Utah's Forest Water Quality Guidelines

A Technical Manual

for Landowners,

Loggers & Resource

Managers

State of Utah

DEPARTMENT OF NATURAL RESOURCES

DIVISION OF FORESTRY, FIRE AND STATE LANDS

UTAH

Forestry, Fire and State Lands

PREFACE

Utah's Forest Water Quality Guidelines (FWQGs) are a collection of voluntary, field applicable practices for use during forestry activities to protect soil and water resources. They are designed to minimize non-point source pollution (sedimentation, soil erosion) associated with forestry activities.

For more information about the FWQGs and their application, contact your local Forestry, Fire & State Lands area office listed on page 61 of this publication.

ACKNOWLEDGMENTS

Authors: Ron Gropp, *Forestry, Fire & State Lands*
Darren McAvoy, *Utah State University*

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CHAPTER ONE

INTRODUCTION

We all depend on clean water for drinking, residential, irrigation and industry uses and for the health of our watersheds. Throughout Utah, forestlands act as collectors of pure water. Much of Utah's water supply originates in the state's high elevation forested watersheds. Our forests play a vital role in purifying and maintaining clean water for streams, lakes and groundwater. For this reason, special care must be taken to protect the water supply when conducting forest management activities in these areas. Protecting the water supplied from our watersheds is everyone's responsibility.

The most practical and cost-effective way to ensure forest management activities do not adversely impact water quality is through the application of Utah's voluntary Forest Water Quality Guidelines described in this manual. These guidelines are designed to provide the best protection for water quality and other resources during the management of forest resources, including timber harvesting. Through proper planning, timber harvesting can be positive for our watersheds while providing the sustained goods and services our society demands.

This manual emphasizes protection of soil and water resources when conducting forestry activities. The FWQGs can be modified for specific site conditions with guidance from a forester or other natural resource manager if the modifications provide equal or greater water quality protection, or if the modification does not adversely impact water quality.

Forestry and Water Quality

Forested lands are an important natural resource in the state of Utah. Utah's generally high elevation forests are the principal source of water production in this arid state. Forests make an important contribution to Utah's way of life and to its quality of life by providing jobs, forest products, critical watershed areas, livestock forage areas, open space, wildlife habitat, scenic vistas, recreational experiences and other socio-economic benefits.

One of the biggest threats to water quality in the United States is non-point source pollution. Non-point source pollution occurs when water runoff from rainfall or snowmelt moves across or into the ground, picking up and carrying pollutants into streams, lakes, reservoirs, wetlands and groundwater. Soil becomes a non-point source pollutant when runoff carries large amount of sediment into a water body.

Silviculture or forest management activities can contribute to non-point source pollution and water quality impairment. Forest management activities can generate the following forms of non-point source pollution:

Sediment - Road construction during timber harvest operations can be the largest contributor of sediments to a waterbody. Exposure of mineral soil to the effects of water erosion through tree removal and improper yarding can also contribute to an increase in sediment delivered to the waterbody. In-stream sedimentation can reduce fish populations, increase water treatment costs for drinking water supplies and interfere with recreational uses of the waterbody.

Dissolved Oxygen - Dissolved oxygen concentration in the water is an important indicator of overall water quality. Insufficient dissolved oxygen in water leads to anaerobic decomposition of organic matter which can cause problems with drinking water.

Water Temperature - When streamside vegetation is removed by timber harvesting, water temperatures generally increase. For streams in the lower watershed, flows begin to play a primary role in regulating water temperatures. High water temperatures can be detrimental to aquatic life and may contribute to low dissolved oxygen levels in the water.

Nutrients - Concentrations of inorganic nutrients in streams may increase after timber harvesting. Burning slash may also increase nutrient releases. Excessive nutrients may cause algal blooms in lakes and streams, which can reduce levels of dissolved oxygen in the water below what fish and other aquatic species need to survive. Restricting the application of chemicals, slash burning next to streamsides and using buffer zones will help minimize potential nutrient problems in streams.

Chemicals - Pesticides, fertilizers and fire retardants applied to the watershed can ultimately be delivered to the stream through runoff or drift from aerial spraying. In some instances, low-level concentrations can be toxic to humans, fish and other wildlife. Also, fuel, oil and coolants used in harvesting and road-building equipment must be handled carefully to avoid water pollution.

PRE HARVEST PLANNING

Careful planning for forest management activities, such as road construction, timber harvesting and site preparation, will help minimize non-point source pollution. Preparing a plan will lead to harvest operations that use the FWQGs, remove forest products efficiently and profitably, and promote sustainable forest growth and water quality protection.

The first step in this process is the development of a comprehensive forest management plan which includes the Forest Water Quality Guidelines. The planning process should help identify major goals and objectives, establish priorities and address management strategies to protect soil and water resources. Forestry, Fire & State Lands service foresters are available to help develop forest management plans and provide other technical assistance.

Recommended Practice Standards and Guidelines

- Contact a professional forester or other resource manager for assistance with developing a forest management plan.
- Prepare a list of all applicable site-specific Forest Water Quality Guidelines needed to protect water quality. Make the FWQGs a part of all timber sale agreements, timber harvest plans and forest management plans.
- Identify and locate environmentally sensitive areas utilizing resources such as topographic maps, aerial photographs or field observations.
- Locate and mark streamside management zones (SMZs).
- Consider physical features such as topography, soils, slope and aspect.
- Identify the most appropriate harvest system for the site. Consider ground-based, cable, or aerial systems.

- Plan for the treatment of slash, site preparation, regeneration and revegetation prior to harvesting.
- Carefully plan road layout along with landings, skid trails, stream crossings and drainage structures.

Always determine if a permit is required before beginning any forest management activities. See Permits and Regulations in the appendix of this publication for more information.

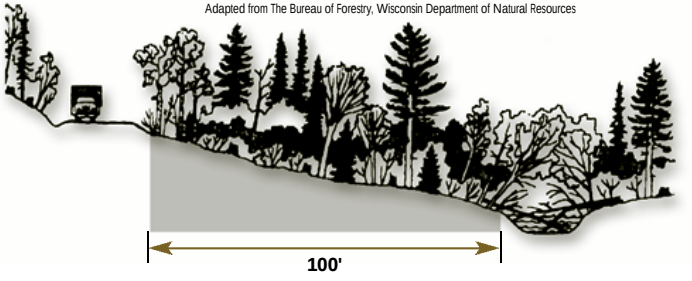
NOTES:

STREAMSIDE MANAGEMENT ZONE

The Streamside Management Zone (SMZ) is an area or strip of land adjacent to a stream or other body of water where management practices are designed to protect water quality, aquatic wildlife and wildlife habitat. Trees and vegetation within the SMZ act as a natural filter to keep sediment out of streams, reduce soil erosion and act as a buffer to protect the stream from degradation caused by nearby activities. The SMZ is *not* a zone of exclusion where silvicultural activities are not permitted. Because of the need to protect water quality and other important values, the SMZ is an area where silvicultural activities should be closely and carefully managed.

Figure 3.1 **Streamside Management Zone**

Adapted from The Bureau of Forestry, Wisconsin Department of Natural Resources



Classification categories used in determining SMZ locations are:

Class I Stream

Streams or other bodies of water used for domestic water supply and/or the spawning, rearing, and migration of fish, including impacted streams with recovery potential for a fishery. Also included are perennial streams that contribute significant flow to downstream fisheries. The width of the SMZ for a Class I Stream is measured from the *Ordinary High Water Mark* on each side of the stream.

Class II Stream

All streams that do not meet the Class I definition and are identifiable in the field as having a defined channel of bed rock, sand, gravel, or rocky material; defined banks, generally having an ordinary high water mark and confines and conducts continuously or intermittently flowing water are considered Class II Sreams. Also included are reservoirs, lakes, and ponds greater than 1/10 acre that do not support fish or provide domestic water supply. The width of the SMZ for a Class II Stream is measured from the *Ordinary High Water Mark* on each side of the stream.

The *Ordinary High Water Mark* is the point on the bank or shore up to which the presence and action of the water is so continuous as to leave a distinct mark either by erosion, destruction of terrestrial (land) vegetation, or other easily recognized characteristic.

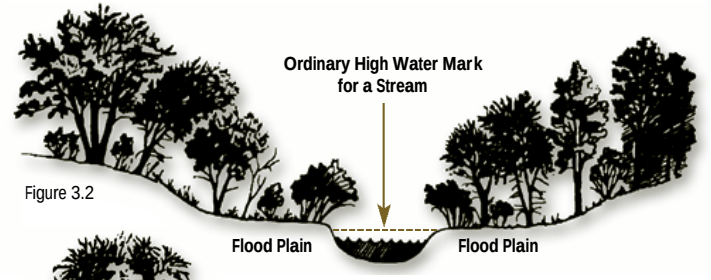


Figure 3.2

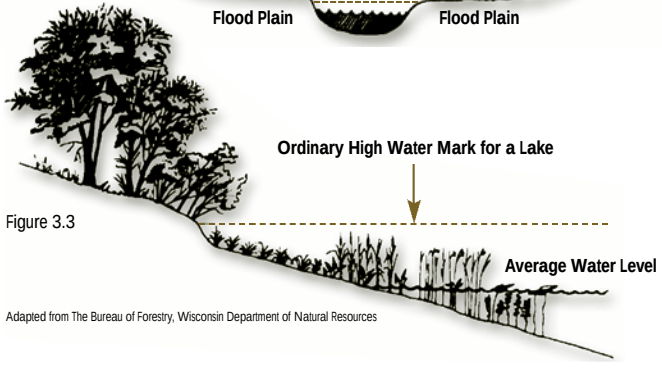


Figure 3.3

Adapted from The Bureau of Forestry, Wisconsin Department of Natural Resources

Recommended Practice Standards and Guidelines

- Designate SMZs in the harvesting area using the table described below. Establish an "undisturbed" strip of at least 15 feet slope distance on both sides of Class I and II Streams beginning at the ordinary high water mark.

Table 3.1
Minimum Recommended SMZ Width Determined by Stream Class and Slope.

Stream Category	Slope		"Undisturbed" Strip
	<35%	>35%	
SMZ Class I	75 feet	100 feet	15 feet
SMZ Class II	35 feet	50 feet	15 feet

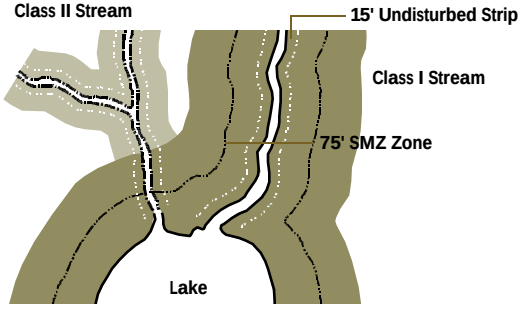


Figure 3.4
Recommended minimum SMZ width based on stream class and slopes less than 35%. The "undisturbed" strip also applies to Class II streams.

Adapted from The Bureau of Forestry, Wisconsin Department of Natural Resources

Note - The width of the SMZ should be increased in the following areas: wetlands adjacent to the stream channel and wetlands intercepted by the SMZ boundary.

- Clearly mark the SMZ boundary with flagging, paint or signs to ensure that equipment operators and tree cutters are able to identify the boundary.
- Locate roads, skid trails and landings outside the SMZ. Locate stream crossings in the SMZ only if necessary.
- Avoid use of heavy equipment in the SMZ to minimize ground disturbance. Use winching or end-line skidding techniques to remove logs from the SMZ.
- Leave an adequate number of trees and shrubs in all age/size classes to provide shade for the stream and a future source of large woody debris (*see Table 3.2*). Along Class I Streams, leave an average of 50 square feet of basal area per acre of trees at least 12 inches in diameter evenly distributed throughout the SMZ or at least 50% canopy cover after harvest to provide shade. Along Class II Streams, leave an average of 25 square feet of basal area per acre evenly distributed throughout the SMZ or at least 25% canopy cover after harvest to provide shade.

Table 3.2
Shading Recommendations for SMZ Class I & II Streams

Stream Category	Recommended Minimum Standards	
	Residual Basal Area (sq.ft./acre)	% Canopy Cover
Class I	50	50
Class II	25	25

- Stream crossing structures for Class I and II streams should be sized to allow for full surface flow of the stream throughout the life of the structure. Use the 50 year - 24 hour design peak flows for sizing permanent structures *(See Chapter 4: Roads, Skid Trails, Landings and Stream Crossings).*
- All structures for Class I Streams should be designed and constructed to allow unrestricted fish passage.
- Do not handle, store, apply or dispose of hazardous or toxic materials in a manner that could pollute the stream or wetland or cause damage or injury to humans, plants or animals.
- Limit the use of chemicals in the SMZ unless labeled for such use. Establish a buffer for chemical application along all watercourses *(See Chapter 7: Chemical Management).*

NOTES:

ROADS, SKID TRAILS, LANDINGS & STREAM CROSSINGS

Roads, skid trails, landings and stream crossings make up a forest transportation system. Poorly located, constructed, or maintained forest roads are the largest source of non-point source pollution from forest management activities. Roads on steep slopes, erodible soils or stream crossings hold the greatest potential for degrading water quality. Research has shown that 90 percent of the sediment that ends up in our Nation's waters is a result of improper roads.

Planning

Soil erosion is a primary cause of stream sedimentation associated with forest roads. Mass movement associated with road construction also causes sedimentation. Careful forest road planning, construction and maintenance protects the water quality of our lakes and streams. Decisions made during the planning stage will affect road construction costs, maintenance needs, service life and the amount of non-point source pollution related to roads.

Recommended Practice Standards and Guidelines

- Use the minimum number of roads to meet transportation needs. Plan road systems that minimize the number, width and length of roads to limit disturbance of the area.
- If possible, locate roads outside Streamside Management Zones (*see Chapter 3: Streamside Management Zone*)
- Design roads for safety, their intended purpose and to fit the natural terrain.
- If possible, locate and construct road surfaces to drain naturally away from the road.

- Plan for drainage features to be placed at suitable locations.
- Minimize the number of stream crossings. Use stream crossings only when necessary.
- Keep road grades below 10% wherever possible and avoid sustained excessive grades (greater than 10%).

Road Construction

The most critical issue regarding road construction is drainage of surface water from the road surface. Traffic causes ruts when standing water is present. Running water erodes the road surface and deposits the sediment in streams and lakes.

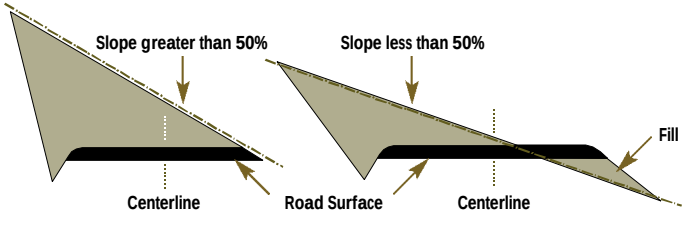
Recommended Practice Standards and Guidelines

- Become familiar with the terrain by using topographic maps or aerial photographs and repeatedly walking the proposed road location. Use flagging to designate the road location.
- Avoid construction activities when ground is wet or frozen.
- Install road drainage at time of construction.
- Compact all road fill material. Do not use snow, ice, frozen soil or woody debris as these will eventually melt or rot, causing voids that lead to road failure.
- Maintain live trees or slash rows at the base of fill slopes to filter sediments.
- Avoid constructing berms that may channel water down road.
- Reseed disturbed areas as soon as practical.

Cuts & Fills

When building roads in steep terrain, it is usually necessary to cut into the hillside to create a flat road surface. The excess material excavated often becomes fill on the downhill side. Cuts and fills can create significant visual scars, are expensive to build and maintain, and should be avoided wherever practical. Both cut and fill slopes should be left no steeper than the angle of repose or the maximum angle that soil or rock will remain on a hillside without sloughing over time.

Figure 4.1
Cuts and Fills



Adapted from The Washington Department of Natural Resources

On slopes 60% or greater, excavated volume should not be side-cast to create a fill slope. Fill should only be used when slope steepness is 50% or less, and should be compacted or allowed to settle before using the road. Cut and fill slopes should be revegetated as soon as practical.

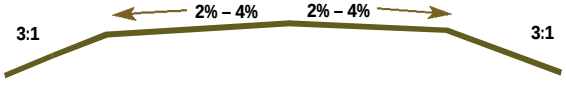
Shaping Road Surfaces

Three options for shaping roads to reduce erosion are crowning, in-sloping and out-sloping.

Figure 4.2

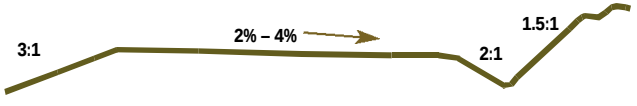
Crowning

- Road surface is sloped from the center to the outside
- Used for roads with heavy, two-way traffic



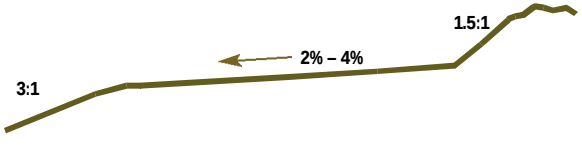
In-Sloped Roads

- Road surface is sloped into the uphill side



Out-Sloped Roads

- Road surface is sloped to the downhill side
- Water flows off of the road before it is allowed to build up enough energy to cause damage
- Avoid out-sloping roads directly into stream channels or unstable slopes



- For safety reasons, avoid out-sloping roads on steep slopes

Surface Drainage

The most effective method to control erosion on forest roads is to keep water from accumulating on the road surface. Erosion from road surfaces can be controlled when water is diverted and dispersed into vegetation and ground litter. The use of water diversion devices or drainage structures such as rolling dips, diversion ditches, cross culverts and water bars can be used to prevent erosion.

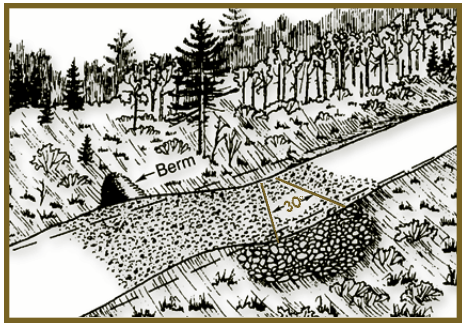
Figure 4.3
Poor road drainage - water should not be allowed to run down a road for any distance.

Photo: Darren McAvoy

Broad Based or Rolling Dips

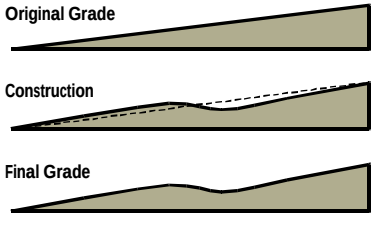
A broad based or rolling dip is much like a hump constructed in the road bed to divert water off the road. A well constructed broad based dip is deep enough to provide adequate drainage and wide enough to allow trucks and equipment to pass safely. The rolling dip is constructed at an angle toward the direction of the road for ease of travel. The bottom of the dip is sloped to the outside to carry water away from the road. Broad based or rolling dips are best suited to road grades of 10% or less and should be spread out over a minimum of 150 feet.

Figure 4.4 **Rolling Dip**



Adapted from The Bureau of Forestry, Wisconsin Department of Natural Resources

Figure 4.5 **Rolling Dip Cross-Section**



Diversion Ditch

A diversion ditch or spreader ditch is designed to remove water from the road surface to the downhill side of outsloped roads. Diversion ditches should be graded on a 2 to 3 percent slope to allow constant drainage and dispersion into nearby forest vegetation. Diverting water off the road and into vegetation allows sediment to settle out and the water to be absorbed into the ground. These are the least costly of the water diversion devices.

Figure 4.6 **Diversion Ditch**

Cross Drainage

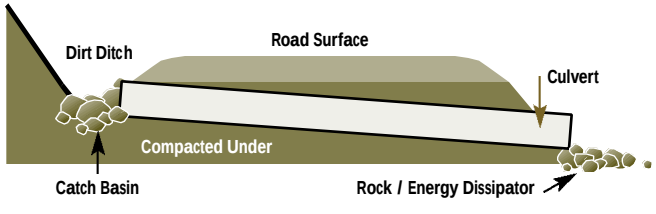
In-sloped roads require cross-drain culverts or ditch-relief culverts to allow water to cross to the downhill side of the road. In-sloped roads rely on drainage ditches on the inside of the road to carry the water away from the cut bank and roadside. Ditch gradients of 2 to 6 percent are best.

Figure 4.7 **Ditch Relief**

Cross Culverts

Cross culverts should be installed to drain water from either the inside ditch or from natural water sources such as seeps or small springs. The size the cross culvert should be designed to adequately handle peak runoff and flood waters. Generally, size culverts to handle a 25 year–24 hour storm event for temporary road crossings and a 50 year–24 hour storm event for permanent road crossings. Cross culverts should be skewed 15 to 30 degrees toward inflow ditch to reduce maintenance requirements.

Figure 4.8 **Cross Culvert**



Water Bars

Water bars are best suited for use on roads that receive little or no use for an extended period of time. To construct a water bar, excavate a trough one to two feet deep by three to four feet wide at an angle of 30 to 45 degrees across the road. The uphill end of the water bar should be connected to the upper bank of the road. A properly constructed water bar also has an outlet on its

downhill end to allow water to be directed into nearby vegetation. Water bars are difficult to drive over, and are easily rendered ineffective when subjected to heavy traffic. Vehicle traffic should therefore be minimized and the water bars should be seeded and fertilized to reduce erosion.

Figure 4.9 **Water Bar Installation**

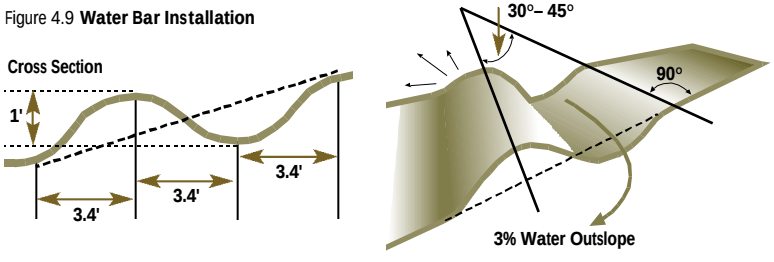


Table 4.1
Recommended Distances between Water Diversion Devices on Logging Roads

Road Grade (%)	Spacing (feet)
2	250
5	135
10	80
15	60
20	45
25	40
30	35
40	30

ROADS, SKID TRAILS, LANDINGS & STREAM CROSSINGS

Road Maintenance

One of the most important parts of road maintenance is keeping ditches and culverts operational and free of debris. Ditches on newly constructed roads may require frequent cleaning and checking after each major storm until revegetation has been established. Road grading is another important part of maintenance.

Recommended Practice Standards and Guidelines

- Grade roads only as often as needed to maintain a stable road surface and to maintain proper surface drainage. Unnecessary grading creates a source of sediment from the newly disturbed surface.
- Leave grass in the ditch unless it has filled with sediment and is no longer functioning.
- Avoid undercutting the toe of cut-slopes when grading roads or pulling ditches. Clean ditches periodically.
- Clean culverts blocked by debris.
- Avoid leaving berms that channel water down the road.
- Reduce dust by applying water, rock, or other appropriate road treatments.
- Close all roads that are unstable, erodible or unnecessary.

Slide Debris
Slide debris can cause increased sediment loads in established roadway drainage systems as well as in established streams. Do not side cast removed material if there is a chance it will enter a stream. The cause of the slide needs to be evaluated. Under some circumstances, removal of the slide debris may make the situation worse by further undercutting the toe of the slope. In some instances, removal of some debris may be required and stabilization of the remaining material may prevent further problems. Consult an engineer for advice if problem persist.

Skid Trails

Skid trails are an important part of any forest transportation system. Skid trails are temporary travel ways or paths that are used by logging equipment to transport logs to a log deck or landing for loading onto trucks. While skid trails are not intended for over-the-road vehicles, their design and location requires care and consideration and should follow all applicable FWQGs to prevent excessive erosion and sedimentation.

Recommended Practice Standards and Guidelines

- Use the fewest number of skid trails possible to limit soil disturbance. The use of designated skid trails is one way of limiting soil compaction and disturbance (*see Figure 4.10*). No more than 15% of the harvest area should be occupied by skid trails (*see Table 4.2*).
- Locate skid trails outside of Streamside Management Zones (SMZs).
- Use the most appropriate skidding system for the soil and terrain, (e.g. rubber-tires skidders, tractors, cable, etc).
- Avoid skidding directly up and down steep slopes for long distances.
- Avoid skidding patterns that concentrate or channel water and runoff.

- Where possible, keep skid trail grades less than 15%. Grades greater than 15% should not exceed 250 feet in length.
- Where steep grades are unavoidable, break the grade and install drainage structures. When skidding is terminated, install appropriate water diversion devices such as cross ditches or water bars to prevent channelization and erosion (*see Table 4.3*).

Table 4.2
Percentage of Harvest Area Covered by Skid Trails Assuming 10' Width

Skid Trail Spacing (ft)	Area in Skid Trails %
75	13.3
100	10.0
150	6.7
200	5.0
250	4.0

Calculating Percent area in Skid Trails

$$\frac{\text{Skid Trail Width}}{\text{Skid Trail Spacing}} \times 100$$

Example: $\frac{10'}{75'} \times 100 = 13.3\%$

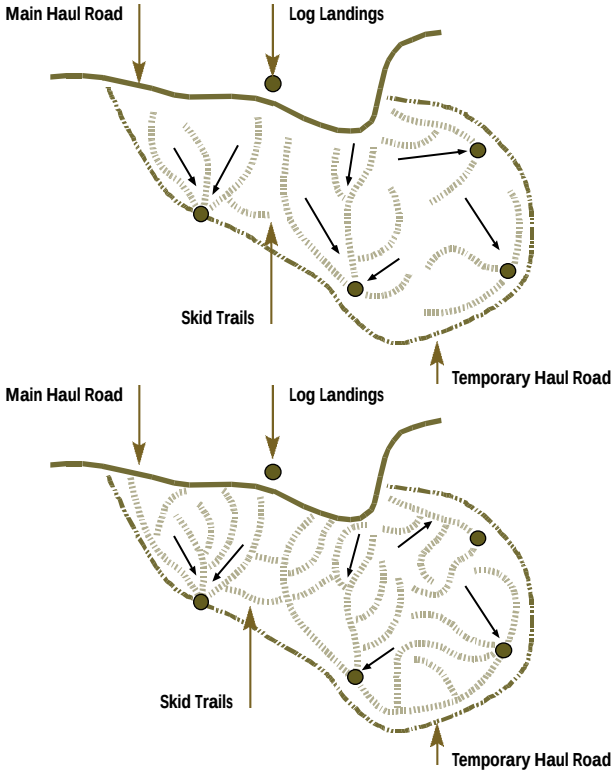


Figure 4.10
Designated skid trails (top) vs. logger's choice (bottom). Note the additional length and number of skid trails. Limit the number and length of skid trails to minimize the amount of area disturbed by skidding (adapted from Nebraska Forest Service, University of Nebraska).

Table 4.3
Spacing of Water Bars On Skid Trails

Grade of Skid Trail (%)	Distance Between Water Bars (ft)
2	250
5	135
10	80
15	60
20	45
30	35
40	30

Landings

Landings are cleared areas where logs are collected for loading and transport. Landings are used for stacking, decking, bunching and limbing of logs. The concentration of activities at landings may cause compaction, erosion or sedimentation.

Recommended Practice Standards and Guidelines

- Avoid locating landings in Streamside Management Zones (SMZs).
- Construct landings with 3 to 10 percent slopes for adequate drainage.
- Minimize the number and size of landings. No more than 3% of the harvest area should be occupied by roads and landings.
- Locate landings away from natural drainages and divert runoff away from streams.

- Locate landings to avoid skidding down, or across drainages and streams.
- Restore landings and reseed if necessary, at the end of operations.

Stream Crossings

Culverts, bridges and fords are all methods used to cross streams. Select a site for a stream crossing before the road system is laid out or planned. Doing so will allow the road system to be designed for the best approach to the stream crossing. The profile of the streambed should not be changed when constructing crossings. Select the most appropriate stream crossing structure considering the following criteria: stream size, cost, maintenance requirements, and whether temporary or permanent. Poorly located or constructed stream crossings are costly and may contribute to sedimentation and erosion. A permit is required for any stream bank alteration from the Utah Division of Water Rights.

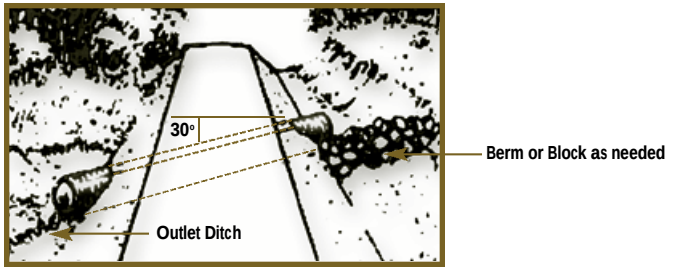
Recommended Practice Standards and Guidelines

- Use stream crossings only when absolutely necessary.
- Keep the number of stream crossings to a minimum. Avoid indiscriminate stream crossings.
- Identify the appropriate type of stream crossing *(e.g. culvert, ford or bridge)*.
- Select a location that has firm banks and fairly level approaches. Design stream crossings to handle peak runoff and flood waters and provide for adequate fish passage.
- Install stream crossings at right angles to the channel whenever possible.
- Construction and placement of stream crossings is critical and should be timed to minimize impacts to water quality.

Culverts

Culverts are the most commonly-used form of stream crossing. A culvert is easily placed, functions well, is relatively inexpensive and can be reused upon removal when no longer needed. Culverts should be of sufficient size to accommodate peak runoff and flood waters. Generally, use of the 25 year - 24 hour storm event for temporary road crossings and the 50 year - 24 hour storm event for permanent road crossings will provide adequate structure sizing. Minimum culvert size should be 15 inches in diameter.

Figure 4.11



Recommended Practice Standards and Guidelines

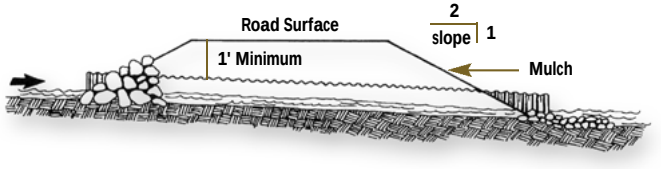
- Place culvert so the bottom is at the same level as the bottom of the ditch or adjoining slope, at the gradient of the original slope, and skewed 15 to 30 degrees toward the inflow ditch to reduce maintenance problems.
- Cover tops of culverts with at least 12 inches of compacted fill for culverts up to 36 inches in diameter and; cover large culverts with fill material ≥ 1/3 of the culvert diameter. This minimizes damage to culverts from heavy vehicles and road maintenance activities.

- Firmly pack material around culverts, especially around the bottom half, to anchor them and prevent washing out.
- Where it is not possible to install culverts at the gradient of original slope the outlet should be armored with rocks, logs, or other materials to dissipate the energy of the falling water. *(See figure 4.12)*
- Place rip-rap around the culvert inlet to prevent erosion due to turbulent water flow. Rip-rap is most effective when placed on top of geo-textile material. Geo-textile is a fabric mat that allows water to drain through it while supporting materials above.
- Use adequately sized culverts for stream and runoff flow. Anticipate storm peak flows and size culverts accordingly (*see Table 4.4*).
- Stream gradients should not be changed when installing culverts. To function properly, culverts should be aligned with the natural stream channel.
- Install culverts with the same slope of the natural stream bed. A pitch of 2-3 percent will cause the culvert to be self-cleaning.
- Protect fill and culvert by armoring the inlet and outlet ends of the culvert.
- Inspect culverts regularly and clean as necessary.

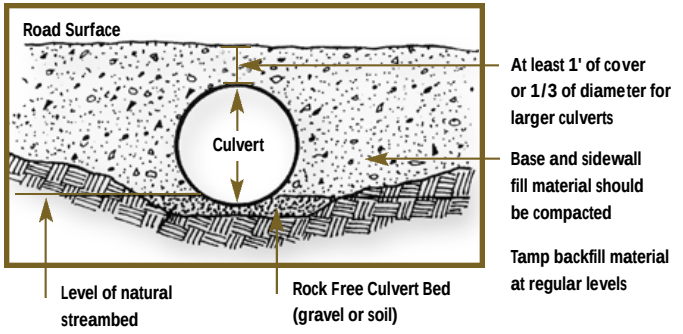
A permit may be required for construction activities affecting the bed or banks of a stream. This includes the placement of stream crossings.
For more information, contact the Utah Division of Water Rights at

P.O. Box 146300
Salt Lake City, Utah 84114-6300
801.538.7375

Figure 4.12
Properly installed culverts result in no change in the stream bed.

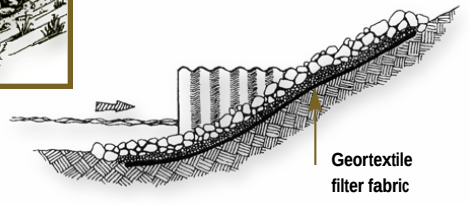


Installation of Culvert



Rock armoring and riprap should be used to protect both ends of the culvert.

Use of geotextile fabric.



Adapted from The Bureau of Forestry, Wisconsin Department of Natural Resources

Determining Proper Culvert Size

Step 1: Determine the channel area. Measure the width at the high water mark and maximum depth of the stream channel to the nearest foot. Multiply the width and depth measurements to determine the channel area. Repeat this process three times at different locations, add the three areas and take the average of the channel area.

Step 2: Allow for additional area to accommodate higher than average flows. This corrected channel area figure will be the one you use to determine the proper culvert size. To do this, multiply the channel area (from Step 1) by 1.2.

Step 3: The minimum size pipe needed to pass the normal high flows must have an area that is as much or more than the corrected channel area determined in Step 2. Select the next larger pipe size to match the area of the stream. (refer to Table 4.4).

Adapted from: Flathead Conservation District Guide to Stream Crossings

Table 4.4
Most Commonly Used Culvert Sizes

Area (sq.ft.)	Pipe Diameter (in.)
1.25	15
1.80	18
3.14	24
4.90	30
7.07	36
9.60	42
12.57	48
15.90	54

Adapted from: Haussman and Pruett 1978, p. 36

Table 4.5
Water Diversion Devices Relative Cost Ranking (installation and maintenance).

Diversion Device	Relative Cost
Water Turn-Outs	Low
Water Bars	Low-Moderate
Broad-Based (rolling) Dips	Moderate
Road Crowning	Moderate
Road Insloping / Outsloping	Moderate
Road Ditches	High
Open-top Culverts	High

Fords

Fords may be the least expensive alternative if conditions allow. A ford is simply a stream crossing without a structure or culvert. They can be used where stream banks are low and firm, the streambed is firm and the stream is shallow. Fords should not be used if significant alteration of the stream bank is required. Rock and gravel may be used to stabilize the stream bed approaches. Concrete may be placed in stream beds or flow areas of intermittent watercourses when warranted to protect the stream bed. Fords should be considered as temporary crossings with low frequency of use.

Recommended Practice Standards and Guidelines

- Stream bed has a firm rock or course gravel bottom, and the approaches are low and stable enough to support traffic.
- Traffic is limited to low volumes of light vehicles
- Water depth is less than 3 feet.
- Crossings should be at right angles to the stream.
- Stabilize the approaches by using non-erodible material. The material should extend at least 50 feet on both sides of the crossings.

Bridges

While usually more expensive, bridges can be used for temporary or permanent stream crossings. Usually, permanent bridges are used for larger streams or for permanent roads. Temporary bridges are used for smaller streams, infrequent or one-time access, and can be made of other suitable materials or devices. Use care to minimize disturbance to stream banks and approaches.

Winter Operations

Winter provides an opportunity to conduct harvest operations in areas which might be sensitive when not frozen. Wetland areas are particularly suited to being logged during winter. Snow can provide support across wet areas which would be deeply rutted if logged during the summer months. Freezing of wetland areas can also extend operating periods and reduce impact from logging. Operations conducted during cold weather months have different maintenance requirements. Roads are vulnerable to heavy damage and erosion if not maintained correctly. However, if properly maintained during winter months, road usage can extend the logging season without creating excessive impacts.

Recommended Practice Standards and Guidelines

- Remove snow from roads initially to allow deep freezing which will increase stability of the road base.
- After roads have frozen solidly, maintain packed snow on the road to insulate the frozen road base.
- Snow berms along road edges can keep melted snow on the road surface from entering streams.
- During times of alternative freezing and thawing, suspend operations if deeply frozen road base begins to thaw.

Road Closures

When harvesting operations are terminated, the future need for roads should be considered. If plans have changed since the harvest, the road may need to be kept open for other uses. However, most roads can be closed when logging operations cease. Road closure can do much to prevent sedimentation of streams and lakes.

Recommended Practice Standards and Guidelines

Temporary Road Closure

- Remove temporary drainage structures and replace with water bars.
- Remove stream crossing structures. Stream courses and natural drainages should be restored to their natural channels.
- If necessary, re-contour the roadbed to the original slope of the land.

Permanent Road Closure

- Roads should be ripped or loosened so vegetation can grow. If necessary, the roadbed should also be contoured to the original slope of the land.
- Barricade roads to prevent or control use by vehicles while revegetation occurs.
- Periodically inspect the road and drainage structures to ensure drainage is being maintained.

TIMBER HARVESTING

While timber harvesting encompasses several different activities, it is the cutting and removal of trees. Timber harvesting can be accomplished while protecting water quality and site productivity. Harvesting activities should be conducted to ensure long-term maintenance of water quality and the availability of forest resources for future generations.

Recommended Practice Standards and Guidelines

Harvesting Systems

- Choose the appropriate size and type of equipment to adequately perform the operation (i.e. ground-based, cable or aerial). Typically, ground-based systems include the use of tracked or wheeled machinery, and should not be used on slopes in excess of 40%. For tracked machinery, skidding distances should be limited to 600 feet or less. For wheeled machinery, skidding distances should be limited to 1200 feet or less.
- Plan and layout roads, skid trails, landings and stream crossings prior to harvesting (*see Chapter 4: Roads, Skid Trails, Landings and Stream Crossings*).
- Exclude the operation of ground-based machinery within SMZs. Trees harvested in SMZs should be end-lined, winched or cable yarded (*see Chapter 3: Streamside Management Zone*).

Figure 5.1
Directional Felling vs. Unplanned Felling

Directional Felling

Unplanned Felling

- Utilize directional felling techniques *(see Figure 5.1)*.
- Avoid the use of skidder blades for braking purposes when descending steep slopes.

Winter Logging

- Install adequate road or skid trail drainage prior to the start of harvesting activities.
- Clearly mark culverts and other drainage structures making them visible in deep snow.
- Keep all drainage structures clear and ensure culverts remain free of debris.

Slash Management

- Select the most appropriate slash disposal treatment that minimizes water quality impacts and reduces the risk of insect infestations (e.g. lop and scatter, crushing, chipping or burning).
- The depth of slash on the forest floor should not exceed 18 inches.

- Use a brush blade for piling slash. Brush blades reduce the amount of soil in slash piles.
- Avoid piling slash in the SMZ.
- To prevent excessive slash accumulations and waste of resources, use pre-determined utilization standards.

Regeneration

- Retain a sufficient number of healthy trees with adequate crowns and good form for seed trees during seed tree, selection, shelterwood and thinning operations *(see Tables 5.1)*.

Table 5.1
Recommended Minimum Number of Residual Trees Per Acre

Forest Type	Residual Trees by Regeneration Method*	
	Seed-Tree (trees / ac)	Shelterwood (trees / ac)
Aspen	N / A	N / A
Ponderosa pine	4-10	20-45
Douglas-fir	5-15	30-90
Lodgepole pine	Not Recomended	35-70
Spruce-fir	Not Recomended	35-100

This table should serve only as a guide. The desired number of residual trees will vary by size and quality of residual trees and site characteristics, and should be specified as part of silvicultural prescription.

*The shelterwood system is preferred over a seed tree system if site conditions (e.g., exposed dry slopes) require moderation of seeding environment. The recommended diameter (DBH) range for residual trees is 10-16".

NOTES:

SITE PREPARATION, REGENERATION & REVEGETATION

Site Preparation

Typically, site preparation involves the use of machinery, chemicals or other means such as fire to prepare a site for tree planting, direct seeding and/or natural regeneration of a forest. Proper site preparation provides adequate planting space to ensure survival and growth of newly planted or established seedlings.

Regeneration

Regeneration is the re-establishment of trees after a harvest. There are two ways to regenerate a new forest - natural and artificial regeneration. Artificial regeneration is used when planting bare root or containerized seedlings, whereas natural regeneration relies on the forest to reseed itself.

When relying on natural regeneration, it is important to retain some of the best trees and choose healthy trees of desired species with sufficient crowns and good form to provide a seed source that is of the best genetic quality. Retaining high quality trees can also benefit planting, as the locally adapted trees that remain can cross-pollinate the selected stock of the planted trees to produce even better stock in the future.

Revegetation

Revegetation is the establishment of herbaceous vegetation in disturbed areas such as skid trails, landings, road cuts and fills.

Recommended Practice Standards and Guidelines

- Dispose and treat slash with fire and/or other means using machinery and chemicals.
- If needed, mechanically scarify soil to create optimal conditions for regeneration.
- Consider chemical site preparation where practical to minimize soil disturbance.
- Retain a sufficient number of healthy trees with adequate crowns and good form for seed trees. *(See Chapter 5: Table 5.1)*
- Retain stocking levels suited to moisture conditions of the site. Dry sites or southern aspects may require retention of additional trees to provide necessary shade for newly established seedlings.
- Choose tree species that are well suited to soil and site conditions and grown from local seed stock.
- Monitor regeneration survival to ensure management and water quality objectives are being met.
- Stabilize exposed soil (including firelines) utilizing native herbaceous seed mixtures suited to site conditions as soon as practical following construction or use.
- Consider hydroseeding and using other soil stabilization techniques in difficult or problem areas.
- Avoid seeding herbaceous vegetation in areas where tree seedling establishment is desired unless erosive conditions warrant
- Utilize slash material to stabilize soil and slow surface water flow
- Minimize fertilizer applications.
- Following removal of culverts and bridges, establish earth or straw dikes on stream banks and seed with proper seed mix to minimize soil runoff into the stream.

CHEMICAL MANAGEMENT

Use of chemicals during forestry activities can have considerable benefit. In most cases, the use of chemicals is unavoidable, such as the use of petrochemicals and antifreeze in vehicles and machinery. When used properly, of chemicals should not have a detrimental affect on water quality. However, most chemicals have a potentially great impact on water quality and aquatic organisms if they are misused, misapplied or spilled. Most water quality problems associated with chemicals are caused when they are spilled or improperly applied to or directly on surface water.

Chemicals generally used in forest management include pesticides (herbicides, rodenticides, insecticides, fungicides, etc.), petrochemicals (oil, gasoline, diesel), antifreeze, fire retardant, and fertilizers.

By federal law, the application of chemicals must follow Environmental Protection Agency (EPA) label directions on chemical containers.

Recommended Practice Standards and Guidelines

General

- Follow all label instructions, EPA guidelines and state and federal laws when applying chemicals.
- Have a contingency plan to follow in the event of a chemical spill. Include the following:
  - contact information
  - absorbent or neutralizing materials
  - instructions for cleanup or containment procedures

Report all spills to the Utah Department of Environmental Quality
Division of Environmental Response and Remediation
Emergency Hotline: (801) 536-4123 • http://www.deq.state.ut.us

- Transport and store chemicals in leak-proof, labeled containers. Chemical storage containers and facilities should be located outside the SMZ. Dispose of chemical waste according to label instructions.
- Designate specific areas for equipment maintenance, fueling and mixing of chemicals. These areas should be located on flat, level terrain and a minimum of 75 feet above the ordinary high water mark from all streams, lakes and other water bodies.
- Apply chemicals when the wind speed is less than 5 mph.

Pesticides

- Apply chemicals during the appropriate weather and season
- Avoid application of pesticides directly to surface waters, by drift or by washing into water, unless labeled for such use.
- Do not mix chemicals or clean equipment or containers in or near streams, water bodies or SMZs.

Petrochemicals and Antifreeze

- Do not drain used oil, fuel or antifreeze onto the ground.
- Fuel and service equipment away from SMZs and avoid spillage.
- Keep all fuel, oil and antifreeze away from surface waters and away from areas where spilled material may enter or be washed into water.

Table 7.1
Guidelines for Chemical Application

Aerial Applications	Mechanical Applications	Hand Applications
Follow all label req.	Follow all label req.	Follow all label req.
Leave at least a 75' buffer next to SMZs (unless label requirements specify larger)	Leave at least a 25' buffer next to SMZs (unless label requirements specify larger)	Do not apply chemicals near or over water. Apply only to specific targets, such as vegetation, trees, stumps, etc.
Leave at least a 200' buffer around homes (unless label requirements specify larger		

Figure 7.1:
When is it too Windy to Apply Chemicals

Wind Speed	Observable Features
Less than 1 mph	Smoke rises vertically; no foliage movement
1 - 3 mph	Foliage and small twigs sway gently; grass and weeds sway and bend
4 - 7 mph	Small trees in open sway gently; loose scraps of paper move, flags flutter; you feel a slight breeze on your face

NOTES:

FORESTED WETLANDS

Wetlands perform an important filtering function to streams and water supplies. Care must be taken during forestry operations to ensure their protection. Wetlands are “areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas”. Forested wetlands are wetland areas covered by or surrounded by trees or forests.

Recommended Practice Standards and Guidelines

- Clearly identify and mark wetland boundaries before harvest operations begin
- Time operations in wetlands when the ground is frozen, snowpacked, or dry
- Use tracked equipment instead of wheeled equipment in wetlands
- Skid or end-line trees out of wetlands
- Divert runoff from roads, trails and landings into upland areas to reduce siltation of wetland areas
- Use mats or similar devices to disperse loads when crossing wetlands
- Keep open water free from slash
- Provide adequate cross-road drainage to minimize changes to natural water flow patterns

Avoid the following:

- Locating roads, trails, and landings in wetlands.
- Pesticide use in wetlands
- Fueling and servicing vehicles in wetlands
- Operating equipment in areas of open water, seeps and springs
- Creating ruts in wetlands
- Skidding through big game wallows and wetlands

The construction and maintenance of roads for other than forestry activities within wetland areas may be subject to federally required Best Management Practices (BMPs). Refer to the Appendix of this publication.

NOTES:

PRESCRIBED FIRE

Prescribed fire is the use of fire as a management tool for a specified purpose and is conducted under certain conditions to attain objectives without causing undue resource damage. Unwise use of fire can have devastating impacts on water quality. Burning should be done during times of inclement weather where management goals can still be attained.

Broadcast burning involves using fire to treat a designated area with defined boundaries. Broadcast burning requires a burn plan to be prepared by a qualified professional prior to ignition. Burn plans should consider expected response of vegetation, weather and fuel moisture content, ignition pattern, personnel requirements, equipment needs and contingency plans. Advantages of broadcast burning, if done correctly, can include reduced equipment costs, reduced soil compaction and favorable conditions for regeneration.

Recommended Practice Standards and Guidelines

- A prescribed burn plan should be prepared by a qualified professional. Part of the plan should include analysis of the need to burn. Alternatives exist which may accomplish the same purpose (see Burning of Slash)
- Avoid burning within the SMZ unless specifically required by a management objective.
- Ensure control of fire at all times to limit the risk of fire escaping the intended burn area. If weather conditions are marginal for control of fire, fire suppression forces should be available to respond if needed.

- Personnel experienced and qualified in fire management techniques should plan and conduct burns, provide supervision or be asked to provide technical expertise to conduct a safe, efficient, minimal-impact burn.
- Prepare a contingency plan which identifies appropriate actions to take if a prescribed fire exceeds control parameters (area, size, flame length or rate of spread).
- Use caution when considering burning on steep slopes. Burning on steep slopes could result in excessive soil erosion.

Burning of Slash

The decision to burn slash should be made judiciously. Other alternatives exist that may accomplish the same purpose.

Recommended Practice Standards and Guidelines

- Slash can be reduced by lopping and scattering, crushing, chipping or adherence to pre- determined utilization standards. Consider removing products such as firewood and fence posts prior to burning.
- Pile and burn slash only which is necessary. Some slash retention provides protection and nutrients for regeneration while excessive removal of slash causes soil compaction and increase soil erosion.
- Slash which is lopped and scattered should be cut in such a manner as to leave all branches and foliage within 1 to 2 feet of the ground.
- Slash which is piled for burning should be free from dirt and other noncombustible material to allow efficient burning for disposal of slash. Use brush blades on dozers when piling slash.

Safety Message:

When using fire, safety must always be considered. Human beings are very susceptible to harm from even the most innocuous-looking fire. As fires increase in rate of spread, intensity or size, the danger increases dramatically. Personal safety, risk of fire escape from areas intended for burning and liability are the main reasons that qualified and experienced personnel are recommended for planning and implementation of prescribed burns. Property owners may be held liable for loss of life, personal injury or property damage from a prescribed fire and suppression costs of an escaped fire.

NOTES:

PERMITS & REGULATIONS

In addition to the FWQGs described in this manual, certain state and federal permits and regulations related to forest management and water quality may also apply. For more information, contact the agency listed below.

Water Quality

Stream Alterations & Crossings

A stream alteration permit is required prior to construction activities affecting the bed or banks of streams, including placement of stream crossings. The Division of Water Rights must always be contacted before these activities begin. They can be contacted at:

Utah Division of Water Rights
P.O. Box 146300
Salt Lake City, UT 84114-6300
(801) 538-7375
www.waterrights.utah.gov

Section 404 of the Clean Water Act requires authorization from the U.S. Army Corps of Engineers related to the dredging and deposition of fill material into the "waters of the United States, including wetlands." However, normal, established (on-going) silvicultural activities, including the construction and maintenance of permanent and temporary forest roads within wetland areas, may be exempt from the regulation if the 15 federally mandated "Best Management Practices" are implemented *(see page 55)*. Contact the Division of Forestry, Fire & State Lands or the U.S. Army Corps of Engineers for more information at:

Department of Natural Resources
Division of Forestry, Fire & State Lands
1594 W. North Temple, Suite 3520
Salt Lake City, UT 84114-5703
(801) 538-5555
www.nr.utah.gov/slf/slfhome.htm

Intermountain Regulatory Section
U.S. Army Engineer District, Sacramento
1403 S. 600 W., Suite A
Bountiful, UT 84010
(801) 295-8380

Forest Practices

Conducting forest practices in the state of Utah requires compliance with the Utah Forest Practices Act (FPA). The FPA requires operators to register with the Division of Forestry, Fire & State Lands. The FPA also requires operators to notify the division of their intent to conduct forest practices at least 30 days prior to activities commencing. Contact the Division of Forestry, Fire & State Lands for more information at:

Department of Natural Resources
Division of Forestry, Fire & State Lands
1594 W. North Temple, Suite 3520
Salt Lake City, UT 84114-5703
(801) 538-5555
www.nr.utah.gov/slf/slfhome.htm

Transportation of forest products within or into the state of Utah requires compliance with the Forest Products Transportation Act. The law requires possession of a contract, permit, bill of sale, bill of lading, receipt or other legal instrument to provide the following information:

- Date of sale, legal description, purchaser name and address, products, species and quantity, transporter's name and address, if different than purchaser, point of delivery, name and address of landowner, agency or vendor
- Proof of ownership is not required for private landowners harvesting or removing products from their own property. Contact the Division of Forestry, Fire & State Lands for more information at:

Department of Natural Resources
Division of Forestry, Fire & State Lands
1594 W. North Temple, Suite 3520
Salt Lake City, UT 84114-5703
(801) 538-5555
www.nr.utah.gov/slf/slfhome.htm

Fire

A burning permit is required for any burning on private and non-federal lands. The permit requirements comply with the statutes and administrative rules of the Clean Air Act and the Utah Department of Environmental Quality. Contact the Division of Forestry, Fire & State Lands for more information at:

Department of Natural Resources
Division of Forestry, Fire & State Lands
1594 W. North Temple, Suite 3520
Salt Lake City, UT 84114-5703
(801) 538-5555
www.nr.utah.gov/slf/slfhome.htm

Chemical

The Utah Department of Agriculture has specific regulations regarding pesticides, including registration and labeling, classification, applicator certification, licensing and transportation. Contact the Department of Agriculture and Food for more information at:

Utah Department of Agriculture and Food
350 N. Redwood Rd.
Salt Lake City, UT 84116-0000
(801) 538-7100
www.ag.utah.gov

Federally Required Best Management Practices

Specific Best Management Practices required by federal regulations drafted under the Clean Water Act [CFR 323.4 (d)(6)] for the construction and maintenance of forest roads within wetland areas include:

1. Permanent roads (for farming or forestry activity), temporary access roads (for mining, forestry, or farm purposes) and skid trails (for logging) in waters of the U.S. shall be held to the minimum feasible number, width, and total length consistent with the purpose of specific farming, silvicultural or mining operations, and local topographic and climactic conditions;
2. All roads, temporary or permanent, shall be located sufficiently far from streams or other bodies of water (except for portions of such roads which must cross water bodies) to minimize discharges of dredged or fill material into waters of the U.S.;
3. The road or fill shall be bridged, culverted, or otherwise designed to prevent the restriction of expected flood flows;
4. The fill shall be properly stabilized and maintained during and following construction to prevent erosion;
5. Discharges of dredged or fill material into waters of the United States to construct a road fill shall be made in a manner that minimizes the encroachment of trucks, tractors, bulldozers, or other heavy equipment within the waters of the United States (including wetlands) that lie outside the lateral boundaries of the fill itself;
6. In designing, constructing, and maintaining roads, vegetative disturbance in the waters of the U.S. shall be kept to a minimum;
7. The design, construction and maintenance of the road crossing shall not disrupt the migration or other movement of those species of aquatic life inhabiting the water body;
8. Borrow material shall be taken from upland sources whenever feasible;
9. The discharge shall not take, or jeopardize the continued existence of, a threatened or endangered species defined under the Endangered Species Act, or adversely modify or destroy the critical habitat of such species;
10. Discharges into breeding and nesting areas for migratory waterfowl, spawning areas, and wetlands shall be avoided if practical alternatives exist;
11. The discharge shall not be located in the proximity of a public water supply intake;
12. The discharge shall not occur in areas of concentrated shellfish production;
13. The discharge shall not occur in a component of the National Wild and Scenic River System;
14. The discharge of material shall consist of suitable material free from toxic pollutants in toxic amounts; and
15. All temporary fills shall be removed in their entirety and the area restored to its original condition.

Artificial regeneration: Direct seeding or by planting seedlings or cuttings.

Best Management Practice (BMP): A practice or a combination of practices, that is determined by a State *(or designated area-wide planning agency)* after problem assessment, examination of alternative practices, and appropriate public participation to be the most effective, practical *(including technological, economic and institutional considerations)* means of preventing or reducing the amount of pollution generated by Nonpoint sources to a level compatible with water quality goals (40 CFR 130.2(q). This definition is consistent with the State of Utah definition of "Forest Water Quality Guideline."

Clean Air Act: Established in 1970 and amended in 1977 and 1990, is the federal law regulating air emissions; enforcement authority lies with the U.S. Environmental Protection Agency (EPA) who is charged with establishing National Ambient Air Quality Standards (NAAQS), these standards were to be established in every state by 1975; states were required to adopt standards that met or exceeded federal standards.

Clean Water Act: Established in 1977 as an amendment to the 1972 Federal Water Pollution Control Act; Clean Water Act makes discharging pollutants from a point source to navigable waters illegal without a permit. The amendments of 1987 provide for the management of nonpoint source pollution into the waters of the United States.

Drainage structure: Any device, excavation, berm or constructed structure used to provide stream crossings or divert runoff and/or stream channels. These structures may include bridges, culverts, waterbars, rolling dips, ditches, cross-drains, pipes, down spouts and other similar structures.

Fireline: A constructed area generally void of combustible fuels that is used to stop or direct the spread of wild or prescribed fire occurring in forest, grass, range or brush.

Fishery: Any stream, lake, river, creek, reservoir, and or other body of water that supports naturally reproducing or stocked fish populations of any life stage.

Forest: An area where the predominant vegetation is trees.

Forest Water Quality Guideline (FWQG): A collection of voluntary, field applicable practices for use during forestry activities to protect water quality adopted by the State and contained within the Nonpoint Source Management Plan.

Guideline: See Forest Water Quality Guideline (FWQG).

Hydrologic modification: Occurs whenever human activities significantly change the hydrologic function *(dynamics)* or the attendant pollutant release regime of rivers *(and streams)* and riverine systems, lakes and impoundments and ground water systems. These modifications can create nonpoint source *(NPS)* water pollution *(and impacts to related aquatic wildlife habitat).*

Insloped road: A road constructed with a surface slope graded toward the cut slope to direct water to a ditch on the cut bank side of the road.

Landing: A collection area, usually centrally located, to where logs or forest products are transported by skidders, dozers, cable systems or other means so the products may be loaded onto trucks for transport to another destination.

Landowner: An individual or group of individuals or any form of a legal entity that owns or possesses any interest in land; any government agency charged with management of public lands or any other type of group or agency that owns or manages land.

Natural Handbook of Conservation Practices: A document containing a collection of specifications on a variety of conservation practices maintained by the United States Department of Agriculture, Natural Resources Conservation Service *(NRCS).*

Nonpoint source pollution: Diffuse sources of water pollution that originate from many indefinable sources and normally include agricultural and urban runoff, runoff from construction activities, etc. In practical terms, nonpoint sources do not discharge at a specific, single location *(such as a single pipe)*. Nonpoint source pollutants are generally carried over or through the soil and ground cover via stormflow processes. Unlike point sources of pollution *(such as industrial and municipal effluent discharge pipes)*, nonpoint sources are diffuse and can come from any land area. The following silvicultural activities are considered to be nonpoint sources of pollution: nursery operations, site preparation, reforestation and subsequent cultural treatment, thinning, prescribed burning, pest and fire control, harvest operations, surface drainage and road construction and maintenance from which there is natural runoff (40CFR 122.27).

Noxious weed: Any plant the Commissioner of Agriculture determines to be especially injurious to public health, crops, livestock, land or other property.

Outsloped road: A road constructed with a surface graded toward the fill slope to direct water off the road in sheet flow.

Riparian areas: Units of land along watercourses or water bodies that product unique vegetation as a result of abundant water in the rooting zone. The species and proportional amounts of vegetation are usually in marked contrast to the more arid adjacent uplands.

Professional forester: A person who has earned a bachelor of science in forestry or masters degree in forestry from a Society of American Foresters accredited college or university or equivalent and has experience in the management of forested lands.

Scarify: To mechanically *(e.g. plowing, disking, ripping)* break up or loosen the surface of the soil, roads or other areas.

Sedimentation: The process of deposition of eroded and transported material, usually in the context of stream channel bottoms, reservoirs and lakes.

Silvicultural activities: Activities that involve controlling the establishment, growth, composition, health and quality of forests and woodlands to meet the diverse needs and values of landowners and society on a sustainable basis; these activities do not include land conversion to non-forest uses or range management activities.

Skid trail: A corridor used for the dragging or transportation of logs by logging equipment.

Slash: Any residual woody material left on the site after any type of harvest operation and usually includes tree stems, branches and foliage.

Slope distance: A distance measured parallel to or along the ground with no correction for the slope.

Soil and Water Conservation Practices (SWCP): The set of practices used by the U.S. Forest Service which, when applied during implementation of a project, ensures that soil productivity is maintained, soil loss and water quality impacts are minimized, and water-related beneficial uses are protected.

Special use permit: A permit issued by the U.S. Forest Service under established laws and regulations to an individual, organization or some company for occupancy or use of National Forest System lands for some special purpose.

Stand: A contiguous group of trees sufficiently uniform in age class distribution, composition and structure, and growing on a site of sufficiently uniform quality to be a distinguishable unit.

Stream: For purposes of SMZ application, a stream is a natural water course of perceptible extent with definite beds and banks that confine and conducts continuously or intermittently flowing water; definite beds are defined as having a sandy, gravel or rocky bottom surface that is a result of the scouring action of water flow.

Perennial stream: Streams that flow most of the year in all but the driest of climactic cycles.

Intermittent stream: Streams that flow only part of the year when they receive water from springs or runoff.

Ephemeral stream: Streams that are above the water table at all times; these streams carry water only during and immediately after precipitation or during snowmelt runoff.

Streamside management zone (SMZ):

State definition: An area of specialized management to protect water quality by limiting soil disturbance and exposure; an area of land adjacent to a waterbody where soil disturbance is minimal and vegetative disturbance is reduced to provide a buffer for the filtration of water entering the waterbody.

U.S.F.S. definition: As defined by the U.S. Forest Service, an SMZ is a designated zone that consists of the stream and an adjacent area of varying width where management practices that might affect water quality, fish or other aquatic resources are modified. The SMZ is not a zone of exclusion, but a zone of closely managed activity. It is a zone which acts as an effective filter and absorptive zone for sediment; maintains shade; protects aquatic and terrestrial riparian habitats; protects channel and streambanks; and promotes floodplain stability. The SMZ may be wider than the riparian area.

Turbidity: An optical property of water that is a measure of the ability of suspended and colloidal materials to diminish the penetration of light through the water column. Turbidity increases with increased suspended sediment concentrations.

Waterbody: Any stream, creek, river, pond, lake, reservoir or other feature that contains or seasonally contains water.

Wetland:

State & U.S. Army Corps of Engineers definition: Areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and other similar areas.

U.S. Forest Service definition: Wetlands are those areas that are inundated by surface or groundwater with a frequency sufficient to support, and under normal circumstances do or would support a prevalence of vegetation or aquatic life that requires saturated or seasonally saturated soil conditions for growth and reproduction. Wetlands generally include swamps, marshes, bogs and similar areas such as sloughs, potholes, wet meadows, river overflows, mud flats and natural ponds.

FORESTRY, FIRE & STATE LANDS AREA OFFICES

Salt Lake City Headquarters
Forest Stewardship Coordinator
1594 W. North Temple, Suite 3520
Salt Lake City, UT 84114
(801) 538-5555
www.nr.utah.gov

Bear River Area
1780 N. Research Parkway
North Logan, UT 84321
(435) 752-8701

Wasatch Front Area
1594 W. North Temple, Suite 3520
Salt Lake City, UT 84114
(801) 538-5555

Northeast Area
152 E. 100 N.
Vernal, UT 84078
(435) 781-5463

Central Area
115 E. 900 N.
Richfield, UT 84701
(435) 896-5697

Southwest Area
585 N. Main, Suite 3
Cedar City, UT 84720
(435) 586-4408

Southeast Area
1165 S. Hwy 191, Suite 6
Moab, UT 84532
(435) 259-3766

State of Utah
DEPARTMENT OF NATURAL RESOURCES
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