promote use of urban Best Management Practices. Use of these practices should not be limited to areas within the urban growth boundary, but should extend to all areas with urban characteristics. These partners should conduct educational efforts that inform the public on BMP's and also stimulate public interest in implementation of these BMP's by outlining desirable, achievable environmental goals. A methodology should be formulated to measure progress toward achievement of these goals, and the public should receive regular progress reports. Partners should promote landscape design that reduces direct urban runoff to streams. Agencies should maintain current restrictions on construction near streams, and currently mandated buffer zones. These recommendations are particularly applicable to **Dairy Creek, North Hillsboro, Lower McKay Creek, Middle McKay Creek, Council Creek and Waibel Creek** subwatersheds.

Hydrology and water quantity issues

Problem: Wetland and floodplain area is greatly diminished from historical levels. This has resulted in loss of hydrologic regulation of flows.

Solution Strategy: The most effective policy given current constraints is to protect existing floodplain and wetland resources, and to prevent encroachment of activities that are incompatible with floodplain and wetland function. Where incompatible uses do not exist, there may be opportunity to restore the functionality of degraded wetlands. Opportunities for wetland enhancement may be available on lands recently acquired by the Jackson Bottom Wetlands Preserve. Additionally, there may be partnership opportunities with sympathetic landowners to create or re-establish wetlands where they do not currently exist.

Specific Recommendations:

- Planning agencies should restrict further residential and industrial development within the 100-year floodplain.

- The Tualatin River Watershed Council, partners and NRCS/SWCD should sponsor a study to determine priority sites for preservation or restoration of historic floodplain and wetland function. For each site, appropriate protection, restoration, or enhancement strategies should be identified. Information gained in this study should be systematically maintained in a database, where it can be referenced for future funding opportunities.

- Partners and appropriate agencies should acquire property or habitat conservation easements to protect or expand existing wetlands. They should also evaluate opportunities for land acquisition with which to create new wetlands. If wetland creation appears to be a viable option, they should purchase lands for this purpose. The greatest potential for restoration of historic wetland function lies in traditional wetland sites in the **Lousignont Canal, West Fork Dairy - Cedar Canyon, Lower West Fork Dairy Creek, Bledsoe Creek, and East Fork Dairy Creek** subwatersheds.

- The Tualatin River Watershed Council and its partners should institute programs to restore functionality to degraded wetlands. This should include replacement of reed canarygrass and other exotics with native vegetation. The subwatersheds with the greatest amount of eligible wetlands include **Lower West Fork Dairy Creek, Lousignont Canal, West Fork Dairy - Cedar Canyon, and McKay-Tualatin confluence.**

- Agencies and partners should conduct post-project monitoring to determine the success of wetland restoration efforts.

Problem: Diversions of streamflow have diminished summer flows far below reference levels. Over much of the year, surface flow appears to be insufficient to support all beneficial uses. Current instream water rights may be inadequate to protect resources.

Solution Strategy: Water conservation is a necessary part of any strategy designed to optimize water supply for all beneficial uses. As irrigation is the largest use of surface water within the watershed, conservation efforts would benefit greatly if agriculture employs technological solutions to minimize waste during irrigation.

During formulation of its action plan, the Tualatin River Watershed Council considered the acquisition of additional water rights to supplement current instream water rights. If the decision is made to acquire supplementary instream water rights, consideration should be given to the OWRD instream leasing program. Several considerations should go into any decision to acquire instream water rights. Seniority, of course, is a prime consideration. However, location of these water rights is also important. In order to

protect cold-water fishery resources, any additional water rights purchases should protect instream flows in the Tualatin Mountains and the upper portion of the plain, where most summer rearing is likely to occur. Downstream of these locations, enhanced flow will have some value for thermal moderation of streams, but is unlikely to provide direct benefit to salmonids outside of migration periods. Other native fish species, such as lampreys, would benefit from resulting improvements in water quality.

Specific Recommendations:

- TRWC, partners, and agencies should encourage irrigation water management, including the use of technological soil moisture sensing devices and the conversion of sprinkler to drip systems on appropriate crops.

- TRWC, partners, and agencies should conduct a study to determine the adequacy of current instream water rights to provide adequate conditions for fish and other aquatic life. If current instream water rights are found to be inadequate, locations of greatest need for supplementary water rights should be noted. Priority for water rights acquisition should be given to the most senior rights available at these locations. When acquiring water rights, strong consideration should be given to use of the OWRD instream leasing program.

Stream channel issues

Problem: Stream channels are severely deficient in large wood. This has limited the development of pools, which provide essential habitat for fish and other aquatic life. Little potential exists for recruitment of large wood to streams.

Solution Strategy: Long-term development of large woody debris recruitment potential should be supplemented by short-term tactics. Potential elements of this strategy include re-introduction of conifers to hardwood stands, thinning within riparian zones to promote development of tree mass, and artificial placement of instream structures. Location of these restoration activities will depend on management objectives. Channel structure throughout the watershed would benefit from placement of large wood. However, wood placement to improve habitat for salmonids would be more effective in the mountains and nearby areas than in lower reaches in the Tualatin Plain. Effective channel restoration strategy throughout the watershed will focus on preservation of existing channel characteristics at relatively high quality sites.

Specific Recommendations:

- As an interim measure, partners performing stream restoration should place large wood in channels, and construct instream structures to create pools in degraded habitat with high fisheries potential. Restoration projects should include substantial post-project monitoring to determine the effectiveness of restoration techniques. Channel structure throughout the watershed would benefit from this recommendation. Sub-basins where placement of large wood would have the greatest benefit for salmonids are listed in the aquatic species and habitat section.

- Landholding partners should manage riparian areas to develop late-successional characteristics so that they can eventually develop large wood for potential delivery to streams. This can include re-introduction of conifers to hardwood stands and some thinning within riparian zones.

Water quality issues

Problem: In many portions of the watershed, sediments are delivered to streams at levels well above reference conditions. These sediments often carry adsorbed pollutants.

Solution Strategy: Strategies to combat sedimentation are described under the erosion section.

Specific Recommendations:

- NRCS/SWCD should continue efforts to expand implementation of agricultural Best Management Practices to reduce sediment discharge to streams (see under Erosion).

- Agencies, partners, and TRWC should work together to restore riparian buffers (see under Erosion).

- Landowning partners and agencies with road maintenance responsibility should minimize connectivity of road drainage ditches to stream channels (see under Erosion). Where necessary, they should build a sediment settling system to detain runoff prior to stream entry.

Problem: High levels of bacteria and ammonia have adversely impacted streams within the watershed. In some cases, inputs of these constituents have caused streams to be listed under section 303(d) of the Clean Water Act.

Solution Strategy: The management strategy for problems related to bacteria and ammonia nitrogen should focus on keeping animal and human waste away from aquatic systems. Successful nitrogen management also relies on effective fertilizer management.

Specific Recommendations:

Agencies should intensify efforts to identify and improve faulty septic systems near streams. In order to facilitate improvement of these systems, homeowners should be offered incentives such as cost-share opportunities. In order to remove streams from the 303(d) list, these efforts should be concentrated in the **Council Creek, Dairy Creek, East Fork Dairy Creek, East Fork Dairy – Gumm Creek, Lower McKay Creek, and Middle McKay Creek** subwatersheds, along with subwatersheds along the extent of **West Fork Dairy Creek**.

Agencies and animal-owning partners should intensify efforts to keep sources of animal waste from entering streams. NRCS/SWCD should continue efforts to identify sources of animal waste to aquatic systems and to work with land owners to eliminate these sources. Together, they should implement appropriate measures, potentially including livestock exclusion, vegetation buffers, and proper storage and application of waste. NRCS/SWCD should continue efforts to publicize available cost-share programs to implement these measures. In order to remove streams from the 303(d) list, these efforts should be concentrated in the **Council Creek, Dairy Creek, East Fork Dairy Creek, East Fork Dairy – Gumm Creek, Lower McKay Creek, and Middle McKay Creek** subwatersheds, along with subwatersheds along the extent of **West Fork Dairy Creek**. Agencies and partners should work together to improve fertilizer management for agricultural, forestry, and urban applications. NRCS/SWCD, other appropriate agencies, and educational institutions should seek funding to continue studies to determine optimal fertilizer application levels. As funding becomes available, they should conduct these studies expeditiously. They should distribute findings of these studies to applicable agency personnel and private agriculture, forestry, and landscaping businesses. Additionally, they should update publicly accessible literature to include the most current findings and create a distribution system to ensure that the literature makes its way to applicable personnel.

NRCS/SWCD should continue to work with land owners to implement Agricultural BMP's that reduce nutrient laden runoff to streams.

Problem: Phosphorus levels in much of the watershed are well above TMDL levels.

Solution Strategy: Due to high natural groundwater levels of phosphorus, massive declines in summertime phosphorus loads are unlikely (except on Waibel Creek). However, continuing efforts will be essential to retaining instream phosphorus at or slightly below current levels. Measures taken to minimize sediment delivery to streams, as well as effective nutrient and animal waste management will limit inputs of adsorbed phosphorus. Reductions in readily decomposable organic matter will reduce anaerobic streambed conditions that release phosphorus from sediments.

Specific Recommendations:

- NRCS/SWCD should continue implementation of rural Best Management Practices and educational programs, especially with respect to nutrient management, animal waste management, livestock grazing, and erosion control.

- An agency or educational institution should conduct a study to determine sources of high phosphorus levels on Waibel Creek.

- Partners and agencies should implement measures to reduce inputs of sediment, manure, grass clippings and other non-woody organic matter to streams.

- Agencies and partners should avoid practices that resuspend stream bottom sediments.

- ODEQ or another agency source should conduct a study to investigate the role of inadequate septic systems in contributing to phosphorus loads. In stream reaches inadequate septic systems are found to be a significant contributor of phosphorus, the source should be identified, and a cost-share program should be implemented to upgrade the septic system to adequate standards.

Problem: Many streams in the Tualatin Plain have temperatures detrimental to salmonids and other aquatic life preferring cool water conditions.

Solution Strategy: Strategies for temperature moderation should focus on protection and restoration of the riparian canopy. Some stream reaches would also receive local reduction of water temperature through leasing of additional instream water rights.

Specific Recommendations:

The Tualatin River Watershed Council, partners, and agencies should work together to implement programs to restore canopy cover through revegetation of the riparian zone with appropriate species. (See under Erosion).

The Tualatin River Watershed Council should explore leasing options for additional instream water rights (See under Hydrology/Water quantity)

Problem: Dissolved oxygen levels are low in some streams within the watershed. Streams with known dissolved oxygen problems include ***Council Creek and the West Fork of Dairy Creek.***

Solution Strategy: Temperature reduction is an important strategy for increasing dissolved oxygen levels. Additionally, strategies should focus on reduction of total chemical oxygen demand.

Specific Recommendations:

- TRWC, partners, and agencies should work together to implement recommendations designed to reduce temperature.
- TRWC, partners, and agencies should work together to limit disposal of organic debris near streams. Agency sources should review current information dissemination methods to determine whether they are adequately informing landowners on proper waste disposal methods and current regulations restricting near-stream waste disposal. They should revise educational methods as necessary.
- NRCS/SWCD should continue to work with animal owners to implement waste management recommendations designed to reduce nutrient inputs to streams (listed earlier).

Problem: Low summer pH levels potentially create a hazard to aquatic life. This problem limits water quality on ***East Fork Dairy Creek.***

Solution Strategy: Low summer pH levels are often due to decomposition of organic material. Strategies should focus on waste management from agricultural and domestic sources, and reduction of algal growth.

Specific Recommendations:

- NRCS/SWCD should work with land and animal owners to implement measures for management of waste and organic debris that have been recommended to address dissolved oxygen and nutrient issues.

Aquatic species and habitat issues

Problem: Salmonid populations are declining. A large proportion of this decline can be attributed to degradation of habitat and water quality.

Solution Strategy: Attempts to restore salmonid populations should focus on habitat preservation and restoration. Tributary preservation is particularly important for cutthroat, while preservation and restoration of mainstem habitats will aid anadromous steelhead trout and coho salmon, as well as the resident cutthroat trout. Habitat preservation should mainly concentrate in the mountains and adjacent narrow valleys, where most existing habitat is located.

Habitat restoration can also provide an important role in the watershed. However, restoration should not substitute for preservation of currently suitable habitats. A likely restoration site is the East Fork Dairy Creek above Greener Road. As late as 1995 this was one of the best salmonid rearing and spawning sites in the Tualatin Basin, which indicates high potential for fish use if habitat is restored. Other restoration efforts should focus on other degraded sites within the Tualatin Mountains, as well as valley sites near to the mountains. If restoration efforts are performed well, these sites have good recolonization potential.

Compared to the mountains, habitat restoration of most streams in the Tualatin Plain has less potential for direct benefit to salmonids. In these reaches, the substrate is generally unsuitable for spawning and salmonid rearing is very limited. However, other native fish and amphibian species could derive benefit from restoration at these sites. Appropriate restoration strategies for valley plain sites should focus on development of appropriate habitat characteristics for these native non-salmonid fish and amphibian species, as well as minimization of obstacles to migration of anadromous fish.

Restoration strategies should focus on restoring channel structure, roughness elements, and habitat diversity. Lack of large woody debris (LWD) seems to be the most important factor impacting channel structure. Current LWD recruitment potential is poor. LWD placement is a viable short-term option, but should not replace riparian protection and other measures that will provide for long-term recruitment potential. Other measures, such as restoration of stream canopy and improvement of water quality,

coincide with objectives of other modules. If efforts are taken to address concerns related to erosion, hydrology, water quality, and stream channel characteristics, benefits to fish will accrue.

Specific Recommendations:

- TRWC, partners, and agencies should work together to preserve existing salmonid spawning and rearing habitat. They should conduct surveys to determine the location and condition of such habitat. During these surveys, appropriate restoration sites should be noted. For optimal results, surveys for steelhead trout habitat should be concentrated within the **Upper West Fork Dairy Creek, Burgholzer Creek, Upper East Fork Dairy Creek, East Fork Dairy – Plentywater Creek, Denny Creek, Upper McKay Creek, and McKay – Neil Creek** subwatersheds. Additional habitats for resident cutthroat trout may be found in other tributaries. Murtagh et al. (1992) identified Poliwaski Canyon and Strassel and Lousignont creeks as sites in particular need of stream surveys.

- TRWC, partners, and agencies should work together to restore instream habitats for salmonids. Such restoration may include placement of large woody debris and/or instream channel structures. Restoration projects should be accompanied by monitoring to determine the most effective techniques. A recommended site for restoration is the East Fork Dairy Creek in the lower reaches of the **Upper East Fork Dairy Creek** subwatershed. Additionally, East Fork Dairy Creek between Roy Road and Highway 26 (**East Fork Dairy – Gumm Creek** subwatershed) was identified by USA (1995) as likely reach for restoration. Most other potential restoration sites may be found in degraded reaches within the subwatersheds listed under "preservation".

- TRWC, partners, and agencies should work together to restore riparian vegetation. Partners should plant appropriate native tree species where the natural riparian canopy has been removed. Where non-native shrub and herb species such as Himalayan blackberry and reed canarygrass have invaded riparian habitats, partners should replace these species with appropriate native trees and shrubs. This recommendation applies throughout the watershed. Areas where riparian restoration would provide the greatest potential benefit for fisheries includes the **East Fork of Dairy Creek** between Mountaindale and Murtagh Creek, and **McKay Creek** between its East Fork and Jackson Creek. For other areas with very poor riparian cover, see recommendations in the Erosion section.

- Landowning partners and appropriate agencies should remove obstructions to fish migration. They should replace culverts and other stream crossing structures that do not provide adequate passage. In some cases, road decommissioning[1] and culvert removal may be a desirable option.

- The Tualatin River Watershed Council should provide input to ODFW to formulate an aquatic habitat plan. The Council should also act as facilitator to help resolve differences between competing social and biological interests.

- Conservation organizations, other partners, or agencies should acquire land or conservation easements in crucial riparian habitats. Agencies should promote incentives for private land owners to implement BMP's designed to protect aquatic habitat. The TRWC, partners, and agencies should strive to form cooperative fisheries enhancement projects across ownership boundaries that maximize habitat improvement.

Problem: Emergency measures taken to preserve roads and other public works during flooding events have resulted in destruction of salmonid habitat.

Solution Strategy: Cooperative planning between wildlife agencies and public works agencies is necessary to prevent future occurrences of habitat destruction. This planning should take place prior to the next emergency event, and should incorporate a streamlined process for handling emergencies.

Specific Recommendations:

- Public works agencies, USFWS, ODFW, and other agencies entrusted with protection of wildlife and aquatic resources should prepare a coordinated, cooperative emergency plan. This

[1] FEMAT (1993) defines road decommissioning as removing "those elements of a road that reroute hillslope drainage and present slope stability hazards. Most of the road bed is left in place". This contrasts with "full site restoration", where the complete roadbed is obliterated and the hillslope is restored to its original contours.

plan should include a streamlined notification process to all pertinent agency personnel when emergency measures requiring channel or habitat alteration are considered necessary. Agency personnel should be prepared to respond promptly to such notification and provide input on correct design and implementation of emergency measures. In anticipation of events when prompt response is infeasible, a set of standard guidelines for handling emergency measures requiring channel or habitat alteration.

Problem: Reductions in wetland area have led to depletion of habitat for wetland and riparian species. This has adversely impacted populations of these species, especially amphibians.

Solution Strategy (Wetlands): The most effective policy given current constraints is to protect existing wetland resources, and to prevent encroachment of *activities* that are incompatible with wetland function. As financing becomes available, procurement of additional lands and conservation easements will also assist in providing wetland habitat. Where incompatible uses do not already exist, there may be opportunity to restore the functionality of degraded wetlands. For example, eradication of reed canarygrass and restoration with native vegetation may enhance the habitat values of these wetlands. Opportunities for wetland enhancement may be available on lands recently acquired by the Jackson Bottom Wetlands Preserve. Additionally, opportunities may exist to enhance habitat values within storage ponds. Many of these ponds already provide open water habitat for waterfowl. Emergent species could be planted along pond margins to increase habitat values for amphibians and other species dependent on shallow water habitat. However, this approach may cause conflicts with other interests using the ponds.

Where feasible, wetland creation could be encouraged by promoting beaver activity. It is anticipated that this approach would work best in the Tualatin Mountains, where fewer conflicts between beavers and management activities exist.

Solution Strategy (Riparian habitats): Strategies for riparian dependent species should emphasize increasing the amount of riparian habitat. Programs are currently underway to meet this objective. One such program is the Conservation Resource Enhancement Program (CREP). Administered by the NRCS, this program provides financial incentives for farmers to establish buffer strips along streams. It is hoped that this and similar programs will increase the amount and quality of habitat available to riparian dependent species.

Specific Recommendations:

- The TRWC should coordinate with partners and agencies to perform population surveys to determine the extent of amphibian species, as well as other riparian and wetland-dependent species.
- The TRWC, partners, and agencies should evaluate and implement programs to restore wetland functionality. These are discussed in the section titled "Hydrology and Water Quantity".
- Conservation organizations, other partners, or agencies should acquire habitat conservation easements in riparian areas.
- The TRWC should facilitate a forum to explore opportunities for beaver production of wetland habitats, as well as means of resolving potential conflicts between beavers and socio-economic interests.

TERRESTRIAL

Vegetation issues

Problem: Management practices have resulted in a change in vegetational characteristics. Amounts of vegetation in late-successional stages has been severely reduced from reference levels. Hardwoods have invaded areas formerly dominated by conifers.

Solution Strategy: The ability to resolve these problems will depend on the management emphases of different landowners. Portions of federal lands are managed under a specific directive to manage for old-growth characteristics. Generally, private lands are not managed under such a directive. Often, restoration of conifers to hardwood areas is in the management interests of both federal and private landowners.

Specific Recommendations:

- Where feasible, landowners should reestablish conifers on sites where hardwoods have invaded.

- Large landowning partners are encouraged to manage currently mature stands of private forests to develop late-successional characteristics.

Noxious/Exotic Plants

Problem: Native species richness within most of the watershed has been compromised by invasive exotic and noxious weeds.

Solution Strategy: Solutions are best achieved by creation of partnerships between the BLM and other land owners. Given the fragmentation of ownerships, the best opportunities for partnerships to reduce the spread of noxious weeds would lie with large landowners, and with organizations representing large amounts of land ownership. Such opportunities could include a cooperative agreement between:

- The Bureau of Land Management;
- Oregon Department of Agriculture, which is contracted by BLM for weed eradication work;
- Industrial owners, of which Longview Fibre is the largest. These measures would probably work best in the East Fork drainage, as the largest blocks of BLM and Longview Fibre lands are located there;
- Washington County, which could assist with roadside weed eradication. However, many owners prefer to retain a no-spray zone beside their properties;
- The Farm Bureau. Cooperation of this entity would be essential in the valley plain. However, with some weed species, farmers may need an economic incentive to pursue eradication.

Small residential landowners may be difficult to enlist toward any organized eradication effort. The best strategy to pursue with such landowners is an educational approach. Prospects for eradication in areas of such ownership are dim.

Success of eradication efforts will vary. Some species, such as Himalayan blackberry, are ubiquitous within the watershed, and we can only hope for localized success in eradicating such species. To prevent recolonization by weed species, planting and cultivation of desirable species should accompany weed eradication.

Specific Recommendations:

- The watershed council should facilitate contact between the BLM, Farm Bureau, ODA, NRCS, SWCD, private industrial landholders, and other entities representing landholders to form partnerships to combat noxious weeds. The Council should coordinate efforts by other groups with current efforts being conducted by the Oregon Department of Agriculture. If feasible, eradication efforts should emphasize non-chemical methods near aquatic systems. Non-chemical methods should also be considered for other areas.
- NRCS, SWCD, and other applicable agencies should advertise the availability of educational pamphlets encouraging eradication of noxious weeds. These pamphlets should be updated as necessary to address problems specific to the Tualatin Valley.
- TRWC, ODA, SWCD, and concerned partners should form a committee to determine which plants have the capability to become noxious weeds within the Tualatin Basin. The committee should work with the appropriate agencies, nurseries, and consumer groups to restrict the ability of these plants to become naturalized within the basin. In particular, scrutiny should be given to giant reed (*Arundo donax*) and Pampas grass (*Cortaderia selloana*).

Species and habitat issues

Problem: Many plant and animal species in the watershed are sensitive to management-induced habitat changes. The Bureau of Land Management has included many of these species on its list of sensitive species. Habitat for many of these species has been reduced from former levels.

Solution Strategy: Proper management strategies for sensitive species will vary by the species. The Bureau of Land Management has identified management strategies for species considered by the Bureau to be sensitive[2].

Knowledge of species distribution is an important prerequisite for successful management for sensitive species. In order to gain this knowledge, systematic surveys should be conducted where habitats are suitable for these species.

Specific Recommendations:

- The watershed council should act as a facilitator to formulate uniform habitat management policies.
- Government policy makers should consider providing incentives for landowners to manage forests for recruitment of snags and down wood.
- The watershed council should seek funding and facilitate partnerships to conduct systematic surveys for sensitive species.

SOCIAL

Issues related to human uses

Problem: Timber, agricultural, domestic, industrial, and wildlife interests often come into conflict for limited resources. As population increases, this competition will intensify.

Solution Strategy: A cooperative approach between various interests is necessary to resolve competing watershed demands. The Tualatin River Watershed Council plays a major role in facilitating this cooperation.

Specific Recommendations:

- In order to achieve Oregon's environmental policy objectives, the Governor's Watershed Enhancement Board should continue funding for the Tualatin River Watershed Council.
- Urban growth should be restricted to the current UGB. Additional extensions of the UGB are detrimental to the watershed. Any new growth should implement technologies that decrease urban runoff and increase infiltration, such as porous pavements and artificial wetlands.

Recreation

Problem: Nearstream recreational activities can lead to disturbance of the riparian zone. Support activities associated with recreational facilities can contribute pollutants to streams.

Solution Strategy: Measures should be taken to minimize the effects of recreational activities upon streams. These include regulation of stream access, maintenance of vegetated buffer strips between streams and activities detrimental to the aquatic system, and monitoring to determine the location, nature, and magnitude of recreation-associated impacts on streams.

Specific Recommendations:

- TRWC, agencies, and partners should work together to conduct a survey to determine specific sites of impacts due to recreational access to streams. Determine whether recreational benefits outweigh impacts at these sites. Where continued access is considered beneficial, consider armoring the streambank or otherwise constructing facilities to minimize impacts.
- Agencies should monitor golf courses and parks to ensure that they do not contribute appreciable inputs of fertilizers, pesticides, and herbicides to stream systems. Managers of these facilities should be encouraged to develop conservation plans through NRCS/SWCD.

Cultural resources

At present, neither problems nor recommendations for cultural resources have been identified.

Road Related Issues

Problem: Roads are significant contributors to problems related to erosion, water quality, stream channels, and aquatic life (see respective sections).

Solution Strategy: A diversified strategy is necessary to deal with road-related problems. This strategy will consist of a combination of road closures, road upgrades, and measures to restrict road-related impacts upon streams.

Specific Recommendations:

- Landowning partners should avoid building new roads on steep terrain (e.g. steep portions of McKay Creek and Williams Creek drainages). Where feasible, roads in these areas should be decommissioned. (See Erosion). Potential criteria for road closure are given on page 32.
- Surveys should be conducted to locate "legacy roads" and abandoned railroad grades that may be posing problems to watershed resources. Additionally, funding should be sought to reduce impacts from these roads.

[2] These are given in BLM Manual 6840, Appendix J2 of the NFP, and in the Salem District RMP.

Recommendations on BLM lands

The following recommendations were specifically designed to fulfill management objectives on BLM lands. Many of these recommendations may be potentially useful on other ownerships, as well.

AQUATIC

Erosion issues

- Where appropriate, reduce existing soil compaction levels by obliterating roads that are not needed for future management and by treating old compacted areas such as dirt roads and cat trails with a winged subsoiler.

- Identify road-related sediment problems, such as old railroad grades with inadequate or failing water crossing structures and roads with failing sidecast. Evaluate the potential for sediment delivery from these sources to determine whether it is appropriate to fix the problems.

Stream channel issues

- Conduct surveys to determine appropriate sites for enhancement projects to increase the amount and size of large woody debris in stream channels, floodplains, and riparian areas. The highest priority areas for enhancement projects are those streamside areas that are dominated by hardwoods or overstocked conifer stands that would benefit from thinning or underplanting.

Water quality issues

- When doing enhancement projects in Riparian Reserves, avoid removal of vegetation along perennial streams that will significantly decrease stream shading during the summer months.

- When conducting forest density management projects inside Riparian Reserves, leave a no-cut vegetation buffer along all intermittent and perennial stream channels, lakes, ponds, and wetlands. The width of this buffer should be determined on a site-specific basis. Additionally, the buffer should include stream-adjacent slopes with a high potential for landsliding. The purpose of this is to protect the streams and riparian zones from any direct or indirect disturbance from project activities, and to ensure that existing shading is not reduced.

- Where a few scattered understory conifers are growing within riparian areas strongly dominated by alder, consider treatments to increase conifer growth, vigor, and exposure to sunlight.

- Consider possible conversion or pocket planting of conifers along stream segments that are dominated by hardwoods.

- Where feasible, avoid road-building activities within Riparian Reserves. Where these activities are necessary, use practices that minimize hazards to aquatic systems.

- When yarding through Riparian Reserves, yard away from or require full log suspension over all stream channels, lakes, ponds, and wetlands. Limit soil disturbance by selecting appropriate yarding systems and restrictions based on site analysis.

Aquatic species and habitat issues

- Maintain active participation in the Tualatin River Watershed Council. Designate a BLM employee to act as liaison with the council. Participate and cooperate in projects when possible and requested to do so by the council.

- Evaluate all stream segments capable, or potentially capable, of supporting salmonid spawning and rearing for potential stream habitat improvement projects. These areas include, but are not limited to East Fork Dairy Creek upstream of Greener Road.

- Explore partnership opportunities with other land owners to evaluate best areas for stream enhancement and to implement enhancement projects.

- Expand efforts to identify fish migration barriers and prioritize barriers for corrective action.

- Take an active role in fisheries information collection and cooperatively distribute information to other land or resource managers. Develop a system to conduct follow-up stream habitat inventories to assess habitat trends over time.

- During the planning stages of timber sales involving Riparian Reserves, consider integrating the use of on site equipment with instream habitat improvement projects.

TERRESTRIAL

Vegetation issues

Noxious/Exotic Plants

- Where appropriate, develop "Memoranda of Understanding" (MOU's) with adjacent landowners and state and county agencies in order to expedite weed control goals.
- Where consistent with safety and management considerations, protect existing native vegetation along roads.
- Consider cleaning heavy equipment that will be used in Riparian Reserves and LSR's, and that will conduct soil disturbing activities, of soil and vegetation from outside sources.
- Consider information from the Oregon State University Weed Survey Report, Spring 1998, to control and prevent exotic/noxious weeds (and invasions of such weeds) on BLM administered lands in the watershed.
- Where feasible, control small weed infestations through manual labor and biological controls.
- Where appropriate to meet management objectives for control of noxious weeds, consider the use of prescribed fire.

Species and habitat issues

- Where appropriate, as opportunities permit, develop MOU's with adjacent landowners (especially industrial owners) to ensure cooperation toward attainment of management objectives for species and habitats.

- Follow enhancement and monitoring guidance in the Conservation Strategy for *Cimicifuga elata*, June 1996.

- Where appropriate to achieve desired wetland characteristics, consider the use of prescribed fire.

- Prepare a Late Successional Reserve Assessment (LSRA) for Big Canyon to determine appropriate management strategies for development of late-successional characteristics within this LSR.

- Maximize the current and future benefits derived from Riparian Reserves, LSRs and administratively withdrawn lands for cavity dwellers and other species dependent upon late-seral stage habitat features. Evaluate LSR stands under 80

years old and Riparian Reserve acres and consider the application of silvicultural prescriptions to benefit the development of late-seral stage habitat. Potentially beneficial treatments include thinning to encourage rapid growth and enhance the development of late seral stage habitat, creating snags (eventual down woody debris), and underplanting with long lived coniferous species in areas where they are largely absent.

- Consider retention of quantities of snags and down wood and wildlife trees in harvest areas commensurate with the availability of such habitat in adjacent areas. Evaluate adjacent sites for current and near-term potential to supply snags and down wood. In young forests and other areas where potential supply is low, retain relatively high levels of snags and down wood and wildlife trees. (As a general guideline, 8-12 wildlife trees may be appropriate). Where sites adjacent to the harvest area have a large proportion of mature timber, less retention of snags, down wood, and wildlife trees will be needed. (For example, 6 wildlife trees may be appropriate).

- Consistent with project objectives, consider the use of logging systems and site preparation methods that would reduce disturbance to reserve trees, existing snags and down wood, especially when operating in Riparian Reserves.

- When implementing silvicultural prescriptions in Riparian Reserves, consider use of logging systems and site preparation methods that would reduce site disturbance, and maintain a "no-cut buffer" appropriate to site specific conditions along stream channels.

- Consider enhancing the recreational hunting experience for some hunters and improve habitat for big game and other wildlife by closing roads where they are no longer needed for management. In particular, this action will be beneficial to late-successional species that are sensitive to disturbance.

- Depending upon site specific conditions, consider providing "visual buffers" adjacent to new regeneration harvest units to limit disturbances to wildlife as well as help with limiting the spread of noxious weeds. Where feasible, maintain an uncut strip of dense native vegetation along roadsides which may include existing young conifers, salmonberry, thimbleberry or other native shrubs.

Forest resources issues [BLM only]

Recommendations for silvicultural treatments in alder-dominated riparian stands[3]:

- Release existing young conifers in riparian areas as the first priority for re-establishing large conifers in alder-dominated riparian areas.

- In Riparian Reserves adjacent to stream channels where conifers are absent or are in very low abundance, consider clearing selected areas in existing alder canopies to plant and maintain young conifers. Openings should probably be 0.5-acre or less and should be well distributed along a given stream reach. Additional areas along the stream reach could be treated when the trees in the first sequence attain sufficient size, perhaps in 10 years or so. Target conifer stocking should be about 50 conifers per acre.

Recommendations for density management thinning in Riparian Reserves:

- Consider thinning well-stocked and over-stocked mid-aged conifer stands in Riparian Reserves to accelerate size development and promote windfirmness in remaining conifers. Variable-density thinnings could also be used to enhance structural complexity of relatively dense conifer stands.

- In young (non-commercial) conifer stands, consider maintaining appropriate conifer stocking adjacent to stream channels or other areas with water to encourage conifer domination of these sites.

- In all management operations, consider maintaining a buffer of trees and brush along stream channels (both intermittent and perennial) sufficient to provide adequate shade to the stream and protect the stream banks and channel.

Recommendations to reduce the potential for excessive damage caused by the Douglas-fir beetle when managing for snags and down wood:

Consider the following:

- Do not leave more than three fresh down Douglas-fir trees per acre greater than 12 inches

[3] These treatments are generally applicable where the natural riparian forest is considered to have been dominated by conifers.

DBH, especially where the down trees are shaded and where tree vigor of the remaining trees is reduced because of root disease or other causes. Where down trees are exposed to full sunlight, the number of trees left for snags and down wood could probably be doubled without posing an undue risk to the surrounding trees.

- When there is a need to add large amounts of fresh down Douglas-fir trees or logs to increase the amount of snags and down wood, add them in a *series* of events spaced three to four years apart.

- To reduce the amount of subsequent killing by Douglas-fir beetles, fell Douglas-fir trees to create snags and down wood no earlier than July and no later than the end of September to avoid beetle breeding and dispersal periods. There may be cases, however, where subsequent beetle killing is desirable for snag creation, such as in Riparian Reserves or LSR's. In these circumstances, adhering to the July to September time period may not always be appropriate.

Recommendations for alder dominated sites:

Consider the following:

- Inventory alder-dominated stands to determine whether to convert particular alder-dominated sites to conifers.

- Those alder-dominated sites capable of supporting conifers at this time, and that are reaching their peak volume production, should be considered for harvesting and conversion to conifer stands to increase timber production in the Matrix. Consider including those alder areas currently suitable for harvest in timber sale plans for the Matrix.

- Alder-dominated sites with compacted soil and/or nitrogen deficiency problems are best left in alder until those problems are alleviated. Sites that are naturally suited to alder production, such as wet areas, are best left in alder and not intensively managed to attain full conifer stocking.

Recommendations for stands infested with *Phellinus weirii* root rot:

Consider the following:

- In regeneration harvests, survey for areas of *P. weirii* infection. Once these areas are located, mark them for subsequent reforestation with disease-resistant or disease-tolerant species.

- Avoid commercially thinning stands of highly susceptible species, such as Douglas-fir, when disease levels are high (present in 20 percent or more of the stand). High levels of *P. weirii* infection are of increased concern when considering commercial thinning, if the disease centers are not well defined.

- Consider early regeneration harvest in pure Douglas-fir stands with disease levels exceeding 25 percent when the disease pattern is dispersed rather than occurring in distinct centers. These stands should be considered relatively high in priority for offering as tracts of timber for sale in the Matrix.

- In disease centers, trees left for wildlife should be species other than Douglas-fir or grand fir if the intent is to have them remain standing.

- In sapling-sized stands of highly susceptible species during pre-commercial thinning, leave disease-resistant or disease-tolerant species in obvious disease centers in a two-tree spacing around the centers.

- In commercial thinning-sized stands of highly susceptible species where infection levels are under 20 percent and infection centers are well-defined (as opposed to dispersed), thin healthy portions of the stand and consider removing all highly susceptible species in the disease centers and within 50 feet of visibly infected trees. In the GFMA, regeneration of the openings created with species that are immune to *P. weirii* should be strongly considered. Red alder is a good choice for an immune species. In the other land-use allocations, regenerate these areas with disease-resistant or disease-tolerant conifer species to increase species diversity, begin the establishment of another canopy layer, and reduce the disease spread.

Recommendations to increase tree growth and value:

Consider the following as funding permits:

- Precommercially thin young conifer stands in all land-use allocations.

- Prune about 100 trees per acre up to 18 feet after precommercial thinning once the average stand DBH reaches four to six inches. Prune the best trees in the stand and do not reduce the crown ratio below 50 percent, which may require pruning to be done in two stages to reach the desired 18-foot height. Pruning is most appropriate in the Matrix land use allocations, especially the GFMA portion of the Matrix.

- Consider fertilization with nitrogen following precommercial and commercial thinning in the Matrix, especially the GFMA portion of the Matrix. Such fertilization should be performed at levels consistent with water quality considerations.

- Promptly reforest regeneration-harvested areas and aggressively manage competing vegetation.

- Where appropriate to achieve management objectives, consider the use of prescribed fire.

- Overstocked Douglas-fir stands that are developing late-seral forest conditions and progress toward achieving late-seral forest conditions should be accelerated by applying density management in the Connectivity portions of the Matrix.

Recommendations regarding relief of compaction using a winged subsoiler:

- Carefully evaluate the trade-off between relieving soil compaction and root damage to residual trees before recommending subsoiling in commercially thinned stands.

General priorities for selecting stands for regeneration harvest in Matrix allocations

1. Pure Douglas-fir stands where more than 25 percent of the area is in *P. weirii* disease centers.
2. Hardwood stands growing on conifer sites where soil compaction is no longer a threat to conifer growth.
3. Mixed hardwood-conifer stands growing on conifer sites where soil compaction is no longer a threat to conifer growth. This priority is particularly applicable to the GFMA portion of the Matrix.
4. Overstocked conifer stands that are no longer suitable for commercial thinning.
5. Conifer stands that have reached or are beyond their peak volume production (culmination of mean annual increment). This priority is particularly applicable to the GFMA portion of the Matrix.

General criteria for selecting stands for commercial thinning in the GFMA

Top priority for commercial thinning should go to Douglas-fir stands that are 30 to 60 years old which have the following characteristics:

- Curtis Relative Density levels in the general range of 55 to 70.

- Live-crown ratios on residual trees of 30 percent or more.

- Less than 20 percent of the stand is in *P. weirii* root rot centers, with the centers being well-defined (as opposed to dispersed).

SOCIAL

Issues related to human uses

Rural interface

To the extent possible:

- Consult community groups and affected landowners during the scoping phase of the environmental assessment process for BLM projects. Increasing our sensitivity to the concerns and desires of the residents of the watershed may decrease conflict on rural interface issues. Participation in watershed councils would provide BLM managers additional information concerning activities occurring or planned within the watershed as well as keeping local publics apprised of BLM activities.

- Reduce vandalism, dumping and resource theft by increasing law enforcement presence through BLM ranger patrols and cooperative agreements with local law enforcement agencies or BLM personnel along with aggressive prosecution of offenders. Public outreach and education programs should also be used to educate the public about the proper use of public lands.

- Where BLM lands lie along publicly accessible roads, post signs on roads indicating boundaries of public lands. At heavily used sites, information signs written to create pride in public ownership, recreational and permit information and asking public assistance in reporting infractions should be erected.

- Produce a pamphlet on BLM management policies in the watershed. Ask realtors to distribute these pamphlets to prospective purchasers of parcels near BLM lands. Make these pamphlets available through other avenues as opportunities arise.

Recreation

- Continue to manage for dispersed recreation opportunities such as hunting, fishing, hiking, and horseback riding. These activities should be allowed to continue on all BLM lands where damage to resource values would be minimal.

- Develop literature for the wise use of the public lands. This literature could provide useful information on what products are available from the public lands and procedures for obtaining a permit. The literature should make the public aware of how their activities impact the resources on forest landscapes and how they could reduce the impacts of their activities.

Road-related issues

Potential strategies to address road-related concerns on BLM land

Road strategy will depend upon BLM objectives within the watershed. To prevent high maintenance costs in the long term, roads should be designed to accommodate the needs of resource management and to accommodate the needs of the resource itself. When constructing new roads, the road network system should be analyzed for future harvest prescriptions, access, and possible obliteration and/or subsoiling of existing roads.

Under certain circumstances, road-related problems may make upgrading or closure desirable. To determine whether these problems warrant closure, the following criteria should be considered:

- Nearness to stream

- Inordinate number of stream crossings

- Large proportion on unstable lands

- High failure history

- Not needed for stand management, fire protection, or other administrative needs.

- High incidence of dumping and vandalism.

- Substantial conflicts with natural hydrologic processes.

Road closure methodology will depend upon the reasons for closure. Such roads as are closed due to dumping or vandalism concerns, but still are potentially useful to BLM operations, should be gated or blocked with debris piles double tank traps. In most other cases, decommissioning would be the preferred option as costs are much lower than for complete obliteration (FEMAT 1993).

The following roads are candidates for closure, obliteration, or subsoiling. These should be reviewed during the final stages of establishment of transportation management objectives (TMO's).

T	R	S	Road number	Description
4N	3W	21	4N-3-21.2 4N-3-21.3	
4N	3W	33	4N-3-33.2 3N-3-3.1	The portion in S33, SE1/4, SE1/4
3N	3W	29	3N-3-29 none	Located in S29, NW1/4, NE1/4
2N	3W	5	2N-3-7 none	Portion in S5, SW1/4, NW1/4 Leaves Road #2N-3-7 in Section 6, SE1/4, SE1/4 and enters S5, SW1/4, SW1/4

The following roads are candidates for easement acquisition:

T	R	S	Road name/no.	Description
3N	2W	9		Needed to access BLM land within S9, N1/2, SE1/4
3N	2W	S18	1050 Layton Road	Both roads are gated.
3N	2W	33	539	
2N	2W	3		Needed to access existing road network
2N	2W	9		Needed to access BLM land in Section 9, NW1/4, S1/2; and SW1/4, N1/2
2N	2W	29		Needed to access BLM land in S29, NE1/4, SW1/4

Consider the need for access to the following parcels. If access is sufficiently beneficial or necessary for management operations, the necessary actions should be taken to provide access.

T	R	S	subsec	Description
3N	3W	29	NE 1/4	No present road access
3N	3W	9	NE 1/4	No present road access
3N	3W	3		Most convenient road access points are closed by landslides.
3N	3W	25	SW1/4	Access closed by landslide
3N	3W	31		Access closed by landslide
3N	3W	35		Access closed by landslide
3N	3W	19		Needs legal access
3N	2W	7		Access closed by landslide
3N	2W	21		Needs legal access
2N	3W	1		Access closed by landslide
2N	3W	11, 12		Needs legal access
2N	3W	21		Needs legal access
2N	2W	7		Access closed by landslide
2N	2W	27		Needs legal access

Culverts

- Culvert spacing should be evaluated. On steep road grades or erodible soils, culvert distance should be more frequent than the standard of every 500 feet. A guideline for placement is:
  - silt and silty sands
    - not more than 150 feet apart on 10% grade,
    - not more than 80 feet apart on 18% grade
  - silt
    - not more than 350 feet apart on 10% grade
    - not more than 150 feet apart on 18% grade
  - rocks, cobbles, gravel
    - not more than 500 feet apart on 10% grade
    - not more than 300 feet apart on 18% grade

- Calculations to determine culvert size should include the volume of water attributed to runoff from insloped roads that flows in the ditch and out of the culvert.

Sediment and Erosion (Preventative Measures)

- Incorporate considerations related to slope, soils, habitat objectives, and hydrologic function into the decision-making process when placing roads near Riparian Reserves.

- Consider obliteration of disused roads with extensive lengths of cut and fill. Obliteration should entail reshaping of the land base to its original characteristics.