

Best Management Practices

SKI AREA BMPs



SKI AREA BMPs

(BEST MANAGEMENT PRACTICES)

GUIDELINES FOR PLANNING, EROSION CONTROL, AND RECLAMATION

Prepared by the USDA Forest Service
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in cooperation with
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This publication describes Best Management Practices (BMPs) that ski area managers can use in alpine and subalpine landscapes to prevent or decrease environmental damage and degradation of water quality. They are highly effective methods that can be planned in advance and adapted to site conditions as needed. Planning and timing of construction activities will help to limit damage to streams and vegetation, reduce duplication and multiple entries, and conserve the amount of time and money spent. Using BMPs, it is possible to have construction in steep mountainous terrain while protecting water quality and the environment, and stay within the confines of laws and regulations.

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PREFACE

This publication is designed to provide basic instruction, guidelines, and technology to ski area operators, contractors, and administrators. It will also have value to implementors of construction projects such as operators, work crews, and technicians.

For those with interest in ski area management and operations, this publication will assist in the following areas:

- Utilizing Best Management Practices to protect water quality
- Planning ski area improvements
- Designing the efficient reclamation of land and streams to restore disturbed areas to proper functioning conditions
- Permitting

All sections of the publication were created with consideration to adaptability, economics, environment, laws, regulations, and reality.

All of the concepts and practices described herein have been successfully implemented at the Snowbasin Ski Area in Huntsville, Utah on the Wasatch-Cache National Forest. Beginning with the award of the Downhill Race venue to Snowbasin in 1995, a major expansion of facilities and amenities has been taking place at the area in preparation for the 2002 Winter Olympics. From 1997 to 2000, when the bulk of construction work was taking place, the practices have proven very effective in protecting water quality within the Wheeler Creek watershed (a source of drinking water for Ogden, Utah and habitat for the sensitive fish species, Bonneville cutthroat trout).

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CHAPTER 1: WHY PROTECT WATER QUALITY

Ski areas have operated in Utah since the 1940s. Today, area operators must consider water quality and stream environments since excessive runoff and sedimentation can lead to:

- Increased filtering costs for drinking water
- Increased flood potential
- Degraded fish habitat
- Downstream channel damage

Intermittent channels have alternating dry and flowing reaches. Whether wet or dry, intermittent channels have washed gravel bottoms and defined banks.



Ephemeral gullies are most often dry, but can be a source of significant sediment to live streams during infrequent flow periods. Disturbed soils are often carried down hill during heavy rainfall or snow-melt events.



Riparian and wetland areas occur adjacent to streams, lakes, springs and seeps. They contain moist or wet soils, high water tables, and water loving vegetation such as sedges, willows, dogwood, and aspen.



Perennial streams flow continuously. When flowing, ephemeral areas and intermittent reaches can deposit sediment into perennial streams. Erosion must be controlled in all operations in the upper watershed, to prevent downstream impacts to perennial streams and wetlands.

CHAPTER 2: COMMON SKI AREA ACTIVITIES

BUILDING CONSTRUCTION AT SKI AREAS

Because of the danger of flooding and foundation settling, most ski area facilities are located well away from streams and wetland areas. Consequently, buildings will rarely have direct impacts to water quality. Indirectly, the construction process presents many opportunities to use BMPs to reduce the impacts of roads, utility corridors, and staging areas that service the construction site.



Mountain buildings can be tucked into hillsides and away from streams, allowing for vegetation strips to filter sediment and runoff.



Staging areas for construction projects can be a significant source for fuel/oil, cement, and sediment pollution to adjacent streams.



Base area parking lots should have a drainage plan to address run-off and snow removal/snow storage.



Day lodges and lift terminals can be combined to reduce building footprints and ground disturbances in sensitive areas.



Stockpiles from foundation excavations should be contained within sediment trapping barriers.

CONSIDERATIONS

- Locate access roads in previously disturbed areas.
- Use helicopter lifting to transport structural materials and concrete to remote locations.
- Preconstruct utilities (electrical, sewer, and water lines) in the same corridor during the same construction season.
- Locate utility lines under existing roads or previously disturbed areas.
- Reuse foundation excavation as fill for access roads or for coarse ski trail grooming.
- Excavate areas for cement truck washing and fuel storage that are well away from streams and wetlands, and divert surface runoff away from these areas.
- Install straw bale or silt fence barriers between the building site, including the staging area, and nearby streams or wetlands.

PIPELINES AND POWERLINES

To service the remote facilities of a ski area, a carefully designed infrastructure is required to move electricity, communications, and water both up and down the mountain. Top driven ski lifts require high load power and communication lines. Mid-mountain restaurants and snowmaking control buildings will need water and sewer lines as well.

It is usually desirable to bury all these types of utilities at some depth in trenches, and to place power, clean water, and sewer in separate trenches.

Power and communication lines are flexible and can easily be buried within the existing road network on the mountain. Unlike powerlines, water and sewer lines are more rigid and do not locate well along the switchbacks of most mountain roads. These linear utility lines will inevitably have to cross streams and wetlands on their journey from base area to mountain top.

Snowmaking supply lines must follow ski runs, and consequently follow the same fall line path as surface streams, runoff, and groundwater flowing off the mountain. In simple terms, a snowmaking trench is really a very efficient stream channel.

Once surface or ground water gets into this channel, it can run for great distances and create much damage to both the pipeline and the environment. Careful planning and implementation of BMPs can prevent this from happening.



Direct burial of electrical lines reduces the width of utility corridor disturbance when compared to trackhoe excavated trenching.



Pipeline trenches, can quickly turn into stream channels if not protected from rainstorm runoff.



Topsoil is a scarce resource in many mountain environments. Trench excavation should salvage topsoil where present to use in restoration work.



To reduce corridor width and disturbance, long sections of pipe can be connected at a central staging area and lined downhill.

WATER WELLS AND DIVERSIONS

A ski area must be able to make snow for those times when nature does not provide enough. The need can be particularly acute for early season openings before the Christmas/New Year holidays. Also, the trend for ski areas to expand services to four seasons has generated new water demands for residential housing, fire protection, and irrigation of lawns and golf courses. Because streams and lakes are generally drawn down to their lowest flow levels in late summer and early winter, finding a dependable source of water for these uses can be problematic. Removing water to irrigate golf courses and lawns, or to make snow, from a stream already at base flows can imperil fish populations and stream side vegetation. Beyond these considerations, the drought conditions associated with the need to make snow or irrigate often have reduced stream flows to where there simply is not sufficient water for these uses, even if the streams were totally diverted and dewatered.

Deep aquifer production wells offer several advantages as sources of water for ski areas. Flows are dependable even in times of drought. Groundwater is a constant cool temperature and may work better than surface streams for producing consistent quality artificial snow. The water quality is often high and can be used with little treatment to provide culinary water.

Several aspects of water well development can impact stream and water quality. Waste rock and fluids produced during drilling operations can affect water quality if the site is located near active springs, seeps, and wetlands. Production testing of well output can generate millions of gallons of clouded silty water that must be treated in some fashion prior to discharge into surface waters. Finally, deep aquifer wells may siphon off water from shallow aquifers they pass through, inadvertently dewatering valuable springs and wetlands.



Backslope and drain well pads away from nearby streams and wetlands.



Protect nearby streams and riparian areas with proper sediment and pollution control practices.



Water from well production tests should be filtered of sediments prior to discharge into wetlands.



Innovative manifolds and hose lays are effective methods for dispersing high volumes of water from well production tests.



Accidental spillage of drilling fluids should be well contained and filtered before entering streams.

CONSIDERATIONS

- Waste drilling mud and fluid from drilling cannot be discharged into surface waters.
- Detain these fluids in settling basins until they can be recycled back into the operation or disposed of off site. Discharge well production test water into upland areas for filter treatment by vegetation and soil.
- Hose lay networks connected to temporary storage tanks through distribution manifolds are effective systems for land treatment of production water.
- Seal well shafts with casing or grouting where they pass through shallow, non-target aquifers.
- Divert stormwater run-on around the drilling site.

STORAGE TANKS AND RESERVOIRS

To operate waterline fixtures such as faucets and snowmaking guns, water must be supplied under pressure. A convenient, economical way to do this is with storage tanks in mid-mountain locations.

Storage tanks are much preferable to reservoirs, which can pose inherent dangers to life, property, and watershed values associated with potential failure of the man-made impoundment dam. Often, placement of a reservoir in mountainous environment will flood valuable wetlands and streams.



Staging areas and access roads can be built from storage tank excavation material.



Once constructed the tank can be covered and revegetated to pre-project conditions.



Storage tanks can generate large amounts of excess excavated material that must be wasted in some location or hauled off of the mountain.

CONSIDERATIONS

- Surplus excavated material can be reused as fill in coarse ski trail grooming.
- Plumb all storage tanks to an emergency fire fighting delivery system.
- Bury tanks on hillsides to reduce visual impacts.
- Avoid placing tanks or locating reservoirs in riparian or wetland areas.
- Daylight tank drains and overflow pipes into flat, well vegetated areas. Provide an energy dissipating rock pad at the outlet of the drain pipe. Do not discharge tank drains or overflow pipes on steep hillsides or directly into streams.



Storage tanks must be cleaned of contaminants before use. This can generate waste water that should be treated prior to discharge.



Towers and cable gantries can be lifted and placed in remote locations with large helicopter sky cranes.

LIFT CONSTRUCTION

Ski lift terminals and towers require concrete for foundations and lifting capability for assembly of large heavy components. Water quality and streams are more likely to be affected by roads needed for equipment access than by the construction work itself. Bottom chairlift terminals, however, are commonly located on flat terraces adjacent to streams or wetlands where sediment from the site could easily affect water quality.



Tower foundations in steep or remote terrain may require excavation by hand crews.



Excavations for ski lift terminal building foundations can yield large amounts of material that can be salvaged as fill for other activities.

CONSIDERATIONS

- Use helicopter lifting for delivery and assembly of remote tower and terminal components, particularly foundations forms, steel, and concrete.
- Use hand crews to excavate tower foundations not easily accessible by equipment.
- Eliminate the need for permanent top terminal service roads by installing bottom drive systems.
- Locate equipment and vehicle storage along with ski patrol facilities into top terminal chairlift buildings.
- Install strawbale or sediment barriers around disturbed areas, particularly between foundation excavations and stockpiles, and nearby streams and wetlands.



Ski lift terminal sites must be accessible by cranes and other large equipment.



Screened trackhoe buckets work well to separate out and salvage valuable topsoils.



Waterbar installation by trackhoe excavator.

CONSIDERATIONS

- When coarse grooming depression areas, fill with subsoil from nearby excavations.
- Do not waste valuable topsoil in deep fill areas, salvage and reapply to slopes to promote better revegetation.
- When working in rocky areas, use a screened trackhoe bucket to help salvage and separate topsoil from rocks.
- Avoid multiple disturbances/entries by scheduling ski run construction and improvement to precede the location of utility pipelines.
- Install sediment fence barriers and cross slope water bars to minimize soil erosion and water quality degradation during construction.
- Plan for the patrol and maintenance of control measures early and often during the first snowmelt period following construction.

SKI TRAIL IMPROVEMENT AND CONSTRUCTION

The best trails are those that allow skiers to consistently be in the same fall line path that rainfall and snowmelt follow down the mountain. Consequently, when improvement or construction activities disturb vegetation and soil, they create a large source of sediment that can be readily delivered into streams and wetlands. Upon completion of work, ski runs usually present a steep, smooth, highly erodible soil surface, devoid of ground protecting vegetation.

Because ski runs are most vulnerable to erosion during the periods of construction and revegetation, water quality is best protected by BMPs which cover bare soil and slow or divert runoff from the slope. Implementation of these BMPs in a timely fashion immediately after construction and prior to heavy rain or spring snowmelt is essential to their effectiveness in protecting soil and water quality.



Vegetation clearing by trackhoe excavator leaving root mass and coarse debris ground cover.



Swales and slope break compressions can be smoothed out by filling with subsoil excavated from building and lift terminal foundations.

CHAPTER 3: PLAN AND DESIGN OF CONSTRUCTION

ROAD DESIGN AND CONSTRUCTION

Every ski area operation needs an infrastructure of permanent access roads. The road system can be the largest single contributor of sediment to area streams and wetlands. Construction projects will also need access roads; the challenge is to identify how much of this roading truly needs to be permanently added to the system, and how much can be used temporarily and then reclaimed. For permanent additions to the ski area road network, it is critical to plan for location, standards of construction, and maintenance that will avoid short and long term sedimentation problems. Temporary work roads and trails should be located and designed with an eye towards minimizing the scale of reclamation efforts needed to restore to pre existing conditions. A narrower, steeper trail can often satisfy temporary access needs as well as a higher standard road, but will disturb far less ground and be easier and less costly to reclaim.



Full bench cut and end haul construction of a narrow low standard access trail.



Oversized culverts on steep gradient channels allow passage of large channel substrate rocks.



Snow cat access trails can be constructed to narrower widths and then widened with snow.



Reduce road corridor widths by building vertical cut slopes and stabilizing with rock retaining walls.

CONSIDERATIONS

- Although slower than regular truck tractors, crawler tractors can pull heavier loads, including cement mixers, supply trailers and assembly cranes, up steeper graded temporary trails.
- Temporary road construction can be reduced by using helicopter lifting for movement and materials at remote sites.
- Salvage topsoil and stockpile conveniently for reuse in reclamation.
- Restore temporary road prisms to the original ground slope and geometry by pulling fill slopes back against cut slopes.
- Overly steep slopes are extremely difficult to revegetate, particularly in high elevation environments. To enhance revegetation, avoid constructing road cut / fill slopes at steeper gradients than 2:1.
- Reuse stumps and slash from road clearing as temporary sediment filter windrow barriers at the base of road fill slopes and wherever a road approaches streams or wetlands.

ENCOUNTERS WITH STREAMS AND WETLANDS

Although avoidance of surface water features is stressed throughout this report as an important BMP, the reality is that most ski area facilities will eventually meet up with a stream or wetland somewhere on the mountain. Both streams and ski area improvements are curvilinear landscape features that inevitably must intersect at some point on their journey from mountain top to base area. Good planning, location, construction and maintenance can assure these encounters are both benign and of little long term consequence.

Construction work that may place fill or sediment, or otherwise alter a stream or wetland, requires State of Utah review and coverage under a Section 404 alteration permit. This can be a time consuming process. Inclusion of BMPs that minimize damage and control sediment will speed up permit issuance and help avoid project delays.



Use detention basins to capture sediment before it can reach wetlands and riparian areas.



Temporary bridging methods allow for heavy equipment to cross streams with minimal disturbance to channels.

CONSIDERATIONS

- Roads represent the largest source of sediment to streams and wetlands. Runoff from any road surface should always drain through some kind of temporary or permanent sediment filter such as a vegetated buffer strip, slash windrow, silt fence, or detention basin.
- Road crossing culverts should be oversized to allow for passage of flood flows and large bed load rocks that are often associated with steep and incised mountain stream channels.
- Maintain all roads and trails so that runoff water drains readily, rapidly, and frequently off the surface.
- Temporary stream channel and bank disturbances must be restored to the original, preexisting condition, including bed gradient and rock size, channel profile and geometry, and bank vegetation cover.
- Use portable bridges or flatcar spans to minimize channel disturbance and reclamation costs associated with temporary stream crossings.



Runoff from roads should be slowed and filtered through rock aprons prior to discharge into wetlands.



Road cut slopes can intercept and expose subsurface water.



Water source wells are often developed in close proximity to wetlands and springs.

AVOIDING MULTIPLE ENTRIES

The most effective way of protecting water and soil quality is to limit the time bare soils are exposed to runoff from rainfall or snowmelt. The best way to accomplish this is to start and finish projects during one summer construction season, and reclaiming the area permanently before winter snows cover the ground.

Erosion control and reclamation work is time consuming and expensive. Seed, fertilizer, and mulching can cost hundreds of dollars per acre in materials and labor costs. Disturbing a freshly reclaimed area with more construction is not only wasteful, but can severely damage soil productivity and limit long term prospects for successful revegetation.

While careful project planning and scheduling is essential to completing projects during the short construction seasons common in the mountains, even the best plans can be derailed by unpredictable summer rains and early snowfalls. Rocky soils and steep terrain can cause breakdowns of specialized construction equipment, meaning further delays. Ski areas must have contingency plans for temporary erosion control for any large project where completion could be delayed until the next construction season.



Restrict vehicle access to reclaimed areas so that multiple trails do not form.



Disturbances from multiple entrances into newly reclaimed areas should be kept as small and narrow as possible.



Multiple entries can damage fragile vegetation regrowth.

CONSIDERATIONS

- Complete all improvements on one part of the mountain, preferably in one construction season, before moving on to other parts of the ski area.
- Complete ski run construction and terrain modification projects prior to placing utility and snowmaking lines in them.
- Construct co-locatable utilities in the same trench at the same time.
- Place all utility lines in a single corridor wherever possible.
- Locate utility corridors in previously disturbed areas, and preferably along roadways.
- Delay entering previously disturbed areas with new construction until vegetation has completely recovered.

CHAPTER 4: PROTECTING WATER QUALITY

CROSS SLOPE WATERBARS

Bare soil is extremely vulnerable to runoff and erosion. Erosion can be prevented by either slowing the velocity of overland flow or by diverting it off of bare soil and into more stable vegetated areas.

Cross slope waterbars are the simplest, cheapest, and most reliable method for managing runoff from bare soil areas. They should always be the first choice for the control of hill slope runoff and erosion.

Spacing of waterbars is very sensitive to slope gradient and soil type. They must be placed close enough to each other that runoff is captured and diverted before it builds up speed and energy. Spacing usually ranges from 200 feet on flatter mountain roads to less than 50 feet on the steepest ski slopes.



Road water bars must have free drainage off the road surface. Special care should be taken to keep water bar outlets free of berms and graded material.



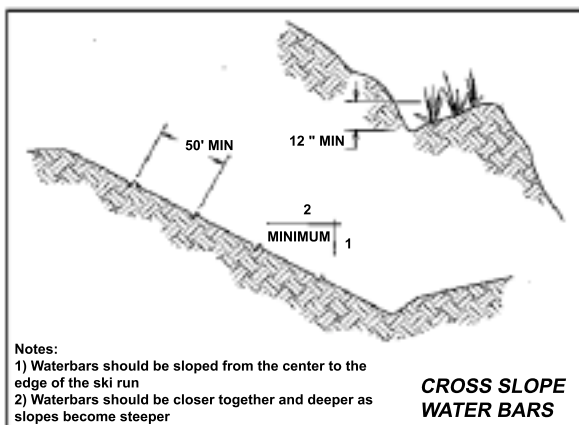
Waterbars should have a slight curve to prevent breaching in low spots. The berm should be firmly



Water bars used to divert water off road surfaces must be shallow and wide to allow vehicle passage.



A trackhoe excavator can quickly construct a very effective waterbar drainage network on steep ski runs.



CONSIDERATIONS

- Properly draining waterbars will be self cleaning of sediment.
- Begin waterbars at a 3 to 5 percent gradient and increase to a finished gradient of 5 to 7 percent.
- On steeper slopes, frequent small waterbars work better than a few large ones.
- Waterbars must be inspected and repaired during spring snowmelt, and then cleaned of sediment following large rainstorms.
- Carry the waterbar well off bare soil slopes into adjacent vegetation.
- To prevent low spots, waterbars should be built with a slight curve.

TEMPORARY STREAM CROSSINGS

Whenever construction work encounters a stream, a safe crossing structure must be designed and permitted on a State of Utah General Permit 400 for the alteration of channels or wetlands.

The two most common situations are where a trail or road must cross a stream to access a work site, or where a stream channel is cut by a pipeline or utility trench. The objective in both cases is to protect water quality by either keeping the stream out of the trench or by limiting bank disturbance and road runoff delivery to the stream.



Steel "I" beams can provide effective and low cost access for heavy equipment across streams with minimal channel damage.



Wherever a trench cuts through a channel, a temporary crossing must be installed to keep the stream out of the trench.



Logs can be used instead of culverts and fill to provide a temporary stream crossing for heavy equipment access across intermittent and ephemeral channels.



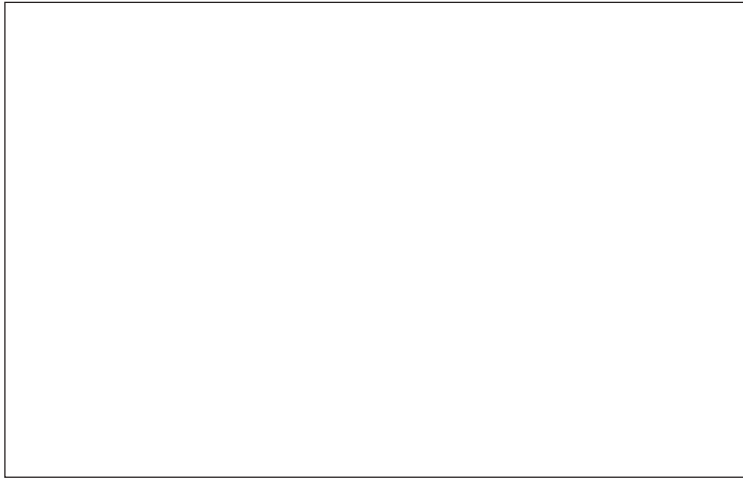
Temporary stream crossing culverts may need to be in place for several weeks until work can be completed and trenches backfilled.



Several culvert sections can be joined where longer temporary stream crossings are required. Be sure to use plastic sheet lining to keep water leaks out of the trench.

STRAW BALE DIKES AND CHECK DAMS

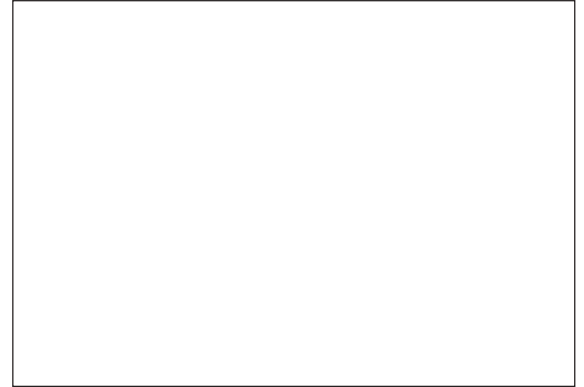
Straw bales are used in dikes and check dams to create very small basins where surface runoff can be slowed long enough to settle and trap sediments. They are typically used in low gradient ditches or channels. They are also effective when used with sediment fencing to filter and trap sediment generated by high velocity flows from steeper side slopes.



Straw bales should be set into the ground and firmly staked to prevent check dam failure.



Use multiple check dam barriers for better sediment filtration.



Double staking helps to keep straw bales in place. Backing up a check dam with silt fencing provides excellent water quality protection.



Gravel or straw check dams should be used in road ditches as a temporary sediment control until vegetation has been established.



Properly functioning straw bale dikes can quickly fill up with sediment and must be cleaned out after rainstorms.

CONSIDERATIONS

- Straw bales will float and can be knocked loose by flowing waters.
- Each bale must be firmly staked in place by driving two stakes or rebar through the bale and 18 inches into the ground.
- The ends of each check dam should be higher so that water spills over the center of the dike and not around the ends.
- Prevent leaks in the dike by embedding the bales a minimum of four inches into the ground, and by tightly abutting the ends of adjacent bales.

SEDIMENT FENCING

Sediment fencing is used to filter sand and silt from low velocity overland flows. Fine sediments should pass through the fabric. Because fabric fences have very little structural strength, water should not pond more than halfway up the fence to prevent failures. Strength may be increased by backing the fabric with straw bales or cyclone fencing.

As with all sediment filter structures, fabric fences need to be checked during snowmelt and repaired if needed. Sediment should be removed from behind the fence before it exceeds one-third the above ground exposed height of the fabric.



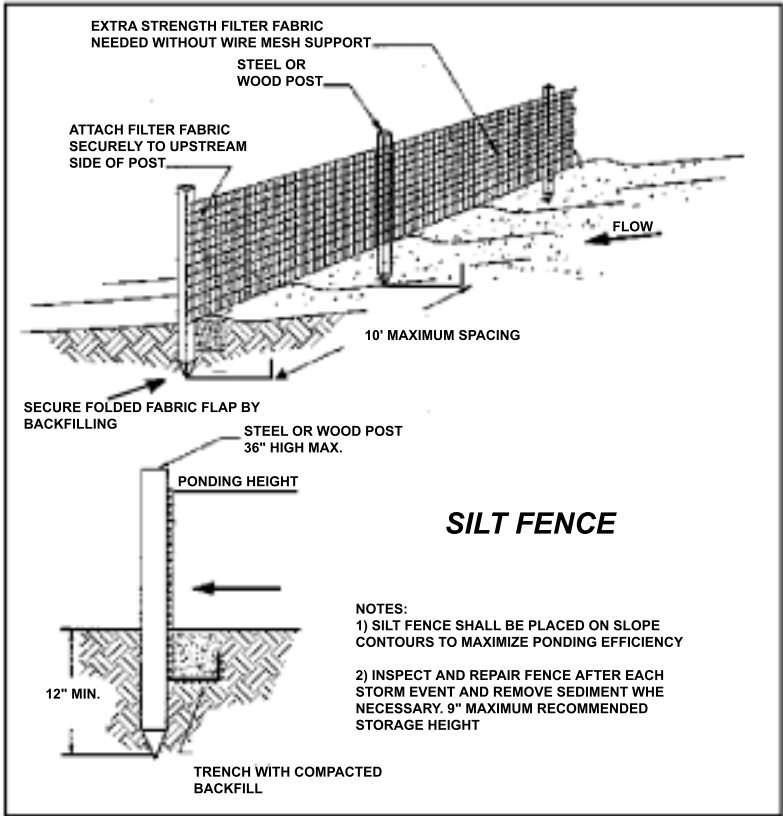
Sediment fencing can be used to define subtle drainage areas and protect them from sediment as well as unauthorized vehicle traffic.



An excavator is useful in silt fence installation. Fencing should be placed in pre-dug trenches, and backfilled to prevent breaching under the fence bottom.



Silt fencing is usually placed on the level and parallel to the contour. Where a fence is sloping, relief outlets must be supplied at regular intervals.



Deep snow will strip a silt fence from its support stakes. Securing the fabric to the stake with cable ties or wire prevents this.



Fencing can be lengthened by wrapping section ends together and then securing tightly with wire.

VEGETATION BUFFERS

In general, most BMPs do a great job of trapping sand and silt sized particles, but are mostly ineffective with finer sediments. The most effective method of treating these fine sediments is by dispersing runoff through a thick screen of live natural vegetation.

In practice, this involves leaving a sufficient buffer of vegetation between live water and construction areas. Effluent from waterbars, silt fences, and detention basins should always be passed through a wide buffer strip of vegetation for final treatment before discharge into surface waters.



Cleared vegetation can also be used as a filter by placing and compacting into a windrow.



A stream side riparian zone may also be used to filter out finer sediments which can pass right through sediment fencing.

CONSIDERATIONS

- Cleared vegetation can be placed in a windrow within the filter strip to enhance effectiveness.
- Buffer strips are ideal for the treatment of water contaminated with fine mud and clay, such as that discharged during well production testing.
- Water discharged into buffer strips should be kept dispersed to maximize filtering and infiltration.
- Water should not be allowed to channelize.



Vegetation buffer strips should vary in width based upon side-slope gradient. Where only a narrow strip is present, it should be supplemented with other sediment control practices such as silt fences or straw bale dikes.



Wetlands should be protected from sediment sources with buffer strips of live upland vegetation.



Where space is limited, less effective practices such as berms, silt fences, and slash barriers can be used together to replace a vegetation buffer strip.

DETENTION BASINS

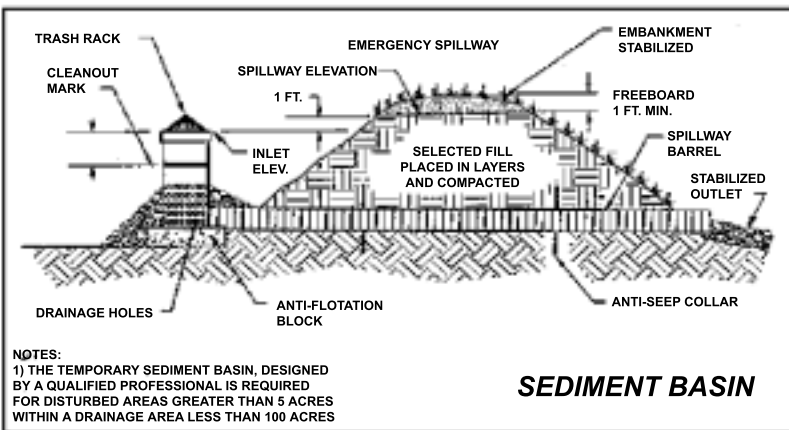
Although all BMPs will capture and filter larger sized sediments from runoff, finer sediments can only be caught in a detention pond of still water. In general, the larger the basin, the finer the sediment is that can be filtered out, and better protection will be provided from the larger rainstorm events. Regardless of size, all basins are usually permanent impoundment features with stabilized inlets, outlets, and emergency spillways.



Runoff from large cut or fill slopes should be routed through sediment trap basins.



Detention basin inlet channels should be protected from high flows and head cutting with rock riprap and flow control gates.



CONSIDERATIONS

- Detention basins are best located below permanent sediment sources such as parking lots and roads.
- Baffles can be placed on the pond bottom to slow inlet velocities and promote still water conditions.
- Basins should be cleaned of sediment following major rainstorms.
- Detention basins and sediment traps should be located off channel and not within a live stream.



Staging areas and parking lots can generate large amounts of runoff and sediment, and consequently need larger detention ponds.



Natural basins in the landscape can be combined with straw bales and silt fence to create temporary detention ponds.



Discharge water from detention basins can be routed through straw bales and silt fence for more complete sediment removal.



Sediment pond outlet ditches should be armored with rock to prevent scouring. Step pools in the outlet ditches allow even more sediment to settle out.

CHAPTER 5: RECLAIMING THE LAND

RESTORING THE LAND

Reclaiming land following construction disturbances will focus on restoring the ability of soil to absorb water from rainstorms and snowmelt without generating undue overland flow or sediment. A good measure of reclamation success is often how quickly vegetation cover can be reestablished to disturbed areas.

Successful revegetation begins with the restoration of a seedbed of thick fertile topsoil. Management of the topsoil resource throughout the construction process is critical. If soil is not salvaged and conserved at the beginning of a project, there will be none left to reapply at the end, and revegetation efforts will be doomed to disappointment or failure.



Reapplied topsoil should be dark in color and a minimum of six to eight inches deep to meet requirements of native plants.

Ideally, when a construction project is begun, all topsoil would be stripped from the area and reserved for later reapplication. From a practical standpoint, salvage of topsoil from a construction area can be very difficult, particularly when steep slopes and rocky soils are involved. Most native plants will be able to re-establish in a topsoil layer that ranges from at least six to eight inches in thickness.

Oftentimes topsoil is naturally very thin at the mountain summits and on the steep upper elevation slopes of ski areas. It may not be appropriate or desirable to import topsoil from “off the mountain” in order to create seedbed soil layers that are thicker than what is natural. Restoring productivity to these types of land is dependent upon limiting topsoil losses to either two inches, or half the thickness of the original topsoil layer, whichever is less.



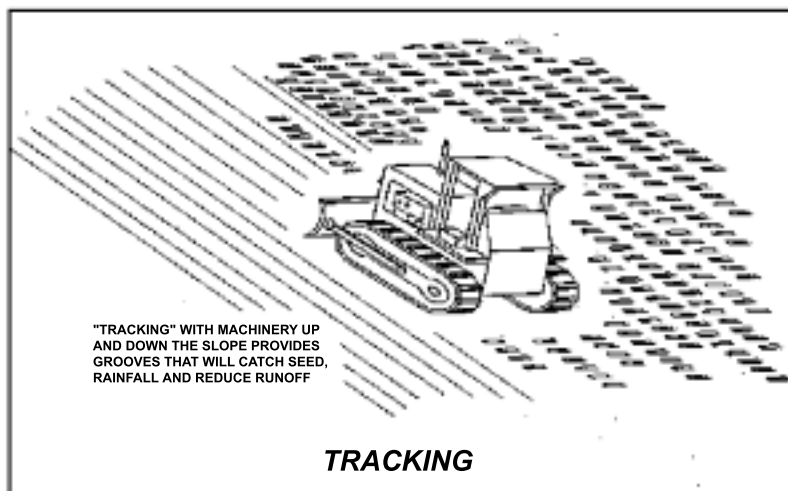
The most important disturbed land reclamation task is to restore a thick layer of fertile topsoil.



In trench excavation, subsoil should be placed above topsoil windrows to protect them from erosion and compaction.



The final reclaimed surface can be roughened with bull dozer tracks to provide micro-sites for moisture conservation and seedling establishment.



For ease of reapplication, topsoil can be stockpiled in windrows at the top of steep slopes.

CONSIDERATIONS

- On steep slopes, stockpile salvaged topsoils at the top of the cut/fill slopes for ease of reapplication.
- Reapplied topsoil layers are extremely vulnerable to wind and water erosion. Protect with BMPs such as caterpillar track surface roughening, cross slope waterbars, and surface mulch blankets.
- Trench excavations should stockpile topsoil and subsoil in separate wind rows. Avoid traversing topsoil with construction equipment.



If stored over the winter, topsoil stockpiles should be terraced and seeded to reduce erosion losses and should then be surrounded with sediment control measures such as berms, silt fencing, or straw bale dikes.

REVEGETATION

Construction work often damages vegetation to the point where it cannot grow back without help. To prevent damaging erosion, vegetation must be re-established as quickly as possible.

Once a proper seedbed of thick fertile topsoil has been prepared, the site is ready to be reseeded. Native grass and forb species are good choices because they are usually adapted to the climate and elevation of the site, and they do not prevent the eventual reestablishment of species that inhabited the site before construction.

Seed should be applied in late autumn to take advantage of snowmelt and rainfall the following spring. If soil tests indicate fertilizer is needed, it can be applied at the same time as the seed.

Seed should be completely covered with soil for successful germination and establishment. Tracking and scarification can help

accomplish this, but in practice at least half of broadcast applied seed will never germinate. To be confident of establishing successful vegetation at 40 plants per square foot, seeds should be applied at the rate of at least 100 per square foot. To reduce the risk of having to reseed harsh sites at a later date, initial seeding rates can be safely pushed to 200 per square foot.



Seed and fertilizer can be mixed together and applied at the same time.



For gentle or moderate slopes, seeding equipment can be mounted on all terrain equipment to cover large and inaccessible areas.



Large and accessible areas can be quickly covered with hydraulic seeding equipment.



Steep and inaccessible areas can usually be covered only with hand seeders.



For improved seed germination, a snow cat can be used to track in and cover the seed with a thin layer of soil.

CONSIDERATIONS

- Incorporate species native to the area into seed mixes. Harvest seed from the area to reduce costs.
- Seed germination is enhanced dramatically by following seeding with some sort of rolling or tracking in treatment.
- Monitor seedling establishment to fine tune seed mixes and determine if supplemental seeding is needed.
- Enhance seedling establishment and growth with supplemental fertilizer application during the spring following initial seeding.
- Phosphorous fertilizer can be especially helpful in promoting deep root systems that help plants survive hot summer conditions.
- Cover freshly seeded areas with a mulch product to create a cool, moist environment for fragile seedling survival.

STRAW MULCH COVERS

Mulch covers serve a dual purpose in the reclamation process. Primarily, they provide protection of bare soil from raindrops and then slow down surface runoff to prevent erosion. While the mulch is preventing erosion, it is also conserving moisture for germinating seedlings and protecting them with shade from summer heat and drought.

In general, flat or gentle slopes with very thick topsoil should revegetate quickly with little concern for erosion. This is particularly true if soil disturbance was light and the root systems are undamaged, and the area is removed from live water sources. Steeper slopes, or those with poor topsoil and heavier damage to vegetation, will require some sort of protective mulch cover.

The type of mulch used depends largely on how long it will be expected to perform its job. Loose straw mulch covers function only through

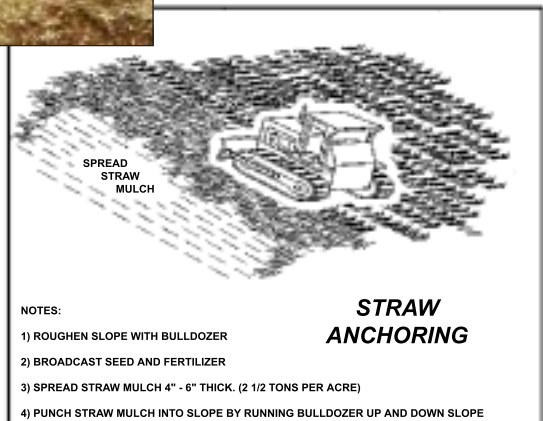
the first snowmelt and growing season. They are not durable and are easily damaged by relatively light winds. More durable erosion blankets, if installed correctly, will survive even high winds and can be expected to function for two or more seasons.



Road cut and fill slopes can be quickly covered with mechanical mulching equipment.



Straw mulch application by hand crews on larger ski slopes is a time consuming task.



To prevent wind damage, straw mulch can be crimped or tracked into the ground with bull dozer tracks or snow cat cleats.



When properly tracked in, straw will be punched into the soil and appear to stand upright.



Straw mulch should be applied at a loose thickness of four to six inches.

Considerations

- Although straw is the cheapest mulch to buy, spreading and fixing against wind damage can be costly and time consuming.
- Blanket mulches save time and money by installing quicker and lasting longer.
- Any mulch type, if installed properly and in good contact with the soil, will enhance revegetation.

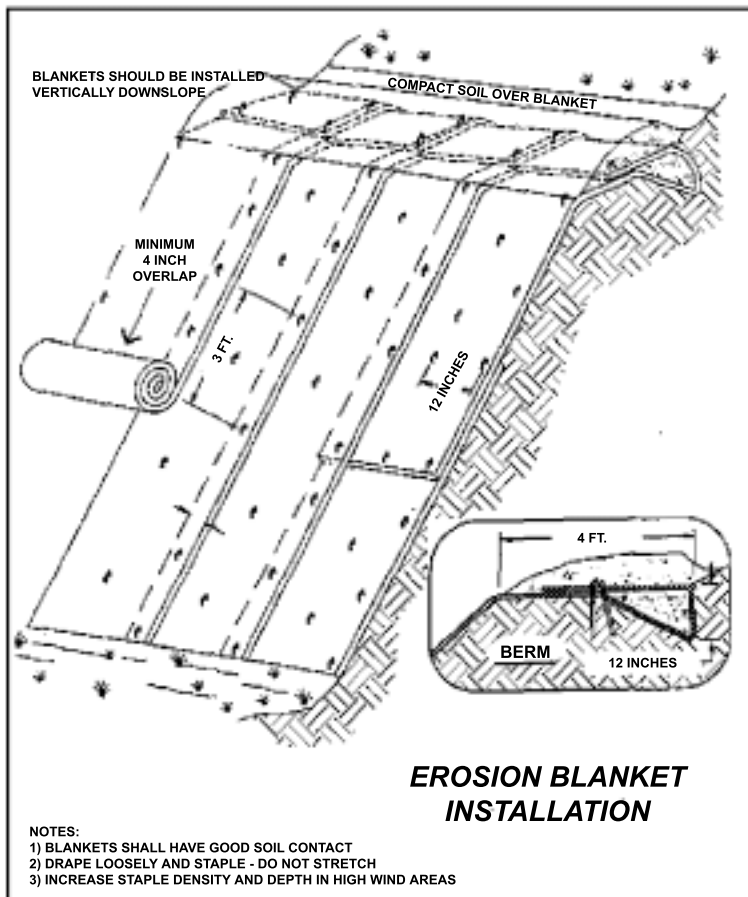


Straw mulches cannot be tracked into rocky or dry soils, and must be secured with either netting or chemical tackifiers.

EROSION CONTROL BLANKETS



Successful revegetation on harsh sites, such as over-steep and erosive slopes, requires a durable mulch blanket cover.



Blankets can be combined with silt fencing to provide added protection next to streams and wetlands.

To work properly and resist wind damage, blankets must be stapled firmly and in close contact with the underlying soil surface.



Although more expensive to purchase than straw, mulch blankets install much faster and are more durable.



Mulch blankets are commonly made from wood or straw fibers and stitched to an open weave net. Either type of blanket is very light and easy to handle and transport across rough terrain.



Blankets must be properly stapled in place to resist lifting and tearing by strong winds.

STREAM RECLAMATION

It can be difficult to completely avoid stream channels and riparian corridors when constructing fall line projects such as ski runs, lifts, and snowmaking lines. Too often, streams are moved to the edge of ski runs and away from sensitive improvements like buried power, communication, and water lines. The streams are straightened, channelized, and armored to prevent them from flooding or meandering. Channelizing destroys many important stream functions, including the ability to support riparian bank stabilizing riparian vegetation. Stream flow character can change from perennial to intermittent as the new channel dries out during summer months. The resulting channel often resembles more of a ditch than a living, functioning stream.

Stream reclamation is an expensive, complicated, and time-consuming operation. None the less, streams and their riparian zones are valuable areas for wildlife habitat. They need to be restored to their original location and condition wherever possible. Such reclamation is usually a requirement of the alteration permits secured for construction projects near streams.



Some facilities, like this snowmaking line drain vault, must be located in a low area. In this case, it makes sense to reclaim the stream by relocating and protecting it from long-term impacts.



The channelized stream on the left can be relocated to extend channel length, increase meandering, and create wetlands and floodplains.



Level sections of streams that dry out in the summer attract temporary staging and construction activities. These areas should be reclaimed by restoring the stream to its original location and condition.



Stream reclamation will require careful survey and design prior to any restoration or relocation work.



This stream has been moved away from new impacts and into the original channel that existed before the chairlift and ski run were constructed.



Stream channels can be reclaimed when unnecessary culverts are removed. Stream banks should be laid back to original form and raw soil protected from erosion.



Small trackhoes and bulldozers provide a lighter touch and are better suited to the fine detail work needed in stream reclamation.



Armored channels can be revegetated with burlap bag "soil pillows" and with willow soil-root plugs.

CONSIDERATIONS

- Move or permanently relocate a stream only when needed to prevent further disturbance to it, or to protect it from persistent sediment sources.
- Survey stream properties and characteristics prior to construction to facilitate proper restoration to original conditions.
- Reconstruct channels to a width, depth, and course that roughly resembles the original condition. Let the stream itself finish the job of restoring the meanders, pools, and riffles that existed before disturbance.
- Enhance stream recovery by using small rocks and soil in reconstructed banks that can easily be moved and rearranged by stream flood flows.
 - Only use large rock armoring when absolutely necessary to prevent abnormal bank and channel bottom scouring or erosion.
 - Use revegetation and sediment control Best Management Practices to protect water quality immediately after reconstruction work.

CHAPTER 6: Permits

404 Permit

This permit applies to projects that would place fill in, or remove material from, waters of the United States (including wetlands).

Examples of qualifying activities include:

1. Placement of subsurface utility lines (water, sewer, communication, or electrical) through jurisdictional wetlands.
2. Smoothing out ski run terrain by placement of fill into wet areas.
3. Excavation of a wet area to install a buried storage tank.
4. Siting of a lift terminal or tower in a wetland.

As part of the permitting process, the applicant should provide drawings that show the location and character of the proposed activity, as well as an accurate wetlands delineation map in accordance with current approved methods. Applications must consider, in order, (1) avoidance, (2) minimization, and (3) mitigation before permit approval will be considered.

Sections 404 and 10 Joint Permit

This permit applies to projects that disturb streams, either by filling or removing materials from the channel or otherwise altering channel shape or condition.

Examples of qualifying activities include:

1. Mountain roads or pipelines crossing a stream channel.
2. Protecting improvements from flooding by installing riprap or levee material on stream banks.
3. Parking lot construction or paving within the upper bank of a stream.
4. Removal of stream side vegetation in ski run clearing.

As part of the permitting process, the applicant should provide, along with a location map, diagrams that show plan and cross-sectional views of the proposed activity.

NPDES Storm Water Permit for Discharge from Construction Activity

Currently, this permit applies to projects that disturb vegetation and uncover bare ground over an area 5 acres in size or larger. In 2003, revised NPDES regulations include all construction that disturbs at least one acre.

Examples of qualifying activities include:

1. Ski run construction that involves coarse grooming (cutting and filling) of terrain features and/or vegetation.
2. Snow making system pipe trenching and installation.
3. Construction of base area parking facilities.

As part of the permitting process, the construction operator should submit a Notice of Intent (NOI) to obtain coverage under the Utah Pollution Discharge Elimination System (UPDES) general permit. To qualify for coverage, the operator must have prepared a Storm Water Pollution Prevention Plan (SWPPP). This plan will disclose temporary and permanent erosion and runoff control practices, and will address maintenance and inspection of the practices to insure effectiveness and compliance with the general permit.

Water Rights and Source Water Protection Plans

If water is used in operations, the Utah Water Rights law must be complied with by obtaining a valid water right.

Examples of qualifying activities include:

1. Diversion of water from a stream for use in snow-making.
2. Storage of stream flows in ponds or reservoirs.
3. Development of groundwater wells for potable, snowmaking, and irrigation sources.

If water is developed for use as a public water supply, a Source Water Protection Plan must be developed that describes potential contaminant sources and prevention measures.

STATE OF UTAH PERMITS

404 permits are administered by the United States Army Corps of Engineers (USACE) with local offices in Woods Cross, Utah, (801) 295-8380.

Joint Section 404 and 10 permits are administered by the State of Utah Division of Water Rights in Salt Lake City, (801) 538-7240.

NOI submissions and SWPPP reviews are administered by the Division of Water Quality – Department of Water Quality in Salt Lake City, Utah, (801) 538-6146.

Applications for water rights are made with the State of Utah Engineers Office – Division of Water Rights in Salt Lake City, Utah, (801) 538-7240.

FOR ADDITIONAL INFORMATION:

This report has presented some general techniques and concepts for controlling erosion, runoff, and sediment from construction activities that commonly occur at alpine ski areas and resorts. The report is not intended as a comprehensive manual of all possible ways to stabilize soil and protect water quality. Rather, the material presented is illustrative of techniques found effective in the development of the winter Olympics venue at Snowbasin Ski Area in northern Utah. Readers interested in more exhaustive treatments of this subject matter can consult the primary references used in the preparation of this report:

1. State of Utah. 1995. Non-point Source Management Plan for Hydrologic Modifications, and addendum to the Utah Non-point Source Management Plan. Utah Division of Water Quality, Salt Lake City, Utah.
2. State of Utah. 1998. Non—point Source Management Plan for Silvicultural Activities. Silvicultural Addendum Subcommittee of the NPS Taskforce. Utah Division of Water Quality, Salt Lake City, Utah.
3. Salt Lake County. 1981. Salt Lake County Water Quality and Pollution Control, Erosion Control Handbook. Salt Lake County Department of Environmental Health, Salt Lake City, Utah.
4. USDA-Forest Service. 1988. R1/R4 Soil and Water Conservation Practices Handbook. FSM 2509.22. Intermountain Region Office, Ogden, Utah.
5. USDA-Forest Service. 1992. Winter Sports Guidebook. Prepared by Rocky Mountain Region with assistance from Regions Four, Five, and Six. Wasatch-Cache National Forest, Salt Lake City, Utah.
6. Utah Department of Transportation. 1999. Temporary Erosion and Sediment Control Manual. UDOT-Region 2, West Salt Lake City, Utah.

These documents are available from the agencies listed in the individual citations. Electronic copies of documents (1) and (2) and other water quality protection related documents are available on the World Wide Web at:

http://www.eq.state.ut.us/eqwq/doc_rule.html

Electronic copies of document (4) are available on the World Wide Web at:

<http://www.fs.fed.us/im/directives/html/fsh2000.html>

Electronic copies of document (6) are available on the World Wide Web at:

<http://www.dot.state.ut.us/esd.html>

In addition to these references, the following websites contain relevant information on the subject, as well as additional links to conduct more extensive searches.

1. The Salt Lake County Engineering Division has a website that provides a tabular guide for selection of specific Best Management Practices based upon site conditions. Practice listings in the guide are actually links to narrative descriptions and illustrations of the practice. The guidance manual can be viewed at:
www.co.slc.ut.us/pw/engin/bmp/pdf/swppp.pdf
2. The Stormwater Manager Resource Center is a subdivision of the Center for Watershed Protection. Its website allows for viewing and downloading of reports from the Centers technical journal, *Watershed Protection Practices*. These can be found at:
www.stormwatercenter.net/Library/Practice_Articles.htm
3. The Environmental Protection Agency has researched many recent publications related to Best Management Practices and the control of pollution from non-point sources. A compilation of abstracts for the best of these publications can be found at:
www.epa.gov/owow/nps/bestnpsdocs.html

