Chapter 5—Describing Opportunities and Setting Priorities

Opportunities for Changes in Road Management Strategy

The process used to determine sub-watershed risk assessments and the results of those assessments are included in Appendix D. This information identifies sub-watersheds with the greatest road related resource risks, and can be used to prioritize sub-forest scale watershed and roads analyses. During sub-forest scale roads analysis, the team should first review the sub-watershed risk assessments, including the maps in Appendix B. This review will help determine how roads may be affecting watershed health in the analysis area and help guide road-related decisions that can address watershed health.

During sub-forest scale roads analysis, the team should also review, validate, and update the watershed and aquatic risk assessments for the primary system roads as displayed in the Road Tables in Appendix A. The results of these road valuations can be used to develop road management alternatives for these roads, including relocation, upgrades, increasing or decreasing the maintenance levels.

During Step 4 of sub-forest scale analyses, the team should review the forest scale responses to the questions found in Chapter 4. Where the forest scale responses do not adequately address the sub-forest scale issues, the team should provide additional information.

Sub-forest roads analyses should be used to evaluate and recommend changes to system roads that involve new construction, reconstruction, changes in status from open to closed or closed to open, or decommissioning. If these changes are subsequently implemented through NEPA decisions, the NEPA teams need to make sure those changes are documented in the Road Management Objectives (RMO) and that all INFRA and GIS databases are subsequently updated.

Evaluating access needs relative to environmental risks allows an assessment as to whether present Operational Maintenance Levels for a specific road or road segment should be changed to meet current needs and anticipated maintenance funding. Possible outcomes of such an assessment include the following types of recommendations:

> **1) Decommission or Convert to Other Uses:** Access or full-sized vehicle access is no longer needed, or a road or road segment is located so poorly that it warrants relocation (reconstruction), it should be decommissioned (removed from the transportation system). Road can either be stabilized and returned to other resource production or converted to other uses such as motorized or non-motorized trail.

2) Implement Year Around Closure: Access needs are relatively low; road is only needed for administrative or project use, for emergencies, or on a permit only basis. The road can be closed between projects. Either resource concerns or maintenance funding limitations provide a need to close the road when not needed for project activities.

3) Implement Seasonal Travel Restrictions: Access is generally needed during the snow free season, but resource concerns indicate a need for travel restrictions during some periods of the year to reduce road related impacts.

4) Decrease Maintenance Level: Identified need for access does not support continuing to maintain the road at the current OML and OML can be adjusted downward and still meet the most critical access needs. Impacts to resources are relatively low and do not require maintenance to continue at present level.

5) Change in Surface Type: The cost of maintaining some roads could be substantially reduced by a change in surface type, while still meeting the anticipated access needs. While fine surface aggregates can provide a smooth running surface, they are typically expensive to produce. Smooth surfaces usually results in an increase in speed, which in turn typically results in rapid wear of the aggregate, mostly as a result of being thrown off the road from high-speed traffic. Use of coarse aggregates will produce a rougher surface, but on many roads it will also serve to reduce user speed, decrease the risk of accidents, and to extend the life of the surfacing aggregate.

6) Maintain As Is: Existing maintenance efforts are generally in balance with access needs, and no resource impacts have been identified that would warrant a change in OML.

7) Increase Maintenance Level: Identified need for access supports increasing the current OML and/or resource impacts have been identified that indicates a need to perform maintenance at a higher level.

This analysis did not evaluate any roads that are recommended candidates for categories 1), 2), or 3) above. But it does identify roads or road segments that have high watershed risks, high aquatics risks, or both. For these roads or segments, opportunities for relocating all or portions of them should be considered. This analysis also recommends changes to the current Operational Maintenance Levels of many of the minimum primary road system (see the recommended ObML in the Road Tables in Appendix A).

Potential Minimum Primary Road System Risks & Opportunities

After evaluating the relative risks for each road or road segment of the recommended minimum primary system (displayed in the road tables in Appendix A), the roads were grouped into overall risk categories to help determine possible road management strategies. The road tables also identify which of the recommended minimum primary

roads need additional investments for resource protection (based on risk ratings), and any recommended changes to their current Operational Maintenance Levels.

Overall Road Risk Categories

The roads that were analyzed were grouped into three overall risk categories based on a combination of the watershed and aquatics risk ratings for each road or road segment. The composite risks were determined by assigning a weighted value of 3 for a high risk rating, 2 for a moderate risk rating, and 1 for a low risk rating, for watershed risk rating and aquatics risk rating for each road or road segment. The weighted values for each risk element were then added together, and roads with a composite weighted risk of 5 or 6 were placed in a high overall risk category, roads with a composite weighted risk of 3 or 4 were placed in a moderate overall risk category, and roads with a composite weighted risk of 2 were placed in a low overall risk category. Within each category, there are possible management options for the roads.

Category 1 – High Risk– Includes about 306 miles of roads (14%) with the following risk ratings:

High Watershed Risk and High Aquatics Risk
High Watershed Risk and Moderate Aquatics Risk
Moderate Watershed Risk and High Aquatics Risk

Considerations for these roads include:

- High priority for sub-forest scale roads analysis to identify high-risk reduction needs and confirm use values.
- High priority for capital improvement funding, road improvement, road relocation, funding, capital improvement program, etc.
- Shift road maintenance funds to these roads to keep their resource risks from increasing.
- Potential for relocation of some segments to reduce risks.

Category 2 – Moderate Risk – Includes about 1127 miles of roads (53%) with the following risk ratings:

High Watershed Risk and Low Aquatics Risk
Moderate Watershed Risk and Moderate Aquatics Risk
Moderate Watershed Risk and Low Aquatics Risk
Low Watershed Risk and Moderate Aquatics Risk

Considerations for these roads include:

- Potential for reducing maintenance level.
- Moderate priority for sub-forest scale roads analysis to identify risk reduction needs and confirm use value.
- Potential for relocation of some segments to reduce risks.

Category 3 – Low Risk – Includes about 694 miles of roads (33%) with the following risk rating:

Low Watershed Risk and Low Aquatics Risk

Considerations for these roads include:

- Focus road maintenance funds on these roads to keep them in this category.
- Potential for reducing maintenance level.

The road miles shown for these three categories of roads combined represent the recommended minimum primary road system for the Malheur National Forest. The arterial or collector roads that are recommended as OML of 3, 4, or 5 in the Road Tables in Appendix A include all of the roads that could potentially be designated as Public Forest Service Roads.

Road Maintenance Costs – Comparing the Recommended Minimum Primary Road System to the Current System

One purpose of a roads analysis is to identify ways to more efficiently spend the limited road maintenance dollars allocated to the forests. Tables 15 and 16 that follow allow some comparisons between the estimated costs of maintaining the existing road system to current OML levels, and how the costs would change if the recommended changes in OML of the minimum primary road system were implemented.

The costs for annual and deferred maintenance in the tables are based on average costs from year 2000 and 2001 surveys for maintenance Level 1 and 2 roads, and on average costs from year 2002 and 2003 surveys for level 3-5 roads. The older surveys were used for level 1 and 2 roads because there were very few roads in these maintenance classes surveyed in 2002 and 2003.

Current Forest Transportation System

Table 15. Estimated Annual and Deferred Maintenance costs to maintain the road system to current OML, and Capital Improvement Costs to complete planned Capital Improvements.

OML	Total Miles	Annual Maintenance		Deferred Maintenance		Capital Improvements	
LEVEL		$/mile	Total $	$/mile	Total $	$/mile	Total $
1	2638	400	1,055,200	660	1,741,080		
2	5812	830	4,823,960	1,720	9,996,640		
3	883	6,320	5,580,560	26,000	22,958,000	16,405	14,485,944
4	317	18,500	5,864,500	170,000	53,890,000	150,276	47,637,492
5	19	18,500	351,500	170,000	3,230,000	396,100	7,525,900
All	9670		17,675,720		91,815,720		69,649,346
The costs in this table are from INFRA and include estimated overhead and administrative costs of 45%.							

This analysis did not analyze roads that were likely candidates for closure or decommissioning, so Table 16 does not include any changes in total road miles or OML 1 road miles. Miles of open road and open road densities are likely to continue to decrease in the future as an outcome of sub-Forest level analyses and decisions. But those decisions and any changes in maintenance costs associated with them are likely to be incremental and occur over a long period of time.

Recommended Minimum Primary Roads System

Table 16–Estimated Annual and Deferred Maintenance costs to maintain the recommended minimum primary road system to recommended OML, and Capital Improvement Costs to complete planned Capital Improvements.

OML	Total Miles	Annual Maintenance		Deferred Maintenance		Capital Improvements	
LEVEL		$/mile	Total $	$/mile	Total $	$/mile	Total $
1	2638	400	1,055,200	660	1,741,080		
2	6425	830	5,332,750	1,720	11,051,000		
3	271	6,320	1,712,720	26,000	7,046,000	16,405	4,445,755
4	317	18,500	5,864,500	170,000	53,890,000	150,276	47,637,492
5	19	18,500	351,500	170,000	3,230,000	396,100	7,525,900
All	9670		14,316,670		76,958,080		59,609,147
The figures in the table include estimated overhead and administrative costs of 45%.							

Comparing Table 15 and Table 16 gives an idea of the potential cost savings if the recommended changes in maintenance levels of the minimum primary road system were implemented. For example, implementation of these changes would reduce annual maintenance costs by about 3.5 million dollars, and deferred maintenance costs by about 15 million dollars. Clearly the biggest potential for savings between the two tables is in the deferred maintenance category, and mostly reflects the fact that there is generally no planned surface rock replacement costs on roads with OML 2 (even though the majority of the roads that are recommended as OML 2 roads in this table currently have aggregate surfaces). If the surface materials were replaced as they wear out on these roads, it would cost an about $93,000 per mile for single lane roads or $130,000 per mile for double lane roads to accomplish, depending on the type and depth of surfacing material and other variables.

Decisions to decommission some of the roads that are not part of the potential minimum primary road system are expected to occur over time as an outcome of sub-Forest level analyses. When those decisions are implemented, any annual and deferred maintenance costs for roads that are decommissioned will be eliminated. Depending on the type of road and decommissioning effort, those costs would range from as low as $1,000 per mile to greater than $10,000 per mile. But it will likely take a considerable amount of funding over an extended period of time to accomplish a significant decrease in the total miles of classified roads and the associated road maintenance costs.

For 2004, the allocated road maintenance budget for planning, construction, and maintenance of roads administered by the Malheur is estimated at $790,000. This funding covers many aspects of road maintenance and management including the organization necessary to accomplish the overall program and associated overhead costs. The net result is that only about half of it is available to accomplish annual on-the-ground maintenance activities.

Other Funding Opportunities

There are likely to be at least some minor funding opportunities to supplement the allocated funding for road maintenance. In the past few years the Forest has been able to supplement road maintenance funding through the Title II funding program (approximately $290,000 in 2002, and $440,000 in 2004). But that funding source will expire in 2006 unless the program is extended or renewed.

Appropriated road funding has historically been supplemented to varying degrees by road construction and maintenance work performed by timber purchasers through the commercial timber sale program. That program and the associated funding opportunities have declined drastically in the past decade. It is also possible that planned hazardous fuel reduction projects could provide some additional road maintenance or funding, but it is unlikely to provide significant relief to the overall funding shortfall.

The PFSR project proposals described in Chapter 2 are also a potential funding source for some large Capital Improvement needs, but whether this program will be approved and at what funding level is still uncertain. Also, the projects that the Malheur submitted did not rank high regionally for funding, so even if the program is established it is likely to be five years or more before any funding is available to implement projects on this Forest.

Funding for Capital Improvements other than through the PFSR program has been very limited in recent years. It is expected that most of the funding that might be available will be focused on bridge replacements and culvert improvements or replacements related to fish passage problems.

All of these potential funding opportunities considered, it is still likely road maintenance funding will be inadequate to fully support even the potential minimum primary road system infrastructure, and the backlog in deferred maintenance costs is likely to continue to grow.

Areas Needing Primary Access Roads

The timber program projected in the Forest Plans will require additional ***primary*** access to meet resource management needs. There are a few areas on the Forest that are shown as suitable for timber harvest in the Forest Plans that currently have little or no motorized access, either because right-of-ways have not been secured or access roads have not yet been constructed. The need for timber access or other motorized access could change with the Forest Plan Revision. Four areas were identified specifically that do not currently have minimal primary roaded access include:

- There is insufficient public access into the Roberts Creek drainage and the area to the east of Roberts Creek on the Prairie City District. In these areas, Forest Lands and private lands are intermingled in a “checkerboard” land ownership pattern, which severely restricts public access.

- The Forest currently has no right of way for collector road 4795, which accesses lands in the Utley Butte Wildlife Emphasis Area on the Emigrant District (prior right-of-way was terminated).

- There is insufficient access into the area on the west side of the Deerhorn Creek drainage and in the Little Butte drainage on the Blue Mountain District.

- There is insufficient access in the Dry Cabin Wildlife Emphasis Area, located in the northwest corner of the former Blue Mountain District.

New Road Construction in Currently Unroaded Areas

This analysis did not include any assessment of new roads in inventoried roadless areas. Current direction for inventoried roadless areas is included in the Forest Plan. The Forest Plan revision process is recently started, and is scheduled for completion in 2007. The revision will include inventory, evaluation, and recommendations on how to manage inventoried roadless areas and any timberlands that are currently identified as suitable for harvest.

Most of the suitable timberland outside of the inventoried roadless is already roaded and is under some form of recurring timber management. In addition to the areas needing primary access identified in the previous section, there are still local areas in the suitable timber base that are outside of inventoried roadless areas that will need some new roads to meet timber management or other resource needs. Most of the roads needed could be managed as either temporary roads or as OML level 1 classified roads, open only when needed for timber management activities.

Forest Plan Revision

This Forest scale roads analysis is an assessment that provides information, recommendations and opportunities that can be used during the Malheur Forest Plan revision. The revision process started in (fiscal year) 2004, and is scheduled for completion in 2007. The revision effort will address all of the major access and travel management issues, including those related to roads, road use and user conflicts.

This watershed and aquatics risk assessments covered all of the Forest lands in each 6th level HUC on the Forest, and should help identify the highest priority areas for future watershed improvements and restoration activities. The overall watershed risk ratings are closely related to overall road densities. Road densities and forest/habitat fragmentation are components of biological diversity, which is likely to be a major Forest Plan revision topic.

NEPA Analysis Needs

This Forest scale roads analysis is provides information, recommendations and opportunities that can also be used for both prioritizing and completing sub-Forest scale roads analyses. Decisions to change the existing road system based on recommendations of sub-forest scale roads analyses will be required to be supported by the appropriate level of NEPA analysis.

General Road Management Guidelines

The following are general road related guidelines:

- If a road's maintenance condition has decreased, consider the need for the road and the historic use, as well as alternative roads in the area before permanently changing the maintenance level.

- Reduce the maintenance level on roads that are currently OML 3, 4, and 5 to the recommended objective maintenance levels in the Road Tables in Appendix A. Reduced maintenance of these roads should not result in any increased watershed risks from these roads, as the most basic road maintenance will focus on maintaining road drainage. The reduced maintenance should only result in reduced user comfort, and reduced comfort could reduce use over time, and possibly further reduce the potential for road related watershed risks.

- For roads that are not part of the minimum primary road system, consider reducing to OML 1, or decommissioning if the roads are no longer needed for administrative or public use. However, overall recreation use on the Forest is increasing and road related opportunities exist to better disperse this use and lessen recreation impacts that are occurring elsewhere. As analyses consider further reductions in open road density (through road closures and decommissioning), they need carefully consider the effects of increasing traffic on the roads that remain open. There may be opportunities on the Forest to convert some OML 1 and 2 roads, and possibly some unclassified roads to motorized and non-motorized trails, although this would result in an increased need for trail maintenance funds.

- It is important for travelers to have the sort of information necessary to make a decision about the road on which they intend to travel. When appropriate, utilize entrance treatments, warning signs, route markers, and information bulletin boards to advise travelers of conditions ahead.

- To reduce annual maintenance costs, implement seasonal travel restrictions on roads susceptible to damage during wet or thawing conditions.

- Collect road maintenance and surface rock replacement deposits (as appropriate) on all commercial use of classified roads (including timber haul).

- Require authorized, permitted operations utilizing NFS roads to pay their fair share of road maintenance costs.

- Consider road decommissioning when planning projects that involve the construction and use of short term, single resource roads: for example, roads planned for mineral projects that undergo exploration, development, and

abandonment phases. By incorporating decisions to decommission the single resource roads at the end of the project, rather than not addressing this issue up front, the Forest will better demonstrate a commitment to managing its road system toward the minimum road system needed. Document planned decommissioning in road management objectives.

- Develop annual maintenance plans that minimize deferred maintenance cost accruals on the minimum primary road system.

- Update the road system databases and keep them current.

- Use an interdisciplinary process to develop, update, and implement road management objectives for all system roads. Assure that information in the transportation atlas and inventory conforms to road management objectives that have been approved.

- At appropriate intervals, update the data contained in the road tables in Appendix A. Analyze the changes to determine new opportunities that may have developed as new information is collected.

- Incorporate yearly Forest road changes into the annual Forest Plan Monitoring Report (via the forest plan revision process). These road changes can include miles of roads decommissioned (classified and unclassified), miles of roads converted to trail (MV and Non-MV), miles roads reconstructed (by maintenance level), and miles of roads constructed (also by maintenance level).

- Use this Malheur National Forest Roads Analysis to help guide sub-forest scale roads analyses through a Forest supplement to the 7700 Manual.

- Continue to perform road condition surveys on classified roads per Washington Office direction.

Road Decommissioning

Discussion

Road decommissioning results in the removal of a road from the permanent transportation system. The impacts of the road on the environment are eliminated or reduced to an acceptable level; the goal is to leave the road in a "hydrologically disconnected" state and convert the former roadway to other resource use. The National Forest Management Act (NFMA) requires "re-establishing vegetative cover" on decommissioned roads within 10 years {16 USC 1608(b)}.

To accomplish this, a number of techniques can be used, such as posting the road closed and installing drainage structures, posting and installing barriers and barricades, ripping and seeding, converting the road to a trail, and full reclamation by restoring the original

topography. There is a different cost associated with each of these techniques, and their effectiveness for deterring unauthorized motorized vehicle use varies as well.

Decommissioning level 1 and 2 roads can consist of removing the few culverts, ripping and seeding, posting closed with signs, and installing drainage structures to discourage unauthorized motorized vehicle use and ensure proper drainage occurs over time.

Decommissioning level 3, 4, and 5 roads is usually more expensive than decommissioning most level 1 and 2 roads. When choosing a technique for road decommissioning, the objectives include eliminating the need for future road maintenance and restoring the ground for other resource uses.

Level 3, 4 and 5 roads are usually wider than level 1 and 2 roads, have culverts installed at designed intervals to cross drain the road, are ditched, have better sight distances designed on horizontal and vertical curves, have larger cuts and fills, and are designed through the topography rather than with the topography. It is more expensive to decommission these roads than level 1 and 2 roads. Given the cost, it would be much cheaper in the short term to reduce the maintenance levels of current 3, 4, and 5 roads (if they do not need to be maintained for low clearance vehicles) than it would be to decommission them. However, future maintenance costs may not be the only factor to consider; other resource considerations may outweigh the costs. For a particular road (level 3, 4, or 5), deferred maintenance costs may exceed the costs of decommissioning.

The Malheur began an active effort to decommission roads that were no longer needed about a decade ago. Some of these efforts have not been completely successful, and it has become apparent that any future efforts must be carefully designed to be effective. When decommissioning efforts are not effective at eliminating motorized use, it converts a system road into an unclassified road.

Problems related to continued use of roads that have been decommissioned have been growing in magnitude, and the credibility of the program is threatened. The Forest has a limited law enforcement capability, so it is critical that road decommissioning policy and practice is as simple and effective as possible. Funding and resources are not likely to increase substantially in the near future. A more comprehensive policy for assuring that existing and future road decommissioning efforts are effective should be a high priority for the Forest. If road decommissioning is not done in a manner that is truly effective, the actions may result in unintended consequences that have much greater impacts to Forest resources and credibility than deferring such actions until they can be successfully accomplished.

Decommissioning Guidelines:

- Balance costs with resource risks and effectiveness of the treatment options when selecting methods for decommissioning roads.

- Convert roads to trails as a decommissioning method when analysis of recreation demand indicates a need to expand, connect or improve the existing trail system in the area. This should only be done if it is determined that use as a trail will not have unacceptable impacts to other resources and that trail maintenance funding is adequate to meet those needs. Adequate trailhead parking would also need to be considered and provided as part of this treatment method (See UR1 and RR1 discussion in Chapter 4).

- Decommission in the most cost effective manner that will assure elimination of vehicular traffic. Often this may require ripping of the road surface to discourage further use.

- Restore a decommissioned road to original contours only when absolutely necessary to achieve resource goals.

Road Closures

Discussion

Over time the Forest road system has evolved to the point that many areas have relatively high road densities, a large number of road miles to maintain, and substantially reduced funding opportunities to accomplish the needed maintenance. The Malheur and Ochoco Forests have had evolving policies and used a variety of methods to accomplish road closures. The "green-dot" road closure areas managed cooperatively with the Oregon Department of Fish and Wildlife have been in place for decades. Since the Forest Plans were implemented in 1989 and 1990, the Forests have made decisions to close an increasing number of roads miles, primarily to reduce road related impacts on other resources. Most of the road closures that have occurred since the Forest Plan implementation are closed on a year around basis (not seasonal closures). Most of these roads can still be used in emergencies and on a permit only basis, but they can also be opened on a temporary basis for other resource management activities.

Many of these road closure efforts have not been completely successful. When road closure efforts are not effective at eliminating motorized use, it results in unwanted resource impacts and an increase in need for maintenance and associated funding. The Forest has a limited law enforcement capability, so it is critical that road closure policy and practice is as simple and effective as possible.

Road Closure Guidelines:

The Forest developed an Access Management Policy Addendum, with a title of "Malheur National Forest Administrative Access Management Guide" in 2002 to direct compliance with the objectives of road closure decisions.

Problems related to non-compliance with road closures continue to increase in magnitude, and the credibility of the program is threatened. Funding and resources are not likely to increase substantially in the near future. A more comprehensive policy for assuring that existing and future road closures are effective should be a high priority for the Forest. If road closures are not done in a manner that is truly effective, the actions may result in unintended consequences that have much greater impacts to Forest resources and credibility than deferring such actions until they can be successfully accomplished.

Capital Improvement Guidelines

Discussion

This analysis revealed that only a relatively small portion of the road miles scheduled for construction and reconstruction in the Forest Plans were accomplished. Revision of the plans will reassess the future need for constructing any new level 3, 4, and 5 roads.

This analysis does show there is a need to relocate (reconstruct) some existing primary road segments and to improve some roads to meet the increasing use and traffic requirements. It also shows a need for major maintenance on many primary roads to correct deferred maintenance work items. Funding limitations require prioritization of reconstruction work. The road risk ratings provide a starting point for developing priorities. The following guidelines should to be used in conjunction with those risk ratings when selecting, prioritizing and implementing road reconstruction and construction projects.

Capital Improvement Guidelines

- Conduct road location reviews prior to all new construction and road relocations. Assure the location meets public and agency needs while mitigating environmental impacts identified in the analysis. Responsible line officers and resource and engineering specialists should participate in the review.

- Continue with the traffic counting program to identify high use roads and traffic patterns.

- Roads with high seasonal average daily traffic volumes should be evaluated for reconstruction if safety problems are identified.

- Use motor vehicle accident safety investigations and reports to help identify road safety hazards.

- Use the following categories to prioritize road investments planned to reduce deferred maintenance backlog on roads: 1 – Critical Health and Safety; 2 – Critical Resource Protection; 3 – Critical Forest Mission. Data for these work items can be found in the infrastructure database.

- Coordinate reconstruction and construction work with other agencies whenever possible. Utilize interagency agreements to develop investment and maintenance partnerships.

Reducing Road Related Watershed and Aquatic Risks

Surface and Subsurface Hydrology:

- Design roads to minimize interception, concentration, and diversion potential.
- Design measures to reintroduce intercepted water back into slow subsurface pathways.
- Use out-sloped road prisms and drainage structures to disconnect road ditches from stream channels rather than delivering water in road ditches directly to stream channels.
- Evaluate and eliminate the potential for intercepting and diverting water down the roadway at road-stream crossings. The intent is that if a stream crossing structure like a culvert should plug or be overtopped at a location where there is currently no grade sag, install a vertical sag, dip, or other means to get the water quickly across the road and back into the natural stream channel.

Riparian Area Concerns:

- Relocate roads or road segments outside of riparian areas.
- Limit clearing distances in riparian areas during construction, reconstruction, and maintenance.
- Restore hydrologic function in areas dewatered by the road system.

Surface Erosion:

- Increase the number and effectiveness of drainage structures.
- Improving the road surface by either gravelling, or adding a binding material to those roads that have native surfaces with no natural binder.

Reducing Risks of Roads Related High Mass Wasting:

- Road relocation to an area with more stable soils.
- Relocation of drainage structures so that the outlets are on less sensitive areas which may include flatter slopes and better-drained soils.

- Adding drainage structures to reduce the concentration of water at any given location.

Improving Road/Stream Crossings:

- Designing crossings to pass all potential products including sediment and woody debris, not just water.
- Realign crossings that are not consistent with the channel pattern.
- Change the type of crossing to better fit the situation; for example, consider bridges or hardened crossings on streams with floodplains, and consider bottomless arch culverts in place of round pipe culverts.
- Add cross-drains near road-stream crossings to reduce the length of road ditch discharging directly into the stream system.
- Reduce the number of road-stream crossings to minimize the potential for adverse effects.

Reducing Road Effects on Wetlands:

- Relocate roads out of wetland areas.
- Where relocation is not an option, use measures to restore the hydrology of the wetland. Examples include raised prisms with diffuse drainage such as ‘”French” drains.
- Set road-crossing bottoms at natural levels of wet meadow surfaces.

Improving Road/Stream Crossings that Restrict Aquatic Species Passage:

- Reset the existing culvert to eliminate the restricting factor.
- Replace the culvert with an alternative crossing such as bridge, hardened low-water ford, or bottomless arch culvert.

Reducing Roads Effects on Riparian Plant Communities:

- Relocate roads out of riparian areas.
- Restore the hydrology in riparian areas that have been dewatered by the road system.