

Low-Volume Roads Engineering

Best Management Practices Field Guide

By

Gordon Keller, PE

Geotechnical Engineer
USDA, Forest Service
Plumas National Forest, California

and

James Sherar, PE

Logging Engineer
USDA, Forest Service
National Forests of North Carolina



Produced for
US Agency for International Development (USAID)



In Cooperation with
USDA, Forest Service, International Programs
&
Conservation Management Institute,
Virginia Polytechnic Institute and State University



July 2003



Information contained in this document has been developed for the guidance of road builders, road managers, and resource specialists in most geographic areas to help build better, more cost-effective roads, and roads that minimize adverse environmental impacts and protect water quality. The U.S. Department of Agriculture (USDA) or U.S. Agency for International Development (USAID) assumes no responsibility for the interpretation or use of this information. The use of trade, firm, or corporation names is for the information and convenience of the reader. Such use does not constitute an official evaluation, conclusion, recommendation, endorsement, or approval of any product or service to the exclusion of others that may be suitable.

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LOW-VOLUME ROADS ENGINEERING

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FOREWORD

The Conservation Management Institute (CMI) in the College of Natural Resources at Virginia Tech is dedicated to helping apply sound scientific principles to the management of renewable natural resources around the world. Access is an important consideration in many settings — not only to facilitate utilization of natural resources, but also to enable people to reach markets for their products and health services. However, it is vital that roads constructed provide adequate access while following sound practices for environmental protection wherever possible. Improperly constructed roads can negatively impact everything from terrestrial plant populations and soil conservation efforts to water quality and populations of aquatic organisms in receiving waters.

This manual was originally published in Spanish as “Practicas Mejoradas de Caminos Forestales” by the U.S. Agency for International Development (USAID) for use throughout Latin America, and has proven valuable in helping to protect forest-based resources. It became clear that the practical advice offered in this manual could be of value to resource managers throughout the world. So, to reach this broader audience and inspired by the original Spanish work, CMI and the USDA Forest Service have collaborated to produce this updated version in English. We hope that the materials presented here are useful to you.

This project grew from our collaboration with Gerald Bauer, of the US Forest Service, on natural resource education programs in Latin America. Mr. Bauer was a contributor to the original manual and found the publication in great demand. This collaboration exemplifies our involvement with USAID and the Forest Service on many natural resource projects. We encourage you to contact USFS or CMI if we can be of assistance in your conservation efforts. Finally, we acknowledge the notable efforts of Julie McClafferty of CMI, who was instrumental in preparing this manual for publication.

B. R. Murphy, PhD., Director, CMI (murphybr@vt.edu)

A.L. Hammett, PhD., Faculty Fellow, CMI and Coordinator of International Programs, College of Natural Resources (himal@vt.edu)

Gordon Keller, PE, Geotechnical Engineer, USFS (gkeller@fs.fed.us)

James Sherar, PE, Logging Engineer, USFS (jrs4trees@aol.com)

ACKNOWLEDGMENTS

A LARGE NUMBER OF INDIVIDUALS have been involved in the development of the Minimum Impact Low-Volume Roads Manual and this subsequent Low-Volume Roads Engineering Best Management Practices Field Guide. These individuals have had the vision and commitment to preserving and enhancing the quality of our environment, while also recognizing the need for good roads. Furthermore, they recognize the planning, design, maintenance, and overall management necessary to have good roads. **Funding for this project has principally been provided by the US Agency for International Development (USAID), the Global Bureau, and the Forestry Team, with contributions from the USDA, Forest Service, Office of International Programs, the Pacific Southwest Region, and the Plumas National Forest.**

The original Spanish version of this document was produced with the help of Ramon Alvarez, Roberto Medina, and Atilio Ortiz with USAID, Honduras. The authors are particularly grateful for the support of Jerry Bauer, Alex Moad, and Michelle Zweede with the International Programs office of the U.S. Forest Service; Jim Padgett and Nelson Hernandez from the Washington Office, USFS; Scott Lampman, Paul DesRosiers, and Mike Bengé with the U.S. Agency for International Development; and the steadfast support from our Plumas National Forest colleagues.

The drawings presented in this document come from a variety of sources, as indicated, and most have been redrawn or adapted with the artistic talent of Jim Balkovek, Illustrator, and Paul Karr, a retired Forest Service Engineer. Scanning, labeling, and computer manipulation of figures for this field guide have been accomplished with the skill and patience of Lori Reynolds of Reynolds Graphics in Quincy, California. Translation of portions of this Field Guide and the original Minimum Impact Low-Volume Roads Manual was skillfully accomplished by Alejandra Medina of the Virginia Tech Transportation Institute.

A sincere thanks to the many professionals and laymen who gave their time in reviewing and editing the document, as well as making valuable suggestions regarding the form and content of this Field Guide. Particular thanks to Jill Herrick, U.S. Forest Service, for her valuable contributions and assistance with editing this guide, assistance with the Definition of Terms and References, and overall content review, as well as to Michael Furniss, Charlie Carter, Jerry Short, Tim Dembosz, and Ozzie Cummins for their numerous suggestions and ideas on drainage and other issues. Thanks to Richard Wiest, author of “A Landowner’s Guide to Building Forest Access Roads”, for his inspiration and ideas on format and layout. Other individuals involved in review and editing include Leslie Lingley of Leslie Geological Services; Marty Mitchell of Clear Water West; Alfred Logie with the International Programs office of the Federal Highway Administration (FHWA); Mike Bengé and Eric Peterson with U. S. Agency for International Development; Dr John Metcalf from LSU/PIARC World Roads Association; Dr. Francis Greulich, Forest Engineer at the University of Washington; Dr. Allen Hathaway, Geologic Engineer at the University of Missouri-Rolla; David

Orr, PE with the Cornell University Local Roads Program; Prof. Raymond Charles, University of West Indies; Art Klassen, Tropical Forestry Foundation; James Schenck and Wilson Castaneda, Cooperative Housing Foundation-Guatemala; Harold Tarver with Africare; Wes Fisher with Tellus Institute; and Sandra Wilson-Musser, Corky Lazzarino, Armando Garza, Gary Campbell, Ken Heffner, Terry Benoit, Allen King, John Heibel, William Vischer, and Greg Watkins, U.S. Forest Service employees dedicated to watershed protection and building good roads.

Most of the photos used in this manual either belong to the authors, Gordon Keller and James Sherar, or to Jerry Bauer, co-author on the “Minimum Impact Low-Volume Roads” Manual. Others belong to individuals as indicated on the specific photo. The retaining wall photo on the cover was provided by Michael Burke.

Finally, the authors wish to give special thanks to Tom Hammett at Virginia Tech for his connections and facilitation of this project and Julie McClafferty of the Conservation Management Institute and Patty Fuller of Poplar Hill Studios in Blacksburg, Virginia, for their magic in layout and publication of this guide and making it look the way it does. Last, and by no means least, a big hug to our wives, Jeanette and Julie, and families for their patience and support during this project!

PREFACE

THE AUTHORS ARE GRATEFUL for the opportunity to develop this guide for the US Agency for International Development (USAID) with the cooperation of the USDA, the Forest Service, the Office of International Programs, and the International Programs Department at Virginia Polytechnic Institute and State University. The original development of this Roads Best Management Practices (BMP) Field Guide was funded by USAID/Honduras, in support of their Forestry Development Program (FDP) and their National Forestry School (ESNACIFOR). It has since been revised and expanded to be consistent with and complement the training manual titled “Minimum Impact Low-Volume Roads” for roads work in developing regions.

This Low-Volume Roads Engineering Best Management Practices Field Guide is intended to provide an overview of the key planning, location, design, construction, and maintenance aspects of roads that can cause adverse environmental impacts and to list key ways to prevent those impacts. **Best Management Practices** are general techniques or design practices that, when applied and adapted to fit site specific conditions, will prevent or reduce pollution and maintain water quality. BMPs for roads have been developed by many agencies since roads often have a major adverse impact on water quality, and most of those impacts are preventable with good engineering and management practices. Roads that are not well planned or located, not properly designed or constructed, not well maintained, or not made with durable materials often have negative effects on water quality and the environment.

This Guide presents many of those desirable practices. Fortunately, most of these “Best Management Practices” are also sound engineering practices and ones that are cost-effective by preventing failures and reducing maintenance needs and repair costs. Also keep in mind that “best” is relative and so appropriate practices depend to some degree upon the location or country, degree of need for improvements, and upon local laws and regulations. Best practices are also constantly evolving with time.

This guide tries to address most basic roads issues in as simple a manner as possible. Complex issues should be addressed by experienced engineers and specialists. Included are key “**DO’s**” (**RECOMMENDED PRACTICES**) and “**DON’Ts**” (**PRACTICES TO AVOID**) in low-volume roads activities, along with some relevant basic design information. These fundamental practices apply to roads worldwide and for a wide range of road uses and standards. Often recommended practices have to be adapted to fit local conditions and available materials. Additional information on **how** to do the work is found in other **Selected References**, such as the “Minimum Impact Low-Volume Roads Manual”.

Most practices apply to a wide range of road standards, from native surfaced, single-lane roads to double-lane paved roads. Desirable general practices include good road planning and location, performing environmental analysis, recognizing the need for positive surface drainage, ensuring adequately sized drainage crossing structures, using stable cut and fill slopes, using erosion control measures, developing good materials sources, and reclaiming sites once work has been completed.

Certain design practices, such as use of rolling dips, out-sloped roads, or low-water stream crossings, are very cost-effective and practical but typically apply to low-volume, low-speed roads because of safety concerns, vertical alignment issues, or unacceptable traffic delays. Other issues, such as the use of log stringer bridges, are very desirable for stream crossings in developing regions to avoid driving through the water, yet their use is now discouraged by some agencies, such as the U.S. Forest Service, because of their short design life and potentially unpredictable performance. Thus the information presented herein must be considered in terms of local conditions, available materials, road standards, project or resource priorities, and then applied in a manner that is practical and safe.

Local rules, agency policies or regulations, or laws may conflict with some of this information or may include more specific information than that included herein. Thus, good judgment should be used in the application of the information presented in this guide, and local regulations and laws should be followed or modified as needed.

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Disclaimer

This Field Guide does not constitute a standard, specification, or regulation from or bound on any professional group, agency, or political entity. It is intended only as a guide for good roads engineering and sound environmental management in developing countries based upon the professional judgment and experience of the authors.

LOW-VOLUME ROADS ENGINEERING

Best Management Practices Field Guide

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Definition of Terms

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I. ROAD COMPONENTS

Figure (I.1): Terms Used to Define Low-Volume Roads

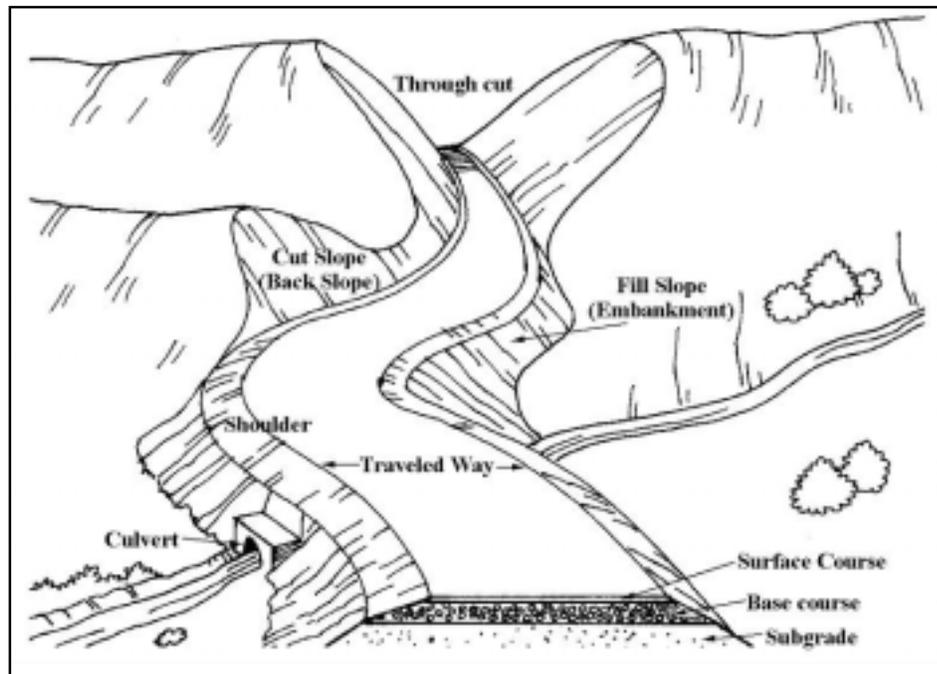
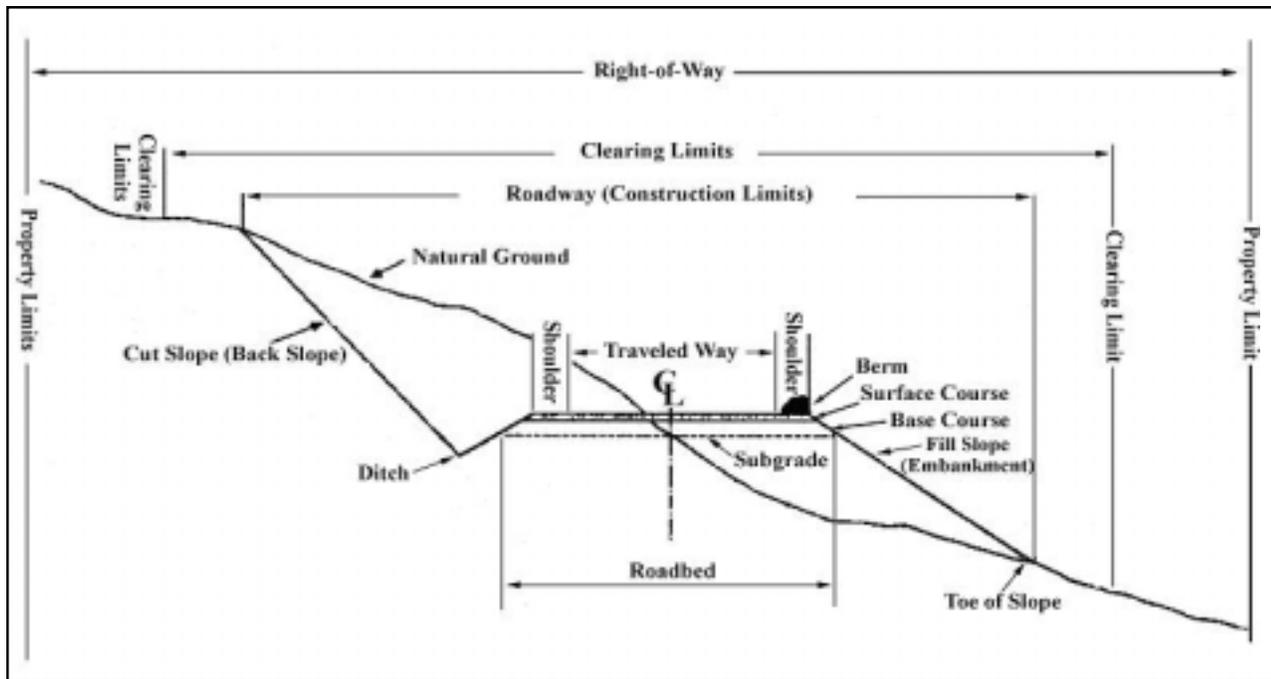


Figure (I.2) Terms Used to Define Low-Volume Roads (Cross-Section)



Base Course - See Section II below.

Berm - A ridge of rock, soil, or asphalt, typically along the outside edge of the road shoulder, used to control surface water. It directs surface runoff to specific locations where water can be removed from the road surface without causing erosion.

Buttress - A structure designed to resist lateral forces. It is typically constructed of large riprap rock, gabions, or drained soil to support the toe of a slope in an unstable area.

Cross-Section - A drawing depicting a section of the road sliced across the whole width of the road (See *Figure I.2* above). Can also apply to a stream, a slope, or a slide.

Cut Slope (Back Slope or Cut Bank) - The artificial face or slope cut into soil or rock along the inside edge of the road.

Cut-and-fill - A method of road construction in which a road is built by cutting into the hillside and spreading the spoil materials in adjacent low spots and as compacted or side-cast fill slope material along the route. A “**balanced cut-and-fill**” utilizes all of the “cut” material to generate the “fill”. In a balanced cut-and-fill design there is no excess waste material and there is no need for hauling additional fill material. Thus cost is minimized.

Ditch (Side Drain) - A channel or shallow canal along the road intended to collect water from the road and adjacent land for transport to a suitable point of disposal. It is commonly along the inside edge of the road. It also can be along the outside edge or along both sides of the road.

End Haul - The removal and transportation of excavated material off-site to a stable waste area (rather than placing the fill material near the location of excavation).

Embankment (Fill) - Excavated material placed on a prepared ground surface to construct the road subgrade and roadbed template.

Fill Slope (Embankment Slope) - The inclined slope extending from the outside edge of the road shoulder to the toe (bottom) of the fill. This is the surface formed where material is deposited to build the road.

Full Bench Cut and End Haul - A method of road construction in which a road is built entirely by cutting away the slope, and the excess material is hauled away (end hauled) to an off-site disposal area.

Grade (Gradient) - The slope of the road along its alignment. This slope is expressed in percent - the ratio of elevation change compared to distance traveled. For example, a +4% grade indicates a gain of 4 units of measure in elevation for every 100 units of measure traveled.

Low-Volume Road - A type of transportation system typically constructed to manage or extract resources from rural or undeveloped areas. These unique systems are designed to accommodate low traffic volumes with potentially extreme axle loads. They are commonly defined as having less than 400 ADT (Average Daily Traffic).

Natural Ground (Original Ground Level) - The natural ground surface of the terrain that existed prior to disturbance and/or road construction.

Plan View (Map View) - View seen when looking from the sky towards the ground. A drawing with this view is similar to what a bird would see when flying over a road.

Reinforced Fill - A fill that has been provided with tensile reinforcement through frictional contact with the surrounding soil for the purpose of greater stability and load carrying capacity. Reinforced fills are comprised of soil or rock material placed in layers with reinforcing elements to form slopes, walls, embankments, dams or other structures. The reinforcing elements range from simple vegetation to specialized products such as steel strips, steel grids, polymeric geogrids and geotextiles.

Retaining Structure - A structure designed to resist the lateral displacement of soil, water, or any other type of material. It is commonly used to support a roadway or gain road width on steep terrain. They are often constructed of gabions, reinforced concrete, timber cribs, or mechanically stabilized earth.

Right-of-Way (ROW) - The strip of land over which facilities such as roads, railroads, or power lines are built. Legally, it is an easement that grants the right to pass over the land of another.

Road Center Line - An imaginary line that runs longitudinally along the center of the road.

Roadbed - Width of the road used by vehicles including the shoulders, measured at the top of subgrade.

Roadway (Construction Limits or Formation Width) - Total horizontal width of land affected by the construction of the road, from the top of cut slope to the toe of fill or graded area.

Side-Cast Fill - Excavated material pushed on a prepared or unprepared slope next to the excavation to construct the roadbed. The material is usually not compacted.

Slope Ratio (Slope) - A way of expressing constructed slopes as a ratio of horizontal distance to vertical rise, such as 3:1 (3 m horizontal for every 1 m vertical rise or fall).

Shoulder - The paved or unpaved strip along the edge of the traveled way of the road. An inside shoulder is adjacent to the cut slope. An outside shoulder is adjacent to an embankment slope.

Subgrade - See Section II below.

Surface Course (Surfacing) - See Section II below.

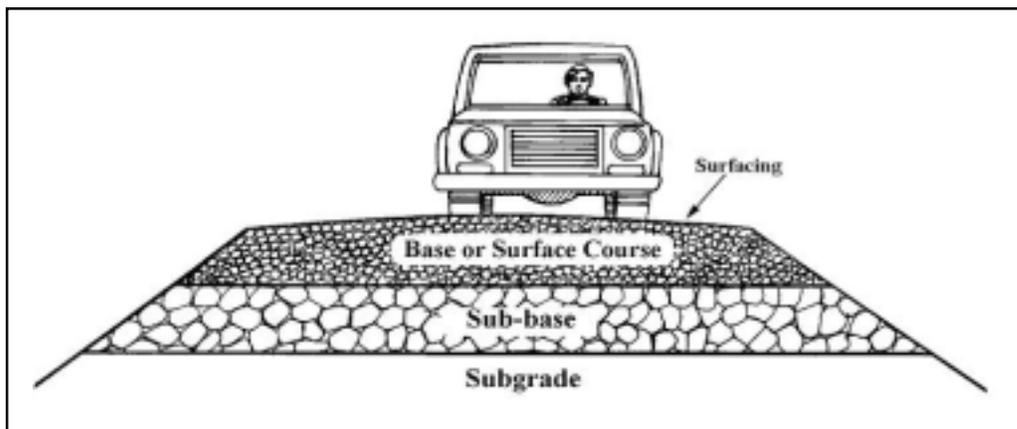
Traveled Way (Carriageway) - That portion of the road constructed for use by moving vehicles including traffic lanes and turnouts (excluding shoulders).

Through Cut - A road cut through a hill slope or, more commonly, a ridge, in which there is a cut slope on both sides of the road.

Through Fill - Opposite of a through cut, a through fill is a segment of road that is entirely composed of fill material, with fill slopes on both sides of the road.

II. ROAD STRUCTURAL SECTION AND MATERIALS

Figure (II): Road Structural Section



Base Course (Base) - This is the main load-spreading layer of the traveled way. Base course material normally consists of crushed stone or gravel or of gravelly soils, decomposed rock, sands and sandy clays stabilized with cement, lime or bitumen.

Borrow Pit (Borrow Site) - An area where excavation takes place to produce materials for earthwork, such as a fill material for embankments. It is typically a small area used to mine sand, gravel, rock, or soil without further processing.

Quarry - A site where stone, riprap, aggregate, and other construction materials are extracted. The material often has to be excavated with ripping or blasting, and the material typically needs to be processed by crushing or screening to produce the desired gradation of aggregate.

Raveling - A process where coarse material on the road surface comes loose and separated from the roadbed because of lack of binder or poor gradation of material. The term also applies to a slope where rock or coarse material comes loose and falls down the cut or fill slope.

Sub-Base - This is the secondary load-spreading layer underlying the base. It normally consists of a material that has lower strength and durability than that used in the base, e.g. unprocessed natural gravel, gravel/sand or gravel/sand/clay.

Subgrade - The surface of roadbed upon which sub base, base, or surface course are constructed. For roads without base course or surface course, this portion of the roadbed becomes the finished wearing surface. The subgrade is typically at the level of the in-place material.

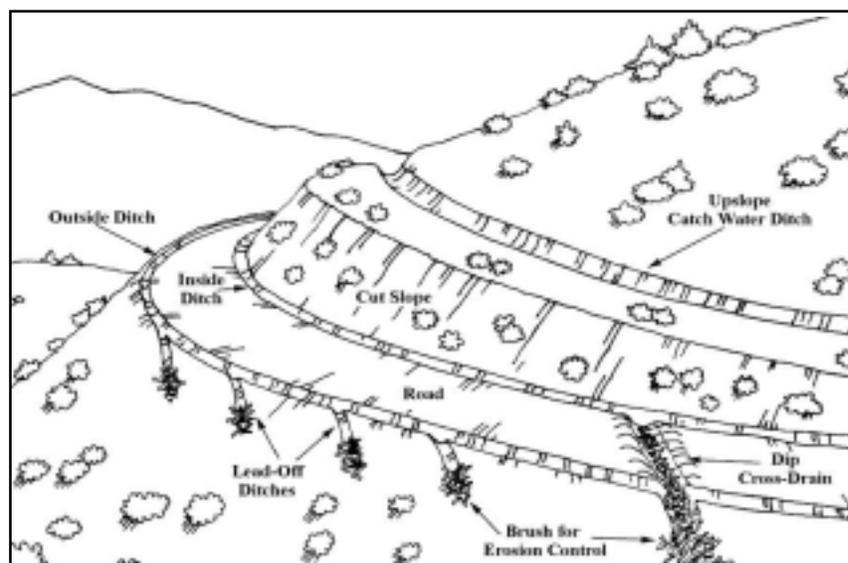
Surface Course (Surfacing) - The top layer of the road surface, also called the wearing course. Rock, cobblestone, crushed aggregate and paving, such as Bituminous Surface Treatments and Asphalt Concrete, are types of surfacing used to improve rider comfort, provide structural support, and weatherproof the road surface for wet season use.

Washboarding (Corrugations) - A series of ridges and depressions across the road caused in soil and aggregate road surfaces by the lack of surface cohesion. This is typically a result of the loss of fines in the road surface caused by dry conditions or poorly graded material. These conditions worsen with excessive vehicle speeds and high traffic volumes.

Wearing Course (Wearing Surface) - The top layer of the road surface that is driven upon. It should be durable, may have a high resistance to skidding, and it typically should be impervious to surface water. Wearing surfaces may be the native soil, aggregate, seal coats, or asphalt.

III. SURFACE DRAINAGE

Figure (III.1): Road Surface Drainage



Armor - Rocks or other material placed on headwalls, on soil, or in ditches to prevent water from eroding and undercutting or scouring the soil.

Catch Water Ditch (Intercept Drain) - A flat-bottomed excavation or ditch located above a cut slope that is designed to intercept, collect and drain away surface runoff water before it goes over the cut slope, to protect the cut slope and roadway from erosion.

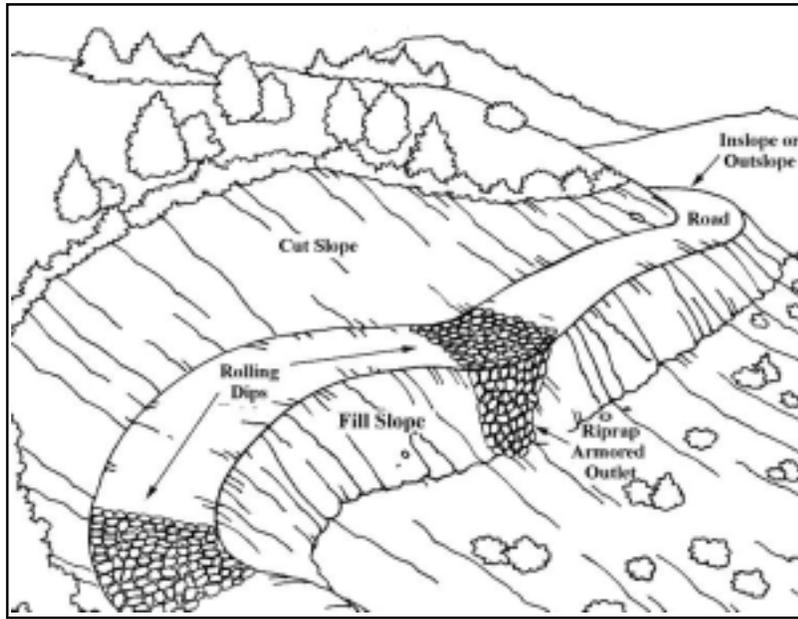
Check Dam (Scour Check, or Dike) - A small dam constructed in a gully or ditch to decrease flow velocity, minimize channel scour, and to trap sediment.

Cross-Drain (X-Drain) - Installed or constructed structures such as culverts and rolling dips that move water from one side of the road to the other.

Crown - A crowned surface has the highest elevation at centerline (convex) and slopes down on both sides. Crown is used to facilitate draining water off a wide road surface.

Debris - Organic material, rocks and sediment (leaves, brush, wood, rocks, rubble, etc.) often mixed, that is undesirable (in a channel or drainage structure).

Figure (III.2): Rolling Grade with Rock-Armored Rolling Dips



Drainage Structure - A structure installed to control, divert, or move water off or across a road, including but not limited to culverts, bridges, ditch drains, fords, and rolling dips.

French Drain (Underdrain) - A buried trench, filled with coarse aggregate, and typically placed in the ditch line along the road, which acts to drain subsurface water from a wet area and discharge it a safe and stable location. French drains may use variable sizes of rock but do not have a drain pipe in the bottom of the trench.

Inside/Outside - Reference to a feature on the inside of the road, which is typically the cutslope (back slope) side of the road/ Reference to a feature on the outside of a road, typically on the fill slope side.

Inslope - The inside cross-slope of a road subgrade or surface, typically measured in percentage. Inslope is used to facilitate the draining of water from a road surface to an inside ditch. An insloped road has the highest point on the outside edge of the road and slopes downward to the ditch at the toe of the cut slope, along the inside edge of road.

Lead-Off Ditches (Turnouts, Outside Ditch, or Mitre Drains) - Excavations designed to divert water away from the ditch and roadway (at a point where this doesn't occur naturally) in order to reduce the volume and velocity of roadside ditch water.

Outslope - The outside cross-slope of a road subgrade or surface, typically measured in percentage. Outslope is used to facilitate the draining of water from a road directly off the outside edge of the road. An outsloped road has the highest point on the uphill or inside of the road and slopes down to the outside edge of the road and the fill slope.

Riprap - Well-graded, durable, large rock, ideally with fractured surfaces, sized to resist scour or movement by water and installed to prevent erosion of native soil material.

Rolling Dip (Dip, Broad-Based Dip) - A surface drainage structure, with a constructed break in the road grade, specifically designed to drain water from an inside ditch or across the road surface, while vehicles travel speed is somewhat reduced (see lower photo on the cover of this Guide).

Underdrain (Subsurface Drain) - A buried trench, filled with coarse aggregate, coarse sand, or gravel, and typically placed in the ditch line along the road, which acts to drain subsurface water from a wet area and discharge it a safe and stable location. Underdrains may use a uniform size of rock, be wrapped in geotextile, and have a perforated drain pipe in the bottom of the trench.

Waterbar - A frequently spaced, constructed drainage device, using soil mounds in the road surface, that interrupt the flow of water and that diverts water off the road surface. They may be drivable by high clearance vehicles or impassable.

IV. CULVERTS AND DRAINAGE CROSSINGS

Figure (IV.1): Culvert Components

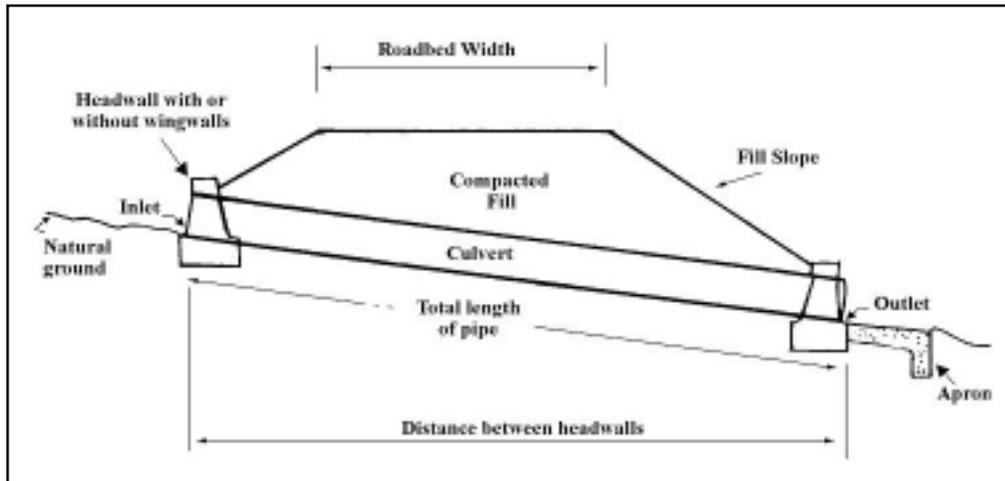
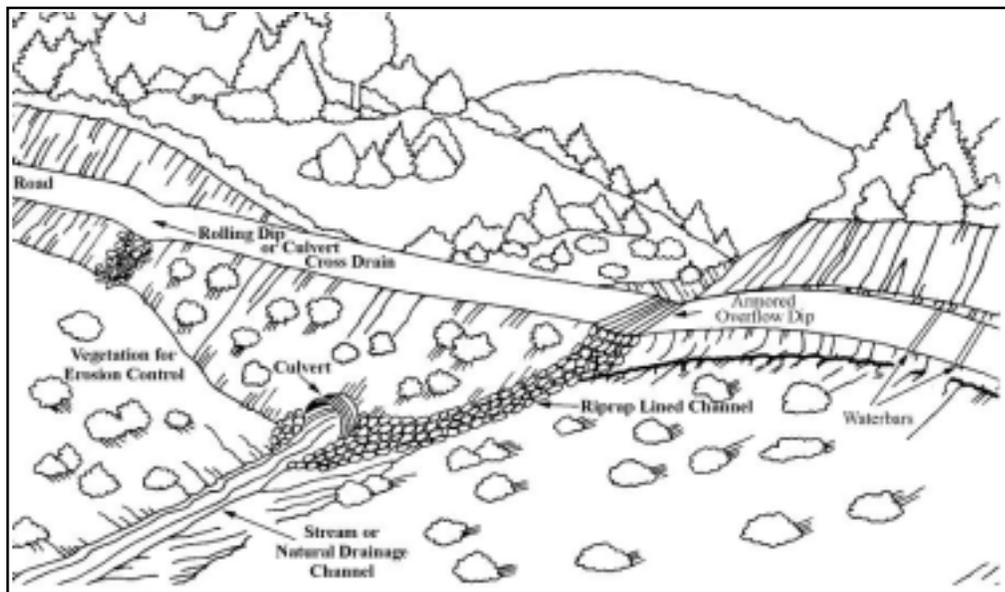


Figure (IV.2): Natural Drainage Crossing with a Culvert



Apron - An extension of the head wall structure built at ground or stream level and designed to protect the stream bottom from high flow velocities and to safely move water away from the drainage structure.

Bankfull Width (Ordinary High Water Width) - The surface width of the stream measured at the bankfull stage. This flow, on average, has a recurrence interval of about 1.5 years. The bankfull stage is the dominant channel-forming flow, and is typically identified as the normal upper limit of stream channel scour, below which perennial vegetation does not occur.

Bedload - Sediment or other material that slides, rolls, or bounces along the streambed or channel bottom due to flowing water.

Catch Basin - The excavated or constructed basin at the inlet of a culvert cross-drain pipe, used to store water and direct it into the culvert pipe.

Culvert - A drainage pipe, usually made of metal, concrete, or plastic, set beneath the road surface, to move water from the inside of the road to the outside of the road, or under the road. Culverts are used to drain ditches, springs, and streams that cross the road. The invert is the floor or the bottom of the structure at its entrance.

Drop Inlet - A masonry or concrete basin, or a vertical riser on a metal culvert inlet, usually of the same diameter as the culvert, and often slotted, to allow water to flow into the culvert as water flow rises around the outside. Drop inlets are often used on ditch relief culverts where sediment or debris would plug the pipe. A drop inlet also helps control the elevation of the ditch.

Flood Plain - A level or gently sloping area on either side of a river or stream active (main) channel that is submerged at times during high water or periods of flooding. Silt and sand are deposited and accumulate in this area along the main channel.

Freeboard - The additional height of a structure above design high water level to prevent overflow or overtopping. Also freeboard, at any given time, is the vertical distance between the water level and the bottom of the bridge slab, girders, or structure.

Headwall - A concrete, gabion, masonry, or timber wall built around the inlet or outlet of a drainage pipe or structure to increase inlet flow capacity, reduce risk of debris damage, retain the fill material and minimize scour around the structure.

High Water Mark - The line on a bank or shore established by the highest level of the water. This is usually identified by physical evidence such as a natural impression (small bench) on the bank, changes in the character of soil, destruction of most vegetation, or presence of litter and debris.

Inlet - The opening in a drainage structure or pipe where the water first enters the structure.

Metal End Section - A manufactured headwall/wing wall, usually made from the same type of metal as the culvert, to enhance inlet flow capacity.

Outlet - The opening in a drainage structure or pipe where the water leaves the structure. The outlet is usually lower than the inlet to ensure that water flows through the structure.

Outlet Protection - Devices or material, such as a headwall or riprap, placed at the outlet of pipes or drainage structures to dissipate the energy of flowing water, reduce its flow velocity, and prevent channel or bank scour.

Perennial Stream - A stream that typically has running water all year long.

Piping - The movement of fine soil under a pipe, embankment, or structure, caused by seepage forces and moving water, that can cause a structure to be undermined and fail.

Rootwad - The ball of tree roots and dirt that is pulled from the ground when a tree is uprooted.

Scour - Erosion or soil movement in a stream bed, stream bank, channel, or behind a structure, typically caused by increased water velocity or lack of protection.

Stream Barb (Jetty) - Typically low rock sills that project away from a stream bank and out into the stream channel to redirect flow away from an eroding bank.

Wing Walls - Masonry or concrete structures built onto the side of culvert inlet and outlet headwalls, designed to retain the roadway fill and direct water into and out of the drainage structure while protecting the road and fill from erosion.

V. FORDS AND LOW-WATER CROSSINGS

Figure (V.1) Simple Ford

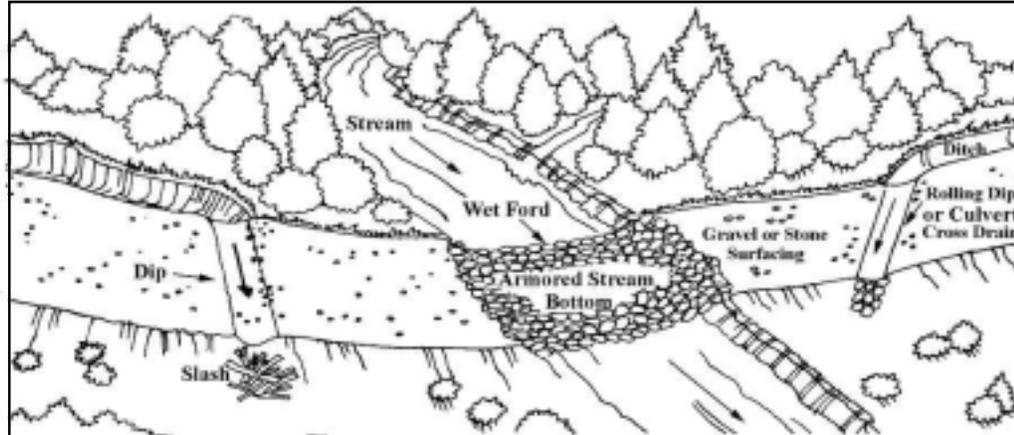
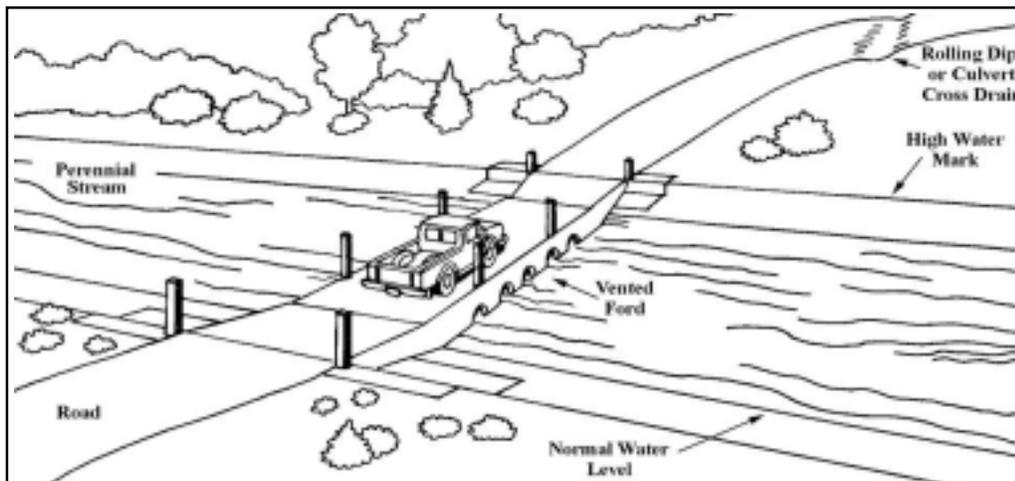


Figure (V.2) Improved, Vented Ford



Ford (Low-Water Crossing) (Drift); Simple - A rock or other hardened structure that is built across the bottom of a swale, gully, or stream channel that is usually dry, to allow improved vehicle passage during periods of low water or no flow.

Ford (Low-Water Crossing) (Drift); Improved - A masonry, concrete, gabion, or other hardened surface structure built across the bottom of an intermittent or live stream that improves vehicle passage during low flow periods and minimizes channel disturbance or sediment production.

Vented Ford - A structure designed to allow normal or low water flow in a stream channel or watercourse to pass safely through the structure (e.g., culverts) below a hardened or reinforced roadway surface. During periods of high water or flooding, the flow passes over the structure and typically prevents vehicle passage.

VI. EROSION CONTROL

Figure (VI.1): Use of Vegetation, Woody Material and Rock for Erosion Control

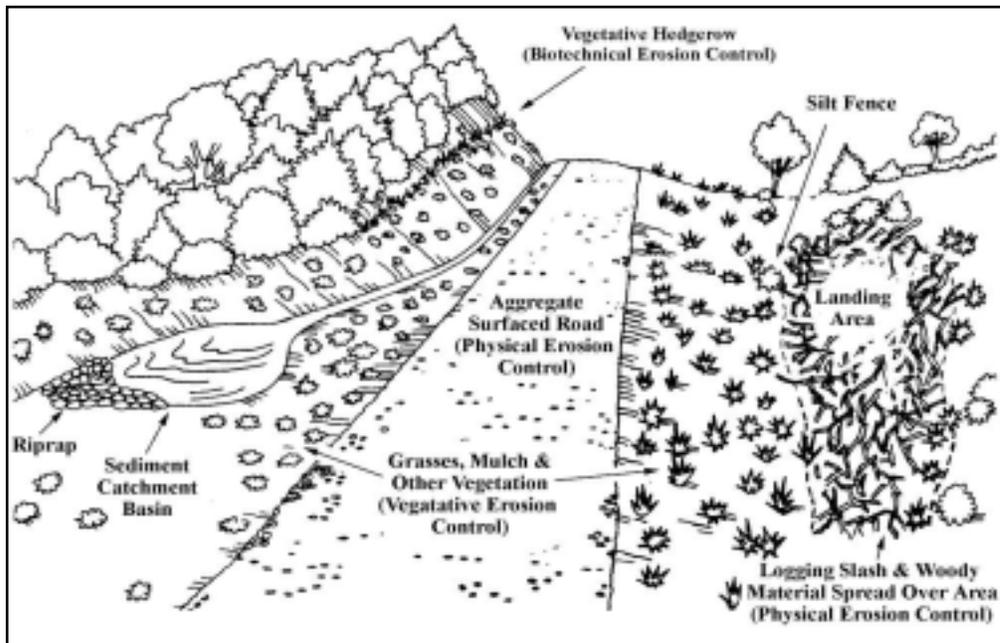
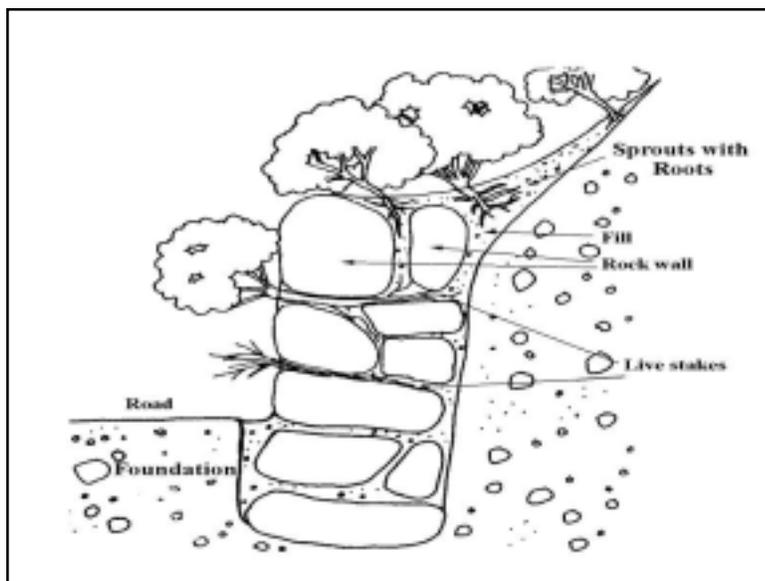


Figure (VI.2): Biotechnical Erosion Control Measures-A Wall with Live Stakes



Biotechnical Erosion Control - A combination of vegetative and structural measures used to prevent erosion or stabilize slopes and stream banks. The term “biotechnical” describes several methods of establishing vegetative cover by embedding a combination of live, dormant, and/or decaying plant materials into banks and shorelines in a structure-like manner or in conjunction with riprap or physical structures such as cribs or gabions.

Brush Barrier - A sediment control structure created using live brushy vegetation or slash piled at the toe of a fill slope, on contour along a slope, along the road, or at the outlet of culverts, leadoff ditches, dips, or water bars to trap sediment.

Brush Layers - The biotechnical practice of digging shallow terraces into the surface of a slope, laying in layers of a vegetative cuttings that will resprout, and backfilling (burying) the cuttings with soil. Cuttings are placed perpendicular to the slope contour.

Erosive Soils - Soils that are relatively prone to erosion and movement by rain drop impact and surface runoff. Fine granular, non-cohesive soils, such as fine sandy sand derived from decomposed granite, silts, or fine sands, are known to be very erosive.

Erosion - The process by which the surface of the earth is worn away and soil moved by the actions of wind or water in the form of raindrops, surface runoffs, and waves.

Erosion Control - The act of reducing or eliminating on-going erosion caused by raindrop impact, rilling, gullying, raveling, and other surface processes.

Erosion Prevention - Preventing erosion before it occurs. Erosion prevention is typically less expensive and more effective than erosion control. Erosion prevention is intended to protect a road, including its drainage structures, cut and fill slopes, and disturbed areas, and to protect water quality.

Live Stakes - Sections of woody plants that are cut into lengths (stakes) and placed or driven into the slope. The plant material is installed during the fall or spring when the original plant (and consequently cuttings from it) is dormant. The plant materials used for stakes are usually hardy species which will root from cuttings easily and eventually grow into mature woody shrubs that reinforce the soil structure of the slope.

Mulch - Material placed or spread on the surface of the ground to protect it from raindrop, rill, and gully erosion, and to retain moisture to promote the growth of vegetation. Mulches include cut vegetation, grasses, wood chips, rock, straw, wood fiber, and variety of other natural and synthetic materials and mats.

Mulching - Providing a loose covering on exposed soil areas using materials such as grass, straw, bark, or wood fibers to help control erosion and protect exposed soil.

Native Species - Occurring or living naturally in an area (indigenous), such as locally grown native plants.

Physical Erosion Control Measures - Non-vegetative measures used to control erosion, such as armoring the soil with riprap, building silt fences, using woven mats, using gabions, spreading or windrowing logging slash or woody material, etc., and controlling water with settlement ponds, armored drainage ditches, etc.

Scarification - The act of ripping or stripping the forest floor or a road surface and mixing it with mineral soil, typically with mechanical equipment, to loosen the soil, reduce compaction, and prepare the area for planting with grasses or trees.

Sedimentation (Sediment) - Soil, most commonly clay, silt and sand, which is eroded from the land or poorly constructed roads and reaches a stream or water course, commonly reducing water quality in rivers, streams and lakes.

Sediment Catchment Basin - A constructed basin designed to slow water velocity and trap sediment as it settles out of the water.

Slash - Any treetops, limbs, bark, abandoned forest products, windfalls or other debris left on the ground after timber or other forest products have been cut.

Silt Fence - A temporary barrier used to intercept sediment-laden runoff from slopes. It is typically made of porous geotextile material.

Vegetative Erosion Control Measures - The use of live cuttings or stakes, seed, sod, and transplants to establish vegetation (grass, brush, trees) for erosion control and slope protection work.

Vegetative Contour Hedgerow - Rows of trees and shrubs, typically planted on contour across slopes, that form a border and can provide erosion control protection against sheet flow, as well as provide food and cover for wildlife.

Vetiver Grass - Any of several varieties of a non-invasive, large bunch grass widely used for erosion control and moisture conservation. When planted as a contour hedgerow, it slows runoff and filters sediment. The curtain-like root system helps anchor soil and competes minimally with adjacent crop roots.

Wattles (Live Fascine) - Long bundles of brush or branch cuttings, bound together into sausage shaped structures, which are buried or staked on contour along a slope, preferably to sprout, and form a sediment trap or break up sheet flow on the slope.

Windrow - Logging debris and woody vegetation that has been piled in rows to trap sediment, as well as decompose or eventually be burned; the act of building windrows.

VII. MISCELLANEOUS TERMS

Angle of Repose - The maximum slope or angle at which a granular material, such as loose rock or soil, will stand and remain stable.

Best Management Practices (BMPs) - Practical guidelines that can be used to reduce the environmental impact of roads and forest management activities (such as the construction of roads, skid trails and log landings) and protect water quality. BMPs address the key planning, location, design, construction, and maintenance aspects of roads or other activities that can cause adverse environmental impacts and suggest methods to prevent those impacts.

Buffer Area - A designated zone along a stream or around a water body or area with sufficient width to minimize the entrance of forestry chemicals, sediment, or other pollution into the water body or protect the area.

Contour - Lines drawn on a plan that connect points having the same elevation. Contour lines represent an even value, with the contour interval being selected consistent with terrain, scale, and intended use of the plan. Contours are level.

Environmental Impact - An action or series of actions that have an effect on the environment. An Environmental Impact Assessment predicts and evaluates these effects, both positive and negative, and the conclusions are used as a tool in planning and decision-making.

Gabions - Baskets (usually made of wire) filled with rocks (or broken pieces of concrete) about 10-20 cm in size, used for building erosion control structures, weirs, bank protection, or retaining structures.

Geotextile (Filter Fabric) - Textile made from synthetic “plastic” fibers, usually non-biodegradable, to form a blanket-like product. Geotextiles can be woven or non-woven and have varying degrees of porosity, open area, and strength properties. They are used as moisture barriers, for separation or reinforcement of soils, filtration, and for drainage.

Habitat - The natural environment that forms a home for native plants and animals. For example, riverbanks are habitat for insects that are the primary source of food for many fish.

Logging (Harvesting) - Logging is the process of harvesting timber from trees. This includes felling, skidding, loading, and transporting forest products, particularly logs.

Landing (Log Deck) - Any place on or adjacent to the logging site where logs are assembled after being yarded, awaiting subsequent handling, loading, and transport. This is typically a relatively flat area, commonly about 20 to 50 meters in diameter.

Mitigation - The act of or a specific item used to reduce or eliminate an adverse environmental impact.

Native Soil - Natural, in-place or in-situ soil that has formed on site and has not been artificially imported to the site.

Reclamation (Rehabilitation) - Activities that reclaim, repair, or improve part or all of an existing road, borrow pit, or disturbed area and restore it to its original or some desired final condition.

Road Closure (Temporary) - Closing vehicular access to a road through the use of barricades such as gates, log barriers, earthen mounds, or other temporary structures. The end result is to restrict the use of the road for some period of time.

Road Decommissioning - Permanently closing a road through techniques that include blocking the entrance, scattering limbs and brush on the roadbed, replanting vegetation, adding waterbars, removing fills and culverts, or reestablishing natural drainage patterns. However the basic road shape, or template, is still in place. The end result is to terminate the function of the road and mitigate the adverse environmental impacts of the road.

Road Obliteration - A form of road closure that refills cut areas, removes fills and drainage structures, restores natural contours, revegetates the area, and ultimately attempts to restore the natural ground shape and condition. Thus, most adverse environmental impacts of the road are eliminated.

Road Management Objectives - Objectives that establish the intended purpose of an individual road based on management direction and access management objectives. Road management objectives contain design criteria, operation criteria, and maintenance criteria.

Skid Trail (Skidding) - A temporary, nonstructural pathway over forest soil used for dragging felled trees or logs to a log landing.

Streamside Management Zone (SMZ) - The land, together with the vegetation that grows there, immediately in contact with the stream and sufficiently close to have a major influence on the total ecological character and function of the stream. It is a buffer area along a stream where activities are limited or prohibited.

Upgrading - The process by which the standard of an existing road is improved or altered to allow for increased capacity and safe use by a greater volume of traffic.

