metal and wood waste.
• Active participation of the Research Needs Committee to identify potential programming and funding opportunities; provide input of needed material reuse and recycling research efforts and to keep up to date on new recycling and reuse technologies, regulations and activities successfully utilized by industry and other state transportation departments. working with state agencies and other organizations to develop training and educational workshops on the use of recycled materials.
• Actively participating with state and federal regulatory agencies on Beneficial Reuse policies.

Mass Highway also initiated a Pollution Prevention Task Force (PPTF) as part of the Environmental Management System Implementation Plan to reduce risk and improve the overall environmental quality at Department facilities through toxic use reduction. The PPTF is comprised of District HazMat Coordinators and other Environmental personnel who cooperate with District Operations personnel in leading pollution prevention efforts for maintenance facilities.

Mass Highway prepares an annual recycling report to meet the requirements of the Commonwealth of Massachusetts’ 2000 Transportation Bond Bill (Chapter 235 of the Acts of 2000) and define Mass Highway’s accomplishments in terms of recycling, environmentally preferable procurement, and pollution prevention; to discuss and
promote ongoing projects; and to establish goals for the coming years. (xliv) In 2000, Mass Highway recycled more than 15,000 tons of waste and used more than 111,000 tons of recycled materials in construction projects. The agency spent nearly $27 million on recycled-content and environmentally preferable materials and products, considered an economic boon for the state. In 2000, Mass Highway attained an overall recycling rate of 76 percent by recycling more than 15,000 tons of its own waste stream, a 10 percent increase over the previous year and more than double that accomplished by municipalities. Waste materials recycled include antifreeze, construction and demolition debris, street sweepings, and tires.

The majority of MHD’s waste stream is composed of materials collected from the State’s highways and stored at its depots. This includes everything from street sweepings, to construction and demolition debris (C&D), to tires. After being transported to MHD’s depots these materials are segregated for future reuse, disposal, or recycling. Segregation ensures greater recyclability and less processing of these materials by reducing contamination. The most prevalent (and problematic) materials collected by MHD are street sweepings, C&D debris, and catch basin cleanings. Materials such as asphalt, brick, and concrete (ABC), and scrap metal have significant value and well-developed markets and are easier to recycle. In 2000, nearly 16,000 tons of waste materials including ABC, C&D, scrap metal, street sweepings, wood, and yard wastes & leaves were collected and stored at MHD depots. Close to 15,000 tons of these materials were recycled. Over 90 percent of the over 300 tons of automotive related waste products created at MHD depots is recycled. Office wastes created by MHD’s six offices are typical and include paper, paper products, and toner cartridges. Mass Highway counted 15.75 tons of paper recycled, reaping energy savings of 161 million BTU’s or emissions savings of 12 tons of carbon dioxide.

Mass Highway tracks agency performance by the percentage recycled in different waste type categories: (xlv)

Table 2: Mass Highway Waste Material Disposal & Recycling Rates

<table>
<thead>
<tr>
<th>Waste Type</th>
<th>Amount Disposed (Tons)</th>
<th>Amount Recycled (Tons)</th>
<th>Percentage Recycled</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Automotive Wastes</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Antifreeze</td>
<td>0.00</td>
<td>3.24</td>
<td>100.0%</td>
</tr>
<tr>
<td>Batteries</td>
<td>0.00</td>
<td>2.00</td>
<td>100.0%</td>
</tr>
<tr>
<td>Filters</td>
<td>2.65</td>
<td>3.26</td>
<td>55.2%</td>
</tr>
<tr>
<td>Gasoline</td>
<td>0.48</td>
<td>1.69</td>
<td>77.9%</td>
</tr>
<tr>
<td>Oil</td>
<td>0.00</td>
<td>21.90</td>
<td>100.0%</td>
</tr>
<tr>
<td>Tires</td>
<td>0.00</td>
<td>259.07</td>
<td>100.0%</td>
</tr>
<tr>
<td>Other</td>
<td>27.85</td>
<td>5.08</td>
<td>15.4%</td>
</tr>
<tr>
<td><strong>Containers</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aluminum Cans</td>
<td>0.06</td>
<td>0.85</td>
<td>93.4%</td>
</tr>
<tr>
<td>Steel Drums</td>
<td>0.25</td>
<td>6.30</td>
<td>96.2%</td>
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</table>
Fixtures

<table>
<thead>
<tr>
<th></th>
<th>Quantity</th>
<th>Cost</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alkaline Batteries</td>
<td>0.00</td>
<td>0.03</td>
<td>100.0%</td>
</tr>
<tr>
<td>Ballasts</td>
<td>0.00</td>
<td>0.26</td>
<td>100.0%</td>
</tr>
<tr>
<td>Florescent Bulbs</td>
<td>0.00</td>
<td>1.20</td>
<td>100.0%</td>
</tr>
<tr>
<td>Surplus Paints</td>
<td>2.18</td>
<td>2.40</td>
<td>52.5%</td>
</tr>
</tbody>
</table>

Office Waste

<table>
<thead>
<tr>
<th></th>
<th>Quantity</th>
<th>Cost</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardboard</td>
<td>0.50</td>
<td>0.50</td>
<td>50.0%</td>
</tr>
<tr>
<td>Magazines &amp; Newspapers</td>
<td>0.00</td>
<td>3.45</td>
<td>100.0%</td>
</tr>
<tr>
<td>Paper</td>
<td>6.35</td>
<td>15.75</td>
<td>71.3%</td>
</tr>
<tr>
<td>Toner Cartridges</td>
<td>0.00</td>
<td>0.56</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

Operations Wastes

<table>
<thead>
<tr>
<th></th>
<th>Quantity</th>
<th>Cost</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absorbents</td>
<td>1.40</td>
<td>0.00</td>
<td>0.0%</td>
</tr>
<tr>
<td>ABC Debris</td>
<td>0.00</td>
<td>1597.37</td>
<td>100.0%</td>
</tr>
<tr>
<td>Catchbasin Cleanings</td>
<td>650.00</td>
<td>0.00</td>
<td>0.0%</td>
</tr>
<tr>
<td>C&amp;D Debris</td>
<td>497.24</td>
<td>2031.50</td>
<td>80.3%</td>
</tr>
<tr>
<td>Clean Wood</td>
<td>20.00</td>
<td>1028.57</td>
<td>98.1%</td>
</tr>
<tr>
<td>Scrap Metal</td>
<td>0.00</td>
<td>303.57</td>
<td>100.0%</td>
</tr>
<tr>
<td>Street Sweepings</td>
<td>100.00</td>
<td>9664.06</td>
<td>99.0%</td>
</tr>
<tr>
<td>Treated Wood</td>
<td>16.00</td>
<td>113.19</td>
<td>87.6%</td>
</tr>
</tbody>
</table>

Trash

<table>
<thead>
<tr>
<th></th>
<th>Quantity</th>
<th>Cost</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>3535.80</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table: 4860.76 15065.80 75.6%

10.13 PRESERVING AIR QUALITY IN MAINTENANCE AND OPERATIONS

Ozone Action Days

DOTs are beginning to partner with other state agencies and metropolitan regions to reduce ozone on red alert days and as part of larger partnership efforts. For example, New York State DOT partners with New York City and the New York Metropolitan Transportation Council to implement a coordinated regional clean air awareness program. Within the agency, NYSDOT works to reduce air quality effects from transportation by disseminating warnings of forecasted unhealthful ground level ozone conditions to a network of NYSDOT regional offices, local agencies, and interested parties. The warnings, along with recommended transportation actions to reduce emissions, are broadcasted to affected areas of the state. The information is transmitted electronically and by telephone and fax. Designated contacts at each receiving location then implement their action plans. New York agencies participating in this Ozone Action Days program deliver the alert information to the public through such means as variable message signs on highways, bridges, and tunnels; and the dissemination of the warnings to area employers and the media.(xlvi)
Flex-time programs
Some DOTs have implemented flex time programs to contribute to the alleviation of congestion, air pollution, and ozone formation. DOTs have also provided shuttle services at the noon hour to help workers avoid having to drive to lunch.

Delaying or Rescheduling Ground Maintenance
A number of DOTs, including Georgia, New Jersey, and New York State, are delaying or rescheduling ground maintenance activities that require gasoline powered equipment such as mowers, blowers, weed-eaters, chain saws, etc. In some cases use of off-road construction equipment is delayed until after 6 p.m. as well.

Restricting or Limiting Painting
Georgia DOT is exploring restricting and/or limiting indoor and outdoor painting on Action days until after 6 PM or not at all on these days. New Jersey DOT also defers spraying and painting on Ozone Action Days. (xlvii)
The Virginia DOT examined episodic limits on asphalt paving and traffic marking activities, in particular prohibiting road paving and traffic marking on ozone action days; however, the benefits from the possible control measures did not meet the NOx or VOC threshold necessary for implementation as a regional air quality control measure in Virginia. Asphalt paving has been found to have de minimis emissions; however reductions in traffic marking have been implemented by Maryland DOT and Montgomery County on Ozone Action Days. (xlviii)

Regular Vehicle Maintenance and Tune-Ups
Most DOTs have programs to perform regular maintenance and tune-ups. Changing the oil and checking tire inflation can improve gas mileage, extend vehicle life, and reduce air pollution.
Wisconsin DOT operates a very effective inspection/maintenance (I/M) program. In 2002, WisDOT produced a report reviews the status of existing I/M programs in the United States and I/M research being performed by other states. The report also reviews the status of current I/M technology, including second generation onboard diagnostics (OBDII) testing, identification of liquid gasoline leakers, particulate/diesel emissions control program, remote sensing programs, toxic emission control programs, supplemental federal test procedure, and EPA activities related to I/M programs. The study concluded that additional research is needed to better define future I/M requirements. Key recommendations included the need for a malfunction indicator lamp response study, evaluation of stand-alone alternatives to centralized OBDII inspection, a determination on how to find vehicles with liquid leaks and other gross evaporative emission problems, and assessing the need for tailpipe tests on high mileage OBDII equipped vehicles. (xlix)

Alternate Fuel Vehicles and Refueling Stations
Some DOTs have been facilitating reduction in air pollution through the use of alternative fuel vehicles. The Colorado DOT has purchased electric bicycles for environmental staff at the District 6 office. Other DOTs and many municipalities have purchased cars and trucks powered by natural gas, hybrid, E85 (ethanol), and electricity.
The Central New York Regional Transportation Authority with the support of the United States Department of Transportation and the New York State Department of Transportation has been a leader in the testing and implementation of compressed natural gas as an alternative vehicle fuel. With a growing fleet of compressed natural gas busses, the agency needed a refueling station. Through interagency cooperation, public-private partnerships, and proactive public involvement, the team utilized Congestion Mitigation and Air Quality Improvement Program funding sources to build an indoor state-of-the-art compressed natural gas refueling facility. The project also included a public compressed natural gas fueling station, which has encouraged more widespread public and private vehicle fleet conversion to compressed natural gas in the greater Syracuse-Onondaga County area. The refueling station has provided many benefits to the surrounding communities by reducing air pollutants from mobile sources and has helped to improve the region’s air quality by minimizing congestion and providing the added benefit of public transportation.\(^{(l)}\)

**Night Refueling and “Don’t Top off the Tank” Policies**
To reduce release of gas fumes in the air, some DOTs have encouraged employees to stop short of a full tank to reduce pollution. Refueling at night can also prevent gas fumes from heating up and creating ozone. Georgia DOT is among those implementing this approach.\(^{(li)}\)

**Truck Stop Electrification**
The Congestion Mitigation and Air Quality (CMAQ) program supports improvements pertaining to operations. In 2003, FHWA issued expanded guidance and provided more information on the eligibility of truck stop electrification (TSE) and other idle-reduction measures under the CMAQ program. The guidance documents and other reference materials about the CMAQ program can be found online. The guidance notes that long-duration idling related to freight movement has become the norm for business operation at highway truck stops, airports, and at intermodal transfer points, emitting pollutants, consuming fuel, producing noise, and increasing maintenance costs. USDOT and EPA have formed a partnership to work with state transportation and environmental agencies, and MPOs to accelerate the implementation of TSE projects on routes heavily traveled by long-haul trucks, to identify appropriate locations and assist in jointly funding projects. CMAQ funded TSE projects must occur in close proximity to and primarily benefit a nonattainment or maintenance area and be included in a conforming transportation plan and TIP. Further information on alternatives to idling can be found at the CMAQ website.

**Atmospheric Dispersion of Deicing Salt Applied To Roads**
The Illinois Department of Transportation funded a study to understand and describe the atmospheric transport of road salt in the form of sodium chloride (NaCl) applied to highways as a deicing material, focusing on interstates in the Chicago area. Results from chemical analysis of aerosol and snow samples are reported that show progress toward characterizing the road salt aerosol with respect to its size, mechanisms of emission, range of atmospheric transport, and mechanisms of deposition. Analysis of the preliminary data suggest: \(^{(lii)}\)
A large portion of the salt aerosol that becomes aerosolized is emitted after the road surface has been cleared of snow and ice.

Approximately 90 percent of the airborne road salt is contained in aerosol particles of diameter larger than 2.5 micrometers (µm) or 10^{-4} inches.

The salt deposition pattern near a treated roadway as determined by snow samples decreases consistently with distance from the road. Average deposition values for a single snow event were found here to yield an aerial deposition of 0.06 grams per square meter (0.6 pounds per acre) at 500 meters (1,640 feet) from the road. The corresponding value for the total deposition per length of roadway is 85 grams per meter or g/m (300 pounds per mile or lb/mi).

Based on evidence from aerosol and snow sampling, the most important emission process is erosion of dried salt material from the roadway followed by dry deposition of the aerosolized salt material. A predictive atmospheric loading model is scheduled for completion in the last half of 2004. No practices to minimize atmospheric deposition from deicing salt are being recommended based on research to date. (liii)

**Open Burning**

Open burning can produce hazardous contaminants, unreasonable smoky conditions, additional fire hazards, and unsafe driving conditions. In areas where open burning is regulated, such as cities, counties, state or federal lands (USFS-BLM), or where air quality standards are in effect, a burning permit is required and burning often will be allowed (if at all) only under very restrictive conditions.

Every attempt should be made to remove and dispose of flammable materials in approved locations such as landfills. Brush and small trees can be chipped and blown back on the right-of-way or hauled away and stored for later use as erosion control mulch. Brush mowing may be another alternative to consider, if practicable.

If it is determined that burning is the best or only suitable method of disposal, it should be done with all due caution, traffic control, and strict adherence to all applicable rules and regulations.

**10.14 Painting Operation Stormwater BMPs**

Environmental stewardship practices for painting operations minimize exposure of paints and solvents to stormwater run-on and runoff. These Caltrans recommended practices safeguard against the accidental release of painting materials into storm drainage systems and natural watercourses. (liv)

Following these storage practices will reduce the exposure of paints and supplies to stormwater run-on and runoff at maintenance facilities:

- Where feasible, store paint materials in an area with a canopy or roof designed to direct runoff away from the storage area.
- Check for leaking or ruptured paint containers.

Careful transport of painting material to and from the work site helps to prevent accidental spills:
• Load and unload paint on level ground when using a forklift to minimize the chance of tip-overs and potential spills.
• Ensure that all paint pallets are securely fastened before moving.
• Secure the paint containers to the transport vehicle using approved methods such as ropes and straps.
• Transport paint and materials to and from work sites in containers with positive locking lids.
• Do not transfer or load paint over or near drain inlets, stormwater drainage systems, or watercourses.

Proper application practices inhibit paint chips and excess paint drift from being transported to storm drainage systems or watercourses by wind or other means. See section 7.3, Bridge Painting/Coating/Sealing and Containment Stewardship Practices for more detailed environmental stewardship practice.

• Monitor weather and wind direction to ensure that paint drift is minimized and does not enter drain inlets, stormwater drainage systems, or watercourses.
• If possible, use canvas or plastic tarps under the work area to capture excess paint or paint chips.
• To avoid spills, follow proper operational procedures for lane striping and paint applications.
• Ensure that the paint spray gun remains closed when not in use to prevent leaks.

Thorough cleanup and disposal practices ensure that paint-related hazardous materials are handled properly.

• Do not clean out the paint spray gun over the ground.
• Wipe up small paint spills immediately with rags. For larger spills, use dry absorbent material.
• Collect all excess material and paint wash solutions in appropriate containers. Secure all containers and transport to a Maintenance facility for proper disposal.
• Dispose of used absorbent and rags, and empty paint and solvent containers in appropriate containers at a Maintenance facility that has approved storage areas.
• Special procedures may be required when removing yellow stripes.
• Follow proper waste disposal procedures. Dispose of hazardous waste according to regulations. Contact the District Maintenance HazMat Manager or refer to the Maintenance Hazardous Waste Manual for more information and guidance.

10.15 ROAD WASTE MANAGEMENT

DOT road maintenance activities generate large amounts of dirt, litter, or road waste debris from sweeping roadway surfaces, picking up litter, clearing vegetation, cleaning highway drainage systems, and clearing landslides from roadways. Road waste materials generally share the same contaminants of concern – bacteria, litter, sharps (glass, needles, etc.), chemicals from spills or illegal dumping, gasoline, oil, heavy metals.
In the past DOTs sometimes stockpiled or disposed much of this roadwaste at maintenance yards, back lots, or along highway right-of-way; however, these options are less viable with growing amounts of waste material, increasing highway traffic and pollution, less available land, and stricter environmental regulations. Managing DOT roadwaste using conventional methods calls for solid waste to go to landfills and liquid waste to sewage treatment plants. Just separating roadwaste into liquid and solid portions using conventional methodologies can be extremely difficult and expensive. Waste is often required to undergo expensive testing or sorting prior to disposal. Likewise disposal of all DOT solid waste in landfills can be impractical, inefficient and cost prohibitive. Landfills and sewerage hookups are not readily available for DOT roadwaste disposal in many areas.

Many roadwaste pollutants are easily detectable. Litter and trash in roadwaste piles can be detected visually. Many chemical pollutants can be detected as odd colors, stains, discoloration, or chemical smells. Other times pollutants can only be detected through chemical testing, or in the case of knowing oil or grease is present, it may still take laboratory testing to determine if levels are toxic. Heavy metals detection requires laboratory testing. Determining risk is key to knowing disposal options. If waste is full of trash, smells of oil and gasoline, it has a high toxic risk and reuse options are limited; hauling waste to a high-risk waste dump can be the quickest option. Trash may be able to be screened from medium risk waste and stored in an appropriate spot while toxic hydrocarbons (present from gasoline or oil contamination) break down. Later, such material may be appropriate for shoulder repair or patching holes under proper circumstances. Some roadwaste, such as landslide debris, has no (or low) toxic risk and can be used as clean fill. With clean waste, the main issue is finding an environmentally appropriate location for final placement where it will not erode or impact a wetland.

ODOT undertook a Roadwaste Research Project in conjunction with the Oregon Department of Environmental Quality and various agencies concerned with highway operations to identify more efficient and effective ways to manage roadwaste materials. The first phase was a literature review, which identified current roadwaste issues and problems across the country and summarized the most effective methods yet developed to manage this special waste stream. Phase 1 findings were documented in the report “Roadwaste: Issues and Options”. The second phase of the project pursued some of the more promising roadwaste management methods identified in Phase 1, with implementation and testing in the field. ODOT worked with local highway agencies in the Portland area to develop methods that would efficiently reuse or dispose of roadwaste generated from local urban roads. Field trials were conducted to collect data on pollutant levels associated with various roadwastes and disposal methods. Phase 2 findings were documented in ODOT Roadwaste Field Trials. The Roadwaste Management Report summarized the findings of the research project and offered recommendations on how ODOT Districts can use this information to better manage roadwaste materials. The major findings of ODOT’s Roadwaste Project can be summarized as follows:

- Roadwaste covers a broad range of materials with a broad range of environmental risks. Roadwaste pollutant levels reflect highway traffic counts and surrounding land uses. Levels of pollutants and trash found in roadwaste will vary widely.
- Some roadwaste is entirely free of contamination and can be managed as clean fill. Managing roadwaste efficiently and saving on disposal costs relies upon
knowing when the waste is dirty, when it is clean, and when it is mildly contaminated. Roadwaste does not classify as a “hazardous waste” (except for the very rare spill or illegal dumping incident).

- Knowing the characteristics and volumes of the waste a District collects helps in the selection of management methods that most efficiently address actual environmental risk.
- Identifying and separating differing roadwastes allows more ready management while requiring less frequent analysis. District-level baseline waste characterizations help identify the most appropriate management methods to address actual risks.
- Roadwaste must be properly managed to address environmental risk. Storing low risk roadwastes separate from more contaminated or trashy waste makes reuse easier and will help control management costs. Ready reuse is available for some materials; other materials require simple treatment. More contaminated materials may require a significant investment in treatment or ongoing tracking unless a conservative management option is selected; e.g., disposal in a permitted landfill. Complying with waste recommendations when nonhazardous wastes are mixed with hazardous wastes costs additional maintenance dollars.
- Partnering with local agencies will save resources, and risks are minimal.
- Efficient management of DOT roadwaste will require District level planning.

ODOT’s Roadwaste Management Flowchart offers a planning process that can be used to manage the roadwastes that ODOT collects and environmental risks associated with them. Finally, it presents specific waste treatment and disposal options and discusses sorting, reuse, and recycling options.\(^{(lviii)}\)

**Stormwater System Residuals and “Vector Waste:” Catch Basin, Sump and Line Cleanout**

On average, vector waste is the most contaminated type of roadwaste with the highest environmental risk. “Vector waste” is so named after a brand of eductor truck commonly used to vacuum out catch basins, sumps and storm sewer lines. Certain factors generally increase the risk of toxic contamination. Generally, the more silts or fine particles present, the higher the chance of contamination. Dead-end sumps will be more contaminated than catch basins, since catch basins let a lot of fine material pass through them. The higher the traffic count or average daily traffic (ADT), the higher the contamination levels. Wastes from more frequently cleaned sumps (or catch basins) can be expected to be cleaner.

Because vector waste contains water, there is an increased risk for runoff and ground infiltration. Infiltration of contaminated water through porous gravel, sand, and fractured bedrock may threaten groundwater. Without contact of oxygen and sunlight, contaminants do not readily degrade. The fine particles in vector waste are easily suspended in runoff and can dramatically impact stream health – both immediately and in the long term. Fines can carry high levels of contaminants and themselves pose threats, e.g., clogging fish gills and burying spawning beds. This wastewater requires special
management and cannot be returned to the storm drain system or disposed on land
without a water quality permit from the state environmental agency or EPA.
Basic environmental practices for dealing with vactor waste are outlined in Appendix B
of ODOT’s report:

- Liquid fractions may not be disposed back into stormwater catch basins or
  collection systems that discharge to surface waters, wetlands, or the subsurface
  unless. Instead, these liquids should be disposed, after approval is obtained, to a
  sanitary sewer.
- Sanitary sewers may require placement of vactor truck decant water only into
  high flow sewers or only after 24 hours to settle out the suspended solids.
- Where sanitary sewers are not available, the DOT hazardous materials section
  may identify DOT-owned areas where public access is limited for field decanting
  of vactor solids or liquids under a state permit. Sites for land application of decant
  water should be free of runoff concerns and able to hold petroleum contaminants
  in the top layer of soil to insure the best chance for treatment, with controls
  preventing public access. Overuse should be avoided to prevent build up of
  contaminants.
- Vactor solids tend to be more contaminated than liquids. Being harder to screen
  for trash and with less ready reuse options, vactor solids are a good candidate for
  disposal at a permitted landfill. An agreement to provide this material for use as
  landfill daily cover can substantially reduce disposal costs. All waste disposed at
  permitted landfills must be dry enough to pass the “paint filter test” and may face
  other requirements.
- Some local agencies have invested in dewatering facilities and may be open to
  partnering.

Vac waste from bridge culvert cleanout normally produces rock and trash and very little
fine material. Bridge scuppers will capture only well-washed rock and gravels. Since
these wastes pose no real risk, they do not need to be tested. Free from trash, they are
ready for immediate reuse. Clean, well-washed rock in the maintenance of other
stormwater facilities can also be reused. Other vactor cleanout waste in the District might
have unique characteristics and deserve separate management under its own category.

Road and Roadside Dirt and Debris

Sweeper trucks remove dirt and debris from the highway system. Contaminant
concentrations in sweepings are usually lower than those found in vactor waste, but even
relatively clean sweepings can contain toxins and require careful management. The risks
posed by these materials are similar to vactor wastes. Wastewater collected with wet road
materials has many of the same concerns as vactor truck wastewater. Sweeper loads full
of fallen leaves and other organic materials may be better managed by composting than
by classic waste disposal.
The City of Portland separates street debris into heavy sand and light debris. Until 1988
sweeper debris was disposed of in general purpose landfills. By 1988 landfill space was
diminishing and disposal rates jumped from $16.50 to $42.25 per ton. The rate is now
$75 per ton. Sand, 20 percent of the volume but 80 percent of the weight of the debris,
could be disposed of for free as cover materials. Separating sand from organic material saved the Bureau approximately $675,000 the first year. (lix)

Basic environmental practices for dealing with sweeping dirt and debris are outlined in Appendix B of ODOT’s report:

- Screen regular sweepings, disposing trash and litter only at DEQ-permitted landfills.
- Store materials such that rainfall will not cause any runoff. (Contaminated runoff could impact other areas on site, wetlands, or surface waters.) Store sweepings to minimize the potential for site impacts from roadwaste contaminants. Storage on an impermeable surface with leachate collection and/or protection from rainfall is preferable. Tarps may be used for cover, or berms or retention ponds may be used to contain runoff.
- Winter road sand may be collected and reused once screened and sized. If sand washing is required to remove excess fines, minimize site impacts, collect the fine particles, and prevent runoff. (Pretreatment by settling or flocculation then permitted discharge to sanitary sewer is a sound practice).
- Most roadwaste is very poor fill, tending to have poor compaction ratings, and reduces in volume substantially as organic matter decomposes.
- Storage, processing and reuse of materials other than road sand and clean fill may require a state solid waste permit. Composting over 25 tons per year usually requires a site-specific permit.
- Screened materials collected from areas known to have low impacts from roadwaste contaminants may be screened for trash and used as poor grade fill in DOT-owned and controlled areas. During storage and processing, fines should not be allowed to become airborne.
- Sidecasting of minimally contaminated sweepings onto non-ditched shoulders can be appropriate if these roadsides are not adjacent to surface waters, wetlands, or stormwater management systems with discharge to surface waters, wetlands or the subsurface.

**Winter Road Sand**

Quick pick up of winter road sand on urban streets can reduce toxic pollutants and result in net direct cost savings. Many DOTs and local governments have road sweeping programs to reduce air and water pollution. Pollution reduction benefits have been quantified in a few cases. A 2002 WisDOT/FHWA/USGS study evaluated the effectiveness of an improved highway sweeping program using a high efficiency sweeper as a best management practice (BMP) for reducing pollutants in urban highway stormwater runoff, believed to be the most complete attempt to date to document the use of a high efficiency sweeper program on an urban freeway section. Based on data collected and analyzed during the study, it was calculated that a once per week freeway sweeping program using a high efficiency can be an effective stormwater runoff best management practice (BMP) for an urban freeway section. WisDOT subsequently developed guidelines for the purchase and use of high efficiency sweepers. (lx)
Road sand quickly removed from roads after a thaw may be ready for reuse as is, or it may require a screening step to remove trash and/or to drop out the more contaminated and less useful fines. The recycled sand replaces new product that would otherwise have to be purchased, and recycling results in less waste to manage. Use of anti-icing and de-icing agents may reduce the need for road sand application.

**Ditching Spoils and Sediment Pond Cleanout**
Contaminant levels in ditching spoils will vary widely, depending on cleaning methods, water flow, traffic count, and surrounding land use. ODOT found that spoils collected from ditches draining high ADT roads in urban areas had contaminant levels as high as those found in vactor wastes, while ditchings from some rural areas tested completely clean. More rarely, rural ditch material had tested at high levels for heavy oils or other contaminants. ODOT manages rural ditchings from low-ADT roads as clean fill in most cases. Roadway sediment ponds detain roadway runoff, dropping out contaminated fines. The spill containment attributes of sediment ponds may require testing for a broader range of constituents. Limited contaminant data on ODOT Interstate 84 sediment cleanout showed levels similar to catch basin and sump waste, in very similar material.

**Landscape Cuttings: Greenwaste**
DOTs can collect high volumes of organic matter during road projects or as a result of slides. In the fall, leaves can accumulate on roadways and in right-of-ways. Taken together, waste organic materials are termed “greenwaste.” As buried organic matter can release toxic nitrates to groundwater, burial is not usually permitted. In addition, as vegetative matter decomposes it reduces significantly in volume, resulting in major settling issues on the ground surface – a problem shared to a lesser degree with sweepings and vactor wastes. Composting is the best alternative for clean greenwaste. Compost can be made on a district basis or hauled to a commercial composter if greenwaste volumes are low. See composting section.

**Construction Site Soils and Slide Debris**
Slide debris and construction site soils and slurries not impacted by road oils or heavy organic loads should be managed as clean fill. Greenwaste should be removed for composting. Care should be taken in storage and placement of these materials. In the Appendix is an example of generated waste from Oregon DOT.(72)

**Disposal and Re-use Options**
As transportation agencies, DOTs are required to accept long-term liability for the wastes it collects from highway maintenance. Only in cases such as a reported spill incident can the responsibility for waste management be placed on another party. Liability for environmental impacts from the wastes ODOT collects is unending; it is “cradle to grave.” The challenge is to substantially limit risk and liability while not incurring undue cost. Reuse and disposal are the two major choices for managing roadwaste solids.
Re-use of Roadwaste
The key to reuse is viewing roadwaste as something of value rather than as something to discard – as a potential product rather than a waste, in which case stringent waste management regulations may not apply. Rather than paying tipping fees for disposal, the product is used to replace materials the DOT might otherwise need to purchase. Reuse also reduces the burden on expensive and difficult-to-site landfills. For a reuse option to work, it must protect human health and the environment while reducing total cost for managing the waste. Disposal of solid waste requires a permit. Only clean soil materials, weathered asphalt and concrete can be used as fill material without first obtaining a permit. Long-term storage, such as stockpiling, will be seen as disposal unless it can be shown to state and local environmental agencies that treatment or storage for eventual legitimate reuse is occurring. Routine screening for trash in loads may facilitate this. Ready Reuse Options can include clean fill, winter road sand reuse, and managing gravel and rock. Besides screening for trash and keeping an eye out for impacts from spills and releases, no treatment or tracking of these clean materials is necessary. More specific reuse options may include: rock fall berms and noise barriers, use as soil amendment (freeway infields/median or agricultural use), poor grade utility trench fill, highway shoulder repair, and asphalt or cement or pre-fabricated concrete manufacture. Untreated roadwaste has poor drainage characteristics and a poor compaction rating. Sweepings, vac wastes, etc. have a high organic component that will decompose, leading to settling, sinkholes and cracking. Thus untreated reuse of these materials is not recommended as construction site fill, or under roads or parking lots. High temperature thermal treatment, which burns off the organic materials along with the contaminants, can make fill options workable.

Berm or Noise Barrier Construction
Marginally contaminated roadwaste might be suitable for use as berm material. ODOT Region 1, District 2B, constructed a berm of roadwaste and landslide debris at the base of Rocky Butte in the City of Portland to prevent rock fall from reaching the I-205 freeway (Figure 13.1). Runoff from this area is contained and infiltrates into the ground through a level grassy area. There is no ready access for human contact. Sampling shows contaminant levels in the berm to be well below industrial cleanup thresholds. The berm and berm water runoff have been routinely sampled to assess contamination risks and to monitor the natural bio-degradation of petroleum contaminants. Recommended practices:

- Remove trash. Solid waste rules require that trash be removed prior to legitimate reuse.
- Limit public access. Place barriers on ODOT-controlled property, so it is inaccessible to foot traffic.
- Contain or treat stormwater runoff. Monitor for pollutants to insure they do not escape into runoff or into accessible areas of the property.
- Limit contaminant levels to below state industrial cleanup thresholds.
- Mixture with uncontaminated materials will reduce contaminant concentration. Roadwaste testing below the industrial cleanup standard might be mixed with clean fill or clean slide debris to reduce site contamination risks. Clean material
can also be used to cap and contain material with low but significant contaminant concentrations. Any mixture of clean materials with contaminated materials, however, runs the risk of creating more contaminated materials.

- Plant and/or mulch berms. Limit erosion and control dust.
- Encourage biological treatment of contaminants with open air and plantings. You may also choose plants to enhance on-site phytoremediation.

The risk associated with using roadwaste for berms is low to moderate. With restricted public contact and controlled stormwater runoff, risk is dependent on contaminant concentration, site and soil characteristics, and future site use. Long-term tracking and monitoring of reuse sites is appropriate. DOT regional environmental representatives or a specialist from the state environmental agency can help assess proper placement and long term management of these berms.

**Use as Soil Amendment**

Use of roadwaste as soil amendment reduces costs substantially, and can even offset costs of purchasing new product. Risk can be effectively controlled by choice in placement. Most roadwaste has decent drainage characteristics, plentiful nutrients, and good water retention, with a good mix of particle sizes appropriate as an effective growing media. After the usual screening for trash, limited use of roadwaste as a soil amendment may be quite feasible if placement of contaminated material is carefully considered. Washington DOT (WSDOT) mixes vac waste with wood chips for an effective growing medium and uses it in freeway infields and medians. The wood, serving to improve the growing media, also fixes metals and petroleum compounds.

Recommended practices include the following:

- To pursue reuse of roadwaste as a soil amendment, it is necessary to know the characteristics of the material. Placement of a product that would result in surface concentrations above industrial cleanup levels would prevent reuse.
- When allowing reuse of untreated roadwaste on land out of DOT control, a contract with the landowner is recommended, limiting placement to cropland, with a significant setback from any water conveyance, state water, or wetland. A simple site review by qualified staff is recommended. Any material released should be at most only marginally contaminated, i.e. having a baseline waste characterization below industrial cleanup standards.
- Place the product where risk of exposure is very low and risk of transport is minimized. With runoff issues controlled during placement and good vegetative cover, the problem becomes long-term tracking. Drying the vac sludge is not essential, as plantings do require moisture.
- Track placement and conduct regular tests to track contaminants.
- Take care to place the waste mixture over existing soil or clay, not over quickly draining sand or gravels.
- Simple treatment by aeration has been observed to substantially reduce petroleum concentrations. The expected reduction of simple compounds prior to reuse will limit risk of transport. Heavier and harder-to-treat compounds are less mobile.
To encourage further aeration and reduce chance for movement to the subsurface, placement should be limited to within two feet of ground surface. In addition, limit placement to areas with little or no chance of human exposure.

**Poor Grade Utility Trench Fill**
Massachusetts allows use of sweepings as poor grade utility fill. They term it “poor grade fill” because it has a poor compaction rating, quickly loses volume, has poor drainage characteristics for use as fill, and is marginally contaminated. Still, use as fill over utility lines is workable and can be protective. Mass Highway does note that the trench must be mounded up to allow for a substantial volume reduction in the fill material; otherwise, the utility line will start to look like a shallow ditch and will accumulate runoff. Mass Highway does not allow reuse of catch basin vac waste as fill, judging it to be too contaminated. Given the known problems with use of roadwaste under paved surfaces, placement is only recommended under open ground. What makes this option work well is that the material is not placed in concentration, so overall site impacts are not likely. Limited reuse as poor grade utility fill away from ready human contact should not present significant risks.

- The use should be limited to commercial or industrial properties and agency-controlled, limited access areas.
- An uncontaminated soil trench cap can further limit potential exposure. Tracking placement of materials below industrial cleanup levels or on ODOT-controlled, limited access areas should not be necessary.
- With a baseline contamination level established for vac waste, a DOT may be able to reuse waste as poor grade utility fill.
- Be careful not to stockpile roadwaste for reuses that may never materialize; this reuse may be more appropriate for public works agencies with greater need for utility trench fill.
- Screening for trash will likely be required prior to reuse.

**Highway Shoulder Repair**
As sweepings or vactor waste can substantially reduce in volume with time, use of these materials as highway shoulder fill can result in soft shoulder problems in the future. Furthermore, since most highway shoulders drop off into ditches, water quality issues may also limit reuse of sweepings and vactor waste in many locations. Potential for public access is another issue limiting use of more highly contaminated materials. It is important to limit material used for highway shoulder repair to relatively clean materials with good compaction ratings.

**Asphalt, Cement or Pre-fabricated Concrete Manufacture**
Asphalt and cement manufacturers can use fines or sand-sized feedstock from a variety of sources though materials with any significant organic matter content must be avoided. Asphalt plants need dry materials free of trash and they can use petroleum-contaminated soils. Cement manufacturers process their feedstock in a kiln, creating sand-sized particles for cement production. Cement kilns operate at extremely high temperatures; any organic matter present burns and as such adds fuel to the fire, which can create
serious upset conditions if not anticipated. Cement kilns need to know the percent of organic matter present in their feedstock. Cement manufacturers often specify that vactor waste be free of oversized materials and debris, and tested for the eight TCLP metals to insure they are not accepting hazardous waste. Each manufacturer will impose its own conditions on acceptance.

Consistent supply of consistent material is key. Water content, trash content, organic matter content, particle size, and amounts are all important factors. As a supplier, the District/Region must be able to deliver product to meet the manufacturer’s schedule. Collection schedules and capacity to safely store roadwaste materials that will go for reuse should be considered. Sweepings that have “cooked out” (i.e. composted) might make better asphalt feedstock, and might supply a more consistent organic matter percentage for cement production. Testing requirements might be waived after a District can show a consistent product.

Although it takes planning and effort to get roadwaste into a manufacturing process, it can pay off. Using more contaminated and problematic material (which poses higher disposal or management costs) as feedstock can yield substantial savings. The basic issue of consistency should be pursued in developing good partnership opportunities and long-term business arrangements. Transportation costs should be factored into any plans for use as feedstock, and hauling distance could limit the applicability of some business opportunities. Still, shipment to distant manufacturers could potentially be more cost effective than disposal. DOT’s positions as large purchasers of asphalt and concrete can put them in a good negotiating position to have their roadwaste reused. Materials contracts might reasonably specify that a minimum percentage of acceptable roadwaste materials be used as feedstock in cement kilns.

The high temperatures in cement kilns destroy the PAHs and TPH fractions and virtually eliminate the risk otherwise inherent in the material. Heavy metals are bound into the cement and are unlikely to pose a concern at the concentrations present. Heavy metals do have the potential to be a concern in the disposal of cement mixer wash-out water; however, cement manufacturers currently use many other materials with higher metals concentrations as feedstock. PAHs do not pose a risk in asphalt, and asphalt uses petroleum as a binder in any case. Heavy metals content in waste asphalt should not prove to be a significant concern.

**Treatment Options**

Treatment is more cost-effective than disposal if the treatment costs (testing, hauling, managing, permits, treating, and tracking) are less than or equal to the disposal expenses plus the cost of buying the product new.

**Composting**

Composting can use a variety of materials as feedstock. Composting leaves and grass on a district level (“greenwaste”) can bring savings over hauling the material to a commercial composter, especially if the compost can be used to replace purchased growing media. For efficient composting, some brush may require chipping, and thick, woody wastes may require tub grinding. Reuse of wood chips and making wood available for home use may also be workable. Washington DOT recycles their vactor sludge into a growing media by mixing it with wood chips.
Composting of non-greenwaste materials is also possible. The City of Portland has been composting greenwaste and sweepings for several years and has encountered good success. Removing trash and sharps (hypodermic needles and glass) is a problem encountered with composting sweepings. Cigarette butts are prevalent and particularly hard to screen out. Great Western Sweepings in Tualatin, Oregon, has worked out a dual screening system that ODOT found to work well.

Roadwaste does not need the turning that normal compost does, since it has a much lower oxygen demand. Treatment studies have also shown that petroleum compounds can bind with organic matter. Woody waste and compost can fix both metals and carcinogenic PAHs, preventing them from escaping into the surrounding environment. Permits may be required for compost operations of a certain size (exceeding 25 tons of input per year in Oregon). ODOT has found there are benefits to obtaining a permit: DEQ can help solve site stormwater issues and provide you with technical assistance to ensure a good product. You will need to know how to avoid hot spot fires and also how to not end up with a stinking mess. The City of Portland study mentioned above may result in a better understanding of risks associated with composting. The use of composted material on lands outside of ODOT control is not recommended except for designated farm use (see Use as Soil Amendment). Although composting requires significant time and expense, the challenges are manageable and, in the right areas, the results will be well worth the effort.

**Thermal Treatment**
Thermal treatment is often used to destroy the gasoline and diesel petroleum fractions in soil collected from underground storage tank cleanups. Gas and diesel can be removed at relatively low temperatures. However, the gasoline and diesel fractions do not pose the most significant risk for management of common roadwastes. The low-temperature thermal desorption technology used by mobile soil burners does not destroy the major risks—carcinogenic PAHs and heavy metals. High-temperature thermal remediation (exceeding 650° F) appears to volatilize a significant portion of the CPAHs, substantially reducing the concentrations of the most significant contaminant. Volatilized contaminants not immediately destroyed are burned off at temperatures above 1,200° F in an afterburner.

The City of Portland takes their vac waste to TPST’s high-temperature thermal desorption facility in North Portland. Prior to thermal desorption, the material is screened for trash. Water content needs to be 30 percent or less; this can be achieved by mixing with other batches. Treatment of CPAH-contaminated batches has shown that this technology can remove these compounds. Heated pile technology is expected to work as long as the material can effectively be stacked with the heating pipes. High-temperature thermal treatment normally results in a sterile product, with all of the organic contaminants and vegetative matter destroyed. The compaction rating of the product is sufficient for use as construction fill. With no organic materials, there is nothing to degrade. The material is no longer suited for use as a growing medium though. Testing for TCLP heavy metals may be required; facilities generally cannot accept roadwaste with a contaminant level so high that it qualifies as a hazardous waste. Minimal level of trash content may be allowable.
The City of Portland has netted $15 per ton cost savings over using Metro area landfills by using this approach. Little to no environmental risk is expected from reuse of roadwaste that has undergone high-temperature thermal treatment if adequate treatment standards are maintained.

*Passive Bioremediation (Simple Aeration)*

Bioremediation allows natural microorganisms to break down contaminants. Some micro-organisms can eat petroleum, using it for energy, and release carbon dioxide and water. Bioremediation cannot be used to “treat out” heavy metals, though metals may be rendered less mobile. “Passive bioremediation” means the microbes already present do their work, without steps taken to enhance their activity. In cleanup parlance, this is often termed “natural attenuation.” Roadwaste piles left alone to naturally bio-remediate have had little or no detectable total petroleum hydrocarbons (TPH) in as little as six months. Reducing diesel and heavy oil fractions does not eliminate the major risks associated with physical contact with roadwaste. The heavy metals and most of the CPAHs are still present. They are tightly bound into the material, however, and not readily transported to groundwater or surface water. In reducing TPH concentrations substantially, the most mobile and highest concentration contaminants are removed from the equation, making placement away from ready access much more workable. Uses for passive bioremediation include preparation for direct reuse (e.g. in noise barriers or rock fall berms), reduction of active decomposition and preparation for landfilling in a roadwaste landfill. Permits may be required by the state regulatory agency for passive bioremediation sites and technical assistance may be available. Care should be taken to make sure requirements address actual risks. Breakdown of organic matter releases organic acids, reducing pH. Lower pH environments can mobilize heavy metals. The same process can happen with composting roadwaste. Care should also be taken to minimize, control, monitor and/or treat stormwater runoff from all storage and treatment areas.

*Active Bioremediation*

Active bioremediation enhances the effects seen in passive bioremediation by adding nutrients to help feed the microbes, surfactants that release bound contaminants, and chemicals that help break down complex chemicals or that provide chemical sources of oxygen. Peroxides can break down complex carbon chains, in some cases making them more ready food for existing microbe populations, as well as introducing needed oxygen. Such techniques have mainly been used in treating petroleum-contaminated soils from underground storage tank cleanup sites. These lighter petroleum compounds are not a concern in roadwaste. The nutrients and microbe populations in roadwaste are usually quite capable of dealing with the normal petroleum fraction (see Passive Bioremediation, above). Thus, using a product designed to break down gas and diesel fractions as a roadwaste treatment technology can be a waste of time and money.

The microbes found in roadwaste are of hardy varieties. Some of the specialized microorganisms introduced to treat complex carbon compounds do not compete well with natural microbes. Special conditions may be required, including the presence of special nutrients or chemicals to enhance or kick-start biological activity; a certain temperature range perhaps found only during special times of the year; or a tight pH soil acidity...
range. Liming agents and other pH adjusters can be used to create an environment better suited to the microbes you are using. Nutrients may be needed.

Overall, active bioremediation is considered an expensive option practical for only a small percentage of roadwaste. Placement of treated materials depends on the success in reducing CPAH concentrations. Of course, heavy metals will not be removed. If heavy metals are present in high concentrations, they could limit potential reuse and may make landfilling a more practical option. Active bioremediation of roadwaste should focus on destruction of the CPAHs. Several samples should be run through a lab after treatment to establish that the treatment was successful.

**Phytoremediation**

Phytoremediation involves using plants to treat contaminants. Certain plant species have been identified that are good at removing or destroying certain types of contaminants. For the heavy metals in roadwaste, planting a variety of grass that is known for its high uptake of lead could result in a crop of grass high in lead content. The grass could either be disposed of, or if high enough in lead content, be sent to a smelter to recover the lead. Lead values as high as one percent by weight have been observed in grass as rich as in some commercial ores.

While metals are a risk driver, carcinogenic PAHs are the main risk driver. Besides CPAHs in roadwaste, roadsides in high-traffic roadway corridors may increase in CPAHs over time due to the incomplete combustion of petroleum fuels. Mulberry bushes have been shown to break down CPAHs in the rhizosphere (the biologically active root zone). Using plantings could be valuable both in treating roadwaste contaminants and as cover crops for roadwaste reuse sites. Using the right plants can also provide a defense against the build-up of CPAHs expected along high traffic corridors. Since roadway maintenance practices require planting cover crops, consider selecting cover crops that will reduce contaminant levels and act as a defense against future contamination.

**Soil Washing**

Soil washing removes contaminants from problem soils by rinsing; however, heavy hydrocarbons are adsorbed onto the surface of particles and will not readily dissolve into water. The goal is removal of the more highly contaminated fine particles from roadwaste, leaving the larger particle size fractions ready for reuse. (The wastewater would then need to be treated and the contaminated fines managed conservatively.) It may be possible to find a way to release all the contaminants into the rinsate, leaving clean dirt and contaminated water, which could be treated separately.

Removing fines creates a secondary problem: effectively managing the wastewater. Besides evaporating the water in large ponds, there is no simple technology to de-water the lighter suspended fines.

An aggressive surfactant may be able to break the bonds holding the contaminants to the roadwaste. However, these soaps or chemical agents themselves can be a problem. Lowering the pH of a roadwaste slurry could dissolve heavy metals into solution. Then the water could be chemically treated, flocculating out the metals. This would be an intensive process, however, and would not address the main risk driver (CPAHs). Thus acid release approaches do not appear workable. Removal of the liquid without entraining fines is difficult.
Field trials on this treatment method have not been conducted, so it is not known how applicable soil washing is for roadwaste management. Surfactant may be available that would release heavy petroleum compounds and metals into solution for removal and recovery and would not pose environmental harm in the resultant product. In theory soil washing could remove heavy metals and petroleum contaminants, leaving benign materials; however, there are too many variables to provide an overall evaluation of risk. The wastewater must be managed carefully, requiring a sealed system. Products resulting from any new treatment process would require laboratory tests to evaluate risk.

**Disposal Options**

Disposal in a permitted, municipal solid waste landfill is expected to virtually eliminate any future liability, a significant advantage. Most landfills cannot accept liquids or wetter sediments though. Costs for disposal at permitted landfills can vary widely.

Siting and obtaining a permit for a publicly-owned roadwaste landfill may be a better option if volumes are high and a good site is available. It is recommended that a roadwaste landfill be lined to prevent ready release of contaminants. Sharing costs and sharing liabilities with other government agencies is reasonable.

It is important to reconsider past practices. Disposal of roadwaste that does not classify as clean fill should not go to unlined construction and demolition (C&D) landfill. Many former sand or gravel pits operating as clean fill landfills are accepting roadwaste. The porous matrix of sand and gravel and the ready access to the water table at these sites makes them inappropriate for use as roadwaste landfills. Some sites have virtually injected contaminants into the subsurface by placing roadwaste in direct contact with the groundwater table. Problems in other states with old, unlined fills, are leading them to clear their roadwaste out of burial sites. Washington DOT is conducting site assessments and characterizing stockpiles of roadwaste, examining the potential for harm. Permitted solid waste landfills are a sound, traditional waste management alternative and serve as a good option for small amounts of more highly contaminated wastes. Landfills are permitted to accept wastes within specified toxicity parameters and manage those risks well. Trash must be landfilled or recycled. Landfills avoid costly laboratory tests and oversight. Tipping fees can be costly in some areas, though. Operating at high volumes, costs of disposal at permitted roadwaste landfills are likely to be much lower than regular solid waste tipping fees. Testing normal roadwaste prior to placement in a permitted solid waste landfill is not necessary and should be avoided if the District has a screening process in place to identify suspect loads.

10.16 **Stockpiling, Spoil Disposal or Placement of Inert Fill**

NYSDOT and the New Brunswick, Canada, DOT outline the following practices for disposal of spoil or excavated material.

- Employees should not allow inert fill to erode or wash into a wetland or classified body of water. Spoil material should not be disposed of within 30 meters (legally 100 feet) of wetlands, within 15 meters (50 feet) of stream bank or within the floodway, whichever is greater, or in floodplains. Wetlands or streams may not be altered or filled without first obtaining permits from appropriate regulatory agencies. Consult with DOT environmental staff if such a permit is needed.
• Spoil material is not disposed of on forest preserve lands or on prime agricultural land.
• Spoil material is not disposed of in the vicinity of historic resources or archaeological sites.
• Disposal areas should be located carefully, taking into consideration of the siting constraints. Disposal areas should not be located so as to block natural drainage. Disposal areas should be located no closer than 100 feet from a watercourse and where runoff from the disposal area cannot enter a watercourse or cause siltation of the watercourse. Additional setback requirements may apply in protected watersheds and designated groundwater protection areas, or may be warranted by site-specific conditions.
• Spoil material is not disposed of in visually-sensitive areas or in other environmentally-sensitive areas.
• Spoil material is not disposed of outside ROW, unless appropriate permits are in place.
• Spoil areas are graded and shaped to blend with the landscape and then re-seeded and mulched to prevent erosion.
• Spoil material is placed in an upland area (away from streams or wetlands), and then seed and mulch the spoil pile.
• Approved areas for filling should be marked by stakes or other markings, and appropriate erosion and sedimentation controls should be used. Filled areas should be graded and stabilized by seeding and/or other appropriate methods when filling is complete. Interim or seasonal stabilization should be used if filling occurs over an extended period.
• Fill that has been contaminated with oil, gasoline or other chemicals should not be used. Sediment from ditches and culverts does not need to be tested unless it smells like fuel, solvents, or sewage, or is mixed with roadside trash. Any material suspected of contamination should be reported promptly.
• Established fishing pools should never be filled in.
• Contractors should obtain permission from the property owners on whose land they wish to place disposal areas.
• Maintenance facility managers should prevent erosion of the fill slopes at their facilities and ensure erosion and sediment controls are properly implemented and maintained.

The Montana Department of Transportation recommends the following practices for stockpiling of DOT maintenance materials: (lxiii)
• Develop site plans for areas adjacent to or near riparian areas to identify erosion and sediment control needs, and to ensure stability of the material.
• Do not stockpile material in-lieu of appropriate disposal.
10.17 MAINTENANCE OF SOILS

Maintenance activities can greatly affect soil structure in a positive or negative way. A solid plant cover is the best defense against erosion and invasive species. Routine maintenance activities can help build the soil to support vigorous plant growth.\textit{(lxiv)}

- Plants suffer from nutrient deficiencies in the soil. Contact the Landscape Architect for recommendations before amending soil. The Landscape Architect can provide information on appropriate fertilizers or soil amendments.
- Allow organic matter to remain on the ground where it will not jeopardize safety or visual quality. Logs and brushpiles enrich the soil and provide habitat while decomposing. Such decomposition can reduce the need for additional fertilization or soil amendments and reduce maintenance expenditures.
- Fresh wood chips can use up available nitrogen and affect plant growth. To avoid this problem, spread wood chips thinly over a large area or add nitrogen to aid in decomposition.
- Avoid driving vehicles or operating equipment on saturated soil and in vegetated areas.
- Reseed, cover, or mulch bare soils as soon as possible when they have been exposed by maintenance activities or errant vehicles.

With regard to control of soil tracked by equipment onto pavement or other inappropriate areas:

- Substantially visible sediment should be swept or vacuumed from the maintenance activity site.
- If not mixed with debris or trash, consider incorporating the removed sediment back into the maintenance activity site.
- Washing and rinsing of equipment should be performed in designated areas and the resulting runoff shall not be discharged to the storm drain system.

10.18 EMERGENCY ACTIONS

All emergency actions in or adjacent to streams, wetlands, lakes, ponds or other water bodies, or historic resources require some form of environmental review and notification to regulatory agencies and thus should be coordinated through DOT environmental specialists or landscape architects. To qualify as an emergency, the damage or threat to bridges, roads or other transportation facilities must present an immediate threat to life, health, property or natural resources and must be the result of a single event, not long-term neglect. Agency notification should include:

- Description of the proposed action.
- Location map and plan of the proposed project.
- Reasons why the situation is an emergency.

In addition, many emergency projects require authorization from the U.S. Army Corps of Engineers or the U.S. Fish and Wildlife Service and must be coordinated appropriately.
For large-scale disasters, batches of emergency projects may be approved with a single authorization, at the discretion of the regulatory agencies. In addition, the following environmental stewardship practices should be employed: (lxv)(lxvi)

- All emergency work should be performed to cause the least modification, disturbance, or damage to the course or bed of a stream and its banks, or any adjacent wetlands. Avoid additional impacts to wetlands or streams where possible and repair any damage to fishery or water resources caused by DOT Maintenance responses to the emergency. Remedial actions for emergencies include bioengineering and fish friendly designs, where practicable for stability and safety.
- No equipment should be operated in the water unless it has been approved by the state permitting agency.
- Identify and plan for slide debris disposal sites as part of local disposal plans. Appropriate sites for long and short-term material disposal should be identified and cleared for any potential wetland or sensitive species impact and mapped.
- When conducting emergency work, all general and special permit conditions must be followed, and if significant project modifications occur during construction, these changes should be coordinated with the environmental specialist and/or the permitting agencies.
- Provide quick response and first inspection, and notify appropriate resource staff in a timely manner.
- Provide, if possible, adequate erosion control or bank stabilization necessary to keep material from entering watercourses.

### 10.19 FIELD REVIEW OF ROADSIDE MAINTENANCE OPERATIONS

**Caltrans Maintenance Activity Pollution Prevention Program**

Caltrans developed a pilot program for review and improvement of roadside maintenance operations, which was ultimately expanded to a full-scale inspection program called the Maintenance Activity Pollution Prevention Program (MAPPP). Program practices include the following:

- Evaluate stormwater Best Management Practices (BMPs) in the field.
- Identify potential improvements.
- Provide a feedback mechanism for work crews.
- Conduct general stormwater training, activity-specific training for work crews, and reviews of specific guidance, expectations, and documentation.
- Develop a documentation method that could be applied consistently statewide.

**WSDOT’s Maintenance Accountability Process and Environmental Factors**

WSDOT has developed a Maintenance Accountability Process (MAP) tool to measure and communicate the outcomes of maintenance activities and to link strategic planning, the budget, and maintenance service delivery. Twice a year, field inspections are made of...
randomly selected sections of highway. The results are measured, recorded and compared to the MAP criteria to determine the level of service (LOS) delivered.

For example, WSDOT’s roadsides are maintained to fulfill highway objectives in four functional categories: operational, environmental, visual and auxiliary. The Operational category includes those functions that provide safe and multi-use roadsides. The Environmental category includes those functions that protect and enhance natural and built surroundings. Visual functions promote a positive quality of life and are integral to the other functions. Auxiliary functions are those that supplement the transportation system, such as safety rest areas. The primary elements of roadside maintenance include, vegetation management, litter control and maintenance of safety rest areas. Results are summarized annually, such as in the September 2003 Field Data Collection Manual, which includes the following A (blue) through F (red, none) grades for drainage maintenance and slope repair and roadside vegetation management.

### Group - 2 Drainage Maintenance and Slope Repair

<table>
<thead>
<tr>
<th>Item</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>2A1 Maintain Ditches</td>
<td></td>
</tr>
<tr>
<td>2A2 Maintain Culverts</td>
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<tr>
<td>2A3 Maintain Catch Basins and Inlets</td>
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<td>2A4 Maintain Detention/Retention Basins</td>
<td></td>
</tr>
<tr>
<td>2A5 Slope Repair</td>
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</tbody>
</table>

### Group - 3 Roadside and Vegetation Management

<table>
<thead>
<tr>
<th>Item</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>3A1 Litter Pickup</td>
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<tr>
<td>3A2 Noxious Weed Control</td>
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<tr>
<td>3A3 Nuisance Vegetation Control</td>
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<tr>
<td>3A4 Control of Vegetation Obstructions</td>
<td></td>
</tr>
<tr>
<td>3A5 Landscape Maintenance</td>
<td></td>
</tr>
</tbody>
</table>

Further details about the methodology of measurement in these areas follow:

**Drainage Ditches**

Units of Measure: Total linear feet of ditch, per 0.10 mile section; total linear feet of filled ditch, per 0.10 mile section.

Threshold: Count as deficient all ditches which are 50% or more full.

Methodology: Measure all ditches within the section and record the total linear feet of ditches. Measure and record the linear feet of ditch that is 50% or more full of sediment or other material.

For purposes of this survey, to be considered a ditch the structure must be designed and constructed to carry water – not a natural swale, or must be maintained as a ditch by Maintenance.

Comments: Streams adjacent to the roadway are not considered ditches. Standing water (tidal or non-tidal) in ditches is not a deficiency. Vegetation growing in the ditch is not a deficiency. Ditches designed solely to capture rock fall shall not be considered a ditch for this survey. *(lxvii)*

**Culverts**

Unit of Measure: Total number of culverts, per 0.10 mile section. Total number of culverts greater than or equal to 50% filled or otherwise deficient, per 0.10 mile section.

Threshold: Count as deficient if:

- Any portion of the culvert is 50% or more filled with sediment or debris, or
- Any end is significantly crushed or deformed, or

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• The volume of the inflow or outflow is reduced 50% or more by obstructions such as rocks, vegetation, or woody debris, or
• The pipe is separated 1” or more, or damaged in a way that the function of the culvert is causing significant damage to the roadway prism or adjacent drainage channel.

Methodology: Count and record all culverts within the section. Count and record any culvert that is 50% or greater filled or otherwise deficient. Evaluate only those culverts that cross state highways or county roads at their intersection with state highways. Do not count culverts under private access roads.

Comments: Vegetation obscuring the end of a culvert is not a deficiency unless it obstructs the flow of water. Standing water (tidal or non-tidal) in ditches is not a deficiency. Culverts designed to be half filled with gravel for fish habitat should not be rated as deficient. (*lxviii*)

**Catch Basins / Inlets**

Inlet Pipe, Outlet Pipe, Flow Line, Elevation, Catch Basin or Grate Inlet, Grate Ground Elevation, Silt Storage, Capacity Varies

Units of Measure: Total number of catch basins and drain inlets, per 0.10 mile section; total number of catch basins and drain inlets that are deficient.

Threshold: Count as deficient any catch basin or drain inlet that has:

• 50% or more of the inlet grate blocked with debris, or
• The catch basin has sediment buildup that reaches or exceeds the flow line elevation of the outlet pipe.

Methodology: Count and record the total number of catch basins and drain inlets in the section. Count and record the number of catch basins and drain inlets blocked by debris or catch basins filled with sediment.

Comments: Both catch basins and drain inlets are rated for blockage of the inlet grate. Only catch basins are rated for sediment build-up. A flashlight and/or probe may be needed to determine if the structure is a catch basin (i.e., has silt storage capacity) and whether it is deficient. (*lxix*)

**Slope Failures**

Unit of Measure: Total number of slope failures, per 0.10 mile section.

Threshold: Only count as deficient a slide or erosion that is at the time of the inspection:

• Jeopardizing the structural integrity of the shoulder or traveled lane(s), or
• Blocking the shoulder or traveled lane(s), or blocking the ditch, or
• Jeopardizing the structural integrity of guardrail or traffic signs.

Traffic may move slower through the area or lanes may be reduced, causing intermittent stoppages. Erosion or slides not meeting the thresholds above shall not be considered deficient.

Methodology: Determine and record the total number of slope failures found within the survey section. Both fill and cut slopes can be affected. (*lx*)
Comments: Chronic or ongoing slope failures that do not meet the criteria listed above at the time of the survey are not to be counted as failures. Edge drop-off is not considered a slope failure. (lxix)

**Noxious Weeds - Weed Infestation**
Units of Measure: Total square feet of infestation, per 0.10 mile section.
Threshold: Presence of noxious weeds on the roadside.
Methodology: Survey the roadside and determine the presence of any noxious weeds. Measure the square feet of the infestation; the total square feet of infestation should not exceed the total square feet of roadside.
Comments: Identifying noxious weeds can be difficult and is best done by a person trained in weed identification. For assistance in identifying noxious weeds consultation with the area roadside or spray crew is recommended. (lxxi)

**Nuisance Vegetation - Weed Infestation**
Units of Measure: Total square feet of infestation, per 0.10 mile section.
Threshold: Presence of nuisance vegetation on the roadside.
Methodology: Survey the roadside and determine the presence of any nuisance vegetation. Measure the square feet of the infestation; the total square feet of infestation should not exceed the total square feet of roadside.
Comments: Identifying nuisance vegetation can be difficult and is best done by a person trained in weed identification. For assistance in identifying nuisance weeds consultation with the area roadside or spray crew is recommended. (lxxii)

**Vegetation Obstruction**
Unit of Measure: Total number of vegetation obstructions per 0.10 mile section.
Threshold: Vegetation blocking sight distance to guide or regulatory signs, or intersections as seen from the driver’s perspective.
Methodology: Measure and record total number of instances where vegetation obstructs sight distance to signs or intersections. For example, if a survey site has two blocked signs and one blocked intersection the surveyor shall record 3 vegetation obstructions on the survey form.
Comments: For the purpose of judging adequate site distance for this survey, signs and intersections should be visible from distances of:

- Freeways 800 feet minimum
- Rural roads 500 feet minimum
- Urban roads 200 feet minimum (lxxiv)

**Litter**
Unit of Measure: Total number of litter counted, per 0.10 mile section.
Threshold: Objects approximately 4 inches in any dimension or larger.
Methodology: Observe and record all litter 4 inches and greater. (lxv)


iii. Personal communication, Leroy Irwin, FDOT Environmental Manager, April 2003.


xv. Personal communication, Raja Veermachaneni, Maryland Highway Administration, February 2004.


xxxiii. New York State Department of Transportation Environmental Analysis Bureau, “Environmental Handbook for Transportation Operations” (July 2001) 44 pp., p. 3.1.9.


xlii. New York State Department of Transportation, Unpublished paper sent to author (February 9, 2004).

xliii. Personal communication, Jim Carney, Missouri DOT, (September 1, 2004).


I. Federal Highway Administration 2001 Environmental Excellence Award: Air Quality Improvements, “Compressed Natural Gas Refueling Station.”
http://www.dot.ca.gov/hq/env/stormwater/ pdfs/maintain/m1_00.pdf.
lvi. City of Portland Sweeper Debris Separation Program,
http://www.trans.ci.portland.or.us/services/streetcleaning/recyclin.htm.

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