Appendix B

Upper Greys Timber Sale Design Features and Mitigation Measures and Effectiveness
Mitigation Reviewed at ID Team meeting 2/9/2009

DESIGN FEATURE / MITIGATION MEASURE	OBJECTIVE	ENFORCEMENT	SPECIALIST'S REPORT
Bridger-Teton National Forest Best Management Practices for timber harvest—including applicable Forest Plan Standards and Guidelines, and measures from FSH 2509.22, R-1/R-4 Amendment No. 1—would be implemented. These BMPs will meet or exceed Wyoming Silviculture Best Management Practices as described in the Wyoming Non-point Source Management Plan.	Minimize the extent of sediment routing to stream channels, minimize impacts to soil resources, minimize impacts to fish habitat.	Timber Sale Design Timber Sale Layout Timber Sale Contract	Hydrology Fisheries
Streamside buffers along perennial streams will be at least 100 feet from stream. Buffers on intermittent streams (i.e., those having defined bed and banks) will be at least 50-100 feet from stream or distance equal to the height of mature tree).	Minimize the extent of sediment routing to stream channels, minimize impacts to fish habitat.	Timber Sale Layout	Hydrology Fisheries
Ground-based harvest equipment would not be allowed within 100 feet of watercourses. Ground-based harvest equipment would not be allowed within 50 feet of intermittent channels and seasonal wetlands. Strive to keep ground-based harvest equipment out of swale bottoms (i.e., draws where there is not a defined channel) to avoid accelerated erosion in these features.	Minimize the extent of sediment routing to stream channels, minimize impacts to fish habitat.	Timber Sale Layout Timber Sale Contract Contract Administration	Hydrology
If contiguous riparian vegetation extends further than the defined buffer widths, the buffer would be extended to include all riparian vegetation.	Minimize the extent of sediment routing to stream channels, minimize impacts to soil resources, minimize impacts to fish habitat.	Timber Sale Layout	Hydrology
Landings would not be constructed within 100 feet of perennial streams or within 50 feet of intermittent channels and seasonal wetlands. An exception to this would be provided only if no other alternatives are available within identified economic and resource constraints, and only if impacts could be mitigated. Landings will be properly drained and ripped to reduce compaction.	Minimize the extent of sediment routing to stream channels, minimize impacts to soil resources, minimize impacts to fish habitat.	Timber Sale Contract Contract Administration	Hydrology

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No fuel storage or equipment refueling would occur within 150 feet of perennial or intermittent stream channels.	Minimize the extent of sediment routing to stream channels, minimize impacts to soil resources, minimize impacts to fish habitat.	Timber Sale Contract Contract Administration	Hydrology
All wet swales, pools or spring areas would be identified and flagged during layout and no equipment would be allowed to enter such areas. Layout of the unit and buffers will be conducted when wetlands, channels, and other aquatic features can be identified.	Minimize the extent of sediment routing to stream channels, minimize impacts to soil resources, minimize impacts to fish habitat.	Timber Sale Layout	Hydrology
New temporary roads would not be constructed within 100 feet of perennial streams or within 50 feet of intermittent stream channels and wetlands, except at stream crossings.	Minimize the extent of sediment routing to stream channels, minimize impacts to soil resources, minimize impacts to fish habitat.	Timber Sale Layout Timber Sale Contract Contract Administration	Hydrology
Install BMPs on high-risk sediment production sites on roads (e.g., lead-in ditches to streams will be mitigated with ditch relief pipes or settling basins), with priority given to areas that drain to stream channels.	Minimize the extent of sediment routing to stream channels, minimize impacts to soil resources, minimize impacts to fish habitat.	Timber Sale Layout Timber Sale Contract Contract Administration	Hydrology/engineering
Install slash filter windrows, or provide another means of sediment filtration, where roads, including the toes of fills, are within 100 feet of perennial streams or within 50 feet of intermittent streams.	Minimize the extent of sediment routing to stream channels, minimize impacts to fish habitat.	Timber Sale Contract Contract Administration	Hydrology/engineering
Either gravel road surface or fabric (in intermittently wet spots) or dust abatement on the haul road along main drainages prior to, and during, haul to reduce the amount of dust that reaches Shale Creek, East Fork, or Greys River. Restrict road use during wet periods if roads are being rutted by use.	Minimize the extent of sediment routing to stream channels, minimize impacts to soil resources, minimize impacts to fish habitat, improve site distance for vehicle safety.	Timber Sale Contract Contract Administration	Hydrology Recreation
All new temporary roads and constructed skid trails would be stabilized (obliterated, re-contoured, seeded, and covered—i.e. Elimination Condition 4) within one season of completion of use, including use for post-harvest activities. This includes removal of crossing structures and re-establishing natural channel form through the crossing site.	Reduce displacement and compaction damage to soils, minimize the extent of sediment routing to stream channels, minimize impacts to fish habitat.	Timber Sale Contract Contract Administration	Hydrology Wildlife

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In conducting post-harvest fuels treatment, the following actions would not take place within 100 feet of perennial streams or within 50 feet of intermittent channels: a. Ground disturbing Fireline construction b. Prescribed fire ignition (fire could be allowed to back into these areas where severity could be minimized) c. Machine piling of slash	Minimize impacts to water quality, minimize impacts to fish habitat,	Timber Sale Contract Contract Administration	Hydrology
Erosion control measures would be inspected by purchaser or sale administrator, and would be maintained on a recurrent basis by the purchaser until the site was stabilized to ensure their effectiveness. Additional inspections and maintenance would occur following high rainfall events and prior to fall and spring runoff to ensure their effectiveness.	Prevent concentration of overland flow and reduce the risk of accelerated erosion and sedimentation.	Timber Sale Contract Contract Administration	Hydrology
Skid trails will be designated and approved and not exceed 15 percent of the unit in area.	Reduce the amount of soil impacts by restricting equipment operations to designated areas.	Timber Sale Contract Contract Administration	Soils/hydrology
Skid trails and landings will be treated to reduce compaction. Slash will be placed on top to reduce erosion and discourage motorized use. Main skid trails will be waterbarred in accordance with BMPs.	Prevent concentration of overland flow and reduce the risk of accelerated erosion and sedimentation.	Timber Sale Contract Contract Administration	Soils/recreation
Ground-based logging will only occur when soil moisture is low (<50%, as measured using field methodology).	Prevent soil rutting and reduce the risk of accelerated erosion.	Timber Sale Contract Contract Administration	Soils
Signs will be placed along the Greys River Road, during logging operations, informing other drivers that logging trucks are using the road.	Improve public safety	Timber Sale Contract Contract Administration	Recreation
If whole tree skidding is used slash may have to be dragged back into unit to meet soil or broadcast burn objectives.	Protect soil productivity, Allow efficient slash burn through whole unit	Timber sale contract/admin	Fire/soils
Any materials such as mulches, straw, seed, etc., used for rehab, reclamation, etc., must be approved by the Forest Service and be certified weed-free only.	Limit the risk of new infestations of noxious weeds into the area.	Timber Sale Contract Contract Administration Range Conservationist	Range

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The area of the proposed haul routes, harvest unit, and surrounding vicinity should be inspected for noxious weeds prior to the initiation of harvest activities. If any weeds are found the area should be treated chemically or mechanically to minimize the threat of spread.	Limit the risk of new infestations of noxious weeds into the area.	Range Conservationist	Range
Prior to entering the National Forest all off-road logging equipment, machinery, and vehicles should be pressure washed to remove any plant material that may have become attached to the vehicle. These vehicles should also be inspected by a Forest Officer or county weed and pest representative to assure that any weed material has been removed from the equipment.	Limit the risk of new infestations of noxious weeds into the area.	Timber Sale Contract Contract Administration Range Conservationist	Range
Data base shows no sensitive plants, but if Payson's Milkvetch is found within the project area, no landings, skid trails, or temporary roads would be allowed to be constructed within 10 feet of a known Payson's Milkvetch site.	Protection of Sensetive Plant Species	Timber Sale Layout Timber Sale Contract Contract Administration	Range
Whole-tree yarding would be required in partial cuts.	Minimize impacts to soil resources	Timber Sale Contract Contract Administration	As per District Rangers' direction
Logging should not occur in spring or early summer (April 1 – June 15) when tree sap is flowing and bark is not tight.	Protect residual timber stand	Timber Sale Contract Contract Administration	Timber
Designate "rub" or "bump" trees—these trees should be harvested last. Rub trees could be protected with rubber tires, plastic culverts sections, or some other material.	Protect residual timber stand	Timber Sale Contract Contract Administration	Timber
Logs cut prior to September 1 would be removed by December 31 of that same year. Logs cut after September 1 would be removed by December 31 of the following year.	Minimize insect populations	Timber Sale Contract Contract Administration	Timber
Removal of slash for biomass utilization may be acceptable, but not not r Agreement needed before this takes place.	Reduce fuels	Timber Sale Contract Contract Administration	Fuels
Sub-merchantable trees that act as fuel ladders to residual overstory trees would be cut. Pull-back slash on critical leave trees to ensure survival.	Reduce fuels/ protect residual rees	Timber Sale Contract Contract Administration	Fuels Timber

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Restrict log hauling during high recreation use times such as the opening day of the general big game rifle season, and holidays.	Provide for public safety	Timber Sale Contract Contract Administration	
Any raptor nests found in the project area during layout or harvest opertations should be protected.	Protection of raptors and nesting areas.	Timber Sale Layout Timber Sale Contract Contract Administration Wildlife Biologist	Wildlife
Logs or rocks would be placed at entrance to temporary roads from existing roads to discourage motorized recreation use.	Minimize impacts to wildlife and soil resources.	Wildlife Biologist	Wildlife/recreation
Maintain at least 7 tons per acre of coarse woody debris.	Enhance wildlife habitat	Timber Sale Contract Contract Administration	Wildlife/soils
Stop ground disturbing activities in any area where heritage resource sites are discovered during the preparation or implementation of this project, until the Forest Archeologist assesses the situation and recommends appropriate action.	Limit risks to heritage resources.	Timber Sale Layout Contract Administration Forest Archeologist	Archaeology
Any slash burning will take place at higher fuel moistures. Broadcast burns will treat at least 70% of the unit to provide for adequate planting conditions.	Limit soil productivity loss and escape fire risk while reducing slah	Burn plan	Fire/soils/Timber

Mitigation Effectiveness (from Hydrology Report, [Simon 2009])

The effectiveness of silvicultural BMPs is documented in forestry audits conducted periodically by multidisciplinary teams of resource professionals on private, state, and federal lands. Audits are coordinated by Wyoming DEQ and the Wyoming State Forestry Division. Results from the most recent audit (2007) are available online at http://slf-web.state.wy.us/forestry/adobe/2007BMPaudit.pdf. Implementation and effectiveness of mitigation measures are also evaluated as part of sale administration, when needed corrections to measures are noted and made on the ground.

Protection of riparian and wetland areas (and water quality, as a result) would be accomplished via implementation of Wyoming Forestry BMPs, Forest Plan Standards and Guidelines, and other guidance on these areas. No logging of riparian areas or of areas within a minimum of 100 feet of perennial channels and 50 feet of intermittent channels, would take place. As stated in State (BMP) Practice #3, where slopes adjacent to a stream channel are less than 35%, a buffer of at least 50 feet (or a width equal to the mean height of mature dominant late-seral vegetation, whichever is greater) would be observed. Where slopes adjacent to streams are greater than 35%, the minimum width would be 100 feet (or determined via the same tree-height guidance as previously described).

These guidelines, which would be used for this project, should provide protection for wetland and riparian resources in the project area. Seyedbagheri (1996) surveyed the literature for information on the effectiveness of Idaho Forestry BMPs. Significant increases in a number of water quality parameters, including turbidity and suspended solids, were noted when buffer strips were not used in logging operations. Other studies cited confirmed the value of leaving riparian buffer strips. Belt and O'Laughlin (1994) and Correll (1996) confirm the value of buffer strips.

The Lolo National Forest (LNF) Best Management Practices (BMP) Effectiveness Monitoring Report (USDA-FS, Lolo NF, 2002) evaluated the implementation and effectiveness of using sale area maps to designate soil and water protection needs and found that marking riparian areas accurately on sale area maps, flagging protection zones on the ground, and informing operators of protection needs effectively protected sensitive areas. For the Upper Greys project, wetlands not shown on National Wetland Inventory maps would be identified during marking, cruising, and administration of any proposed timber sales, per Forest sale contract provisions.

Seyedbagheri (1996) compiled the results of research on effectiveness of Idaho Forestry BMPs. Effectiveness of different BMPs varied widely for different measures, addressing different resource concerns and varying longevity of effects from logging activities. One study showed that, by stabilizing skid trails by waterbarring (with seeding and slash barriers), sediment was found to be contained onsite during the first four years, after which skid trails had stabilized. Stabilization of skid trails by scarification was recommended on granitic and volcanic sites, based on a study that found persistent compaction lasting more than 25 years on ground-skidded areas. Effectiveness depends greatly on implementation and site-specific conditions.

Other mitigation measures and design criteria have also been studied. Retention of coarse woody debris (CWD) on-site is often used to reduce surface erosion and protect long-term site productivity. As cited in Seyedbagheri 1996, Meeuwig (1971) found that surface cover was the most important predictor for erosion during simulated high-intensity rain events, and the effect increased as slope steepness increased.

Rehabilitation of landings and skid trails would also be required under the proposed action. Seyedbagheri (1996) summarized literature that found **water bars** (especially log water bars) to be highly effective in diverting water: on a scale of 1.0 (completely effective) to 4.8 (completely ineffective), log water bars rated 1.78 on granitic soils and 1.54 on basaltic soils, compared to 2.15 (granitic) and 2.25 (basaltic) for slash dams, and 2.93 (granitic) and 1.60 (basaltic) for lopping and scattering of slash (Kidd 1963). Other findings cited by Seyedbagheri:

- **Seeded skid trails with slash barriers or cross ditches** generally contained erosion during the first 4 years, after which skid trails had stabilized (Haupt and Kidd 1965).

- McGreer (1981) determined that, where ash layers had been removed from skid trails, **placing slash** on a 50% gradient skid trail resulted in 98.5% less erosion than on a 40% gradient skid trail without slash, and 94.7% less than a 15% gradient skid trail without slash.
- **Scarifying of compacted areas** (skid trails in the reference cited—Froehlich et al. 1985) was found to be effective due to persistence of compaction (more than 25 years) on some soils. Landings were not successfully **decompacted** in one study using standard rock rippers: it was recommended that other implements be tested (Clayton 1990).
- In the studies presented in Seyedbagheri, **seeding** was evaluated in conjunction with other methods rather than being tested separately. The General Erosion Research Summary at the end of the document contains many examples of research clearly showing the need for establishing vegetation.

Road Mitigation and Rehabilitation Effects

Culvert removal: Culvert removal involves a short-term disturbance to channels at the crossing site, with an associated release of sediment to a stream during and immediately after removal. Seyedbagheri (1996) cites a study in the Horse Creek Study Area in which sediment increases were observed with new road construction and culvert installation (p.33). Sediment concentration levels returned to preconstruction levels shortly after construction, except during storms when sediment loads were 100 to 1000 times higher than normal. A year after construction, sediment loads during storms were about 10 times higher than normal. With care, however, the amount of short-term impact may be quite small. On Siegel Creek, on the Lolo National Forest, sediment delivery downstream of the site where a 72-inch culvert was removed was monitored during and after culvert removal. There was a pulse of increased sediment production during removal, but sediment levels decreased to pre-removal levels within approximately 24 hours. Total sediment introduced to the stream was 1-2 cubic yards from a total fill removal of 420 cubic yards (120 yards over the pipe, 300 yards from the sides). Complete rehabilitation of the site, including stabilization of the section of channel that was reconstructed, was achieved within two years. (USDA-FS, Lolo National Forest, 1999)

Road decommissioning/obliteration/recontouring: Temporary road decommissioning/obliteration would involve short-term disturbance and associated sediment production. Long-term, sediment production would be reduced below pre-existing conditions, and reduced hydrologic connectivity would decrease the impact of these roads on surface runoff. Hickenbottom (2001) studied the effects of road recontouring in O'Brien Creek on the Lolo National Forest. Recontoured roads initially had higher surface runoff and higher sediment production than existing road components (cutslope, fillslope, road center, and road tread). After one year of revegetation, however, volumes of runoff and eroded sediment decreased to near natural slope conditions. These results were obtained under optimal conditions of rehabilitation treatment (intensive seeding and fertilization); most responses are not likely to be as rapid, although the same trend would be expected, as described by Switalski et al. (2004). Madej (2001) also found reduced sediment yields on logging roads under various treatment scenarios when compared with untreated roads.

Mitigation measures for roads: Proper culvert sizing and placement, relocating roads, and limiting road gradients can reduce adverse impacts to local hydrologic resources from roads that are left open to use. Effects may also be offset by implementation of mitigation measures to reduce the amount of sediment produced by various road features (cutslopes, fillslopes, ditches, relief culverts, road beds) and by reducing the amount of material that actually reaches channels. Table 1, below, shows the effectiveness of selected measures in reducing erosion, based on research.

Table 1: Effectiveness of selected erosion control measures (Seyedbagheri, 1996)

Measure	**/reduction in erosion**
Straw mulch	32-47% reduction in erosion
Dense (grass) cover	99.5% reduction in erosion
Filter windrows	87-99% retention of eroded material
Hydromulch, seed, fertilize	71% effectiveness
Straw, crimp, netting	93% effectiveness
Excelsior mats	75% on 1:1 cutslopes, 60% on 0.75:1 cutslopes

Further examples of erosion reduction from selected road treatments are shown below (from Burroughs, 1990; Burroughs and King, 1989):

Table 2. Further examples of the effectiveness of erosion control measures (Burroughs, 1990; Burroughs and King, 1989)

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Seasonal road closure when roads are wet	Reduces rutting; trials showed ruts increase sediment production by 2.1 times over an unrutted road.
Surfacing (trials used a 4-inch layer of 1.5-inch minus rock). Need at least 4 inches of gravel for notable decrease in sediment production.	Reduction in sediment production by 79% compared to unsurfaced condition. 6" of 1.5-inch minus gravel reduced sediment production by 70-92%, in several studies.
Erosion mats on cutslopes	Sediment reduction of 95% on 1:1 slopes (gneiss and schist parent material)

In both Tables 1 and 2, actual effectiveness depends on site conditions (steeper slopes and higher silt content lead to lower

effectiveness) and on actual implementation methods. Both Burroughs (1990) and Burroughs and King (1989) stress the need to install protection measures as soon as possible after construction since most material is eroded in the first few years after construction: about half of the total fillslope sediment production measured over two years in one study took place in the first summer and fall after construction. Therefore, measures that are put in place immediately after construction have a greater chance of reducing sediment production than measures that are installed later.

Reducing the amount of displaced material that actually reaches stream channels is the second important aspect of reducing sediment delivery from roads, after reducing erosion. As cited in Seyedbagheri (1996), Haupt (1959) found that "slope obstruction index" (indicator of amount of logs, vegetation, etc. on slopes below roads that would slow surface runoff) was the variable most highly correlated with sediment transport distance. (p.41 in Seyedbagheri, 1996) Other authors also acknowledge the importance of slope obstructions in reducing sediment transport distances (Ketcheson and Megahan, 1996).
(2004), Madej (2001).