LOW-VOLUME ROADS ENGINEERING

Best Management Practices

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G. Keller

Best Management Practices- General

Environmental Protection Agency. Draft 2001. National Management Measures to Control Non-point Source Pollution from Forestry. EPA Contract No. 68-C7-0014, Work Assignment #2-20. Prepared for Office of Water, U.S. Environmental Protection Agency by Tetra Tech, Fairfax, Virginia. (A comprehensive guide to measures for reducing water pollution from roads and logging activities.)

Michigan Department of Natural Resources. 1994. Water Quality Management Practices on Forest Lands.

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U.S. Department of Agriculture, Forest Service. 2000. Water Quality Management for National Forest System Lands in California-Best Management Practices. Vallejo, CA: Pacific Southwest Region, U.S. Department of Agriculture, Forest Service. 186 p.

U.S. Department of Agriculture, Forest Service. Draft. 2001. Best Management Practices for Forest Roads: A performance-based framework. Washington, DC: A cooperative effort between the U.S. Department of Agriculture, Forest Service, and U.S. Environmental Protection Agency. 24 p.

\*U.S. Department of Agriculture, Forest Service. 2012. National Best Management Practices for water quality management on National Forest System lands, Volume 1-National core BMP technical guide. FS-990a. Washington, DC. April. Available at:

<http://www.fs.fed.us/biology/resources/pubs/watershed/FS_National_Core_BMPs_April2012.pdf>

\* Wisconsin Department of Natural Resources. 1995. Wisconsin’s Forestry Best Management Practices for Water Quality-Field Manual for Loggers, Landowners and Land Managers. Publication No. FR093. March. Madison, WI. 76 p.

**Note: If you just want to choose one or two (\*\*) or a few (\*) publications from any subject area list, these are what I consider the most useful documents or my personal favorites! Gordon**

**Environmental Analysis**

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Burpee, G; Harrigan, P; Remington, T. Second Edition 2000. A Cooperatoring Sponsor’s Field Guide to USAID Environmental Compliance Process- Based on Regulation 216 to the USAID Environmental Documentation Manual for PL 480 Title II Food for Development Programs. Published jointly by Catholic Relief Services and Food Aid Management. Baltimore, MD. 69 p.

Public Law 91-190. [S. 1075]. National Environmental Policy Act of 1969. Act of January 1, 1970. [An act to establish a national policy for the environment, to provide for the establishment of a Council of Environmental Quality, and for other purposes.] In its: United States statutes at large, 1969. 42 U.S.C. sec. 4231, et seq. (1970). Washington, DC: U.S. Government Printing Office; 1970: 852-856. Vol. 83.

World Bank, The. 1997. Roads and the Environment: A Handbook. Report TWU 13, and update WB Technical Paper No. 376. Washington, DC: The World Bank Environmentally Sustainable Development Vice-Presidency and Transportation, Water & Urban Development Department Transport Division. [Online] <http://www.worldbank.org/transport/publicat/reh/toc.htm>

**Environmental Issues and Special Applications**

California Invasive Plant Council. 2012. Preventing the Spread of Invasive Plants: Best Management Practices for Transportation and Utility Corridors. Cal-IPC Publication 2012-01, California Invasive Plant Council, Berkeley, California. 62p.

Available at: <http://pollinator.org/PDFs/TransportationUtilityCorridorsPreventionBMPs.pdf>

\*Clarkin, K. et al. 2008. Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings. Gen. Tech Rep. 0877 1801- SDTDC. San Dimas Technology and Development Center, USDA Forest Service, San Dimas, CA. Available at: <http://www.stream.fs.fed.us/fishxing/aop_pdfs.html>

Clevenger, A.P.; Huijser, M. 2011. Wildlife Crossing Structure Handbook: Design and Evaluation in North America. FHWA-CFL/TD-11-003. Western Transportation Institute and Federal Highway Administration, Washington, DC. 224p.

Dykstra, D.; Heinrich, R. 1996. FAO Model Code of Forest Harvesting Practice. Rome, Italy:Food and Agriculture Organization of the United Nations. 85 p. (ISBN 92-5-103690-X). [Online] <http://www.fao.org>

\*Forman, R. T.; Sperling, D.; et al. 2003. Road Ecology: Science and Solutions. Washington, DC: Island Press. 482 p. (ISBN 1-55963-933-4) ( A comprehensive and thoughtful book addressing the many ecological impacts of roads, their principles, and approaches to solving transportation problems.)

\*Huijser, M.P.; McGowen, P.; Clevenger, A.P.; Ament, R. 2008. Wildlife Vehicle Collision Reduction Study: Best Practices Manual. Western Transportation Institute, Montana State University and Federal Highway Administration, McLean, VA. 174p. (See the link <http://www.fhwa.dot.gov/environment/wildlifecrossings/> for extensive information on this.)

\*Kilgore, R.; Bergendahl, B.; Hotchkiss, R. 2010. Culvert Design for Aquatic Organism Passage. Hydraulic Engineering Circular (HEC) 26, FHWA-HIF-11-008-HEC-26, Central Federal Lands Division, Federal Highway Administration, Lakewood, CO. 234 p. Available at:

[**http://www.fhwa.dot.gov/engineering/hydraulics/pubs/11008/hif11008.pdf**](http://www.fhwa.dot.gov/engineering/hydraulics/pubs/11008/hif11008.pdf)

PIARC World Roads Association. 1999. Natural Disaster Reduction for Roads, Final Report 72.02B, Paris, FR: PIARC Working Group G2. 275 p. (ISBN 2-84060-109-5) (Also see Comprehensive Report 72.01B, 1995.) [Online] http://www.piarc.org

Rajvanshi, A.; Mathur, V.; Teleki, G.; Mukherjee, S. 2001.Roads, Sensitive Habitats and Wildlife: Environmental Guidelines for India and South Asia. Wildlife Institute of India, Dehradun, India, in collaboration with Canadian Environmental Collaborative Ltd. Toronto, Canada. [Phone # 1-416-488-3313] 215 p. (ISBN 81-85496-10-2) ( A comprehensive book on the issues of wildlife, their habitats, and roads, discussing problems,mitigations, and case histories).

U.S. Department of Agriculture, Forest Service, 2000. Water/road Interaction Toolkit- FishXing: CD software and Interactive Learning for Fish Passage through Culverts. Water/Road Interaction Technology Series-SDTDC. November. Washington, DC: U.S. Department of Agriculture, Forest Service. San Dimas Technology & Development Program.

 [Online] <http://www.stream.fs.fed.us>/fishxing (A CD covering various aspects of fish passage.)

**Basic Engineering Considerations for**

**Low-Volume Roads**

\*\*American Association of State Highway and Transportation Officials. 2001. Guidelines for Geometric Design of Very Low-Volume Local Roads (ADT<400). Washington, DC. (ISBN

1-56051-166-4). [Online] <http://www.transportation.org> (Covers the geometric design standards for very low-volume, local roads.)

B. C. Ministry of Forests. 2002. Forest Roads Engineering Guidebook. Forest Practices BR., B.C. Min For. Victoria, B.C. Forest Practices Code of British Colombia Guidebook.

Casaday, E.; Merrill, B. 2001. Field Techniques for Forest and Range Road Removal. Eureka, California: California State Parks, North Coast Redwoods District. 63 p. (A useful Field Guide to Road Closure and Obliteration, with great photos and figures.)

Charles. R. 1997. Design of Low-Volume Low Cost Roads. UWI Public Information Series/Roads, Volume 1. Dept of Civil Engineering, University or West Indes, West Indes. 132 p. ( A practical design manual that covers all aspects of rural road design, particularly considering tropical climates).

Department of Transport, South African Roads Board. 1993. Guidelines for Upgrading of Low Volume Roads. RR 92/466/2, Division of Roads and Transport, South African Roads Board, Pretoria. (ISBN 1-874844-90-9). (A manual that provides information, considerations, and needs for upgrading rural gravel roads.)

\*Faiz, Asif. 2012. The Promise of Rural Roads: Review of the Role of Low-Volume Roads in Rural Connectivity, Poverty Reduction, Crisis Management, and Livability. Transportation Research Circular No. E-C167. Transportation Research Board of the National Academies, Washington, DC, September. 52p. Available at:

[**http://onlinepubs.trb.org/onlinepubs/circulars/ec167.pdf**](http://onlinepubs.trb.org/onlinepubs/circulars/ec167.pdf)

\*\*Gesford, A; Anderson, J. 2006. Environmentally Sensitive Maintenance for Dirt and Gravel Roads. PA-2006-001-CP-83043501-0, Pennsylvania State Center for Dirt and Gravel Roads Studies, in cooperation with Commonwealth of Pennsylvania, Pennsylvania DOT, and US EPA. Harrisburg, PA.

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\*\*Giummarra, G., Editor. 2009. Unsealed Roads Manual: Guidelines to Good Practice, Third Edition. Australian Roads Research Board (ARRB Group Ltd.). Vermont South, Victoria, Australia. A useful manual for gravel road design and maintenance, particularly in semi-arid regions.) (Must be purchased).

[**http://www.arrb.com.au/Information-services/Publications/Reports-Manuals.aspx**](http://www.arrb.com.au/Information-services/Publications/Reports-Manuals.aspx)

Geunther, K. 1999. Low Maintenance Roads for Ranch, Fire and Utility Access. Wildland Solutions Field Guide Series, Clyde, CA: Wildland Solutions. 48 p. [Online] [www.wildlandsolutions.com](http://www.wildlandsolutions.com)

\*\*Keller, G.; WilsonMusser, S.; Bolander, P.; Barandino, V. 2011. Stabilization and Rehabilitation Measures for Low-Volume Forest Roads. 1177-1801*—*SDTDC. San Dimas, CA: U.S. Department of Agriculture, Forest Service, San Dimas Technology and Development Center. 333 p.

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\*\*Keller, G; Sherar, J. 2003. Low-Volume Roads Engineering-Best Management Practices Field Guide. USDA Forest Service, Office of International Programs and US Agency for International Development, Washington, DC. 158 p. (Also available in Spanish)

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[**http://www.clrp.cornell.edu/workshops/pdf/basics\_of\_a\_good\_road-2010-web.pdf**](http://www.clrp.cornell.edu/workshops/pdf/basics_of_a_good_road-2010-web.pdf)

Moll, J.E. 1996. A guide for road closure and obliteration in the Forest Service. San Dimas Technology and Development Program. Pub. No. 7700. Washington, DC: U.S. Department of Agriculture, Forest Service. 49 p.

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National Research Council, Transportation Research Board. 1978. Geometric Design Standards for Low-Volume Roads. Transportation Technology Support for Developing Countries Compendium 1. Washington, DC: National Academy of Sciences. 297 p. (Compendium contains ten selected texts intended to provide useful documentation to those in developing countries concerned with the geometric design of low-volume roads).

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U.S. Department of Agriculture, Forest Service. 1999. Road analysis: Informing decisions about managing the national forest transportation system.Misc. Report FS-643. Washington, DC: U.S. Deptartment of Agriculture, Forest Service. 222 p (Covers costs to maintain and mitigate in relationship to values at risk – uses and benefits as opposed to environmental damage.) .

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U.S. Department of Agriculture, Forest Service. Forest Roads and the Environment- a DVD of Five different Videos on aspects of Road Maintenance. Available from San Dimas Technology and Development Center, San Dimas, California. (909) 599-1267. Ask for Publications!

\*Walbridge, T. A. 1997. The Location of Forest Roads. Virginia Polytechnical Institute and State University, Blacksburg, VA: Industrial Forestry Operations. 91 p. (A primer on basic road planning, reconnaissance, location and drainage in mountainous terrain. Also available in Spanish.)

\*Weaver, W; Hagans. D. 1994. Handbook for forest and ranch roads-A guide for planning, designing, constructing, reconstructing, maintaining, and closing wildland roads. Ukiah, CA: Pacific Watershed Associates for the Mendocino County Resource Conservation District, in cooperation with CDF and the NRCS. 161 p.

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### Hydrology for Drainage Crossing Design

American Association of State Highway and Transportation Officials. 1999, Highway Drainage Guidelines (Metric Edition) (Fourth Edition). Washington, DC. (ISBN I-56051-126-5). [Online] <http://www.transportation.org> (A comprehensive guide on all aspects of highway drainage design). 630 p.

Jennings, M.E.; Thomas, W.O.; Riggs, H.C. 1994. Nationwide summary of U.S. Geological Survey regional regression equations for estimating magnitude and frequency of floods for ungaged sites, 1993. Water Resources Investigation Report 94-4002. Reston, VA: U.S. Geologic Survey. 38 p. Prepared in cooperation with FHWA and FEMA. (Available through NTIS, Springfield, Va. Phone (703) 605-6000) [Online] <http://www.ntis.gov>

Linsley, R.; Kohler,M.; Paulhus, J. 1958. Hydrology for engineers. New York, NY: McGraw-Hill Book Company, 340 p. (A classic text on hydrology.)

\*McCuen, R; Johnson, P; Regan, R. 2002. Highway Hydrology, Hydraulic Design Series No. 2, Second Edition, FHWA-NHI-02-001. Federal Highway Administration, National Highway Institute. Arlington, VA. 424p. (Covers hydrologic techniques and methods suitable to small drainage areas.) [Online] <http://www.fhwa.dot.gov/bridge>

\*Ries, K.G., III. 2006. The National Streamflow Statistics Program: A Computer Program for Estimating Streamflow Statistics for Ungaged Sites: [**http://pubs.usgs.gov/tm/2006/tm4a6/**](http://pubs.usgs.gov/tm/2006/tm4a6/) or

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**Tools for Hydraulic and Road Design: Manning’s Formula;**

 **Riprap; Filters; and Use of Geosynthetics**

Barnes, H. Jr. 1967. Roughness characteristics of natural channels. U.S. Geological Survey Water Supply Pap. 1849. Washington , DC: U.S.Government Printing Office. Available through U.S. Geological Survey, Arlington, VA. 213 p.

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### Drainage of Low-Volume Roads

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**Culvert Use, Installation, and Sizing**

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### Bridges

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